AN INTEGRATED APPROACH FOR COMMUNITY HAZARD, IMPACT, RISK AND VULNERABILITY ANALYSIS: HIRV

by

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Abstract

The Great Hyogo-Ken Nanbu earthquake, Hurricane Andrew, the Lockerbie air crash, and many other disasters have had terrible impacts on communities around the world. Disasters will continue to occur, and their social, economic, political, and environmental impacts will continue to increase. Communities are becoming increasingly concerned about this and are working to develop disaster management programs to prepare for, respond to, and recover from disasters. Hazard, risk, and vulnerability (HRV) analyses form the basis of disaster management processes; unfortunately, to this point, communities and regional districts have not had access to effective HRV models.

This dissertation focuses on HRV analyses that are community-based, and it argues that the goal of such analyses should be to assist communities in developing and prioritizing mitigation strategies for hazard management. It also argues that HRV models should allow for the integration of disaster management and community planning, along with a high degree of public participation.

Through a literature review, fourteen key objectives for determining the adequacy of current HRV models are derived. When extant models are measured against these objectives, it becomes clear that the former are deficient in a number of areas. In order to rectify these deficiencies, a new HRV model – the hazard, impact, risk, and vulnerability (HIRV) model is introduced. The HIRV model is developed through extensive use of exploratory studies and (1) incorporates a high degree of public participation, (2) is all-hazard in scope, (3) provides for realistic and practical risk assessment, (4) establishes guidelines for determining vulnerabilities, (5) provides guidelines for determining the potential impacts of a disaster, and (6) provides a method for prioritizing mitigation strategies. The potential effectiveness of the implementation of the HIRV model is evaluated through the use of participatory case studies in the British Columbia communities of Barriere, Taylor, and Kamloops.

In short, the HIRV model provides a way for communities and emergency planners to make effective use of existing resources in order to develop comprehensive and practical disaster management programs and to move towards sustainable hazard mitigation.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Acknowledgements

At times, the development of a hazard, risk and vulnerability analysis model seems to parallel the development of a doctoral thesis: there are numerous hazards, risk and vulnerability factors abound, and setting priorities is central to being successful. As always, many people have contributed to the success of this thesis, but in particular I would like to thank the following:

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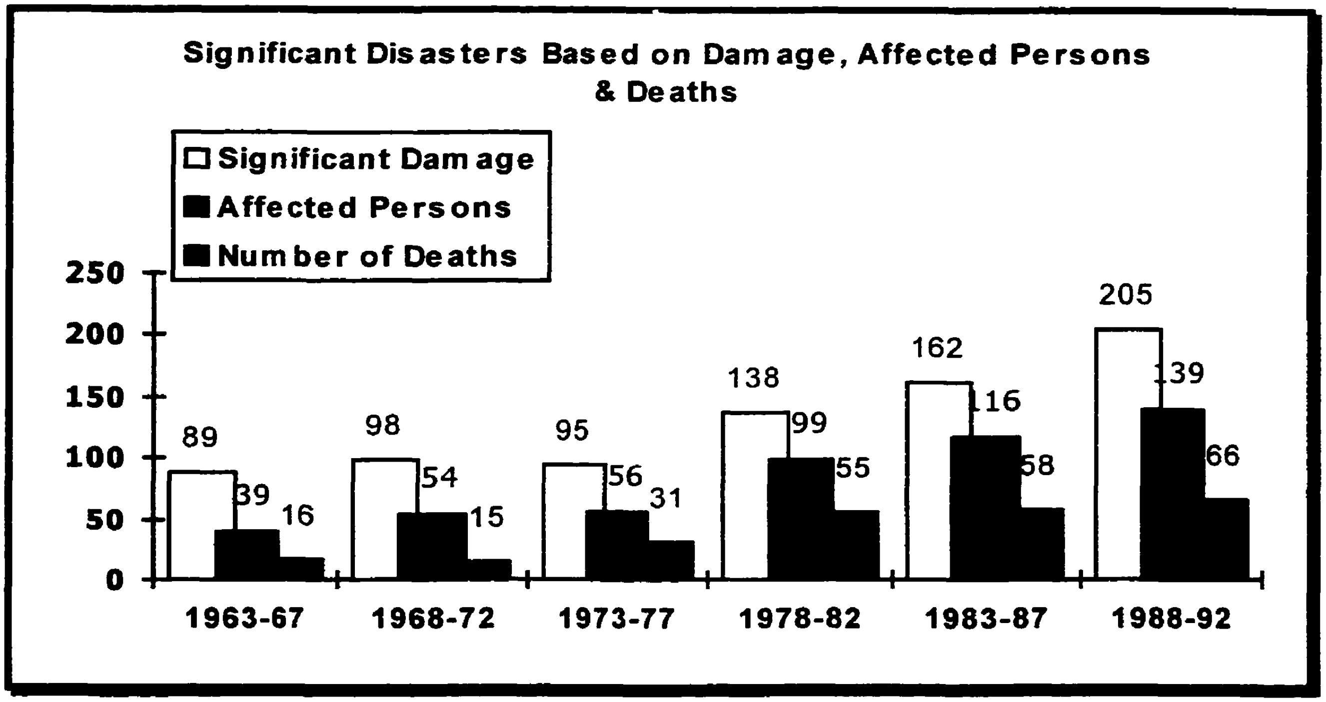
1. Introduction

For centuries communities have been coping with disasters: thousands died as a result of the Lisbon Earthquake of 1755 (Ward 1989), and, in 1998, Hurricane Mitch was responsible for the deaths of over 10,000 people (United Nations Office for the Coordination of Humanitarian Affairs 1998). In the past two decades, disasters have killed some 3 million people, affected a further 800 million, and caused damage in excess of US$23 billion (Kuban 1993). The following chart, presented by Bruce (1994), was prepared by the Geneva Secretariat for the International Decade for Natural Disaster Reduction. It clearly illustrates, on an international scale, the increasing number of natural disasters entailing significant social and economic costs. Significant disasters from natural causes include those in which (1) damage was equivalent to 1 per cent or more of gross domestic product; (2) more than 1 per cent of the people of the country were affected; and/or (3) there were more than 100 deaths. For example, between the years 1988 and 1992 there were sixty-six disasters in which more than 100 people died (see Figure 1).

Since this chart was completed, there have been numerous major disasters. The Saguenay Flood of 1996 was Canada's first billion-dollar disaster (Grescoe 1997). Less than two years later, the 1998 ice storm in southern Ontario and Quebec resulted in costs surpassing $1 billion (Harris 1998). In 1994, the Northridge earthquake, whose epicentre was located in Los Angeles County, killed over sixty people and resulted in costs in excess of US$30 billion (Pearce and Pearce 1994). Exactly one year later, in 1995, over 5,000 people were killed, and economic losses were estimated to be in excess of $100 billion, in the great Hyogo-Ken Nanbu earthquake (Mileti 1999). And it is not only natural disasters that have caused deaths and resulted in property damage. In 1995 the world was shocked when terrorists released sarin gas in the subways of Japan and bombed the Alfred P. Murrah Federal Building in Oklahoma. We have also witnessed worldwide concern over the avian flu in Hong Kong, the threat of ebola-like viruses in Africa, and mad cow disease in England. Clearly, preparing for and responding to disasters is important; disasters are not aberrant events (Hewitt 1983, Oliver-Smith 1986).

Figure 1: Numbers of Significant Natural Disasters



Source: **(Bruce 1994)**

Hazard, risk and vulnerability (HRV) analysis was a key component of early defence strategies: who is the enemy? how likely are they to attack? and how is the community most vulnerable to such an attack? Upon determining the answers to such questions, leaders would either set about fortifying their communities and/or entering into peace accords with their perceived enemies. As well as trying to protect themselves against invading armies, for centuries people have attempted to influence nature. For example, Pacific Island natives allegedly sacrificed young women to volcano gods in an attempt to reduce the risk of fatal eruptions. More recently, the US Corps of Engineers built numerous dams, levees, and dykes across the United States to mitigate the impact of riverine flooding. The 1994 and 1995 Mississippi floods demonstrated that natural disasters are not prevented simply by building dykes and levees, and that the building of dykes and levees has actually contributed to the problem (National Wildlife Federation 1998). Communities are now moving homes and businesses out of flood plains rather than trying to control the waters (FEMA 1997).

1.1. Consequences of Inadequate HRV Analysis

When communities do not have access to an adequate HRV analysis, the consequences are numerous:

(1) Without a complete analysis of potential hazards communities are unable to develop effective warning and evacuation systems

One of the best Canadian examples of the consequences of the failure to complete an adequate HRV analysis is the 1987 Edmonton tornado. In that year Edmonton suffered devastating losses following a category F4 tornado.[1] On the Friday before the August long weekend, at approximately 1600h, the tornado touched down in the southeast part of the city; then, travelling northward, it touched down in the industrial sector, finally concluding its thirty-minute journey at the Evergreen Mobile Home Park in the northeast part of the city. Most of the people who died in the tornado were residents of this park, which was virtually destroyed. Damages totalled over $149 million, twenty-seven people were killed, and hundreds more were injured (Wilson 1988).

Prior to this tornado, the City of Edmonton was touted as one of the Canadian cities best prepared for dealing with a disaster. It had an emergency plan that had been tested on a regular basis, and it had provided training to responders. Yet it suffered large numbers of casualties as a result of this tornado. Why?

While Edmonton's HRV analysis included a number of different hazards (e.g., hazardous material spills, severe snowstorms, and flooding), it did not include tornadoes. There was no warning and alert system for tornadoes, nor had any training been provided for responders and community residents regarding what to do before, during, and after a tornado. The hazard and risk analysis did not include tornadoes because, despite numerous sightings, no one could remember one ever having affected the city (Wilson 1988).

Emergency planners are well aware that, following a tornado, mobile home parks suffer terrible damage -- so much so that in several communities in the US "tornado belt" serious consideration has been given to completely banning mobile home parks. One of the first steps a prepared community takes following a tornado warning is to

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[1] The Fujita scale is used to classify the wind speed of tornadoes. An F4 rating is applied to a tornado with wind speeds ranging from 333 to 418 kilometres per hour (Grazulis 1993).

evacuate these parks. Had the City of Edmonton initiated an evacuation of the park once the tornado was sighted, there is no question that lives would have been saved. Clearly, a complete HRV analysis of potential hazards would have benefited the citizens of Edmonton. Current planning for the city does include consideration of tornadoes, and there is now a plan for the evacuation of mobile home parks following a tornado warning (Bruce Wilson, personal communication).

The 1984 Bhopal disaster is arguably one of best examples of what may occur when a community is ill-informed about the nature of the business being conducted within its boundaries and, specifically, of the potential effects of leaking toxic gases. With neither warning plans nor evacuation and response plans in place, when the toxic gases escaped from the Union Carbide pesticide factory, over 5,000 people were killed and more than 600,000 were permanently injured (Cohen 1994).

The Union Carbide factory was built in 1969 in order to produce "Sevin Technical," a paralytic insecticide that was made with imported methyl isocyanate (MIC). In 1979 Union Carbide built an MIC-producing facility adjacent to the existing plant, and it was this facility that was the source of the toxic leak[2]. At first, Union Carbide's application for a development permit to build the MIC facility was turned down because it failed to meet Bhopal Development Plan regulations. These regulations required hazardous or polluting industries to be located away from residential and heavily populated areas. Nevertheless, Union Carbide was able to influence government officials, who eventually granted it the development permit. Most local residents were unaware of the increased danger, even though a local journalist began writing articles warning of the danger in 1982. His concerns, and the contents of a legal notice served on Union Carbide by a local attorney, were categorically and publicly denied by Union Carbide officials. Had Union Carbide disclosed the true nature of its business and the associated dangers to the public, it is doubtful whether the residents would have allowed the MIC facility to be built; at the very least they would have insisted upon the existence of an elaborate safety plan – one that would have included a community warning and evacuation plan. Had such a plan been in place, many residents could have been spared death and injury.

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[2] This information is taken from the Amended Class Action complaint filed by Bhopal survivors and victims' organizations in the US federal district court. See *Sajida Bano et al. v. Union Carbide et al.*, 99 Civ. 11329 (http://www.bhopal-justice.com/causes.htm).

(2) Without a complete analysis of potential hazards, community planning initiatives may place future residences and businesses at risk

In Honduras in 1998 Hurricane Mitch resulted in thousands of people being killed and over 800,000 being evacuated (United Nations Office for the Coordination of Humanitarian Affairs 1998). Many communities were completely cut off, as mudslides and floods damaged much of the national road network and infrastructure. One of the contributing factors to the devastating losses was local initiatives that involved harvesting existing forests and replacing them with agricultural crops. The denuded hillsides were not capable of absorbing the heavy rains that accompanied Hurricane Mitch, and the highly saturated soil caused numerous mudslides, effectively cutting off transportation throughout most of the country.

Nag's Head, North Carolina, is an excellent example of a community at risk from a variety of coastal storms. Over the years, many persons built homes along the ocean front, in some cases removing previously existing sand dunes in order to improve the view. Following a hurricane these homes were damaged due to storm surges and interior flooding. In an attempt to mitigate the damage from storm surges, subsequent planning requirements insisted that construction occur at higher elevations. However, these planning initiatives failed to include adequate design considerations and, as a result, homes were built with sharp angular roofs and no shutters, thereby increasing the likelihood of wind damage (Bush 1994). Areas that are well forested are not generally subject to flooding or to wind hazards, but development can result in the increased degradation of exposed portions of the forest due to salt spray and thus create the risk of runoff flooding. Consequently, planning initiatives need to take into account the potential loss of trees and vegetation.

(3) Planning for hazards that are unlikely to occur may waste time and resources

The Canadian federal Vital Points (VP) program dates back to 1938, when Cabinet decided it was necessary to identify facilities, manufacturers and services that were critical to a national war effort (Emergency Preparedness Canada 1991, 1). During the Cold War era many citizens were especially concerned about the possibility of nuclear war, and the aforementioned program flourished. Thousands and thousands of dollars were spent by the Canadian government on building and servicing underground bunkers across the country. These were to serve as refuges for heads of government when the bombs were landed. Monies were spent on civil defence programs that stressed planning for war rather than planning for natural or other more likely hazards. Even average citizens were encouraged to build nuclear-proof shelters in their backyards.

The risk of nuclear war was perceived to be greatly diminished following the collapse of the Soviet Union, and yet, despite the streamlining of the Vital Points Program in 1989 (Emergency Preparedness Canada, 1991), the Canadian federal government continues to put considerable dollars into preparing for nuclear warfare. Never mind that, even at the height of the Cold War, Canada was, at best, only a secondary target. The government continues to maintain a computerized list that "covers the approved points and provides quick access to a variety of important information about them, such as their exact location, similar facilities in the area and the additional manpower required to guard them in time of crisis" (Emergency Preparedness Canada 1991).

When one considers that the chances of surviving a nuclear war are negligible, then one must question the validity of spending thousands of dollars on such efforts. Furthermore, nuclear warfare is unlikely and has never occurred on Canadian soil, unlike hazards such as flooding and forest fires, which occur every year. Despite the deaths that occur annually as a result of floods, Canadians maintain a Vital Points Program but no national flood insurance program. In fact, other than nuclear warfare, the only hazard that has been identified as worthy of a national program is earthquakes (National Earthquake Support Plan).

(4) Planning for hazards that will have little impact may waste time and resources

Probably the hazard that causes the greatest public concern, yet is the least likely to occur, is the post-disaster epidemic(s). Every year, following many disasters, hundreds of thousands of dollars are spent on community vaccination programs. Considerable effort is put into developing these programs, particularly those whose purpose is to guard against typhoid. Although, historically, epidemics have been thought of as secondary effects of disasters, in reality; since the 1950s, this has rarely been the case (Blake 1989, 7). In a study of twenty-seven major disasters that occurred in various parts of the world between 1970 and 1985, only three resulted in a post-disaster outbreak of a communicable disease. And almost none of those vaccinated against these communicable diseases benefited from the vaccinations. One of the reasons for this is that, in order to be effective, the typhoid vaccine (one of the most common vaccines requested) requires three separate inoculations. The second shot is given one month after the first shot, and the third shot is given three months after the first shot. By this time it is apparent that the first shot was not necessary. Furthermore, after the first shot, almost one-quarter of those vaccinated will be unable to work or to assist in the post-disaster clean-up due to the high fever and pain associated with the vaccination.

(5) Without an understanding of how a community is vulnerable to a particular hazard, mitigation projects may fail to reduce the risk of a disaster and its consequences

There are numerous examples of situations in which a community has embarked on a mitigation project of considerable size only to find that, when the disastrous event occurs, the project is of little or no value. In some cases, not only do the mitigative activities not provide any positive service, but they also give citizens a false sense of security and impede other, more suitable, activities. Flooding situations provide an excellent example of this. During the 1993 Mississippi flood numerous communities found that their extensive dyking was of no value because they had failed to take into account the vulnerability of those communities that had not completed dyking projects. When the floodwaters inundated undyked communities they simply continued across the land, flowing in behind the existing dykes of so-called "protected" communities. When floodwaters finally started to retreat they were trapped behind the dykes, and residents had to endure yet longer periods of inundation (Mairson 1994; FEMA 1997).

The Field Act was passed in California following the 1933 Long Beach earthquake, in which numerous school buildings were damaged. This act required that all new school buildings incorporate a seismic design (International Association of Engineering Geology 1976). School boards were required to ensure that schools met the high requirements of the building code. Many school boards spent a great deal of money ensuring that schools met the code for seismic risk, but they did not take into account other hazards and vulnerabilities. For example, it was not until 1994 that the Castaic Union School District in California examined the potential hazards facing its elementary school and its middle school. They discovered that not only were the schools in the area vulnerable to the ground-shaking effects of an earthquake, but they also faced a risk from the possible collapse of the Castaic Dam and a fire or explosion from the nearby 1925 gas-welded pipeline (FEMA 1997). Their assessment indicated that the risks were too high, and so, with the aid of a FEMA grant and a school bond, in 1996 the school board condemned the older buildings and rebuilt the schools in a less hazard-prone area. One can only wonder how much money was spent ensuring that the buildings met the Field Act requirements.

(6) Ill-informed communities are ill-prepared communities and, thus, are likely to suffer preventable losses

When over a metre of snow fell in twenty-four hours on Victoria, British Columbia, in December 1996, it constituted the worst snowstorm the city had experienced in over seventy-five years (Lavoie 1997). The population of 300,000, 25 per cent of whom were over the age of sixty-five, was completely unprepared. Victoria seldom receives any snow, and the city does not even have a snowplow. While the likelihood of a major snowstorm in Victoria was very low, the vulnerabilities were high. The older population is very dependent upon public transportation, and many are on prescription medicines and live close to the poverty line (relying for their income on old-age pensions). Very quickly, due to downed power lines and no heat, seniors found themselves without food or medication. There was no plan for dealing with residents who were stuck in their homes: all emergency plans dealt with evacuations to local reception centres. It was, in fact, a local radio station, CFAX, not the emergency planners, that organized a volunteer support network and set up call-in lines so that seniors and others could call for assistance (Lavoie 1997).

Because the community was ill-prepared, there were no media messages cautioning citizens, for example, of the need to shovel snow off flat roofs. As a result, when the rain came some forty-eight hours later, many roofs collapsed from the combined weight of snow and rain. The media also failed to caution elderly residents concerning the risks of engaging in sudden physical activity (e.g., shovelling snow), and this led to a number of heart-related medical emergencies. There was no coordinated transportation plan across municipal boundaries, and once ambulances and other emergency vehicles were able to move, they would traverse one municipality, along one of the few cleared roads, only to come to a complete halt when they reached a municipal boundary and found that the other municipality had chosen to clear a different transportation corridor (Provincial Emergency Program 1997). Clearly, had Victoria and its residents been more aware of their vulnerability to a major snowstorm, and had the community been better prepared, losses could have been prevented.

Which natural event killed the most American citizens in 1995? Most people think of floods, hurricanes, or other such atmospheric hazards. Actually, it was the 1995 Mid-Western heat wave, which was implicated in over 500 deaths (Changnon et al. 1996). This heat wave serves as another example of a situation in which a community was ill-prepared: emergency planners failed to consider the increased vulnerability of the elderly and the poor.

Older persons are more vulnerable to heat waves because, as people age, they become less able to regulate their body temperatures and to compensate for extreme cold or heat (Kilbourne 1989). The poor are more vulnerable than other members of the population for a number of reasons: (1) they are unable to afford air conditioners; (2) they are generally in poorer health than the rest of the population; and (3) they tend to live in crowded multi-residential buildings, which have a higher ground temperature and allow for less disbursement of heat during the night than do more open buildings (Kilbourne 1989). In any case, because emergency planners failed to take into account the vulnerabilities of the poor and the elderly, the instructions that were broadcast on radio and television failed to provide the appropriate warnings. Planners also failed to provide air-conditioned shelters for those suffering from the heat.

When a second heat wave struck the Mid-West a few weeks later, emergency planners were better prepared. For example, planners in Chicago arranged for the elderly and poor to gain access to air-conditioned shopping malls and public facilities in low-income areas of the city. They also ensured that specific warning messages were publicly broadcast for the elderly and that these messages dealt with the signs and symptoms of heat exhaustion and so on. These and other efforts are largely credited for the very few deaths that occurred during this second heat wave.

1.1.1. Summary

When communities lack access to an adequate HRV analysis, they are unable to develop effective warning and evacuations systems; are unable to ensure that planning initiatives do not place residences and businesses at risk; waste time and resources by planning for hazards that are unlikely to occur or that, if they do occur, will have little impact; are unable to develop effective mitigation programs; and are ill-informed and, thus, ill-prepared for potential disasters. In order to effectively prepare for a disaster, a community must conduct a comprehensive HRV analysis.

1.2. Thesis Problem Statement and Thesis Goal

The preceding six subsections all attest to the fact that an adequate HRV analysis is the cornerstone of successful disaster management: communities need to be able to identify potential hazards, to determine those hazards most likely to occur (and not to occur), to evaluate vulnerabilities, and to develop mitigative programs in order to reduce the likelihood and consequences of disasters. Communities have not had access to a useful, practical, and reliable HRV analysis – thus the need for a new approach. Further, even if a community does have access to an effective HRV analysis, it is important to recognize that the latter is only part of an overall process and that any successful approach to disaster management must be integrated into community planning. After all, there is no point in a community having access to an in-depth HRV analysis if it is not going to act on its findings. The goal of this dissertation is to develop and to evaluate an integrated and community-based model for HRV analysis – one that has the potential to successfully mitigate the impacts of a disaster. The next section describes how this goal is reached in terms of the methods used and the specific research questions addressed.

1.3. Research Methodology and Research Questions

"The strength of qualitative research lies primarily in its inductive approach, its focus on specific situations or people and its emphasis on words rather than numbers" (Maxwell 1996, 17). There are two main reasons why qualitative research is better suited to the study of HRV analysis than is quantitative research:

(1) Qualitative research, unlike quantitative research, is as concerned with the subjectivity of people as it is with the objectivity of data. And, indeed, implementation of sustainable mitigation strategies has more to do with people than it does with formulae and numbers. Various approaches to HRV analysis have been available to disaster managers and community planners, and yet, as research shows, availability has not translated into implementation. Understanding the context in which residents, officials, and politicians influence how and when HRV analyses are implemented is critical to the development of a successful approach to HRV analysis.

(2) Qualitative research, unlike quantitative research, emphasizes process as much as it does outcomes. Completing an HRV analysis involves a number of people from a number of disciplines (e.g., disaster management and community planning); thus, in order to come up with an effective analysis, these people need to be involved in the development of that analysis. In other words, they must be involved in the process. Given the importance of process, the process of conducting my exploratory studies is as crucial to the final outcome of my research as is anything else.

Maxwell (1996, 21) states that qualitative research has an advantage over quantitative research in that it addresses three practical goals: "(1) generating results and theories that are understandable and experientially credible ...; (2) conducting formative evaluations, ones that are intended to help improve existing practice rather than simply assess the value of the program or product being evaluated ...; [and] (3) engaging in collaborative or action research[3] with practitioners or research participants." He argues that "the conceptual context of the thesis *is* a

[3] the involvement of the researcher with participants in a natural setting as opposed to a laboratory.

theory" (25) and states that this conceptual context has three main sources: (1) experiential knowledge, (2) extant theory and research, and (3) exploratory studies.

1.3.1. Experiential Knowledge

The philosopher Hilary Putnam (cited in Maxwell 1996, 29) argues that there cannot be such a thing as a "God's eye view" -- a view that offers the one true objective account. Indeed, according to Maxwell, "any view is a view from some perspective, and therefore, incorporates the stance of the observer" (29). My desire to complete this research is founded in both professional knowledge and personal experience. In the following account I situate myself and, in so doing, display the critical subjectivity that has framed my research into HRV analysis.[4]

I have been involved in disaster management for over fifteen years. In the early 1980s I quickly became aware that disaster management was occurring in isolation: it was not part of the communities it was designed to protect. Disaster managers believed that citizens would panic if they knew the potential for disasters and, therefore, would be unable to plan rationally for them. Disaster managers, who often had para-military backgrounds and were involved in second careers, sat in their offices and developed disaster plans – sometimes without even consulting key response agencies (e.g., police, firefighters, and ambulance staff). Disaster plans were seldom read, seldom understood, and seldom up-to-date. They were seen as a necessary tool, but they remained a plan without a process.

In an attempt to provide a solution to the problem of planning in isolation, in 1989 I completed my master's thesis, "Disaster Planning Theory," which advocated a community-based disaster management process. Synthesizing both community planning and business management literature, I recommended a planning theory based on the following tenets: (1) citizens need to be educated regarding hazards and risks; (2) citizens need to be sold on the need for disaster management; (3) citizens need to participate in planning, training, response, and recovery activities; and (4) citizens need to be given responsibility for self-preparedness. Today, with many

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[4] Reason (1988, 2) refers to critical subjectivity as "a quality of awareness in which we do not suppress our primary experience; nor do we allow ourselves to be swept away and overwhelmed by it; rather we raise it to consciousness and use it as part of the inquiry process."

communities heavily committed to neighbourhood preparedness activities, it seems difficult to believe that, at the time it was written, my thesis was considered revolutionary by many of those engaged in disaster management.

The shift in focus in disaster management has led to more aware and better prepared communities; however, problems still exist. Community planning still takes place in isolation from disaster management planning. Politicians continue to approve the development of homes and businesses in hazardous areas (such as flood plains) and next to hazardous material transportation routes. There is little political will to allocate resources for a disaster that may not occur during a particular government's term of office. Similarly, there is great reluctance to ensure that existing homes and businesses are safe (e.g., by passing a building retrofit ordinance) or to protect valuable resources or heritage sites from the impacts of a disaster.

The need to complete an HRV analysis has been well documented in disaster management literature. However, what was not clear was how, exactly, to go about completing one. The 1987 Edmonton tornado gave me the impetus to research the consequences of not having an adequate HRV analysis. A check with disaster managers around the country indicated that few were using any established approach to HRV analysis. Even when they *were* using a particular approach, such as the one advocated by Emergency Preparedness Canada, there was little evidence that the findings were put to any meaningful use or that they led to the adoption of successful mitigation strategies. Communities still continued to develop plans without building resilience to, or attempting to mitigate, potential disasters. The poor and vulnerable were still the ones who, although they had little to lose, stood the greatest risk of losing everything they owned.

Given the economic climate and the many competing interests for resources, I believe that, until those who are most at risk are able to influence how politicians allocate community resources for disaster management, there will be no changes whatsoever in allocation. Of course, to some degree, everyone is at risk from some hazard; consequently, the implementation of an effective model for HRV analysis (which, by my definition, is one that leads to the adoption of equitable mitigative strategies) will benefit the entire community. The less vulnerable the community in times of disaster, the healthier and stronger the community in times of stability. I believe – and hope – that access to and implementation of an adequate HRV analysis will lead to better and safer communities for all.

1.3.2. Extant Theory and Research

As stated earlier, the consequences of an improper HRV analysis are numerous and serious. The importance of HRV analysis is well documented in the literature, and different approaches are available. My first research question is: ***Why are existing models for HRV analysis so seldom used?*** Once basic definitions of hazard, risk, and vulnerability have been established, HRV research involves two key steps: (1) conduct a thorough literature review; and (2) identify extant obstacles to the adoption and utilization of HRV analysis. My literature review delves into the findings of numerous disciplines and presents a critical analysis of current obstacles to the implementation of HRV analysis. From this review I derive a list of factors that any adequate HRV analysis must address. However, how do we know if this list is comprehensive? The need for an overall framework within which to situate HRV analysis is impeded by the fragmented nature of the literature on risk. In order to ensure comprehensiveness, I take a specific framework, adapt it, and integrate it with what I have found in the literature review. This integration enables me to develop the key objectives of an adequate HRV analysis.

The second research question is: ***Do any of the extant models for HRV analysis incorporate the key objectives of an adequate HRV analysis?*** I respond to this question by completing an extensive literature review in order to identify and assess extant models to HRV analysis. None of them meets all the of objectives; many meet very few.

The third research question is: ***Can I develop a new model for HRV analysis that meets the key objectives?*** In response to this, I develop the HIRV (Hazard, Impact, Risk and Vulnerability) model for HRV analysis. I do this by completing a comprehensive interdisciplinary literature review in order to determine how to implement the objectives in question. I ask and address such questions as: if one important objective is ensuring that the HRV process incorporates public participation, then how should the latter be used and to what degree? Further to this, I conduct a number of exploratory studies, learning much both from the process of doing so and from the outcomes.

1.3.3. Exploratory Studies

Maxwell (1996, 44) states that "exploratory studies serve some of the same functions as prior research, but they can be focused more precisely on your own concerns and theories." Over a number of years I conducted a series of exploratory studies, mostly in British Columbia, to assist in developing a new approach to HRV analysis. At various stages of the development of the HIRV model I presented it, within a structured setting, to various disaster managers, community planners, and other interested parties – all of whom came from different regions and communities. These people applied the HIRV model either to a "sample" community or to their own respective communities. Their comments and suggestions help me to establish key factors of HIRV methodology and to refine some of the data used to substantiate the adequacy of the HIRV model.

1.3.4. Participatory Case Studies

The fourth research question is: ***How do I know whether or not the HIRV model to HRV analysis can be successfully implemented?*** Completing an HRV analysis is not a short-term project; it would take longer than the timelines for this thesis to adequately assess the effectiveness of any HRV model. What it *is* possible to assess, however, is (1) whether or not the participants of three community-based participatory case studies conducted in British Columbia are able to successfully implement the HIRV model, and (2) whether or not they believe that the HIRV model meets its stated objectives. Using organizational development literature as a base, I analyze the contexts of these case studies, the issues raised, and the conclusions derived by drawing information from the films and tapes that I made of these studies.

1.4. Thesis Outline

Chapter 2 defines HRV-related terms as well as such terms as "community" and "region." A major difficulty in this field of study is that common terms are used with widely differing meaning. The definitions used in this study are derived from a varied literature, including sociology, medicine, law, and disaster management. Chapter 2 also lays the foundation for positing "sustainable hazard mitigation" as the goal of disaster management.

Chapter 3 identifies the obstacles to integrating an awareness of hazards into local decision-making processes. The literature review includes an analysis of the historical, social, communication, economic, technological, and political factors that influence the adoption of HRV processes at the local level. An important point, and one that is discussed in some detail, concerns the historical differences and commonalities between current disaster management and community planning approaches. I argue for the need to include community participation within disaster management and offer a case study (the Portola Valley, California) to illustrate the successful integration of disaster management and community planning. This chapter concludes with a list of key objectives for an adequate HRV analysis. These objectives are derived from a synthesis of factors that emerge from the literature review.

Chapter 4 focuses on analyzing eight extant models for HRV analysis identified through a literature review. I evaluate these eight models, which are taken from around the world, by measuring them against the objectives developed in Chapter 3 and conclude they each have significant deficiencies.

Chapter 5 focuses on the development of an effective community-based model for HRV analysis: the Hazard, Impact, Risk and Vulnerability (HIRV) model. The method for developing the model consists of assessing the objectives of adequate models, completing a literature review to determine the best means of meeting those objectives, maximizing the strengths and eliminating the weaknesses of extant HRV models, and building upon exploratory studies.

Chapter 6 provides a reflective review of a number of exploratory studies I conducted whose participants come from varied backgrounds and communities. Over several years the HIRV model was modified and refined based on the feedback obtained from these early studies.

Chapter 7 focuses on three community-centred participatory case studies that were conducted in Barriere, Taylor, and Kamloops, British Columbia respectively. The participants involved in each study , unlike those involved in the exploratory studies discussed in Chapter 6, are residents of the community in which it is conducted. The merits of using participatory case studies as a qualitative method of research are discussed, and then the cases presented. An overview of community demographics and key information is provided and followed by an analysis of (1) how Barriere, Taylor, and Kamloops went about the process of implementing the HIRV model, and (2) how well participants believed that the HIRV model met its stated objectives. The final section concludes with a discussion of how the HIRV model met its objectives, and it presents a number of recommendations with regard to the implementation and development of this model for HRV analysis.

Chapter 8 begins with a summary of the previous chapters and concludes with a summary of how the thesis goal and key research questions were addressed.

2. Laying a Foundation

Before attempting to present and discuss a framework within which to consider the development and evaluation of an integrated, community-based approach to HRV analysis, it is important to determine exactly what is meant by the various terms used in this dissertation; namely, "disaster," "disaster management," "hazard, risk, and vulnerability (HRV) analysis, "mitigation," "hazard," "risk," "vulnerability," "risk management," "community," and "region." These key terms need to be defined for purposes of this study as they are used in widely differing ways by different authors and in some cases current definitions of these terms have a number of shortcomings – shortcomings that I critique and attempt to rectify by providing my own definitions.

Along with defining the terms to be used, this chapter also sets out the overall goal of disaster management: sustainable hazard mitigation.

2.1. Definitions of Disaster

In defining "disaster," it is useful to consider this term within the context of four categories: (1) lexicology, (2) origin/cause, (3) characteristics, and (4) capacity to respond.

2.1.1. Lexicology

In many cases, words such as "emergency" and "planning" have been used interchangeably with words such as "disaster" and "management," respectively. According to the *Oxford Canadian Dictionary* (1998) an "incident" is considered to be a minor situation; an "emergency" a more serious situation; a "disaster" a yet more serious situation; and a "catastrophe" the most serious situation of all. However, depending on one's discipline, terms such as "incident" as opposed to "emergency," or "emergency" as opposed to "disaster," are less clear. It would be helpful if disaster management and emergency response agencies could agree on a common terminology. Still, as long as we have incident command systems[5] to deal with large-scale events (such as the Northridge earthquake) and emergency response teams to deal with two-car pile-ups, not to mention both Emergency Preparedness Canada (EPC) and, in the United States, the Federal Emergency Management Agency (FEMA), consensus as to the precise definition of "emergency" as opposed to "disaster" is unlikely to occur in the near future. Therefore, in order to obviate the confusion caused by these two terms, one must examine other factors.

2.1.2. Origin/Cause

Foster (1980) maintains that disasters are the consequences of extreme events. Many disaster planners still think of disasters in terms of their origin (e.g., natural as opposed to technological), while most researchers seldom view them as agent-specific (Hewitt 1995). The exception to this may be with regard to war. Some researchers (Gilbert 1995a) feel very strongly that war should be included in a definition of disaster. That war and disaster have something in common is clear; however, depending on one's bias, a war may be perceived either as a disaster or as

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[5] An Incident Command System (ICS) is an organizational structure used to determine overall command and planning during disaster response (Kuban 1996).

the first step away from a previously unbearable way of life. It is this moral (or immoral) dimension of war that makes it difficult to include under a definition of disaster, and, following Drabek (1986) and Auf der Heide (1989), this dissertation does not include it in its definition.[6]

Perhaps because of the difficulty of including all of the potential causes of a disaster within a succinct definition, and because of multi-hazards (i.e., situations within which one hazard [e.g., an earthquake] causes another [e.g., a landslide]), it is extremely difficult to define disaster in terms of cause. Most pieces of legislation in Canada (Emergency Program Act [Bill 38, sec. 1(1): 2]; Emergency Act [c. 29, sec. 2(5): 779]) define a disaster by referring to its particular characteristics or impact.

2.1.3. Characteristics

Many of those who choose not to define a disaster by its origin/cause define it according to its characteristics. These may include: (1) length of forewarning, (2) magnitude of impact, (3) scope of impact, and (4) duration of impact (Kreps 1995, 258). Disaster researchers generally agree that a disaster affects people (Korver 1985; American Red Cross 1986) and that it is often catalogued in terms of the number of dead and injured. However, others have expanded the definition to reflect major losses to both population and physical structures – losses that disrupt the social structure and essential functioning of a community (Fritz 1961, 1969; Dynes 1970; Gilbert 1995a). The problem with focusing on community disruption as a way of defining disaster is reflected in situations such as that of Lauda Flight 004, which, carrying 213 passengers, crashed in a remote jungle site in Thailand in 1991.

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[6] It is also beyond the scope of this dissertation to include "complex emergencies," as defined by the Department of Humanitarian Affairs for the United Nations, in its definition of disaster. Complex emergencies refer to situations of prolonged civil conflict, often compounded by drought, famine, or other hazards and usually characterized by hunger and poverty. Recently, responding to complex emergencies has consumed much of international humanitarian efforts.

Researchers such as Handmer (1992) and Rosenthal et al. (1989) have pointed out that in the developed world, the impact of disasters is more readily evident in their psycho-social and politico-economic impacts than in their mortality rates. But, because the impact of a disaster can be both unexpected and extremely varied, it is extremely difficult to include all potential impacts within any single definition. Similarly, in situations in which no human lives are lost (such as the 1989 *Exxon Valdez* oil spill), definitions based on impact on humans become less relevant (at least in regard to direct impact).

Others researchers, such as Drabek (1986, 46-47), state that disasters have six characteristics that differentiate them from emergencies: (1) degree of uncertainty, (2) urgency, (3) development of an emergency consensus, (4) expansion of the citizenship role, (5) convergence (i.e., the sudden influx of people and material upon a disaster scene), and (6) de-emphasis of contractual and impersonal relationships.[7]

Drabek's first characteristic, degree of uncertainty, seems to be a major preoccupation of a number of researchers, as five of the contributors (Dombrowsky, Gilbert, Horlick-Jones, Kreps, and Porfiriev 1995a) to an issue of the *International Journal of Mass Emergencies and Disasters* agreed that a disaster should be defined not in terms of cause and effect but, rather, in terms of uncertainty. Uncertainty is seen as a product of the increasing complexity of modern communities, and a disaster is seen as "the loss of key standpoints in common sense, and the difficulty of understanding reality through ordinary mental frameworks" (Gilbert 1995b, 237-38).

However, I would contend that Kreps (1995) and others who focus on characteristics when attempting to define disasters fail to take into account the great differences between these events. As technology has improved, many disasters that, twenty or even ten years ago, would have been unexpected events can now be forecast with some accuracy. For example, Hurricane Andrew was forecast ahead of time and thousands of people were able to evacuate prior to its arrival. In this case, uncertainty had little relevance to an event that resulted in few casualties but billions of dollars worth of damage. Likewise, factors such as duration bear little relationship to amount of damage. For example, the Kobe earthquake, whose impact can be measured in seconds, is the most costly disaster of

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[7] Drabeck would define as impersonal the relationship between response agencies (such as the police and firefighters) and/or the relationship between state agencies and local agencies.

recent years: over US $100 billion (Mileti 1999). In an attempt to overcome the problems posed by defining disaster in terms of impact, some researchers define it in terms of capacity to respond.

2.1.4. Capacity to Respond

The issue of the local government's capacity to respond is crucial to many Canadian and American definitions of disaster (Richie 1983; Tierney 1985). Britton (1986) employs three levels of social crisis – (1) accidents, (2) emergencies, and (3) disasters – each of which is defined according to who is involved, the degree of their involvement, and the degree of disruption to the social system, thus combining the capacity of a community to respond with the actual impact of the event. Quarantelli (1987) states that, in disasters (unlike in emergencies), organizations have to: (1) involve the public to a great degree, (2) lose a certain amount of autonomy, and (3) relate to different agencies and organizations. Focusing on Quarantelli's last point, Drabek (1986, xix) differentiates between emergencies and disasters according to the number of agencies required to adequately respond to the situation: generally, the greater the number of agencies required, the greater the disaster. However, I contend that Drabek's model is limited in that it is urban-based, tailored to first responders, and does not lend itself to minor incidents -- incidents that may require a number of different players but that may still be negligible in terms of effect (e.g., minor oil spills). Although the inability of a community to respond to a situation is certainly a key point, it is not very reliable to define "disaster" according to the number of agencies required to attend to it.

2.1.5. A New Definition

It would appear that any adequate definition of disaster must reflect a given locality's capacity to respond; the fact that what has occurred is unusual; and the fact that the impacts of what has occurred are of social, economic, political, and ecological significance. Having considered the pros and cons of the various definitions set forth in this and the preceding section, I offer the following as a comprehensive working definition of disaster: ***A disaster is a non-routine event that exceeds the capacity of the affected area to respond to it in such a way as to save lives; to preserve property; and to maintain the social, ecological, economic, and political stability of the affected region.***

This definition of disaster does the following:

(1) It eliminates from consideration such routine emergencies as house or apartment fires, and motor vehicle accidents. Disasters are unusual events, complex and difficult to respond to, and their impacts may last for generations. By defining them as non-routine I exclude events that even though they might involve death and destruction, can be handled by simple operating procedures.

(2) It takes into consideration the capacity of the local area to respond to an incident. This is important because, in most cases, large communities, simply because of the number of their available resources, are more capable of handling very serious situations than are small communities.

(3) It takes into consideration the importance of maintaining the social, ecological, economic, and political stability of the affected area. This is important because, clearly, when people are killed and homes are destroyed, those who survive will suffer long-lasting emotional and psychological effects. Property damage results in both direct (e.g., property loss) and indirect (e.g., job loss) economic consequences. Oil spills and tsunamis can destroy shellfish habitat and other areas of ecological significance. Incoming personnel from higher levels of government and national and international agencies may disrupt local decision-making processes, and terrorist operations may increase political instability. All of the foregoing may be included under the potential effects of a disaster, and, as Handmer (1992) indicates, any definition of disaster must recognize their seriousness.

2.2. Disaster Management: A Process

Various terms (e.g., emergency preparedness, disaster planning) have been used to describe the process of dealing with disasters. In order to avoid confusing the reader, throughout this dissertation the commonly recognized expression "disaster management" is used when referring to the process of attempting to control/manage disasters.

2.2.1. Definitions of Disaster Management

"Disaster" has been defined in the previous section. Certo et al. (1983, 9) define management as "the process of reaching organizational goals by working with and through people and other organizational resources." However, this definition can be problematic since there are many organizations involved in dealing with disasters and each may have its own goals (e.g., firefighters may be focused on putting out a fire, while others may be concerned about securing property). Drucker's (1974, 17) definition of management is preferable: "[making] people capable of joint performance by giving them common goals, common values, the right structure, and the ongoing training and development they need in order to perform and to respond to change." Certainly, disasters involve change, and responders and the community need assistance in dealing with it.

Most disaster management, from an operational perspective, has focused on the development of an emergency plan (Quarantelli 1986; Faupel 1987); however, according to Aquirre (1994, 2), "despite its obvious relevance to preparedness activities, planning for disasters has not received a great deal of research attention in the social sciences." Much of the research has been devoted to post-disaster sociological or psychological studies.

Essentially, Quarantelli (1986), Drabek (1986), and Faupel (1987) agree that the disaster management process is comprised of a series of activities that precede, carry on during, and follow a disaster. Drabek (1986) expands the concept of disaster management to conform to the nomenclature proposed in the 1979 National Governors' Association report entitled *Comprehensive Emergency Management: A Governor's Guide*. This concept includes four phases:

Table 1: Concept of Disaster Management

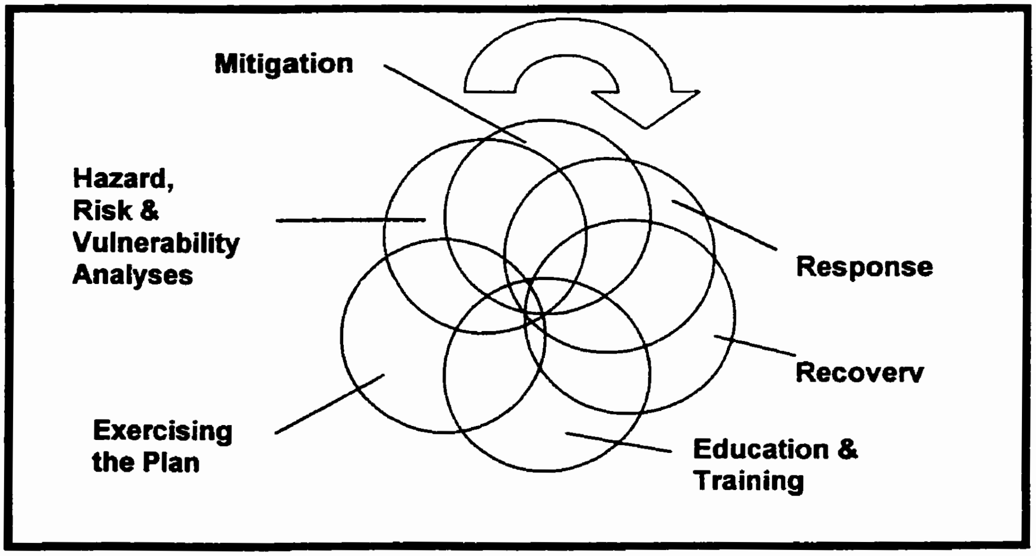
1. Preparedness	**3. Recovery**
Planning	Restoration (6 mos. or less)
Warning	Reconstruction (6 mos. or more)
2. Response	**4. Mitigation**
Evacuation and Pre-Impact Mobilization	Hazard Perceptions
Post-Impact Emergency Actions	Adjustments

***Source:* (Drabek 1986)**

This framework suggests a linear approach to disaster management, while others extol a circular (Quarantelli 1981). Drabek also omits reference to the development of, training for, and testing of the plan. In keeping with Quarantelli, I contend that the disaster management process includes activities in six areas: (1) hazard, risk, and vulnerability (HRV) analysis; (2) mitigation; (3) response (including alert and warning, impact, immediate post-impact, and rescue); (4) recovery and reconstruction; (5) education and training; and (6) exercising or testing of emergency plans.

HRV analysis is included as one step within a circular disaster management process wherein, although one activity clearly leads to the next, the activities in any given step affect those in all steps (see Figure 2). In other words, Figure 2 shows that (1) the disaster management process is circular rather than linear; (2) each step in this process is distinct; and (3) each step affects every other step.

Figure 2: The Disaster Management Process



2.2.2. Hazard, Risk, and Vulnerability (HRV) Analysis as Part of Disaster Management

While researchers agree that HRV analysis is an important part of the disaster management process, they do not agree as to where, in the overall process, this analysis should be conducted. And they often do not agree on the particulars. Hoetmer (1991, xxi), for example, states that the emergency management process requires that the "community undertake a hazard and risk analysis, assess its current capabilities in the areas of mitigation, preparedness, response, and recovery, and devise action steps to close the gap between existing and required levels of capability." How this is to be accomplished is left very vague. Hays (1991, 8) makes the point that HRV analysis is only the first step of the disaster management process: an HRV analysis is not an end in itself; it is the means towards an end (i.e., to mitigate the risks and consequences of disasters). In other words, Hays believes that HRV analysis forms the cornerstone of mitigation. However, he and others (Maskrey 1989; Godschalk 1991; Scanlon 1991) are less clear about the direct relevance of HRV analysis to mitigation. For example, Godschalk (1991) gives a number of reasons why the results of HRV analysis are important for disaster management planning, but they are presented in theoretical terms rather than in practical examples. For example, he says that an HRV analysis should "justify management decisions for altering program and staffing assignments that may vary from the previous norm" (145). This leaves the reader uncertain as to the direct contribution of HRV analysis to the overall disaster management process.

It is important to understand the role of HRV analysis in the development of mitigative strategies within the disaster management process. Fischhoff et al. (1978) state that, since hazards are divided into events and consequences, one has the following options: (1) prevent the event from occurring; (2) prevent the potential consequences of the event from occurring; or (3) lessen the harmful consequences of the event. To this could be added (4) develop strategies to share in risk reduction measures. It is apparent that, without adequate HRV analyses, communities may neglect to plan for likely hazards. This is because, without understanding the extant hazards and vulnerabilities, it would be impossible for them to adequately follow any of the foregoing options. Consequently, they would not be able to achieve "sustainable hazard mitigation" (Mileti 1999, 215).

Drabek (1986, 21) defines mitigation as "purposive acts designed toward the elimination of, reduction in probability of, or reduction of the effects of potential disasters." There is, however, a blurring of the timing of mitigation, as Quarantelli (1986, 4) classifies prevention activities as those geared to preventing the occurrence of an event, while he classifies mitigation activities as those geared to lessening the impacts of an event. As is shown in Figure 2, I choose to define mitigation as representing those pre-, during, and post-disaster activities that reduce the risk and consequences of any given disaster. For example, seismic retrofitting of unreinforced masonry buildings, raising the level of dykes during a flood, and moving homes out of a flood plain after a flood are all mitigation activities. Because of its importance within the context of disaster management, the concept of mitigation must be explored further.

2.2.3. Mitigation

Current research defines the concept of mitigation as central to the success of disaster management. In the mid-1990s many of the United States' top hazards experts met and collaborated on the *Reassessment of Natural Hazards in the United States*, which was completed in 1998 (Mileti 1999). Based on its findings, Mileti concluded that a shift in the field of disaster management must take place so that it would be possible to focus on "sustainable hazard mitigation" (2). Mileti argues that there are six objectives that must simultaneously be reached in order to mitigate hazards in a sustainable way: (1) maintaining and enhancing environmental quality (i.e., human activities should not reduce the carrying capacity of the ecosystem), (2) maintaining and enhancing people's quality of life, (3) fostering local resiliency and responsibility, (4) recognizing that vibrant local economies are essential, (5) ensuring inter- and intra-generational equity (i.e., not precluding a future generation's opportunity for satisfying lives by exhausting resources in the present generation), and (6) adopting local consensus building.

The importance of mitigation is recognized in FEMA's major initiative, "Project Impact" (FEMA 2000), which was developed as a partnership between communities, government, and businesses in order to build disaster-resistant communities. Sustainable hazard mitigation warrants an inter-disciplinary approach that encompasses environmental, social, and economic considerations as well as technical analysis in order to determine hazards, risks, and vulnerabilities. This being the case, it is clear that an adequate HRV analysis is critical to the success of sustainable hazard mitigation.

This concept of mitigation parallels the conclusions of MacCrimmon and Wehrung (1986, 10) concerning risk: "There are three components of risk – the magnitude of loss, the chance of loss, and the exposure of loss. To reduce riskiness, it is necessary to reduce at least one of these components." Taking into account Mileti's conclusions regarding mitigation, one could reword MacCrimmon and Wehrung to state that the components of mitigation strategies are to eliminate or reduce (1) the consequences of loss, (2) the probability of loss, and (3) the sharing of loss. In most cases it will be impossible to eliminate the probability of loss (i.e., the probability of a natural hazardous event taking place), but it may be possible to do so in the case of person-induced hazards (e.g., hazardous waste in-situ spills).

In keeping with Mileti's conclusions, any definition of disaster management must be able to incorporate the concept of mitigation. As will be seen, mitigation is also central to the definitions of "hazard," "risk," "vulnerability," and "risk management."

2.2.4. A Definition of Disaster Management

Myers (1997, 1) states that: "Mitigation, preparedness, response and recovery are not separate endeavors and they should not be pursued by separate professionals. They are a long-term process and must be linked." Indeed, this is implicit in my definition of disaster management: ***Disaster management is the process of forming common objectives and common values in order to encourage participants to plan for and deal with potential and actual disasters.***

Quarantelli insists that in order for disaster management to be successful, attention must be given to process rather than merely to written plans. The foregoing definition takes this into consideration. It also assumes that disaster management involves a number of participants, each one of whom (whether an individual or an agency) needs to cooperate with the others and to establish common objectives and values. Since time and resources are not unlimited, some activities will be given priority over others. The process of disaster management should help participants to arrive at common objectives; namely, those itemized by Mileti (1999), which, in turn, should help them to arrive at suitable priorities (i.e., those that most adequately reflect community values). Thus the goal of disaster management is to encourage sustainable hazard mitigation, and all steps in the disaster management process must support this end.

2.3. Hazard Identification

In disaster management, a hazard refers to the potential for a disaster. I use the definition developed by Harris et al. (1978), who conclude that hazards "are threats to humans and what they value: life, well being, material goods, and environment." Harris et al. indicate the need for judgment when determining whether or not a potential hazard exists. If, for example, a meteor were to fall on a desolate barren area of northern Canada (even if it killed no one, destroyed no property, and left minimal damage to the environment), then it would be considered a potential hazard. This contradicts Hewitt's (1983) view that "hazard" refers to the potential for damage to a vulnerable human community. Following Harris et al., it is not important for a hazardous event *actually* to take place; it is only important that it is *likely* to take place.

Beginning in the 1960s, disaster management literature discussed hazards without considering their origin. This changed in the 1980s, when hazards began to be described as either natural or technological (Lindsay 1993). While natural hazards were defined as "Acts of God," technological hazards were defined as fitting into four categories: hazardous materials, hazardous wastes, hazardous substances, and extremely hazardous substances. As Parker (1992, 237) points out, however, "the significance of these classifications varies across countries and even among agencies within the same country."

2.3.1. Hazard Classifications

Why is it important to classify hazards? First, scientific disciplines tend to be insular and to have narrow foci: atmospheric researchers do not necessarily communicate with hydrologists and other natural scientists. By failing to classify hazards, research may be duplicated and gaps may go unnoticed. Second, and perhaps most important, as "the type of hazard affects the choice of mitigation strategy" (Godschalk 1991, 40), failure to accurately classify types of hazards may lead to the misapplication of mitigation strategies. For example, if one is trying to combat an increase in the number of forest fires by installing additional lightning monitors when, in fact, the fires are being caused by careless campers, not only will the strategy not work, but it will also waste resources. Third, failure to correctly classify hazards leads to failure in other parts of the emergency management process. For example, in order to receive FEMA funding, communities must conduct at least three exercises every four years and must include in them "a natural, a technological and a civil disaster" (Daines 1991, 187). Because of the way in which hazards are defined, communities are not encouraged to think about, or to consider how they would deal with, an epidemic.

For these reasons, I propose that hazards be classified. However, a number of researchers (e.g., Kreps 1991; Quarantelli 1991) have questioned the need to separate the causes of hazards from one another. Jovanovic (1988), for example, believes that person-induced and natural hazards are interrelated because humans can influence natural events and natural events can change and modify human activities. However, I maintain that while in many cases there are similarities between the consequences of, and responses to, both person-induced and natural disasters, because their causes are different, the mitigation strategies adopted to reduce them will also be different – thus the importance of classification.

As can be seen, hazards have been classified in a number of ways – usually by cause. Fischhoff et al. (1978) recognize that, in terms of both events and consequences, natural hazards differ from technological hazards. Similarly, Britton and Oliver (1991) differentiate between natural and technological hazards. According to them, natural hazards result from a *lack* of control, whereas technological hazards result from a *loss* of control. They conclude that hazards have three origins: (1) natural; (2) failure or misuse of technological processes; and (3) misapplication of technology, medicine, or biology. While it is important, in terms of applying mitigation strategies, to determine the origin of technological hazards, it is difficult to justify, in the planning stages, the use of Britton and Oliver's typology. For example, an aircraft can crash as a result of mechanical failure, metal fatigue, poor maintenance, a bomb explosion, pilot error, and so on. Defining hazards by origin seems unsatisfactory, as they have numerous possible origins – only some of which may actually lead to a disaster. With the current emphasis on carcinogens and other similar concerns, it is important to distinguish between these hazards and those leading to major disasters such as earthquakes and explosions. Therefore, it seems more suitable to classify hazards by general cause rather than by specific origin. To this end, I propose that hazards be classified as: (1) natural; (2) diseases, epidemics, and infestations; and (3) person-induced.

White (1979, 15) defines natural hazards as "any extreme events in natural systems which have the potentiality of causing major perturbations in social systems." This definition appears to be accepted within the disaster management community, and it is the one used throughout this dissertation.

Interestingly, while natural hazards are the focus of much current research, diseases and epidemics are usually overlooked. Yet the latter can affect people, plants, or animals. While some diseases, such as the bubonic plague, have existed for centuries, others, such as acquired immune deficiency syndrome (AIDS), are quite new. Some diseases are the result of bacterial or viral infections (e.g., meningitis) that have natural causes, while some are the result of human manipulations. Locusts have been swarming in Africa for hundreds of years, but threats of an Asian gypsy moth infestation in British Columbia have only occurred in the last few years. Furthermore, genetic researchers are capable of creating new diseases. Consequently, diseases and epidemics do not fit nicely into either natural hazards or person-induced hazards. As well, while controlling other hazards typically means evacuating people, animals, and property, controlling diseases and epidemics typically means containing them. For these reasons, diseases and epidemics should be classified separately from natural hazards and person-induced hazards.

Drabek (1991, xxi) points out that researchers have traditionally identified three types of disasters according to type of potential hazard: (1) natural, (2) technological, and (3) civil. He adds that a fourth type of disaster – ecological – has now entered the picture. Ecological disasters are events "that are caused principally by human beings and that initially affect, in a major way, the earth, its atmosphere, and its flora and fauna" (xxi). While the need for natural hazards has already been discussed, the term "person-induced hazards" includes Drabek's typology of technological, civil, and ecological hazards as well as what are commonly referred to as "man-made hazards." I use the term "person-induced hazards" because: (1) it is gender-neutral and non-sexist; (2) people do not "make" disasters, they "induce" them – either through acts of commission (e.g., planting a bomb, crashing a plane, or spilling chemicals) or through acts of omission (e.g., not building a dam able to withstand seismic conditions, failing to maintain a proper watch at sea, or using poor construction techniques); and (3) it addresses the issues presented by Britton and Oliver (1991).

2.3.1.1. Impact of Hazard Identification on Emergency Response Plans

There has been considerable academic discussion concerning the need to develop disaster management emergency plans for specific hazards rather than for all hazards. Some researchers believe that different types of disasters warrant different types of plans, while others believe that the similarities between any two disasters are sufficient to allow for generic plans. A generic, or all-hazard, plan would be one that could be used for any hazard, regardless of its cause or effect. For example, Quarantelli (1991, 98) maintains that "there are more individual and organizational behavioural similarities than differences for all disaster occasions." Similarly, Kreps (1991, 38) states that one of the key requirements for adequate emergency preparedness is a generic rather than an agent-specific approach to planning.

Both Quarantelli and Kreps believe that for most disaster management needs, the type of disaster is irrelevant. For example, with regard to warnings, "regardless of whether the threat is a hurricane, a chemical spill, a flood, a tidal wave, or a nuclear emergency, what matters is whether people will understand, believe and respond to warning messages. There must be an alerting system that works, and warning messages must be accurate, precise, consistent, and timely" (Kreps 1991, 40). Kreps goes on to point out that a general preparedness approach to disaster management is efficient in terms of time, effort, and money and that it helps to avoid duplication of effort, gaps in responses, and possible conflicts between divergent approaches. He believes that for these reasons, moving from a generic all-hazard plan to a hazard-specific plans would be politically undesirable.

And yet social researchers keep reminding planners that disasters affect different populations differently. If one assumes that all parts of a disaster area will be equally affected, no matter what the hazard, then resources will, in fact, be poorly utilized. For example, when a tornado approached Edmonton (Edmonton Police Department, 1987), despite an excellent general disaster plan,

- no public warning system was in place to alert people to the hazard and to tell them what actions they should take (as there were no specific references to tornadoes);

- there was no specific plan in place to evacuate the Evergreen Mobile Home Park, the source of the majority of deaths (notwithstanding widespread knowledge that tornadoes are extremely destructive to mobile home parks); and
- as there was no consideration of the widespread flooding that normally follows tornadoes, no alternate routes to the northern part of the city had been developed.

Kreps (1991, 40) argues that writing elaborate plans for specific functions results in too detailed a plan, thus creating a false sense of security. Some researchers, such as Hoetmer (1991, xxi), believe that the Integrated Emergency Management System (IEMS) is adequate: "Operationally [IEMS] provides the framework to support the development of emergency management capabilities based on functions (warning, shelter, public safety, evacuation, and so forth) that are required for all hazards." Others, such as Daines (1991, 167), believe that IEMS (as developed by FEMA) is problematic because of the large amount of documents it produces. IEMS supports hazard-specific planning but treats disaster management generically and, as Daines points out, may not meet community needs (169).

Quarantelli (1991) states that to move from a generic to a hazard-specific plan is to assume that, with regard to any two disasters, there are fewer individual and organizational behavioural similarities between them than there are differences. He disagrees with this, stating that concepts of disaster have shifted from a physical focus to a social focus. Following this, a disaster is defined according to "the characteristics of individuals and groups reacting to a situation." This notion of disaster focuses on the common properties of a social event rather than on "the social happening and away from the physical features of natural and technological agents and their effects" (98). He then goes on to state that, no matter what is involved, people must be evacuated according to a common warning system. "What motivates people to heed warning messages, what kind of warning message is effective, what limits the acceptance of a warning, and so on, is the same in all cases" (98).

Even though Showalter and Myers (1992, 10-11) were able to list nineteen differences between natural and technological disasters and only fourteen similarities (see Table 2), Quarantelli argues that, although tactics may differ (e.g., how far to evacuate), strategies do not. He says that the generic approach to disaster management is difficult to accept because of its tendency to deal with disasters according to cause. He states that the generic approach does not deny that there are important differences between disasters, only that they are not linked to specific types of hazards.

Table 2: List of Differences Between Natural and Technological Disasters

Natural Disasters	Technological Disasters
Are an expected aspect of the physical environment	Are created by human development and use of hazardous materials and are usually caused by human error
Are considered uncontrollable	Are considered controllable
Issues of control appear to produce more psychopathology in affected citizens	Issues of control appear to produce lower psychopathology than natural disasters
Humans are not held responsible	Responsibility is perceived as lying with a human or group of humans who calculate an event's predictability
Onset often allows warning/evacuation	Characteristically occur rapidly and without warning
Reluctance to evacuate until the threat is seen as extreme	A large portion of the population will evacuate without formal instructions to do so
Usually have a clear beginning and end via obvious destruction	Although the onset may be clear (e.g., warning sirens signalling a release), its "end" may not
The event and its effect on people and the environment are generally visible	The event and its effects on people and the environment are generally invisible
Recovery is generally visible (e.g., removal of debris)	Recovery is generally invisible (i.e., removal of radiation cannot be seen)
Individuals can personally observe the effects of a natural disaster	Because the effects are often invisible, individuals are more dependent on authority figures and/or the media for facts
Private individuals, public agencies, and corporations become involved in the response	Corporations and governments respond while private citizens are relegated to roles as victims and/or must be separated from the event's aftermath to ensure their safety
Authority figures are seen as helpful	Authority figures are seen as evasive and unresponsive
Individuals tend to personalize event	Individuals tend to depersonalize event
Mitigation focuses on human adjustment to potential events or to hazardous areas	Mitigation tends to focus on the technical process
Response/relief efforts more common than mitigation because of perceived lack of control over the event	Because of perceived control, mitigation is more common than response/relief
Familiarity develops due to experience	Familiarity is lacking due to lack of experience
Accumulated experience guides mitigation, management, and preparation decisions	Few accumulated experiences to guide mitigation, management, or preparation decisions
Following an event, community solidarity and consensus generally emerges	Following a technological event, a community may search for a "culprit," and conflict may emerge
No documented increases in naturally occurring hazardous events	A greater potential exists for hazardous technological events because: (1) a greater number of facilities use hazardous materials; (2) greater numbers and amounts of hazardous materials are in the marketplace; and (3) the population, along with its spatial distribution, has increased

***Source*: Showalter and Myers (1992, 10).**

Quarantelli (1991, 101) concludes that there are eight dimensions to any given population's response to a disaster and that these are crucial to the establishment of a generic plan. These dimensions are: (1) the relative proportion of the population involved, (2) the social centrality of the affected population,[8] (3) the length of time the affected population is involved, (4) the rapidity with which the population becomes involved, (5) the predictability of involvement, (6) the unfamiliarity of the crisis, (7) the depth of the population's involvement, and (8) the recurrence of involvement. According to Quarantelli, these dimensions apply almost exclusively (and equally) to only two of the four stages of the disaster management process: (1) emergency preparedness and (2) response.

Quarantelli and others notwithstanding, I believe that there are a number of reasons for choosing a hazard-specific approach to disaster management, assuming that emergency planners capitalize on similarities wherever and whenever possible:

(1) It seems inadequate to address only part of a process. Likewise, few mitigation strategies (e.g., non-structural retrofitting of buildings) apply to all hazards. For example, Quarantelli mentions the purchase of insurance as a mitigation strategy but, in Canada, residential flood insurance is not available.

(2) Education and training may require very specific skills and knowledge. While public education and training are necessary components of the preparedness phase of any disaster management process, the audiences, the content of courses, and the skills taught will vary depending on whether one is discussing, for example, flood evacuation or search and rescue (SAR) operations. Community residents require different knowledge, depending on whether they are learning how to lay sandbags or how to prepare an earthquake emergency kit. Furthermore, the skills and the education needed to implement a building retrofit mitigation policy are very different from those required to persuade office personnel to attach filing cabinets to their walls.

(3) Warnings differ. First, the length of warning periods are not the same (e.g., consider a drought as opposed to a hazardous material spill). Second, the instructions for any warning must be heard and then understood. The warning for an approaching tornado will be quite different in both format and content from the warning for an approaching blizzard. The idea of a single warning simply seems ineffective. For example, some communities, such as Port Alberni, British Columbia, have a siren that is sounded when a tsunami warning is given. When

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[8] That is, whether or not the affected population is central or peripheral to the larger social community.

residents hear the siren they know to take their vehicles and go to higher ground. To also use this siren to give notice of other types of hazards (e.g., a hazardous material spill) would in fact be dangerous because, not knowing which specific hazard the siren was for, residents could head directly into the danger area.

(4) Recovery and reconstruction activities following a disaster must often be hazard-specific. The recovery and reconstruction issues following a flood are very different from those following a nuclear accident. In order for these activities to be effective, there must be a clear understanding of hazards, future risks, and community vulnerability. While strengthening a bridge may well be advantageous regardless of whether one is concerned about a flood or an earthquake, the actual type of engineering involved would depend on the specific disaster for which the community is preparing.

Even though to continue to advocate a generic approach to disaster management seems to contradict the findings of Showalter and Myers (1992), Quarantelli (and, it would seem, a majority of researchers) continues to do just that. It is interesting and, I think, not surprising to note that none of the researchers supporting a generic approach has developed a sample of what her or his plan might look like. Given that the aim of disaster management is to provide communities with a process that will assist them in preparing for, dealing with, and recovering from a disaster, I maintain that the disaster management process should be hazard-specific. And this means that it must involve a careful and comprehensive HRV analysis the purpose of which is sustainable hazard mitigation (Mileti 1999).

2.4. Risk

This section begins with a review of how various researchers define risk, and it ends with how this dissertation defines it.

Penning-Rowsell and Handmer (1990 6) found that risk is defined in three ways:

- with regard solely to the occurrence probability of the damaging event -- a statistical concept;
- with regard to both event probability and the degree and type of damage or potential damage (here, risk is seen as the product of event probability and severity of impact); and
- with regard to the distribution of power within society as well as to the distribution of costs and benefits. In other words, who bears and who imposes the risk?

Let us examine how researchers have used these three ways of defining risk.

Many communities have been sited in locations that place them at considerable risk (e.g., flood plains). In other cases, the risk remains unknown until a disaster occurs or until new information is provided. Like many authors who define risk as related to likelihood or probability, Lawrence (1981, 109) describes risk "as the probability that a potential situation will cause damage to people, property and environment." Similarly, Godschalk (1991, 132) states that risk "is the probability that a hazard will occur during a particular time period" and that probability "is the number of chances per year or other time span that a disaster of a certain magnitude will occur" (144). This is, by far, the simplest definition of risk.

Scanlon (1991, 80) expands the concept of probability slightly by stating that risk is "a function of the way in which the hazard is handled. For example, a chemical plant may deal with hazardous chemicals but be low risk because of good safety procedures." Scanlon's focus on how a hazard is handled may make sense for industrial and technological hazards, but it has little value for many of the natural hazards.

As per Penning-Rowsell and Handmer's (1990) second definition of risk, geomorphologists often combine the probability and the consequences of an event: "the hazard is commonly defined ... as the probability of a change of a given magnitude occurring within a specified time period in a given area; the associated risk is the consequent damage or loss of life, property and services" (Varnes et al. 1984). Whyte and Burton (1980), on the other hand, define risk as the product of the probability of the occurrence of a hazard and its societal consequences. In both of the two preceding definitions, hazard and risk are connected: in the former, the hazard assessment is central and is perceived as an objective scientific discipline; in the latter, the focus is on risks as societally evaluated phenomena, and the concept of risk supersedes the concept of hazard (Slaymaker 1995, 1).

Similarly, for a number of researchers, risk seems to be linked to probability and magnitude. In other words, it is not enough to know that the river will flood; it is just as important to know when the flood will occur and whether it will be six centimetres or six metres. However, connecting the concepts of probability and magnitude (i.e., probability x consequence) within a definition of risk is problematic.

For example, it may be impossible to reduce the *probability* of an event, especially in the case of natural hazards (e.g., an earthquake), while there may be a multitude of actions, especially social actions, that can be taken to minimize the *consequences* of an event (e.g., getting decent building codes, developing neighbourhood response plans, etc.). On the other hand, when considering person-induced hazards (e.g., a hazardous material spill), there may be some actions that can reduce the likelihood of the disaster occurring and other actions that can reduce its negative consequences. The point is, steps taken to reduce the probability of a hazardous event do not necessarily have an impact on its consequences. For example, improving safety practices at a chemical plant may reduce the probability of the event taking place, but it will do little to reduce the community impact of an escape of toxic gases. However, in some cases there may indeed be a link between the likelihood of an event and its consequences (e.g., increased safety practices may lead to a faster response to the leak of toxic gases). Furthermore, while we may have very good data on the probability of an event taking place, we may have little information regarding its consequences (or vice versa). By attempting to combine the two, uncertainties get masked and may, in fact, be completely hidden.

However, given that the goal of an HRV analysis is to assist in the prioritization of mitigation strategies, and given that "risk assessment is presented as a way of examining risks so that they may be better avoided, reduced, or otherwise managed" (Wilson and Crouch 1987, 267), it would seem, assuming that time and resources are not unlimited, that risk assessment involves the ability to rank the likelihood of a disaster occurring along a continuum from high to low risk.

> The main definition of the verb "risk" in the *Oxford English Dictionary,* is "to expose to the chance of injury or loss." ... First, it is necessary that there be a potential loss of some amount (we will use "loss" as a general expression to include "injury"). Second, there must be a chance of loss. A sure loss is not a risk. Third, the notion "to expose" means that the decision maker can take actions that can increase (or decrease) the magnitude or chance of loss. Therefore "to risk" implies the availability of a choice. (MacCrimmon and Wehrung 1986, 9)

As stated by MacCrimmon and Wehrung, the availability of choices is directly related to the adoption and implementation of mitigation strategies. Who implements these mitigation strategies and how they are decided upon leads us to Penning-Rowsell and Handmer's third definition of risk, which involves the distribution of power within society. According to Aysan (1993, 1): "Quite often ... physical vulnerability to hazards occurs where people lack the resources, awareness, knowledge, power, or the choices to mobilize the defences against hazards. Reduction of disasters and its sustainability, above all, necessitate making positive changes in these conditions." However, increased pressure to implement mitigation strategies by formerly disenfranchised populations may reduce the impact of a disaster but not the likelihood of its occurrence (consider, for example, an earthquake). Thus, I would argue, with Aysan, that the relationship between societal power and the likelihood of a disaster is better handled within the vulnerability assessment process than within the risk assessment process.

2.4.1. A Definition of Risk

Clearly, there is no universally accepted definition of risk. Therefore, for the purposes of this dissertation, I define risk as *the probability, based on available data and scientific knowledge, of a disaster occurring in a particular place*. The impact on the community may be very different, depending upon the magnitude or severity of the disaster, but the likelihood of each disaster has to be calculated separately from its consequences. The consequences of a hazardous event are considered under the vulnerability and impact phases of HRV analysis.

2.5. Vulnerability Assessment

> Risk ... should not be confused with vulnerability, which refers to the resources and coping abilities of a specific community to a specific hazard ... Vulnerability is a reflection of the community's coping resources and may vary within the smaller social and economic groups which form a large community. (Lindsay 1993, 68)

As with risk and risk assessment, there are a number of different definitions of vulnerability; however, with regard to the latter, there appears to be a greater degree of consensus. Godschalk (1991, 132) offers what is probably the best general definition of vulnerability: "[The] susceptibility to injury or damage from hazards." His definition specifies that both people and structures can be negatively affected. To carry the point further, since, obviously, the contents of structures are as vulnerable to damage as are modes of transportation, recreational areas, and sites of historical or cultural importance, we could say that vulnerability is (1) the susceptibility of people to injury as the result of a hazardous event, and (2) the susceptibility of the things people value to damage as the result of a hazardous event.

Buckle (1995, 11) adds the concept of resilience to the definition of vulnerability. He identifies potential social, economic, and environmental effects and introduces the notion that vulnerability is associated with an ability to recover (which is not always apparent in other definitions), and he implies that there are some political decisions to be made regarding allocation of resources (and that these decisions contribute to vulnerability). He also introduces a key concept of the vulnerability assessment process: the increased susceptibility of a community to a disaster (its vulnerability) results in increased losses. Just as it is important to identify vulnerabilities to a disaster, so it is important to identify the negative impacts of a disaster. These can be social, political, environmental, or economic in nature. We know that, by definition, disasters are capable of causing death and injury. We also know that housing and schools may be destroyed. These particular losses may be considered to be social impacts, as they affect the ability of individuals and families to function.

With regard to negative environmental impacts, if a community contains important ecological sites (e.g., the site of a unique flora or fauna habitat), then these areas may be extremely vulnerable to almost any sort of disaster. Many ecological sites are already threatened by a number of factors (e.g., logging practices, pollution, human habitat), and so any further degradation of them could easily destroy their ecological stability. As well, many types of disasters can affect air and water quality for very long periods of time (e.g., Chernobyl). Clearly, it is important to recognize how environmental impacts are compounded when a community is vulnerable to the effects of certain hazards.

There is monetary loss, or negative economic impact, whenever buildings, non-structural property, or infrastructure is damaged or destroyed. These losses can also result in loss of jobs, loss of economic stability, and loss of services (e.g., power). The more vulnerable the community to these types of losses, the greater the economic impact of a disaster. For example, the economic impact of an earthquake in an area that primarily includes buildings made of unreinforced masonry (URM) will be significantly higher than it would be in an area where buildings have been seismically retrofitted.

Finally, the ability of the community to influence policy makers to reduce vulnerabilities is critical. We know that a disaster entails political impacts. After a disaster has struck, a community often turns to its politicians when looking for someone to blame. If local politicians have not allocated resources for emergency preparedness and mitigative measures, then they can expect to pay the political price. However, prior to a disaster, as is discussed in Chapter 1, politicians often have to make trade-offs among many issues competing for the same tax dollars (e.g., fighting crime, creating park land, cultural projects). If asked to choose between allocating funds for reducing car theft or protecting oneself again a possible earthquake, many citizens would support the measures taken to reduce car theft and lobby against funding for earthquake mitigation. After the earthquake, however, it may well be a different story. Thus politicians are often caught in a "Catch-22," balancing an immediate problem (e.g., the need for a street light) with a potential one (e.g., an earthquake).

Some emergency managers include geophysical and topographical factors in the vulnerability assessment process, while others include them in the risk assessment process. For example, Pickett and Block (1991, 278-79), following the work of Terrence Haney, discuss the development of an earthquake hazard vulnerability model that utilizes data from five key areas: (1) geophysical, (2) topographical, (3) transportation and utility infrastructure, (4) structural facilities (buildings and bridges), and (5) demographic factors. However, Pearce et al. (1993, 4) argue that the consideration of geophysical and topographical factors belongs in the risk assessment process. For example, an analysis that concludes that the existence of a fault-line increases the likelihood of an earthquake occurring is part of risk assessment; however, the proximity of the community to the fault-line may increase or decrease the vulnerability of the population. Related to this argument is Anderson's (1992) suggestion that emergency planners should give special consideration to the growing vulnerability of metropolitan areas. Anderson makes an important point, as often the consequences of disasters in metropolitan areas are related to how geographic and topographic information has been considered. If, for example, such information is perceived to be part of risk assessment, then proximity to a fault-line would lead to mitigation measures that could address the need to reduce risk by zoning against construction near the line, expropriating existing properties, and so on. If, on the other hand, such information is perceived to be part of vulnerability assessment, then the issue becomes not one of reducing the likelihood of experiencing an earthquake but of how to decrease one's vulnerability by residing in an earthquake-resistant building, improving the infrastructure, or whatever.

I would argue that geographic and topographic information is best dealt with in the risk assessment phase of HRV analysis. For example, proximity to an airport increases the risk of experiencing an air crash, while living next to a hazardous material site increases the risk of experiencing the results of a hazardous material spill. If these situations are not considered under the risk assessment phase, then it is possible that those concerned may neglect to consider ways to reduce the likelihood of their leading to disasters.

Vulnerabilities may be considered in terms of the individual, the general location, the capacity to respond, and the time of day, week, or year. The vulnerability of the individual may be reflected in a number of ways. For example, if a person is of low socio-economic status, then she/he is more vulnerable than is someone of high socio-economic status and, as a consequence, will be less able to recover from a disaster (Bolin 1976,1982; Drabek and Key 1984; Bolin 1993). As for general location, one needs to be aware of the vulnerabilities specific to one's area. Clearly, those living near or on a flood plain would be more vulnerable to flooding than would those living on a steppe. Regarding capacity to respond, a prepared community is less vulnerable than is an unprepared community. If residents have adequate stored water, first-aid kits, emergency food rations, and other emergency supplies, then they will not be as vulnerable as will those who do not have these things. Finally, the time of day and day of the week can affect one's vulnerability. If one is living in an earthquake-resistant home, but at 0800h each morning is travelling across a bridge that is not earthquake resistant, then, at that time, one is extremely vulnerable to the effects of an earthquake.

2.5.1. An Enhanced Definition of Vulnerability

Given the foregoing, for the purposes of this dissertation, I define vulnerability as *the susceptibility of people, property, industry, resources, ecosystems, or historical buildings and artefacts to the negative impact of a disaster.*

The more vulnerable the region, the greater the difficulty the community has in adequately responding to a disaster. The more vulnerable the people, the greater the potential for deaths. The greater the value and number of buildings, industries, and resources, the greater the likelihood of social and economic instability. Similarly, the greater the uniqueness of a community's ecosystems, the greater the likelihood of the disruption of potentially irreplaceable fauna and flora. Historical buildings are worthy of special note, as it is often only after a disaster that residents realize their importance and that great pains are taken to ensure their preservation.

2.6. Risk Management

> Risk management decisions that benefit some citizens can harm others. In addition, people do not all share common interests and values, so better understanding may not lead to consensus about controversial issues or to uniform personal behaviour. (National Research Council 1989, 3)

Risk management is the final phase of HRV analysis, and it should succeed in providing information on existing and potential hazards, risks, and vulnerabilities so that a community can make informed decisions with regard to mitigative strategies.

2.6.1. Definitions and Descriptions

The term "risk management" may vary according to one's discipline. For some, the term is used interchangeably with "risk assessment"; for others, it encompasses the entire HRV process. There are as many different definitions of risk management as there are definitions of risk and risk assessment. Similarly, there is no agreement as to whether risk assessment and risk management should be considered as one process or two processes. But most, like Lave (1986) and Paoli (1995), suggest that risk assessment is one of a number of steps that occur within the risk management phase of HRV analysis. This is the approach that I follow.

There are two key questions that must be addressed when defining the risk management process: (1) does it include implementing mitigation strategies? and (2) what steps are necessary to ensure that it is meaningful vis-à-vis disaster management?

There is no agreement in the risk management community with regard to whether or not risk management and the development of mitigative strategies should be separated. With regard to relegating risk assessment to the sphere of the scientist and risk management to the sphere of the policy maker, Rowe (1991, 23) says, "while it is possible to effect such separation in some cases, generic adherence to such a rule can lead to the masking of critical policy issues." However, I would argue that they should be separated. Knowing what risks and vulnerabilities exist is important, as is being able to rank them according to which are most likely to occur and, having occurred, to have the greatest negative consequences. However, having this information is one thing; being able to do something with it is quite another. The discussion concerning which mitigation measures to adopt in order to deal with risks and vulnerabilities incorporates such issues as the availability of resources, political will, public pressure, availability of tools and techniques for dealing with the situation, and so on. Risk management and the development of mitigative strategies, respectively, involve different experts (e.g., seismologists versus engineers, hydrologists versus building inspectors, etc.) and are based on different sets of information. Thus, I would argue that the risk management process should prioritize the areas slated for mitigative strategies and make recommendations regarding which issues should be tackled; but I would also argue that it should not include the implementation of mitigation strategies.

Although the risk management step is critical with regard to allocating resources for mitigation and with regard to the development of an emergency response plan, few models have identified it (and the necessary steps it encompasses) in a practical, easy-to-carry-out fashion. The ease with which researchers and practitioners gloss over risk management seems curious. Godschalk (1991, 143) asserts that "risk and vulnerability mapping is simply a procedure for locating areas with different degrees of probability and susceptibility." He illustrates this with the use of a hurricane flood map, which shows areas of potential flooding and possible evacuation. He then states that the value of the buildings and structures could be calculated and that the dollar value could provide communities with a vulnerability analysis. Although acknowledging that, throughout the United States, few such maps have been completed for anything other than floods, he concludes: "In the meantime, the local emergency manager must use various local, state, and federal resources to compile risk and vulnerability maps" (146). And when the maps are not available? Godschalk is vague.

He lists, as the first two of three steps in his mitigative process:

1. Identifying all local hazards: their characteristics, locations, probabilities of occurrence and potential impact on people, property and the environment; also identifying appropriate actions to reduce structural and non-structural damage.
2. Analyzing the probable risks of disaster occurrence and the vulnerability of people, property and the environment to injury or damage. The analysis is based on inventories of structures and populations at risk, estimates of economic loss, studies of risk perception, and projections of mitigation costs and benefits. (135-38)

Here he proposes what it is that a mitigative process should address, but he neglects to describe how it should be conducted.

I would argue that the risk management phase must include not only the risk assessment phase, as previously defined, but also the vulnerability assessment phase (as is suggested by Godschalk). Paoli (1995) includes a risk evaluation phase (e.g., benefit/cost analysis) and a risk control phase (i.e., that which identifies feasible risk control options and evaluates them for effectiveness, residual risk, and stakeholder acceptability), but he ignores the concept of vulnerability. Additionally, he fails to acknowledge that the frequencies and consequences of risk scenarios are largely unknown and that uncertainty is very high. And, even though there are methods for looking at the distribution of benefits and costs, due to the complexity of disasters they are simply not appropriate in this context. Often what is of direct benefit to one sector of the population (e.g., providing jobs in a hazardous waste disposal site) is not of benefit to another (e.g., providing increased potential of a dangerous hazardous material spill).

Lave (1986, 465) suggests that risk management is made up of nine steps (see Table 3). He includes references to vulnerability factors under the first column (Facts and Data), but he indicates neither how analyses are to be completed nor how judgments are to be made. For example, he says that "the elements of the problem must be pulled together in a decision analysis" (469). How they are to be identified and how they are to be pulled together – and, indeed, how the decision analysis is to be structured – is not given in any practical detail. It is also interesting that there are no lines explicitly forming any relationships between the various elements. Furthermore, Lave makes no mention of who is supposed to be completing the risk management process.

Nonetheless, Lave's (470) list of criteria for determining whether or not a risk has been properly managed appears to be a good one.

- The first criterion is the extent to which the risk has been reduced to a level of acceptability.
- The second criterion is efficiency.
- The third criterion is equity.
- The fourth criterion is administrative simplicity.

Table 3: Steps of Risk Management

Facts and data	Conceptual Steps	Judgments
Human experience, toxicology, or epidemiology	Hazard identification	
Exposure patterns, potency, other challenges, susceptibility	Risk assessment	Causality, nature of risk
Economic, social, and legal facts	Identification of regulatory alternatives	Incentives and company information
Uncertainty, risk, economic and social projections	Decision analysis	
	Regulatory analysis	Importance of other social, economic and legal effects
	Legal or political challenges	costs of regulation, projected profits, perceived social goals
	Implementation and enforcement	
Emissions, ambient measurements, and epidemiology	Monitoring	Are goals being met?
	Hazard identification, etc.	

***Source*: Lave (1986, 465).**

In summary then, Paoli's (1995) description of what a risk management process should look like resolves some issues but creates others (especially within the context of disasters), namely: (1) the difficulty of determining the stakeholders' needs; (2) the great number of uncertainties that exist regarding when and where disasters are likely to occur; (3) the lack of consideration of vulnerability factors; and (4) the use of benefit/cost analyses to deal with human and social impacts. Godschalk (1991) and others view the risk management process as almost a technical task (based on mapping tools) and thus easily avoid having to wrestle with some of the practical problems of dealing with risk and vulnerability assessments. Lave (1986) provides a structure that includes integrating and judging data without ever explaining how to do this. In order to avoid such deficiencies, I have chosen to use the risk management process defined by the National Research Council (NRC) (1991, Appendix).

The NRC list indicates the steps that communities concerned with hazard reduction should take. It is practical, incorporates many of the definitions already established for other phases of the HRV process, and is relatively easy to follow. It also stresses that the goal of the risk management process is to make recommendations for the implementation of mitigation strategies. It does not, however, incorporate any of the criteria that stress public participation,[9] the sharing and providing of information, and so on (as is demonstrated later, these criteria can easily be incorporated into this model). The NRC list reads as follows:

(1) Identify natural hazards (location, intensity, frequency).

(2) Map hazard-prone areas and environmentally sensitive areas.

(3) Inventory structures and areas vulnerable to hazards (e.g., unreinforced masonry, mobile homes).

(4) Inventory critical facilities and resources (e.g., hospitals, schools, utilities, and endangered species).

(5) Inventory sites containing hazardous and toxic materials, determine vulnerability.

(6) Inventory special-needs groups (e.g., elderly, people with handicaps).

(7) Conduct hazard and risk assessments (vulnerability of population and natural resources to specific hazards).

(8) Prepare hazard overlay maps in order to depict vulnerable areas and populations.

(9) Digitize hazard and risk assessments (e.g., geographic information systems).

(10) Develop procedures and schedule for updating hazard and risk assessments.

(11) Translate hazard and risk assessments into recommendations for action (e.g., community public awareness, mitigation, preparedness programs).

Points one and two have been included in the hazard identification and risk assessment phases of HRV analysis, respectively. Points three, four, and six have been included in the vulnerability assessment phase. The first part of step five (completing an inventory of hazardous and toxic materials) would be completed during the hazard

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[9]It should be noted that more recent NRC work on environmental risk does include stakeholder involvement (NRC 1996) and this work, and other related research, is discussed in Chapter 5.

identification phase, and the vulnerability to these hazards would have been included as part of the general vulnerability assessment. Point eight deals with the preparation of maps that would depict the areas of high vulnerability for each hazard being considered. The overlay maps may, in communities that are vulnerable to numerous hazards, prove to be ineffective, as the entire community may be "blocked out." However, if there are only a few vulnerable areas and not many hazards to consider, then the overlay maps may be useful in determining the areas of high vulnerability.

Digitizing hazards and risks onto a geographic information system would provide the participants in the risk management process with the ability to easily add further information. For example, if a GIS map of the community were incomplete with regard to soil types, then, as soil studies were completed, they could be added to it. However, this step is not critical to the overall risk management process.

The final step of the risk management process – translating findings into recommendations for action – coincides with the ultimate goal of conducting an HRV process: to provide information to communities so that they may forestall disaster through the implementation of effective mitigation strategies.

2.7. Defining Community and Region

The focus of this dissertation is limited to models that are applicable at a community or regional level. A community is defined as a village, municipality, or township. It may be composed of a number of neighborhoods (geographically and conceptually defined), and each of these smaller "communities" may engage in emergency planning. However, the focus of this work is on communities with stronger and broader powers than those found at the neighbourhood level.

A region includes areas that are geographically and administratively united. As stated by Hodge (1991, 280): "Often 'regional planning' seems a nebulous term. This arises from the fact that what is a region from one point of view may not constitute a region from another. Regional planning boundaries cannot be drawn with precision because of the variety of concerns involved." These concerns may include planning for natural resources (e.g., the Tennessee Valley Authority) and planning for economic development. In Canada, regional planning is most often identified with planning for rural areas. In British Columbia, for example, a region can include unincorporated areas outside of municipal jurisdiction. A region can also include any area in which a regional authority has responsibility for planning across local boundaries. For example, the Greater Vancouver Regional District (GVRD) is comprised of a number of member municipalities, and the GVRD board is empowered to make rules and regulations that apply to agreed-upon policies and services. In some cases municipalities may choose to align themselves administratively in order to implement one (or more) specific program or policy. For example, the area in the BC Lower Mainland that is comprised of West Vancouver, the City of North Vancouver, and the District of North Vancouver is familiarly known as the North Shore. These three municipalities have agreed to plan for emergency preparedness through one coordinated program; thus, in this dissertation, the North Shore would be considered a region.

The next chapter further elaborates on communities and regions and discusses the influences of both community planning and disaster management on community development.

2.8. Summary

In this chapter I have reviewed and evaluated a number of definitions and terms used in this thesis. I developed a new definition of "disaster" – a definition that takes into account the inability of a community to respond to an event so as to adequately protect its social, ecological, and economic resources as well as to preserve its political stability. I identified "disaster management" as a circular process – a process that incorporates HRV analysis, mitigation activities, response and recovery planning, education and training, and the implementation of a plan. I contend that HRV analysis is the cornerstone of the disaster management process – a process whereby participants plan for and deal with potential and actual disasters.

I classified hazards as being: (1) natural, (2) diseases, epidemics, or infestations; and/or (3) person-induced which established the need for hazard-specific planning rather than generic planning. Risk was defined as the probability, based on available data and scientific knowledge, of a disaster occurring in a particular place. I defined vulnerability as the susceptibility of people, property, industry, resources, ecosystems, or historical buildings and artefacts to the negative impact of a disaster and as a function of people, place, preparedness, and time. Four potential impacts of a disaster were identified: social, economic, environmental, and political.

I concluded with a definition of risk management and a brief discussion of communities and regions. Utilizing the foregoing definitions, in Chapter 3 I go on to address the problems and benefits associated with integrating hazard information into local decision-making processes.

3. Integrating Hazard Information into Local Decision-making Processes

There are a number of problems involved in integrating information about hazards into local decision-making processes, and any adequate framework for evaluating the success of disaster management and HRV analysis must be able to address them.

Using the definitions and background provided in the previous chapter, five obstacles to the integration of HRV analysis and decision making are examined: (1) historical factors, (2) social factors (including how persons perceive and evaluate risk), (3) technological factors, (4) organizational factors, and (5) political factors. Chapter 3 concludes with the identification of an adequate framework within which to situate HRV analysis.

3.1. Historical Factors

What follows is a brief historical overview of how the field of disaster management has developed in North America. It shows how the development of disaster management and community planning has led to lack of public understanding and participation. I argue that this deficiency has contributed to a lack of integrated planning at the local level, and I offer a retrospective analysis of the importance of public participation in disaster management. This is illustrated with a case study (Appendix A) – the Portola Valley, California.

3.1.1. Historical Overview

Historically, disaster management planning has been viewed from a para-military perspective (Scanlon 1982); that is, planning has been conducted for, not with, the community (Laughy 1991). Disaster management planning originated during the Cold War, when planning for nuclear war and the building of bomb shelters was encouraged. Once the threat of nuclear war ebbed, concern turned towards responding to natural disasters. Drabek (1991) concurs with this and adds that disaster management in the United States is based on civil defence and natural disaster responses as well as on behavioural science research. Nevertheless, as Petak (1985, 3) says, "public administration, as a discipline, has generally neglected to consider emergency management within the mainstream of its activities." And, according to Aquirre (1994, 3), "it is very seldom that local governments attempt to educate the public to the hazards that threaten them." This is despite the fact that surveys indicate that the public would welcome such efforts (Drabek 1986, 23).

So, in the past, communities have often been left out of the disaster management planning process altogether. However, there may be a relationship between the degree to which communities accept disaster management planning and the degree to which they experience disasters: the greater the exposure to disasters, the greater the interest in disaster management (Drabek 1986). However, if one were to designate those areas with the strongest community-based disaster management plans, it would undoubtedly be those with full-time emergency coordinators. And, as Kreps (1991) found,[10] the larger the municipality, the more likely it is to have a full-time emergency coordinator. However, he goes on to say that whether or not a municipality has an effective emergency management department depends, to a large extent, on the credibility given to it by local government officials (48). He concludes that, at present, there is no work, either in Canada or the United States, that exhibits a comprehensive understanding of local government emergency management strategies and their effectiveness.

According to Rubin (1991, 240), just as community members were becoming increasingly frustrated with being excluded from the decision-making processes involved in community planning, so they were becoming increasingly frustrated with being excluded from those involved in disaster planning. Fortunately, community participation is gradually becoming an accepted part of the disaster management process. One of the most exciting changes to community emergency management has been brought about by the push, originating in California and sweeping up the Pacific coast through Canada, to develop neighbourhood emergency programs. These programs (e.g., the Home Emergency Response Organization System [HEROS] in Coquitlam, British Columbia) entail recruiting a leader and volunteers from each neighbourhood. Their tasks are to (1) complete a neighbourhood inventory of equipment (e.g., chainsaws) and skills (e.g., nursing) that could be useful during and after a disaster; (2) develop a list of special-needs situations (e.g., elderly people living alone); and (3) arrange for local stockpiling of medical supplies, food, and water. In return, the community provides basic emergency training, basic Search and Rescue (SAR) training, first-aid training, and financial assistance with regard to equipment costs. These types of community disaster management programs have proven to be very effective (Renteria 1992).

Recent findings in Australia suggest a shift from a focus on response and recovery issues to a focus on mitigation issues (albeit that not much has been done in terms of developing recovery plans). The Australia/New Zealand Risk Management Standard (1995, 360) states that "risk management is a framework for the systematic application of management policies, procedures and practices to the tasks of identifying, analyzing, evaluating, treating and monitoring risk." It is recognized that while a top-down policy is needed, it is really the local-level

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[10] Kreps (1991) suggests that a 1982 survey by the International City Managers Association (ICMA) is still the best source of data regarding local government and emergency preparedness in the United States. In this survey of 6,000 US cities, 67 per cent had no emergency planner.

bottom-up policy that provides the impetus for the implementation of mitigation strategies and a successful disaster management process. Salter (cited in Disaster Preparedness Resources Centre 1998, 179) summarizes the shift in disaster management as follows:

From		To
• Hazards	→	• Vulnerability
• Reactive	→	• Proactive
• Single Agency	→	• Partnerships
• Science Driven	→	• Multi-disciplinary Approach
• Response Management	→	• Risk Management
• Planning for Communities	→	• Planning with Communities
• Communicating to communities	→	• Communicating with Communities

There are several interesting aspects to this shift in disaster management planning. First, it takes the focus away from specific hazards and incorporates general vulnerabilities into the disaster management process. While these vulnerabilities include property concerns (e.g., poorly constructed buildings), they also include concerns about people living in the community. Second, the shift from reactive to proactive measures moves disaster management from a focus on response and recovery activities to a focus on community planning (e.g., land-use policies, flood-plain management, etc.). Third, this multi-disciplinary approach recognizes the many interests that exist in the community and, by striving to create partnerships, attempts to balance competing interests while working towards common goals. Fourth, the stress on working with and communicating among communities puts a strong onus on disaster managers and community planners to involve residents in their activities.

The work in Australia and New Zealand parallels the recent work completed by hazards experts and researchers for the Second Reassessment of Natural Hazards in the United States, summarized by Mileti (1999). The American findings add the concept of "sustainability" to hazard mitigation (see Chapter 2). However, in Canada, the idea that mitigation is central to disaster management is still in its infancy.[11] While some agencies and businesses have taken steps to incorporate mitigation strategies into disaster management, by and large, federal, provincial, and municipal governments have yet to make any significant changes in how they operate. For example,

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[11] The Disaster Preparedness Resources Centre of the University of British Columbia hosted a conference entitled "Mitigation Symposium: Towards A Canadian National Mitigation Strategy" in January 1998 (Disaster Preparedness Resources Centre 1998).

in the spring and summer of 1999 there was a high risk of major flooding along the Fraser River in British Columbia's Lower Mainland. All levels of government contributed millions of dollars towards dike repairs and other flood mitigation activities; however, once the threat diminished, funding stopped and day-to-day operations have continued without any consideration of on-going mitigation programs (Harrower 1999). Attention was given only to one hazard, and only when it presented an immediate and serious threat to the community. Once this threat was alleviated, work ceased and little, if any, attention was given to other hazards, risks, and vulnerabilities. The fact that the HRV process is not fully integrated into the overall disaster management process at the community and regional levels may be due to the fact that its importance is not understood and/or the fact that the tasks involved in completing an HRV analysis have not been adequately defined.

Mileti (1999) focuses attention on various mitigation tools. He contends that (1) hazard identification and impact assessments are essential to developing comprehensive land-use plans (157), and (2) that hazard-specific knowledge is critical to being able to predict, forecast, and warn populations of potential hazards (175). Deyle et al. (1998, 121) make a stronger statement: "The first step in appreciating the potential utility of hazard assessment is to understand how it is conducted and how it has been used and can be applied to land use planning and management." They go on to state that hazard identification, vulnerability assessment, and risk analysis are each essential to realizing the full potential of the disaster management process.

Godschalk et al. (1998) are very clear about the need to complete HRV analyses before attempting to integrate sustainable hazard mitigation and local land-use planning. They believe that, while state and federal governments and agencies have a role to play in establishing mitigation policies, it is up to local communities to initiate and implement those policies that will lead to the adoption of mitigative strategies. And they see land-use planning as key to this process.

So, given the links between HRV analysis and land-use planning, what are the links between disaster management planning practices and community and regional planning?

3.1.2. Integration of Community Planning and Disaster Management Planning

Although rooted in very different ideologies, community planning and disaster management planning share some common features: both have been conducted in isolation from the community; both are concerned with the physical community (e.g., buildings, infrastructure, etc.) as well as the human community; both are based in local government; and both take a predictive approach to planning. They differ in that community planning has a long academic heritage and is rich in theory and design, is long range, is comprehensive, and has often been criticized for being overly optimistic[12] (Hodge 1991). Disaster management, on the other hand, has only emerged since the mid-1950s. Also, disaster management has often been seen as a second career for retired police officers and members of the military, and it is only very recently that academic institutions have begun to offer degrees in it. Disaster management has tended to be concerned about the short-term situation (e.g., rebuilding damaged homes in flood plains), to have a narrow focus, and to be pessimistic[13].

Both community planning and disaster management can make important contributions to community safety, thus it is quite surprising that the two disciplines have not communicated with one another and attempted to coordinate their efforts. According to Myers (1997, 1):

> People who work to manage natural hazards must repackage themselves and what they know from the local community's viewpoint, across adjustments and across hazards, but in context of non-hazards community goals. Our research is telling us that local stakeholders' capacity to manage their own environment, resources, and hazards must be increased, and that it is the locals who must decide what they are willing to lose in future disasters.

As discussed in Chapter 1, as catastrophic losses mount, previous disaster management strategies are seen to be ineffective. Change seems inevitable, and the trend is clear: ensure more community involvement, ensure basic responsibility at the local level, and ensure that there are links between disaster management and community planning. On a practical level, the links between disaster management and community planning seem abundant.

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[12] Hodge (1991, 182) states that the community planning process has been criticized for being optimistic, "both about our analytical capabilities and about the altruism of community members."

[13] In many cases disaster managers have somewhat unrealistically focused on worse-case scenarios (e.g., the nuclear bomb that destroys entire countries).

Indeed, they may lead to zoning bylaws to avoid high-risk areas, building codes to reduce the consequences of hazards, mitigation strategies to offset the potential of hazards, and so on. Yet, traditionally, the disciplines of disaster management and community planning have not been linked. Why not?

To begin with, disaster managers and community planners come from very different backgrounds, the former being comfortable with phrases such as "command and control," "incident command system," "emergency responders," and "aid to the civil power," and the latter being more familiar with phrases such as "not in my backyard (NIMBY)," "community empowerment," "special interest groups," and "public forums." Furthermore, disaster managers see things differently than do community planners. For example, to local community planners, the gentrification of older unreinforced masonry buildings represents an opportunity to preserve local history and culture as well as to bring in tourist dollars; to disaster managers, these edifices represent collapsed buildings during an earthquake. Community planners have traditionally advocated local zoning in order to keep industrial and residential areas apart (although this is slowly changing); disaster managers have traditionally seen industrial areas as conglomerates of dangerous goods. However, despite their different orientations and backgrounds, both community planners and disaster managers have similar goals: to make the community as safe and as secure as possible while maintaining its cultural heritage and maximizing the quality of human life.

There are two kinds of phenomena that need to be considered: (1) those planning activities that occur before the disaster, and (2) those that occur during or after the disaster. Of course, as will be recalled, mitigation activities occur in all phases of disaster management and are usually conducive to cooperation and coordination between the disaster manager and the community planner. For example, most communities have official plans that plot their progress and future development. Discussions around these plans should include the local disaster manager as well as community planners. New developments should not be built without considering both existing and potential hazards and risks. This is especially important with regard to schools, hospitals, and other critical facilities. As communities retrofit existing infrastructure, disaster managers should be directly involved in discussions and decision making.

When a community has not been included in the policy and decision-making processes, in post-disaster situations it often finds itself caught between contrasting philosophies. For example, some people will want the community to return to pre-disaster conditions, while others will want to take the opportunity to pursue various other planning goals (Central United States Earthquake Consortium 1993, 44).

The challenge, therefore, is twofold: (1) to integrate the processes of community planning and disaster management planning so that both are working towards the same goals, and (2) to encourage a high degree of community participation. Consider the following principles in Australia's Safe Community Program (Salter, cited in Disaster Preparedness Resources Centre 1998, 127):

- Listen to the community -- let them define what they believe are the most important problems;
- Mobilize all members of a community creatively;
- Coordinate efforts at a regional level;
- Raise public awareness of the importance of managing risk; and
- Ensure that powerful interest groups support the community efforts.

The social mobilization planning tradition (Friedmann 1992, 1987) is strongly represented by the above principles: people in their own communities have to take their destiny into their own hands; the community should determine its own future; individual and collective needs must be balanced; and there must be a move towards self-reliance. As is evident, both social mobilization planning and the disaster management philosophy espoused in the Safe Community Program stress the importance of public participation.

Godschalk et al. (1998) espouse four community planning options from which communities can choose when developing sustainable hazard mitigation: (1) stakeholder participation, (2) planning components, (3) plan types, and (4) mitigation strategy. The first option involves the degree to which community help and support is enlisted in formulating and implementing the mitigation plan. The second option integrates the HRV assessment into community values, and it is then used to formulate policy and planning actions in order to meet community expectations. The third option involves deciding whether the sustainable hazard mitigation plan should be fully integrated with the community development plans or whether it should be a stand-alone plan. Godschalk et al. (1998), in all but a few situations, are strong advocates of incorporating the two plans. The final option involves the type of mitigation strategy that the community chooses. This involves answering the following questions: (1) what is the degree of cooperation? (2) which local authority will take the lead role? (3) how will the strategy affect current development as opposed to future development? (4) to what degree will hazards be controlled and how will this be affected by human behaviour? (5) what will be the emphasis on pre-disaster as opposed to post-disaster activities? and (6) to what degree will outside partners be involved? It is suggested that the results of an adequate HRV analysis may well determine the mitigation strategy that the community finally adopts. But a great deal of the impetus for adopting Godschalk et al.'s four options will depend on the degree of community support.

3.1.2.1. Why Include the Public?

If community planners and local officials ignore the local community, then they decrease their chance of providing reasonable solutions to disaster-related problems. As Parker (1992a, 134) points out, "A review of the major catastrophes during the twentieth century reveals the shortcomings of existing governmental structures to receive critical information from beneficiaries just when they need it most, when important decisions are being made following major disasters." As Britton (1989, 17) indicates with regard to the Cities Commission Report following a cyclone in Darwin, Australia, "[It] created a rift between the public and the planners, and the destruction of public confidence contributed significantly to the failure of the planners to bring about changes in land use that were desirable....By 1977, as reconstruction neared completion, land use change in Darwin had, if anything, reinforced the pre-cyclone trends which the planners had tried to halt."

The disadvantaged need to be able to gain access to information about, and to have a say in the development of, mitigative strategies. For example, as Bolin (1993, 45-46) points out with regard to the earthquake in Whittier Narrows, a suburb of Los Angeles, the construction that followed it resulted in reduced low-rent housing and increased rents in commercial buildings. Because of a twenty-one-month delay in completing the comprehensive reconstruction plans (it took the city government seventeen months to appoint a consulting firm to prepare a plan for the uptown area), the Whittier Narrows' Earthquake Relief Fund ($420,000), originally intended to provide relief to all victims, ended up going exclusively towards grants for small businesses that agreed to stay in the uptown area.

For too long officials have not wanted to reveal hazards and risks to their respective communities, fearing that panic would prevail or that people would flee. The evidence, however, demonstrates the contrary. For example, according to the International Federation of Red Cross and Red Crescent Societies (1995, 18), when the Bangladesh Rural Advancement Committee took it upon itself to inform parents of the causes of, and cure for, dehydration in children, the result was that, in the aftermath of the 1991 cyclone, diarrhoea rates remained normal.

Community members have the right to know and to understand what hazards to expect, and they also have the right to participate in making difficult decisions. Again, according to the International Federation of Red Cross and Red Crescent Societies (1995, 37), all disaster research in the past decade has clearly indicated that community members in disaster-stricken areas already knew of both the risks and, for the most part, the remedies: "The gap has been in the political will to apply remedies prior to full-scale disaster and to commit resources to this vital developmental need rather than, for example, to the building up of a sophisticated armoury."

In order for community members to influence politicians, they need to have access to the information essential to rational decision making. As the International Federation of Red Cross and Red Crescent Societies (1995, 37) points out, the public's right to information is a fundamental feature of democracy and is essential to disaster preparedness: "Once people have access to information as a right -- not just from their country's government, local authorities, companies and interest groups, but also from international organizations and aid agencies, they can then plan for themselves, make informed choices, and act to reduce their vulnerability." Of course a community is not monolithic, and, as Boothroyd and Anderson (1983, 6) discuss, those involved in social planning must continuously address the question: "planning for whom?" For if the differences within any given community are not addressed prior to a disaster, then, typically, they hamper recovery efforts.

In post-disaster situations, the poor and visible minorities are always the most affected and constitute the majority of those who need alternate housing, counselling, and other social services. This is true in both developed countries and in developing countries. The poor and the disenfranchised must not be overlooked in disaster planning activities -- especially today, when "the ability of local groups to respond to crisis and the more chronic problems of vulnerability is becoming increasingly important as the traditional welfare net provided by governments is being eroded in almost all countries of the world" (International Federation of Red Cross and Red Crescent Societies 1995, 16).

When the public is not involved in the disaster management process, it often, not surprisingly, challenges the decisions and actions of those in command. The following quote regarding the Italian Mezzogiorno earthquake in November 1980 exemplifies what may happen when a community is left out of the post-disaster planning process.

> And in Calitiri, a town of 3,400 persons, an old man politely stopped a convoy of vans that had arrived to take villagers out of the storm-battered highlands and to hotels along the Amalfi coast. "You are a good and capable man, but don't come again," the old man said to the young police captain who was in charge of the relocation job. "This is where we lived, and this is where we want to die" (Ward 1989, 281).

However, even though public participation is important, it is not always easy to incorporate it into emergency planning. Lash (1995, 82), citing the US Environmental Protection Agency's 1990 Scientific Advisory Board, sets out the objective of public advisory committees, which is to

> help educate the public about the technical aspects of environmental risks, and [to] help educate the government about the subjective values that the public attaches to such risks. The result should be broader national support for risk reduction policies that necessarily must be predicated on imperfect and evolving scientific understanding and subjective public opinion.

In other words, *how* citizens are invited to participate in disaster management is critical to the success of that participation.[14]

What can be done about the difficulty of getting disaster management programs established and getting local governments to seriously recognize their importance? The answer may well be that instead of asking ourselves how community participation can become an effective process within disaster management, we should assume that, with it, disaster management will become an effective process within the community. According to Berke and French (1994, 247) what is needed is high-level government dedication to encouraging local commitment to disaster planning. This may manifest itself through education and consensus-building processes that heighten citizen

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[14] Chapter 5 includes a substantive discussion on the merits and means of incorporating public participation into an HRV process.

ownership of the plan. For example, Beatley and Berke (1994) discuss the progress made in Charleston, South Carolina, which has held a number of professional workshops and community information forums, and which is also home to such educational groups as the Earthquake Education Center at Baptist College. Experts, local officials, and elected representatives have to ensure that community planning processes are designed to "allow the integration of specialized technical and abstract knowledge with local concrete knowledge and feelings ... The community environment will be considered in all its aspects – ecological, economic, etc." (Boothroyd and Anderson 1983, 11).

Simply and solely providing information to citizens is not enough. Many communities have available, and even distribute, an assortment of brochures and pamphlets. However, regardless of whether or not this material is read (never mind implemented), communities must do more to ensure that their residents become an integral part of their disaster management processes. Posting notices for opportunities to participate is important, but unless emergency planners make active efforts to directly involve community residents in the planning process, these opportunities may be ignored. As Aguirre (1994, 5) indicates, it is important to instill in the public a sense of individual responsibility vis-à-vis disaster preparedness. Salter (cited in Disaster Preparedness Resources Centre 1998, 127) states that "the community that has established capabilities for building relationships, organizing community intervention, and achieving results has taken the valuable first steps for becoming a Safe Community."

I refer the reader to Appendix A for an example of a planning approach that integrates land-use planning, disaster management, and a high degree of public participation – the Portola Valley, California, case study. Portola Valley is a small town of 4,300 residents where much of the residential development was located in areas subject to the effects of landslides and earthquakes. Following a major landslide in 1967, the town formed a geologic hazards committee that was given a mandate to minimize geological hazards-related losses to developers, homeowners, and the town itself. The recommendations that evolved were incorporated into draft zoning regulations and were discussed at public hearings as well as with the affected property owners. Development proposals were modified, slope-density regulations were incorporated into zoning regulations, and homeowners were encouraged to leave areas of open space (e.g., taller, more compact homes with larger gardens). The success of the Portola Valley's disaster management program is attributed to a fully integrated approach to community/disaster planning -- one that entails a high degree of public participation.

3.1.3. Summary

To summarize: (1) although disaster management has not traditionally been linked with community planning, the emerging focus on sustainable hazard mitigation clearly points to an integration of both; and (2) as demonstrated by the case study, public participation is beneficial to both disaster management planning and community planning initiatives. The challenge is to overcome historical obstacles and move towards an integrated approach to hazard mitigation. Therefore, if an approach is to be conducive to conducting an adequate HRV analysis, then it must ensure that concepts of public awareness and participation are incorporated into the disaster management process.

3.2. Social Factors

As Erik Auf der Heide (1989) mentions, there are a number of social factors that affect the success of disaster management processes. Lack of public awareness, much of which is due to the historical development of disaster management, is one of these. However, there are other factors, including: (1) public apathy, (2) risk communication, (3) risk perception, and (4) acceptance of risk. While all of these factors are interrelated, I now present a brief overview of each and show how they relate to a community-based disaster management program. This demonstrates that it is vital for any HRV approach to take these factors into account.

3.2.1. Public Apathy

Disasters are not events in which most people are interested (unless they are happening somewhere else!). They are unpleasant to contemplate: no one likes to think of their friends or family dying or lying injured after some devastating event. Some ethnic and cultural communities (e.g., the Chinese) think that it is "unlucky" to talk about the likelihood of disasters. According to Drabek (1986, 329), "ethnicity should be retained as one of several independent variables, as cultural systems obviously impact hazard perception. Some evidence indicates that ethnic differences, like those associated with gender, may reflect lack of knowledge about the hazard." Perry (1987) found that racial and ethnic minorities assessed risk differently from the majority. For example, he noted that in various surveys conducted across the United States, Blacks and Mexicans tended to be more fatalistic about earthquakes and more sceptical about the relevance of science than were Whites. He also found that certain events, such as flooding, were seen by Blacks to be uncontrollable and, thus, they were less confident in their ability to deal with them than were Whites. A summary of Drabek's (1986, 329) collection of research indicates that hazard perceptions also vary according to occupation and that, just as risk perception differs from person to person, so it differs from community to community and, as Giarini (1993) points out, from culture to culture.

Denial of the potential for disaster continues to be a major factor in public apathy towards disaster mitigation. A study conducted on behalf of Emergency Preparedness Canada by Environics Research Group Limited (1995) found that 65 per cent of Canadians do not think their area will be affected by a natural hazard, that over 80 per cent think that war or acts of terrorism are unlikely, and that approximately 50 per cent think that they will not be affected by a technological disaster. These results are similar to those found by Rocky Lopes (1992) in the United States, where he learned that unless they had actually experienced one, most people did not think that a disaster would occur where they lived (74 per cent). Overcoming denial is one of the key factors in dealing with public apathy. How risks are communicated is another.

3.2.2. Risk Communication

Much of the risk communication literature dealing with disasters focuses on warnings, on how people interpret them, and on whether or not they act upon them. Risk communication assesses (1) how participants receive and understand information regarding local hazards and risks, and (2) how the results of the HRV analysis are communicated to the policy makers and decision makers. The resultant information could be construed as a warning, even though it does not occur in an atmosphere within which one has to take immediate action in order to preserve one's life.

The following example illustrates the difficulty of risk communication. In 1990, rumblings from Japan's Mount Unzen began to concern scientists, and the Coordinating Committee for the Prediction of Volcanic Eruptions stepped up its seismic monitoring. On 13 May 1991, shallow earthquakes were detected beneath Mount Unzen. As seismic activity increased, scientists predicted lava and pyroclastic flows and prepared a hazard map that was used to evacuate 12,000 people from the area by 10 June. But the committee had been unable to predict the exact times of Unzen's major eruptions and, on 3 June 1991, a groove connected to the crater suddenly produced a pyroclastic flow that killed forty-two people, including three well-known volcanologists (Robinson 1993).

The Committee on Risk Perception and Communication of the National Research Council (NRC) chose to define risk communication as "an interactive process of exchange of information and opinion among individuals, groups and institutions .... We construe risk communication to be successful to the extent that it raises the level of understanding of relevant issues or actions for those involved and satisfies them that they are adequately informed within the limits of available knowledge" (NRC 1989, 2). This definition is applicable to the role risk assessment plays in local community HRV analyses. Access to experts is essential, and these experts must ensure that the information they provide to community participants is both understood and of sufficient depth. As Penning-Rowsell and Handmer (1990, 11) put it: "Risk communication is the passing of risk information from those who have that information to those who are presumed to be without it ... Risk communication cannot start without risk awareness and evaluation."

Communication implies dialogue and, thus, the active participation of both experts and laypersons. The NRC (1989, 149) concludes that four objectives are key to improving risk communications: (1) goal setting, (2) openness, (3) balance, and (4) competence. As a means of achieving these objectives, it is important, at the start of any given project, to determine:

- what the public know, believe, and do not believe about the subject risk and ways to control it;
- what quantitative and qualitative information participants need to know to make critical decisions;
- and how they think about and conceptualize the risk. (NRC 1989, 153)

An assessment of the first and third statement will help to determine the educational needs of those involved in completing the HRV analysis. Allowing for local conditions, any HRV process should provide participants with the requisite quantitative and qualitative information.

Pidgeon et al. (cited in Horlick-Jones and Jones 1993, 31) conclude that there are four different conceptual approaches to risk communication:

- Scientific communications – "top-down" or one-way transmission of some message about a hazard from a particular "expert" source to a target "non-expert" audience.

- Two-way exchange – an interactive process that recognizes the important role that feedback plays in any complex communication.

- Wider institutional and cultural contexts stressed – communicator takes account of the actions of risk management institutions, possible conflicting messages, and the history of the hazard in question.

- Risk communication as part of a wider political process – the process as a prerequisite to the enabling and empowerment of risk-bearing groups.

Certainly, as per Pidgeon et al.'s first and second points, the HRV process should include both scientific and two-way exchanges. Ideally, as communities engage in the HRV analysis they should be sharing and exchanging information on issues of joint concern. In their third point, Pidgeon et al. stress the importance of institutional and cultural contexts, and these are important for those involved in the HRV analysis. For example, after the Whittier Narrows earthquake in 1987, emergency managers were initially surprised by the large numbers of Hispanic people who refused to return to their homes after they had been assessed as safe by local engineers. In many cases Hispanic residents, unused to the superior building standards in the United States, thought a large crack in the plaster indicated the likelihood of building collapse. Often residents left the parks and returned to their homes only after "reassurance teams" – comprised of translators, social workers, engineers, and community leaders – met with each family at its home (Bolin 1993).

Finally, as per Pidgeon et al.'s fourth point, they state that risk communication can be part of a wider political process. In many cases it is the poorer socio-economic sector which faces the greatest exposure to hazards. As an example, wealthy neighbourhoods are not usually located next to industrial properties, along railroad tracks or major transportation corridors. In many cases residents living in areas which are vulnerable to many hazards are there because of financial constraints - they can not afford to live in "safer" neighbourhoods. Therefore, communicating the risks associated with where they are living may be considered a first step towards mobilizing residents to lobby for change and for safer living environments.

Thus the key points that an adequate framework must take into account are: (1) the need to have a dialogue amongst and between local stakeholders and experts, (2) the need to provide stakeholders with essential and easily understood quantitative and qualitative data, and (3) the need to recognize the importance of assessing and understanding community vulnerabilities.

And one should not ignore the media, as heightened media interest seems to influence emergency preparedness at the community level. This is in agreement with the 1979 findings of Okabe et al. (cited in Yamamoto and Quarantelli 1982, 165-66): "The more often people obtain information: (1) the more they trust an earthquake prediction; (2) the more they prepare against an earthquake; (3) the stronger their anxieties are; (4) the stronger their desires to move are; and (5) the more severe damages they predict." For example, in the Lower Mainland of British Columbia, an area that has not experienced a major earthquake for decades, earthquake preparedness has a high degree of public interest and appears to be well supported in a number of communities. Media coverage of the risk of potential earthquakes has been high relative to coverage of other hazards, and numerous articles have been written concerning earthquakes experienced by other cities around the world (e.g., Los Angeles, Kobe).

In a number of studies (Wenger 1980; Greene et al. 1981) mass media were found to be the most salient sources of information. Most community residents (60 per cent to 70 per cent) reported that television and radio were crucial sources of disaster information. The role of the media is especially important during the warning phase, when residents need to take precautionary measures (e.g., sandbagging) or make plans for evacuation (Scanlon et al. 1985, 123). Clearly, an HRV process needs to take into account the significance of outside agencies, such as the media, in order to ensure that it is amenable to the sharing of information. However, as I now go on to show, even once risks are adequately communicated, people will tend to perceive them in different ways.

3.2.3. Actual and Perceived Risk

In any process that involves the determination of risk, it is important for the players to understand the concept of risk perception. Slovic (cited in Slaymaker 1995, 3) defines risk perception as "the 'common sense' understanding of hazards, exposure and risk, arrived at by a community through intuitive reasoning ... usually expressed ... as 'safe' or 'unsafe.'" He goes on to mention that "policy decisions are almost always driven by perceived risk among the population affected and among decision makers [and that] these perceptions are commonly at variance with 'technical' risk assessments."

People need to have the most accurate information available when assessing the probability of a hazardous event, and researchers have found that there is often little correlation between perceived risk and actual risk (Fischhoff et al. 1983, 1991; Fischhoff 1984; Covello et al. 1987; Auf der Heide 1989; Derby and Keeney 1991). When people realize exactly how a hazardous event will affect them they are much more likely to put pressure on the local government to reduce their vulnerability. One need only look at how quickly community lobby groups form once people are aware of the possibility of having a hazardous waste facility in, or high-powered electric transmission lines running through, their neighbourhood.

In 1986, Drabek stated that Gilbert White's summary still stood as a reasonable interpretation of the research on risk assessment, and it continues to stand in 2000.

> Variation in hazard perception and estimation can be accounted for by a combination of the following: 1. Magnitude and frequency of the hazard; 2. Recency and frequency of personal experience, with intermediate frequency generating greatest variation in hazard interpretation and expectation; 3. Importance of the hazard to income or locational interest; 4. Personality factors such as risk-taking propensity, fate control, and views of nature. This variation is not related to common socio-economic indicators such as age, education and income. (White 1974b, 159)

Many researchers (Drabek 1986, 323-24) have found that the more experience one has with specific hazards, especially if one has a direct economic relationship to them, the greater the accuracy of risk perception. However, this experience is not universal, as some people still believe that "lightning never strikes twice in the same place." Others believe that if their properties were damaged in the last disaster, then they won't be damaged in the next one. In some cases, people who have "lived through" a disaster minimize future risk. For example, it became rapidly apparent to researchers that many people who stated that they had previously survived a hurricane ("it wasn't so bad") had, in fact, only been directly affected by its periphery and, thus, were unrealistic in their assessment of their ability to survive another one (324).

Slovic et al. (1982, 263) define the characteristics of risk perception and attitudes (all of which, it would seem, may be readily applied to the field of disaster management) as follows: (1) voluntariness, (2) dread, (3) knowledge, (4) controllability, (5) benefits to society, and (6) number of deaths. Voluntary hazards (e.g., mountain climbing, use of X-rays, driving motorcycles) tend to be controllable and well known, while hazards that threaten future generations tend to be seen as catastrophic. Risks that are not clearly understood, that evoke a feeling of dread, and that affect a large number of people are considered more dangerous than others (Slovic et al. 1982, 263).

It is, therefore, important to determine what factors people take into consideration when determining whether or not a potential event is risky. As Giarini (1993, 243) says, "Risk perception differs greatly according to the size and nature of the perceiving entity or group concerned: individuals, groups within society, companies, nations; as also according to historical and cultural context and geographic region." Hohenemser et al. (1983, 382) concur with Giarini: "The most striking aspect of these results is that perceived risk shows no significant correlation with the factor of mortality. Thus, the variable most frequently chosen by scientists to represent risk appears not to be a strong factor in the judgment of our subjects." It has been shown that awareness of previous disasters is directly related to age, length of residence, and proximity to the damaged area (pp. 325-26). The individual perception of some risks is intrinsically linked to periods of life (Giarini 1993, 246). For example, a twenty-year-old may find the idea of car racing exciting, while a fifty-year-old may simply find it dangerous. It also appears that long intervals between disasters can lull people into a false sense of security. Morgan (1985, 323) agrees, and he mentions that the public does indeed concern itself with factors other than mortality rates.

> Other things besides the number of people killed or injured count to most people ... things like equity, things like whether the benefits and the risk are imposed on the same or different people, and things like whether the risk is voluntary or involuntary. There is nothing irrational about such views. Indeed they are highly rational views. They reflect concerns about things like freedom, justice and democracy that we hold to be important in our society.

So, what are the key points that should be incorporated into a framework for determining risk assessment? First, because several decades of study on droughts, earthquakes, and floods show that any analysis of risk needs to take into account how it is perceived by the people directly affected as well as by the individuals and organizations involved in responding to it, relying solely on the perceptions of scientific and technical analysts may give one a false impression of the actual situation (White 1988, 173). Therefore, we need to ensure that the public is an active participant in the HRV process.

Given that the process of risk assessment is often grounded in how people perceive risk, and given that most researchers agree that the general public is not very adept at estimating risk, it is critical that any such process include an educational component with regard to risk perception and risk assessment. Participants will need to have guidelines to help them assess whatever data is available. And, finally, understanding the social vulnerabilities of people and where they live and work continue to be key elements in dealing with how people perceive and communicate information about hazards and risks.

3.2.4. Risk Acceptance

> How does one deal with an unacceptable risk? There are two ways to answer this question: one, reduce the risk so as to make it "acceptable"; or two, eliminate the risk. (Leytens 1993, 70)

Upon hearing about the risk posed by a particular hazard, one person moves away and another pays it little or no heed. What is not acceptable to one is perfectly acceptable to another. However, in many situations, while some people might find the risk acceptable, others might simply be unable to avoid it due to financial or other considerations. For example, while families might not find living next to an industrial site acceptable, they may well be unable to afford to move to a safer location. Similarly, in the case of earthquakes, families may not be able to leave a high-risk seismic area, as it would mean unemployment and the loss of relatives and friends.

Even after a major disaster, for a variety of reasons residents are often reluctant to leave the affected area. Consider the situation in Skopje, Yugoslavia where, following the 1976 earthquake, it is estimated that 150,000 people left the city within the first three weeks. "However, families did not like being split up, children could not speak the language of different Yugoslav republics and the net result was that within 2 1/2 months they had virtually all returned" (Davis, cited in Drabek 1986, 241).

What is acceptable risk? How safe is safe enough? As William W. Lowrance asks, "Who should decide on the acceptability of what risk, for whom, in what terms, and why?" (cited in Haimes 1992, 314). Consider the following anecdote:

> A real estate developer standing on the ground floor of a new apartment building on the floodplain of a creek in a Missouri valley town was asked whether he thought he was taking any risk in locating a structure there. He replied to the contrary and, when pressed, observed further that he knew that the stream had many years earlier reached a stage at the point as high as his shoulders. How then could he say there was no risk? His answer was, "There isn't any risk; I expect to sell this building before the next flood season." (Burton et al. 1978, 96)

The self-interest of the real estate developer aside, some people are greater risk takers than are others; some would be willing to buy those apartment units and others would not. As Luhmann (1993, 112) says,

> Empirical research shows above all that the willingness to take "risks" depends on how firmly we believe ourselves capable of keeping precarious situations under control, of checking a tendency towards causing loss, or maintaining our coverage by means of help, insurances, and the like in the event of losses occurring. It is not infrequent to overestimate our own competence while underestimating that of others.

According to Svenson (1988, 199): "One important aspect of the mental representation of a risk is whether it is considered acceptable or nonacceptable. If the risk is regarded as acceptable, no further action is taken. But if it is seen as unacceptable this builds up a potential for action." If the public deems a risk to be unacceptable, and if the community does nothing to rectify it, then people may simply leave. The solution is to engage in proactive mitigation measures. As Giarini (1993, 246) says, "Uncertainty may be described as the sum of all potential hazards around us, perceived or not. Each individual can ignore some of these potential hazards, take preventive action against others through physical or financial protection, or fall into a state of anxiety that ends him up in hospital."

It is important for the public to understand what others (e.g., regulators, scientists, and politicians) deem to be acceptable risk. While those completing the risk assessment do not necessarily have to accept the conclusions of experts and politicians, they should at least understand their reasoning. For example, the government of British Columbia has stated that, if the flood has an annual return frequency of 1 in 500 years, then it is acceptable to rezone the land in the flood plain for residential dwellings. Since there is no flood insurance for private dwellings in Canada, the government believes that having to pay out compensation for flood damage on a 1-per-500-year basis is quite acceptable. That floods could occur within two years back-to-back (as was the case in the Mississippi Valley) is, apparently, also acceptable. As stated by Burby (1998 264), government programs such as the National Flood Insurance Program in the United States have actually increased the willingness of people to build in flood plains because it has made the risk acceptable.

In every case, an individual's perception of risk is based on her or his background; thus, those engaged in the HRV assessment process need to be aware of their own biases. Williams and Mileti (1986) state that much of what can be considered under acceptability of risk is related to the quality of life (e.g., income, health, safety, community integration, education, individual expression, etc.) of the individuals involved. For example, "most people would experience some difficulty relating to an event that had a return period of greater that 100 years, but this does not prevent them from having perceptions on acceptability" (Morgan 1991, 61).

Given these various concepts, what key points must an adequate approach take into consideration? Coburn et al. (1991) state that it is the concept of risk tolerance and the thresholds of unacceptability that determine how the public decides to fund mitigation projects. Given that the implementation of mitigation policies and programs is the goal of disaster management, any approach that is to be used for HRV analysis must take into account the concepts of acceptable and unacceptable risk, for it is when the risks are considered unacceptable that pressure will be put on local governments to implement mitigation strategies.

Clearly, the unacceptability of risk is directly linked to existing vulnerabilities and accurate information. Therefore, in order for an approach to be conducive to conducting an adequate HRV analysis, it must take into consideration the vulnerabilities of people and their immediate surroundings.

3.3. Technological Factors

There are a number of technological obstacles to successful mitigation programs. These can be loosely classified as: (1) the reliability of scientific and technological data, and (2) access to technology.

3.3.1. Reliability of Scientific and Technological Data

Slovic et al. (1991) state that overconfidence in current scientific knowledge is one key technological obstacle to a successful mitigation program. As was previously indicated, reliance on dams, levees, and other human-made structures can prove deadly. Because such structures are built by "experts," people tend to believe that the flood will never come over the top and that the storm surge will never sweep over the sea wall (Auf der Heide 1989). The reality is that scientists and engineers do not know enough to accurately predict "how safe is safe." Consider the 1993 Mississippi flood: the experts were believed, and the result was that fifty people died and property losses were in the billions (Mairson 1994).

While scientists are aware of most hazards and the possible risk factors associated with them, the art of predicting when disasters will occur is still in its infancy. We do know that the field of disaster management has the scientific and technical expertise to predict which hazards are most likely to occur in certain instances. However, in most cases no one can predict, with any amount of precision, when or where disasters will strike. For example, Atwater (1996, 13) points out that, along the southwestern coast of British Columbia, it is difficult to predict the intervals between earthquakes because not much is known about their number and age. As a result, current estimates "range from a few centuries to about 1,000 years."

Predicting the time and location of person-induced hazardous events, such as hazardous material spills, is even more difficult than is predicting the time and location of natural hazardous events. As Bjerknes (cited in Robinson 1993, 32) aptly points out:

> We are in the position of the physicist watching a pot of water coming to a boil. He knows intimately all the processes of energy transfer, molecular kinetics and thermodynamics involved. He can describe them, put them in the form of formulas and tell you a great deal about how much heat will boil how much water. Now ask him to predict precisely where the next bubble will form. (Bjerknes, cited in Robinson 1993, 32)

Nor can scientists and experts be expected to accurately predict the severity of a disaster. For example, when referring to a potential subduction earthquake in the Lower Mainland of British Columbia, Garry Rogers from the Pacific Geoscience Centre estimates a "quake of 8.2 to 9.3 on the open-ended magnitude scale" (Koppel 1989, 8). While we can itemize some vulnerabilities to hazards, without having the ability to predict the severity of a disaster we cannot predict its impact. Because it is not possible to make accurate predictions regarding the time, place, and magnitude of all potential disasters, "the basic questions a hazard analysis must answer are not those relating to predictions, but rather: If hazard agent X develops into a crisis of Y magnitude, what would be the most likely impact upon the Z vulnerability of people and property at risk in a given area? How do the interrelationships of the X, Y, and Z factors of one potential emergency compare with those of others we face?" (Godschalk 1991, 144).

As Golding et al. (1992, 1) point out, "we have relatively little information on how ... hazards and their associated risks are distributed geographically, how they vary among different socioeconomic and demographic groups, and how these distributions have changed over time." Disasters are always finding new ways to happen. Fifty years ago, the disasters at Bhopal and Chernobyl would have been impossible. Each year the Canadian Emergency Transport Centre adds approximately 20,000 newly developed chemical compounds to its data base (CANUTEC 1996). In fact, the size and complexity of every growing technical system, and hence its vulnerabilities and risks, are causing an increasing number of people to view themselves as the victims, rather than the beneficiaries, of technology (Giarini 1993, 247).

It follows that, in order for it to be conducive to conducting an adequate HRV analysis, approach needs to take into account the existing degree of scientific and technological knowledge as well as the inability of the scientific and expert community to accurately predict potential hazardous events.

3.3.2. Access to Technology

Sometimes the requisite tools are just not readily accessible. Following the 1996 Saguenay flood, for example, someone located a 1978 map produced by the Québec provincial government. This map rated the safety of the terrain from Alma, Québec, to La Baie, Québec. Many of the areas around La Baie were classified as being at significant risk of landslide. And yet, in 1996, these same areas were heavily built up. But La Baie's city planning department's maps – dated 1992 – show no sign of these old landslides, no indication that building in the area could be dangerous. "The tools the government makes available to the municipalities just aren't used," says Vallée. "When it comes to urban development, local governments have trouble resisting market pressures. When geographers suggest risk studies, it's perceived as an obstacle to be stifled, for fear of upsetting the promoters' clients and losing lucrative projects" (Grescoe 1997, 37).

Access to technological information is often a factor of economics. As society has access to more and more sophisticated data, there is a tendency to demand a greater and greater number of inputs. For example, a recent risk assessment and hazard mitigation assessment of Long Beach, Mississippi, used a merging of high-resolution multispectral imagery with high-resolution topographic survey data.

> In addition to the imagery, high-resolution topographic data were gathered using a LIght Detection And Ranging (LIDAR) system....These data were used to develop a Digital Elevation Model that was used to compute the slope of each pixel in the imagery and to delineate basins within the city. The combination of the imagery and topographic data will be used to parameterize an overland flow model that will be used to determine flood risks throughout the city (Easson and Davis 1999, 1).

While the results of this analysis may be accurate and useful, completing such analyses are well beyond the financial means of most North American communities.

There has been a trend to turn to technology, as though it could provide answers without taking into account a community's access to data and its financial resources. Even *HAZUS*, FEMA's computerized tool for estimating earthquake losses, requires: (1) detailed information about local community geology, (2) an inventory of buildings in local communities, and (3) data regarding utilities and transportation systems (FEMA 1996). The publication states that "geotechnical and structural engineers may be required for this analysis" (FEMA 1996, 5).

And this is only for the Level 2 analysis: a Level 3 analysis requires even more resources and data. Training in the use of HAZUS is over three days in length and requires each community to purchase approximately $5,000 worth of equipment and software in order to begin to use the program. After all of this, FEMA issues this caveat: "While potentially useful for preliminary estimates, results evaluated in this manner are considerably uncertain" (Whitman and Lagorio 1999, 9).

Emergency Preparedness Canada and Nobility Inc. (2000) are following the same path as is FEMA in that they use NHEMATIS,[15] an "expert system, Geographical Information System functionality (using ESRI's Arcview desktop mapping product), relational databases and quantitative models" (EPC and Nobility Inc. 2000, 1). Like HAZUS, NHEMATIS uses advanced models, algorithms, and extensive geographic databases in order to conduct HRV analyses. This is not to say that further research is not important, nor is it to say that such sophisticated systems may not be important for major cities and urban centres; however, the reality for most small and mid-sized communities is that they do not have access to the resources that are necessary for the use of these advanced systems. Therefore, planning tools should encompass a wide range of options – options that are not highly dependent upon technology and that are affordable at the local government level.

[15] Natural Hazards Electronic Map and Assessment Tools Information System.

3.4. Organizational Factors

There are a number of other factors that can help explain why some communities seem to enjoy a relatively high degree of support for disaster management while others do not. Anderson (1969, 60-61) identifies four conditions most likely to be associated with successful disaster management planning at the local level:

> (1) local civil defence personnel are experienced in handling community disasters; (2) civil defence is legitimated by the municipal government; (3) the local civil defence director is able to create significant pre-disaster relationships among those organizations involved in emergency activities; and (4) knowledge of available emergency resources is widespread.

Interestingly, Anderson does not include the link between disaster management and community planning as one of the conditions of successful disaster management. This perspective parallels that of disaster managers who have operated in relative isolation from the day-to-day business of city hall and planning departments. And while Anderson does see the importance of forging links with those involved in emergency activities, she does not seem to see the importance of forging links with those agencies or departments that may have a role in mitigating the consequences of disasters.

However, Anderson, along with others (Wyner and Mann 1983), does note that the experience and training of the disaster manager is important. For example, inexperienced disaster managers who rush out to conduct public information sessions with a lot of graphic photographs or videos of the last disaster may in fact be deterring people from taking positive action. Lopes (1992) found that one sure way to ensure that people do not take mitigative action is to show them pictures or slides of disaster scenes. In a controlled study of over 4,000 subjects, Lopes's research showed that people who had only been given factual information about hazards responded much more positively than did those who had been given both factual information and pictures. Of those who had seen the disaster pictures, most did not take action because the viewing of the latter led to avoidance and denial. The pictures were just too graphic, and they were too upsetting to think about. Lopes's research has an important lesson to teach those planners trying to elicit community involvement in an HRV process: (1) citizens need to be provided with clear factual information; (2) displaying pictures of disasters may be counter-productive.

Generally speaking, disaster managers are ill-prepared to take on their responsibilities. Currently, there is no college or university in Canada that offers a certificate, diploma, or degree in the field of disaster management. As previously discussed, most disaster managers assigned the responsibility for disaster planning have had little exposure to disaster management per se.

Anderson's third point (her second is covered in the section on political factors) is that there must be a positive relationship between the various emergency response teams. As Aguirre (1994, 3) points out, disaster planning is often complicated by conflicts between various organizations (e.g., disagreements between and among the military, the police, the fire department, medical personnel, etc. over how best to proceed).

As per Anderson's fourth point, while relationships between response agencies will vary from community to community, availability of resources continues to be a major problem for most communities. For example, even major Canadian cities do not use adequate HRV analyses. In 1996 I conducted a simple telephone survey of Canada's capital cities (including Ottawa, Whitehorse, and Inuvik) in order to determine how many of them were using HRV analyses. Only two disaster managers were using a formalized HRV process: (1) Victoria was using a 1992 version of the HIRV approach to HRV analysis (see Chapter 5), which was included in a course that I had developed for the British Columbia Institute of Technology; and (2) Halifax was using an American approach to HRV analysis that had been developed by FEMA (see Chapter 4).

Clearly, trained emergency managers are important; however, given that the ways in which disaster managers are chosen and disaster management processes are conducted are unlikely to change in the near future, it is critical that communities have access to the resources necessary to conducting disaster management business. These resources include: access to data, guidelines for disaster management processes, and staffing (Olshansky and Kartez 1998). However, without the political will to allocate enough resources, few communities will be sufficiently prepared to deal with disasters.

3.5. Political Factors

Having and sharing good information is not enough: information must translate into action. There must be the opportunity to take what knowledge is available and, through it, to persuade local governments to initiate and to implement mitigative programs. There are three main political obstacles to implementing a successful disaster management program at the local community level: (1) lack of awareness regarding local responsibilities and hazards, (2) economics, and (3) lack of an organized constituency.

3.5.1. Awareness

When a community feels that its local politicians have not adequately reduced either the risk or consequences of a disaster, these officials can be in serious trouble. As Stallings (1995, 7) points out, "There can ... be grass-roots protest in the aftermath of an earthquake. Citizens often do angrily confront public officials, write letters to their congressional representatives, and lobby for change."

Unfortunately, by the time a community realizes that adequate plans have not been made, it is often too late. With local officials usually elected for two-year terms, there is a tremendous learning curve for newly elected officials, and local officials are seldom well-informed about local hazards and risks (Burby 1998). Burby propounds the need to "label" hazard-prone property and to increase political awareness of flood plains, fault lines, and other geographical land features. He also recommends the need for better information regarding the impacts of disasters on economic production.

As one moves from national to local governments, the "disaster damages experienced from that level's perspective are less frequent" (Auf der Heide (1989, 22) and the effects of a disaster become less apparent. Auf der Heide (22) calls this the "inter-governmental paradox." Because local governments have the least exposure to disasters they often give the implementation of mitigation strategies a low priority. And yet, it is the local governments that bear the brunt of responsibility for carrying out disaster warnings as well as response and recovery activities.

3.5.2. Economics

Even when communities are knowledgeable regarding local hazards and risks, the economic benefits of choosing to implement mitigative programs are often not clear. Beatley and Berke (1993), when examining seismic mitigation programs across the United States, found that even when local governments had knowledge of the potential risks of an earthquake, few mitigative programs were actually implemented. They listed the obstacles to effective local seismic mitigation: (1) it would place undue burdens on particular sectors of the population (e.g., land developers); (2) its benefits would be uncertain and would occur in the future; (3) its benefits would be diffuse and not attached to a particular sector of the population; and (4) crime, health care, and so on were deemed to be more pressing concerns than were low-probability events such as earthquakes (85).

Basically, paying now for uncertain payoffs in the future is a key point in understanding the dilemma in which politicians find themselves. Ideally, when additional resources are provided to deal with problems concerning crime and health, results are immediate: crime goes down, waiting lists for hospitals diminish. When resources are allocated to disaster mitigation, the results may not be evident in the residents' or the politicians' lifetimes. Politicians are aware of this, and thus disaster management planning often needs to be regulated by higher levels of government.

In analyzing disaster management plans, Berke and French (1994, 245) found that they entailed "six types of polices for reducing potential loss from natural hazards: awareness-building, regulatory, incentive, infrastructure, recovery and preparedness measures." In a comparison of communities, those that were mandated to include emergency plans had stronger regulatory, infrastructure, recovery, and preparedness policies than did those that were not so mandated. However, with regard to awareness and incentives, there was very little, if any, difference between the mandated and non-mandated communities. Thus, it is apparently not sufficient simply to mandate communities to include some degree of participation. According to Berke and French, responsible senior governments "should undertake actions that will increase the commitment of local governments, and particularly of elected officials, before they focus on increasing the expertise of local planning staffs or providing better technical information for plan making" (247).

Agreeing with Berke and French, May and Burby (1996, 189) found that government commitment to hazard management is crucial to housing and recreational development management. For example, if local government regulates against building new homes along coastal hazard zones, then there will be little damage when hurricanes and storm surges occur. If regulations are not in place (and enforced) however, then the lure of ocean vistas will enable developers to quickly sell lots in high-risk areas.

May and Burby went on to compare state hazard-mitigation policy in Florida and New South Wales as well as to address procedural and substantive compliance under the two differing polices. In Florida, the 1975 implementation of a very weak and ineffectual hazard-mitigation mandate was followed a decade later by a very coercive planning mandate. The Local Government Comprehensive Planning and Land Development Regulation Act, 1985, mandated the preparation of local comprehensive plans and land-use regulation, established an enforceable schedule of due dates, established review procedures, and established severe sanctions for local governments that failed to get involved in planning. These sanctions included withholding 1/365th of state-revenue sharing funds for every day that the plans were late and requiring attendance at administrative hearings (May and Burby 1996, 179). In New South Wales, the situation was reversed; a coercive 1977 planning provision created such a political backlash that, in 1984, the government introduced a cooperative approach to hazard mitigation. May and Burby (171) concluded that

> when local governments are not committed to state policy objectives, the coercive policy produces better results, as evidenced by higher rates of procedural compliance and greater effort by local governments to achieve policy objectives. When local government commitment exists, the cooperative policy produces substantive results that are at least the equivalent to the coercive policies. Moreover, over the long run cooperative policies may have greater promise in sustaining local government commitment.

It is interesting that neither the coercive nor the cooperative mandate considered either public participation or community awareness to be an important criterion for determining success. It is unclear why this is so, especially since May and Burby (189) state that the "political demands by neighborhood and other groups are the clear driver of commitment, as partially offset by development demand within hazardous areas and the intractability of the hazard problem." This is echoed by Tierney (1985), who found that, unless citizens put pressure on governments to take emergency preparedness measures seriously, governments do very little. And so the need for an adequate approach to ensure that the public has both access to information and the opportunity to develop a political constituency.

3.5.3. Lack of Organized Constituency

Unfortunately for disaster managers, while we often see and hear of protests against cutbacks to health care and freedom of speech, we do not hear of protests against cutbacks in disaster management budgets. And we find that those charged with protecting the public are often reluctant to do so because this mandate conflicts with their other political interests (Petak 1985).

One of the lobby groups often at odds with those wishing to restrict land use are the private (and, on occasion, public) land developers (Petak 1985; Olshansky and Kartez 1998). Developers can mount pressure on public officials to allow development on potentially hazardous locations (e.g., flood plains). Frequently these hazardous locations are sought after due to their proximity to ocean and river frontage, good views, and so on. In the United States, there is a growing number of property owners who feel that they have the right to develop their property without government interference (Auf der Heide 1989), and they have helped marshal resources against land-use planning that takes hazardous conditions into account. Despite repeated examples that homes located in flood plains will eventually be damaged by floods, communities continue to grant development permits in these areas.

Competing special interest groups can hinder not only the disaster planning process, but also the disaster recovery process. What happened during the aftermath of the 1986 Whittier earthquake illustrates the kind of conflict that may occur between special interest groups. The pro-development sector and the city government (who were both primarily concerned with economic issues) were opposed by the cultural and historic preservationists. For the latter group, the symbolic value of old buildings for the cultural integrity of the local community outweighed the potential economic stimulus of building demolition and new construction. And so reconstruction became embroiled in conflict as various groups sought to promote alternative, and sometimes incompatible, visions of how Whittier should be reconstructed. Separate from these organized and activist interest groups were the other residents of Whittier who, based on the victim surveys, wanted to see Whittier quickly reconstructed along the lines of what existed before the earthquake (Bolin 1993, 38). Because of the difference in organization and power between interest groups (e.g., conservationists were quick to obtain legal injunctions and to hold public demonstrations) and the general community, the latter was unable to participate effectively in recovery planning.

So it is apparent that, in order for an approach to be conducive to conducting an adequate HRV analysis, it must take into account competing special interest groups. If it does not do so, then not only will we not recognize the effect of these groups on the political stage, but we will also not recognize their effect on the adoption of mitigation strategies.

3.6. Summary Of Challenges

As Haimes (1995, 8) says, "Good management must ... incorporate and address risk management within a holistic and all-encompassing framework that incorporates and addresses all relevant resource allocations and other related management issues." It is not reasonable to expect every community to complete an extensive soil mapping analysis, to enter all kinds of census and topographical data into a GIS, or to spend vast amounts of money to reduce the risk to a very few. However, it *is* reasonable to expect every community to engage with its citizenry in good faith when working through the HRV process and to accept the need to mitigate future losses in an equitable fashion.

In completing a literature review of various challenges to good disaster management planning, I was able to identify a number of factors that must be considered when choosing an overall approach within which to situate HRV analysis. It must be kept in mind that, while these factors will certainly influence the choice of an approach, the latter must not be manipulated in order to accommodate the former. The key factors are:

Historical Factors

1. although disaster management has not traditionally been linked with community planning, the emerging focus on sustainable hazard mitigation clearly points to the need for integration;
2. public participation is beneficial to both disaster management planning and community planning initiatives;

Social Factors

3. risk communication is dependent upon a dialogue among and between local stakeholders (i.e., community residents) and experts (i.e., community planners and hazards experts);
4. stakeholders need adequate quantitative and qualitative data, and these data need to be presented so that they are easily understood;
5. identifying and dealing with differing vulnerabilities means fairly and equitably examining community values;
6. the media need to be part of the planning process;
7. an analysis of risk needs to take into account how risk is perceived by the people directly affected by it as well as by the individuals and organizations involved in responding to it;

8. the process must include an educational component in order to ensure that participants are clear as to how one's perception and acceptance of risk can influence the outcome of an HRV analysis;
9. concepts of acceptable and unacceptable risk need to be taken into account, for it is when risks are considered unacceptable that pressure is put on local governments to implement mitigation strategies.

Technological Factors

10. the state of scientific and technological knowledge needs to be determined, and the inability of the scientific and expert community to accurately predict potential hazardous events needs to be acknowledged;
11. disaster management planning tools should encompass a wide range of options that are not highly dependent upon technology;
12. planning tools need to be affordable at the local government level.

Organizational Factors

13. disaster managers need to be trained, and they need to be knowledgeable about disaster management principles;
14. the disaster management process needs to be educational in nature.

Political Factors

15. the concept of risk sharing, and the political tradeoffs that result from engaging in it, need to be recognized;
16. competing interests need to be recognized; and
17. various social interests need to be affirmed.

3.7. Derivation of the Fourteen Key Objectives of an Adequate HRV Analysis

Having arrived at the seventeen factors previously listed, I was unsure whether or not this list was complete. Despite numerous research projects and academic works on the topic of risk, both Kasperson (1992, 155) and Renn (1992, 55) concur that there have been few attempts to develop a coherent framework within which to integrate the technical and social aspects of risk (or, as Renn calls it, the "transdisciplinary taxonomy of risk perspectives"). The first section of Appendix B discusses the search for a framework within which to situate HRV analysis, and it provides a review of some of the key approaches to HRV analysis propounded by academics and researchers in the areas of disaster management, mitigation, hazard management, corporate management, and risk. As identified in Appendix B, for the most part these various approaches were deficient in a number of ways; however, Renn's (1992, 57) *Systematic Classification of Risk Perspective* met the requisite criteria.

The second part of Appendix B provides an overview of Renn's framework. His taxonomy encompasses an extensive literature review and considers seven different approaches to risk perspectives, four of which were extrapolated and adapted for the purposes of completing an HRV analysis: (1) all-hazards data, (2) probabilistic risk analysis, (3) psychology of risk, and (4) social theories of risk. There were no contradictions between the findings that emerged from Renn's work and the seventeen factors that emerged from the literature review. There were some minor differences between the two, but they were not significant. It is for this reason that I decided to place the review and analysis of Renn's framework in an appendix. Table 4 shows the similarities and parallels between what I found in the literature review and what I found in Renn.

Both the literature review and Renn stress the importance of public participation during the HRV process. Renn identifies a number of key stakeholders in the HRV process: experts, high technology/high risk industry, special interest groups, and those most vulnerable within any given community. The literature review supports this but also stresses the importance of involving the media in the HRV process.

Table 4: Comparison of Factors

Factors Derived from the Literature Review	Factors Derived from Renn's Approach
Historical Factors	
• although disaster management has not traditionally been linked with community planning, the emerging focus on sustainable hazard mitigation clearly points to the need for integration	
• public participation is beneficial to both disaster management planning and community planning initiatives; • the media need to be part of the planning process	• the need for widespread public participation on the part of the various stakeholders, including: experts, high technology/high risk industry, special interest groups, and vulnerable members of the community
Social Factors	
• risk communication is dependent upon a dialogue among and between local stakeholders (i.e., community residents) and experts (i.e., community planners and hazards experts) • stakeholders need adequate quantitative and qualitative data, and these data need to be presented so that they are easily understood	• risk communication is an essential element of the HRV process • the need to have access to information
• an analysis of risk needs to take into account how it is perceived by the people directly affected by it as well as by the individuals and organizations involved in responding to it • the process must include an educational component with regard to risk perception and risk assessment	• the need to affirm varying perceptions of risk • the need to have an evolving educational process
• identifying and dealing with differing vulnerabilities means fairly and equitably examining community values • concepts of acceptable and unacceptable risk need to be taken into account, for it is when risks are considered unacceptable that pressure will be put on local governments to implement mitigation strategies	• the need to provide an adequate forum by which to acknowledge and address issues of equity and fairness • the need to empower vulnerable members of society through the HRV process

Table 4 cont'd...

Technological Factors

• the state of scientific and technological knowledge needs to be determined, and the inability of the scientific and expert community to accurately predict potential hazardous events needs to be acknowledged	• accurate identification of hazards is important • the need to identify various risk factors[16] that lead to the ability to estimate risk • the need to assess the accuracy of qualitative and quantitative data • the need to acknowledge and deal with uncertainty
• disaster management planning tools should encompass a wide range of options that are not highly dependent upon technology • planning tools need to be affordable at the local government level.	

Organizational Factors

• the disaster management process needs to be educational in nature • disaster managers need to be trained and they need to be knowledgeable regarding disaster management principles	• the need to have an evolving educational process

Political Factors

• the concept of risk sharing, and the political tradeoffs which result, need to be recognized • various social interests need to be affirmed • competing interests need to be recognized	• political legitimation is essential to ensuring the adoption of mitigative strategies

Under social factors, both the literature review and Renn stress the need for adequate risk communication during the HRV process. Access to adequate quantitative and qualitative data is underscored, as is the need to present this data so that it can be easily understood. And both acknowledge that any HRV process needs to take into account how risk is perceived by those directly and indirectly affected by a particular hazard.

Both the literature review and Renn identify the need for an educational process. The literature review places special emphasis on an educational component pertaining to risk perception and risk assessment, while Renn indicates the sociological importance of having an educational component present throughout the HRV process.

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[16] Risk factors are those factors that people take into consideration when determining whether or not a particular potential event is risky (e.g., being situated on an earthquake fault would be considered to be a risk factor).

Under the heading of technology, both the literature review and Renn indicate the need to acknowledge and to deal with (1) uncertainty and (2) the accuracy of both qualitative and quantitative data. Renn's framework allows me to pinpoint some factors that did not specifically emerge from the literature review: (1) the need to identify hazards accurately, and (2) the need to identify those risk factors that will enable one to accurately estimate risk.

Two other technological factors emerge from the literature review: (1) the need to encompass a wide range of options that are not highly dependent upon technology, and (2) the need for planning tools to be affordable. As Renn's work is, by definition, all-hazard in approach, one would not expect it to emphasize the need for a wide range of options for dealing with risk: this need would simply be assumed. As well, one could not expect his work to address the issue of affordability, as it is only through various case studies and discussions that it became known that many high-tech systems are not accessible to the majority of smaller communities.

Under organizational factors, the literature review demonstrates, through case studies, the need for disaster managers to be educated and trained in disaster management. Because the discipline of disaster management has emerged so recently, many disaster managers are unaware of the full scope of the disaster management process. This clearly indicates the need for this process to be educational in nature. Again, Renn's framework corroborates the need for the HRV process to be educational.

Under political factors, the literature review provides insights into how political trade-offs occur and how competing interests gain access to the political system. In order to be able to address the social diversities that exist in our communities, we need to affirm various social interests. Renn's framework recognizes that political legitimation is crucial to ensuring the adoption of mitigative strategies. His sociological approach to risk implicitly accommodates various special interest groups and approaches to risk.

In summary, none of the factors that emerge from the literature review or Renn contradict one another: in fact, most parallel or complement one another. From the literature review I am able to derive specific factors that enhance the depth of Renn's work, while from his framework I am able to derive a number of technological factors that enhance what emerges from the literature review.

3.8. Summary

As discussed in the previous section, the differences between the findings derived from the literature review and the findings derived from Renn were insignificant. Thus, for the purposes of this thesis, it makes sense to integrate the two approaches into one comprehensive list of fourteen key objectives for an adequate HRV analysis:

1. Disaster management and community planning need to be integrated in order to successfully focus on sustainable hazard mitigation.
2. The HRV process needs to involve widespread public participation on the part of the various stakeholders, including: experts, high technology/high risk industry, special interest groups, the media, and vulnerable members of the community
3. Adequate risk communication is an essential element, and dialogue among and between local stakeholders (i.e., community residents) and experts (i.e., community planners and hazards experts) needs to occur so that research data are easily understood
4. Community stakeholders need access to adequate quantitative and qualitative data.
5. An analysis of risk needs to take into account how it is perceived by the people directly affected by it as well as by the individuals and organizations involved in responding to it.
6. The HRV process needs to have an evolving educational process.
7. The HRV process needs to provide an adequate forum within which to acknowledge and address issues of equity and fairness.
8. The HRV process should empower vulnerable members of society.
9. The state of scientific and technological knowledge needs to be determined.
10. Hazards must be accurately identified.
11. The various risk factors that lead to the estimation of risk need to be identified.
12. The HRV process needs to acknowledge and deal with uncertainty and the inability of the scientific and expert community to accurately predict potential hazardous events.
13. Tools for HRV analysis should encompass a wide range of options that are not highly dependent upon technology and that are affordable for local governments.
14. The HRV process needs to have political legitimation in order to ensure the adoption of mitigative strategies. This will involve affirming the diversity of social interests and recognizing the various competing interests that exist within the community.

Having now identified the fourteen key objectives of an adequate HRV analysis, in the next chapter I go on too analyze extant models for HRV analysis.

4. The State of HRV Analysis

Chapter 4 focuses on answering the following research question: "Do extant models for HRV analysis take into account the fourteen key objectives of HRV analysis identified in Chapter 3?" Various models have been developed to assess hazards, risks, and vulnerabilities; however, I focus on those few that are directly related to the goal of this thesis (i.e., to develop and to evaluate an integrated and community-based model for HRV analysis – one that has the potential to successfully mitigate the impacts of a disaster). These models (1) pertain to disaster management, (2) are all-hazard in approach, (3) are community- or region-based, and (4) derive from a planning perspective.

The first section of this chapter reviews the search for models for HRV analysis that meet the criteria stated above. Eight such models are identified; a review of those that were excluded from the critique is included in Appendix C. The second section of this chapter introduces and then evaluates these eight models for HRV analysis. As will be demonstrated, all eight models are flawed: none meets all fourteen objectives of HRV analysis.

4.1. The Search for Adequate Models for HRV Analysis

In my search for extant community- or region-based models for HRV analysis, I first contacted different levels of government in Canada, the United States, and Mexico. In British Columbia, at both the municipal and provincial government levels, there were no HRV models currently in use, although a number of communities referenced the Emergency Preparedness Canada (EPC) model to HRV analysis. Although EPC has previously published a number of different models to HRV analysis, this chapter addresses its latest (1992). The EPC model meets the four criteria listed previously in that it (1) focuses on events that have the potential to be disastrous, (2) is all-hazard in approach, (3) is community-based, and (4) is derived from a planning perspective.

An HRV analysis of the Dartmouth regional area (which includes the cities of Halifax, Dartmouth, and Bedford) in Nova Scotia was completed in 1987 (Public Works 1987). The report stated that it was based on the EPC model for HRV analysis; however, a detailed review identified that it was based on an American model for HRV analysis that appears to have only been circulated outside of the United States by FEMA.[17] This model HRV analysis is disaster-related, all-hazard in focus, and community-based. I refer to it as FEMA 1.

Considerable work in the area of HRV analysis has been conducted in the United States. FEMA publishes a workbook entitled *Hazard Identification, Capability Assessment and Multi-Year Development Plans for Local Governments* (1987) as part of its Integrated Emergency Management System (IEMS). I refer to it as FEMA 2. The FEMA 2 model to HRV analysis collects the necessary information on hazards, assesses the current capacity of the community to respond to disaster, and documents multi-year development plans for disaster management. It also provides local jurisdictions with a tool to assist them in identifying and scheduling activities to improve their capacity to respond to a disaster. The FEMA 2 model is heavily weighted with factors that relate to the community's capacity to respond. According to the FEMA 2 handbook, hazard assessment must be completed on a regular basis, response books must be issued, and information must be analyzed for the hundreds of communities that request

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[17] This FEMA HRV model is also discussed and published by Australia's Natural Disasters Organisation (Natural Disasters Organisation 1991).

federal funding.

Although the workbook for FEMA 2 was republished in 1992, the methodology has not been changed (Joan Buntin, FEMA Hazard Mitigation Officer for Region X), and, since the 1992 edition is no longer in print, the 1987 FEMA 2 edition is still in use. Completion of the IEMS workbook is mandatory if local communities are to continue to receive emergency preparedness funding from FEMA. FEMA 2 is compulsory for all US jurisdictions that receive FEMA financial assistance through state emergency management agencies.

In 1993, FEMA completed an extensive assessment of local and state capacity to respond to disasters (FEMA 1993), and it published a draft report in 1994 (FEMA 1994). Based on this work, it is expected that the entire format of its approach to HRV analysis will change. However, as of 2000, no draft copies of this report are available. Part of the reason for a lack of further research on behalf of FEMA in this area may be due to its focus on HAZUS (FEMA 1996), the natural hazard loss estimation methodology that FEMA has been actively pursuing and that is discussed in Chapter 3.[18]

The CD-ROM entitled *Community Vulnerability Assessment Tool: New Hanover County, North Carolina* (NOAA 1999) and produced by the National Oceanic and Atmospheric Administration (NOAA) offers a model for HRV analysis that includes eight crucial steps (see Section 6.2.4 below). It is also geared towards opportunities for mitigation. New Hanover County, North Carolina, is used as a case study, thus providing a regional basis for this model for HRV analysis. I refer to it as the NOAA model.

According to Mexican government agencies[19], no all-hazard HRV analyses were in use in Mexico. With regard to models for HRV analyses used in Pan-Pacific and European countries, Australia's Natural Disasters Organisation publishes a handbook on the SMUG (Seriousness, Manageability, Urgency, and Growth Hazard Priority System) model. This models for HRV analysis is used in both Australia and New Zealand. It pertains to

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[18] See Appendix C for further discussion on HAZUS.

[19] Based on discussions with the Mexican delegates who attended the Tri-Lateral Workshop on Natural Hazard Risk Assessments, February 11-14, 1994.

disasters, is all-hazard in nature, and is community-based. As will be discussed, it derives from a planning perspective.

I found little in the way of local community-based HRV analysis in Europe. One HRV model that is used is the United Nations Environment Programme Industry and Environment/Programme Activity HRV process, known as the Awareness and Preparedness for Emergencies at Local Level (APELL) model. As will be seen, the APELL model does include provisions for addressing events that would be smaller than those of the magnitude of a disaster; however, disasters are also covered. It is all-hazard in scope (although more focused on person-induced hazards), is community-based, and is derived from a planning perspective.

The other European-based HRV analysis that I review is that published by the Norwegian Directorate for Civil Defence and Emergency Planning (1995) and entitled *Guidelines for Municipal Risk and Vulnerability Analysis*. This model for HRV analysis (which I call the OSLO model) directly pertains to events that could lead to a disaster, is all-hazard in approach, and is community-based. It includes a planning approach to disaster management based at the municipal level.

The last model for HRV analysis chosen for critical review is the United Nations Disaster Relief Organization (UNDRO) model, which was designed for use primarily in developing countries. Although UNDRO is now called the United Nations Office for the Coordination of Humanitarian Affairs (OCHA), for the purposes of this dissertation it will be referred to by the name under which it was developed. The UNDRO model to HRV analysis clearly pertains to disasters, is all-hazard in approach (although biased towards natural disasters), is community- and regional-based, and derives from a planning perspective.

4.2. Review and Evaluation of Extant Models for HRV Analysis

The following section reviews and evaluates, in alphabetical order, the eight models to HRV analysis discussed in the preceding section. I organize my evaluation in two parts: the first part discusses how each model for HRV analysis deals with the overall HRV process; the second part discusses those factors that relate to methodology.

It is important to note that, despite a thorough literature review,[20] I could not locate any published critiques of these eight models for HRV analysis. Although certain organizations and agencies extol the virtues of using these models (e.g., the Norwegian Directorate for Civil Defence and Emergency Planning urges communities to use the OSLO model), there are no independently critiqued evaluative studies. As well, published case studies of the application of any of the eight models for HRV analyses are scarce. Whenever I could locate such studies, I included them in my evaluation. I summarize my findings in Table 5, which is located at the end of this chapter.

4.2.1. Review of the APELL Model for HRV Analysis

This model for HRV analysis is presented as part of the Awareness and Preparedness for Emergencies at Local Level Programme, based on the 1989 *Swedish Rescue Services Board Handbook* and refined by the United Nations Environment Programme Industry and Environment Program Activity Centre (UNEP) (1991). It is primarily aimed at reducing technological accidents and improving emergency preparedness.

The goal of the APELL model is "to show how risk objects can be identified, evaluated and ranked by a basic 'rough analysis' method and to encourage an increased risk consciousness and environmental awareness as development takes place in the community" (UNEP 1992, 7). "Risk objects" are defined as buildings (e.g., hardware stores, filling stations) and as sites (e.g. harbours).

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[20] The literature review included a traditional library search of journal articles and books published since 1992; GEOBASE and other science-oriented databases; a search of all doctoral dissertations written in North America since 1995; and a search of EPC, FEMA, Emergency Management Australia, the Norwegian Directorate for Civil Defence and Emergency Planning, and United Nations web sites (as well as other disaster-related WEB sites).

The APELL handbook presents a ten-step process to aid local communities in strengthening their emergency response capability:

1. Choose an object (industrial facility, school, commercial operation, etc.).
2. Determine what operations are being conducted at that object (e.g., manufacturing, selling, service, etc.).
3. List the items capable of producing a hazard (e.g., chemicals, processes, or geological features) along with an estimate of the amount of the items in question (if possible).
4. Determine the risk types -- the type of hazardous event that might occur (e.g., explosion, fire, earthquake).
5. Determine who or what would be threatened. The guidelines indicate three primary areas: people, the environment, and property.
6. Consider the consequences of the event taking place (e.g., contaminated drinking water, damage to infrastructure).
7. Examine and rank four possible consequences: life and health, the environment, property, and the speed of development of the hazard. These areas fall under the category "seriousness," and each has a range of values associated with it.
    - Consequences for life and health range from unimportant (temporary slight discomfort) to catastrophic (more than 20 deaths, hundreds of serious injuries, and more than 500 evacuated).
    - Consequences for the environment range from unimportant (no contamination) to catastrophic (very heavy contamination, widespread effects).
    - Consequences to property range from unimportant (less than $1,000) to catastrophic (greater than $20,000).
    - The speed of development is the attempt to determine if there is an adequate warning system, with values ranging from one for having an early and clear warning system to five for having no warning system.
8. The probability is determined from a range of one for improbable (occurring less than once per 1,000 years) to five for probable (occurring more than once a year).
9. Based on these rankings, compare the consequences and then rank them in terms of priority.
10. Include any additional comments.

The APELL model purports to be all-hazard in scope, but it has a definite bias towards the chemical industry. While in many developed areas the chemical industry and associated hazards are of major concern, the possibility of other disasters must be thoroughly reviewed, especially since the APELL model specifically states that it is designed for "industrializing" as well as industrialized countries. The APELL handbook contains definitions of key words and some discussion about dealing with risks; however, it does not stress mitigation (although the handbook does mention the need for preventive measures regarding specific hazards).

4.2.1.1. Evaluation of the APELL Model for HRV Analysis

The APELL model has a number of strengths; however, these are far outweighed by its weaknesses. First its strengths. The APELL model advocates that those engaged in the HRV process maintain strong ties with the community planning process when it comes to transportation of dangerous goods, physical planning, and environmental protection. And the APELL guidebook provides participants with (1) background information as to the importance of completing an HRV analysis, (2) a review of concepts associated with risk and vulnerabilities, (3) information on hazards and disasters, and (4) sources of additional information. As participants work through each neighbourhood, they become better educated regarding what particular hazards exist in each building and structure as well as what potential impact those hazards might have upon the immediate vicinity.

The weaknesses of the APELL model are many. First, while a coordinating group is central to the APELL model and involves "fire and rescue services, hospital and health services, civil defence, industry, environmental authorities and building authorities" (UNEP 1992, 18), there is no mention of laypersons or residents being included in the HRV process. The focus is clearly on experts. Perhaps the focus on experts contributes to an overall failure to acknowledge: (1) the potential lack of quantitative and qualitative data vis-à-vis hazards, risks, and their impacts; (2) the uncertainty that exists in dealing with potential disasters; and (3) the inability of the scientific and expert community to accurately predict potential hazardous events.

One of the APELL model's greatest weaknesses concerns the way it handles the issue of vulnerability. The APELL handbook does not address the subject of vulnerability; rather, it deals with people and property as "threatened objects." There is no attempt to identify those who may be more vulnerable than others. This creates a problem when it comes to considering mitigative actions, for, without examining why vulnerability occurs, it is impossible to consider how to mitigate it. For example, if we are unaware that the reason a building is vulnerable to an earthquake has to do with its type of construction (e.g., unreinforced masonry), then it is impossible to consider building retrofit ordinances as a mitigative measure. The list of vulnerabilities is also very biased towards industrial hazards. The failure of the APELL model to consider social vulnerabilities results in a process that is unable to address issues of equity and that lacks the ability to empower those persons most vulnerable to potential disasters. The inability of the APELL model to consider vulnerability also decreases the ability to politically mobilize the community so as to ensure the implementation of mitigative strategies.

The APELL model to HRV analysis is also weak in terms of methodology. While all-hazard in scope, it is heavily weighted on the side of hazardous material spills and related industrial accidents. The APELL handbook presents eight potential natural disasters: (1) earthquakes, (2) landslides, (3) floods, (4) hurricanes, (5) tsunamis, (6) extreme frost, (7) drought, and (8) heat waves. However, it also covers fires, explosions, chemical leaks, and combination hazards. Although the handbook suggests that other hazards be considered, it offers no suggestions as to how participants might identify them. This factor is compounded by the fact that identifying additional hazards is considered to be the fourth step in the APELL model. The first step is to identify the object that is potentially threatened (e.g., the building or site); the second is to identify the agents (e.g., chemicals); the third is to identify any hazards specified (e.g., fire, explosion). It is only when these three steps have been completed that one may turn to additional hazards. When one is focusing on the various chemicals located in a particular facility, it is very difficult to also focus on external agents such as hurricanes and earthquakes. In other words, the APELL model's methodology is not particularly flexible. Going through all the potential causes of a hazard is a time-consuming process, and the practical value for the community of listing thirty different chemicals that all have the ability to create an explosion and fire is unclear (unless they have unusual combustion properties, such as extreme toxicity). While having this information is essential to emergency response (e.g., the firefighters need to know what chemicals are in the building), it is not essential to determining community risk and vulnerability (for this, it is only essential to know that there is the potential for an explosion, toxic cloud, or whatever).

Additionally, the APELL handbook lists three areas that may be adversely affected by exposure to hazards: (1) life and health, (2) the environment, and (3) property. The values for each of these three areas range from unimportant to catastrophic; however, the handbook's definitions of "catastrophic" are not at all similar to those used by researchers or, for that matter, many businesspersons. For example, it rates a disaster with more than twenty deaths, with hundreds of serious injuries, and the evacuation of over 500 persons as "catastrophic." The APELL model also categorizes a hazardous event resulting in costs exceeding $20,000 as catastrophic. It must be remembered that the APELL model is based on a building-by-building assessment of a single site and, indeed, a cost exceeding $20,000 may well be catastrophic to a small building; however, many businesses, and certainly a large number of industries, could sustain a loss of $20,000 and barely notice it. These examples, and numerous others, provide a lot of room for disagreement, thus adversely affecting the communicability of the APELL model.

With regard to the hazards that APELL *does* address, neutral terms such as "temperature," rather than "increased risk with rising temperatures," are used to address a number of risk factors. Thus, the link between risk factors and the likelihood of a disaster is not explicitly stated. This leads to a lack of adequate risk communication, and the consequences of this are notable. For example, the APELL model requires participants to examine and rank four possible consequences of a particular hazard. Using APELL methodology, it is difficult to understand, let alone explain to laypersons, why, for example, if no warning plan is in place, the potential speed of development of a particular hazard should be given a rating of "5" (a catastrophic consequence) under life and health. On the positive side, APELL methodology does not require a lot of technical equipment, and the process is not an expensive one to undertake.

There are a few published case studies pertaining to the use of the APELL model; however, only two of these are evaluative in nature (Barranquilla, Colombia; Shanghai, People's Republic of China). It is interesting to note that, while the APELL model is intended to be all-hazard in scope, none of the case studies applies it to anything but hazardous materials. In Barranquilla, Columbia (Barranquilla APELL Group 1997), the APELL model was used to develop a scenario for an exercise drill in a chemical plant. It appears that it was used in order to identify the potential for a chlorine leak, thus enabling the staff at the plant and a number of emergency response teams (e.g., the local fire brigade) to develop an exercise to test their response to such an eventuality. In Shanghai (Sen 1997) the APELL model was used to identify several hundred major hazard units (MHUs) within the many chemical facilities in the city. Based on the findings, city staff: (1) developed a regulatory system to inspect MHUs on a regular basis; (2) set up a chemical rescue command system and supporting communication network; (3) conducted a number of exercises; and (4) developed a public awareness program, including "Chemical Rescue Education Day" (Sen 1997, 36). There is no discussion of any intent to increase the scope of the APELL model to include other hazards.

The other three published case studies are descriptive and quite general. One uses the APELL model to assist in the development of a chemical information system in Kolin, Czech Republic (Palecek 1997); another combines it with existing emergency planning initiatives in order to deal with a port in Santiago, Chile (Palacios 1997); and another uses it to evaluate hazards in the Manali-Enmore industrial zone in Madras, India (which, in turn, led to the setting up of a national advisory committee on chemical hazards) (Umakanthan 1997).

While these case studies resulted in successful outcomes (e.g., the development of coordinated chemical response centres), it is significant that the APELL model was used only with regard to chemical plants and industrial facilities.

4.2.2. Review of the EPC Model for HRV Analysis

The revised *Evaluation of Peacetime Disaster* (EPC 1992) replaced *The Emergency Preparedness Canada Manual for Hazard Identification, Vulnerability Analysis and Risk Assessment* (EPC 1986) and was developed as an aid to Canadian communities. It has been widely publicized through the courses offered at the Canadian Emergency Preparedness College in Arnprior, Ontario, and is provided in the course handouts for most of the basic emergency preparedness courses. The EPC model for HRV analysis follows seven steps:

1. Review the list of identified hazards and determine if any additional hazards should be included.
2. Collect historical documentation. Assess whether or not the hazard has occurred frequently. The frequency of the hazard is linked with the degree of damage experienced, the number of persons affected, the number of problems faced by the community, and the expenses incurred. This information is given a rating from 1 to 5.
3. Consider the internal risk factors or changes in circumstances that either increase or decrease the likelihood of the hazard occurring. The values for this step range from -3 for highly decreased risk to +3 for highly increased risk.
4. Consider the external risk factors to the community (such as what may be occurring in a neighbouring community). The values for this step range from -3 for highly decreased risk to +3 for highly increased risk.
5. Express the community's vulnerabilities as the "lack of ability to cope." This factor is rated from 0 (reflecting no change in vulnerability from the previously documented historical data) to 3 (reflecting a high change).
6. Add the values for steps 2 through 5 to get the rating for potential hazards.
7. Compare values and assign priorities.

4.2.2.1. Evaluation of the EPC Model for HRV Analysis

The EPC model to HRV analysis has a number of weaknesses and few strengths. To begin with its strengths, of all the models for HRV analysis, the EPC model includes the most comprehensive list of hazards. This makes it very likely that disasters will be adequately anticipated. It identifies twenty-four natural hazards, including diseases and epidemics affecting people, plants, and animals; pest infestations; and twenty-five person-induced hazards. Furthermore, the EPC model provides an educational component (albeit only for the benefit of the emergency planner) and some information regarding definitions of terms and hazards. It also includes a component dealing with risk perception, along with guidelines for risk assessment.

Now for its weaknesses. Probably its greatest weaknesses are: (1) its lack of integration with any other community planning process, (2) its lack of public participation, and (3) its focus on emergency planning versus sustainable hazard mitigation. It makes no mention of being part of the community planning process, and it is non-participatory (e.g., its handbook makes no mention of community involvement when instructing emergency planners on how to complete an HRV analysis). The EPC handbook does suggest contacting the local police and long-term residents as well as reviewing newspaper clippings in order to obtain additional information on certain hazards and risks, but these suggestions only pertain to the search for specific data and are not identified as part of a process. Its failure to recognize the value of public participation, combined with its failure to recognize the need to adopt mitigative strategies, means that the EPC model has little chance of success.

Assuming that integration of public participation becomes part of the EPC model, there are still a number of inherent difficulties relating to its methodology. Although the EPC model has a relatively simple structure (and, therefore, the results of the HRV process can be easily communicated to the community at large), this simplicity comes at a cost. For example, the EPC model provides no risk factors for the emergency planner to consider when she or he is trying to determine whether or not there has been a change in circumstances regarding flooding. Thus it leaves her/him with very complex decisions to make and no suggestions as to how to make them. With no firm decision-making process, it would be very difficult to communicate and support the results of an HRV analysis to the community at large.

Another problem with the EPC model is that, since historical data are combined with the amount of damage that occurred in previous situations (e.g., a value of 1 is given to a hazard that has occurred one or two times, has involved few people and problems, and has resulted in slight damage; while a value of 5 is given to hazards that occur frequently, entail very heavy damage, a large number of victims, many complex problems, and very large expenses), it does not have the capacity to rate hazards that occur frequently but that entail little damage (and vice versa).

Yet another problem is that, from a risk management perspective, the EPC model is of little value to the community because it lacks robustness and does not provide logical explanations for the many different values that it assigns to the components of its analysis. Summing the values simply compounds the fundamental errors inherent within the process as a whole.

4.2.3. Review of the FEMA 1 Model for HRV Analysis

FEMA has published an HRV analysis that has been distributed internationally and that I refer to as FEMA 1. FEMA 1 uses four criteria in a rating and scoring system (Natural Disasters Organization, 1991) based on estimates of High, Medium, or Low. It is a general hazard and risk assessment model for HRV analysis, and it walks the planner through the following steps:

1. History
    - Low = 0-1 times in the past 100 years and High = > 4 or more times
2. Vulnerability of people
    - implies the consideration of vulnerable groups (elderly, disabled, etc.), densities of population, and location of population in relation to hazards.
    - implies location and value of property as well as vital facilities
    - the vulnerability of both people and property is listed as low if < 1 per cent and high if > 10 per cent
3. Maximum threat
    - area of community impacted: high if > 25 per cent and low if < 5 per cent
4. Probability
    - based on chances of occurrence per year
    - less than 1 in 1,000 is low, greater than 1 in 10 is high
5. Low is given a value of 1 point, medium is given a value of 5 points, and high is given a value of 10 points. FEMA 1 states that some criteria are more important than others, and it gives weighting factors of:
    - History (2)
    - Vulnerability (5)
    - Maximum Threat (10)
    - Probability (7)
6. Each hazard is then scored by totalling the ratings times the weights. FEMA 1 suggests a threshold level of 100 points to assist in the ranking of hazards. All hazards that score over 100 should receive a high priority in emergency planning.

4.2.3.1. Evaluation of the FEMA 1 Model for HRV Analysis

The FEMA 1 model has few strengths in terms of process. Although mitigation is not specifically mentioned, it seems to be implicit and its goal is to form a firm basis for community emergency planning. The FEMA 1 model does encourage participants to talk to scientists and experts in other communities; however, these experts are not part of the HRV committee. The rest of the FEMA 1 process is weak. FEMA 1 is not linked to the community planning process, and public participation is invited only so far as the public is used to assist in the identification of hazards. Public participation is not part of the assessment process, as the planning committee involves only those with a background in emergency planning.

Like the EPC model to HRV analysis, the FEMA 1 model lacks adequate risk communication between the local stakeholders and experts, and it provides neither educational material nor direct references to sources of additional information. FEMA 1's methodology is weak, primarily because it lacks guidelines for determining (1) which hazards to consider, (2) the risk of a disaster, and (3) vulnerability. It also has an arbitrary weighting system. FEMA 1's methodology implies that only hazards that are capable of serious consequences should be considered, yet it provides no hazard lists. The method for determining hazards involves having group members visit libraries, government offices, and the general community and then having a facilitator elicit answers from them. The danger is that potential hazards may be ignored simply because no one can remember them having previously posed a problem, and new information is not readily available.

FEMA 1's methodology does not consider any risk factors in the risk assessment phase but, rather, uses a best-guess estimate based on the collective wisdom of the group. If the group thinks that the chances of the hazard occurring is greater than 1 in 10 in any given year, then the probability of occurrence is rated as high. No guidance is given as to how the group is to make this analysis. Equally, there are no guidelines for participants to use in determining why the probability of a hazardous event is less than 1 in 1,000 per year or between 1 in 1,000 and 1 in 10. This makes the decision difficult for community members who, when asking why the probability is what it is, deserve a better response than "Because we think so!" Thus, while FEMA 1 establishes a process for estimating the likelihood of hazards based on their history, magnitude, and probability, its methodology is not robust and it gives too much discretion to its committee to determine whether a hazard is of high, medium, or low risk.

While FEMA evaluates the vulnerability of people in terms of age and possible disability, population density, and proximity to hazard, the assessments of all of these factors are amalgamated into one value, which is then expressed as a percentage of the total population. The degree of human vulnerability is reflected as high, medium, or low, just as is the degree of property vulnerability. Although the FEMA 1 model attempts to include those persons who are highly vulnerable to a specific hazard, its result is so diluted by its methodology that the determined value is not properly representative of the extant vulnerabilities. The degree of vulnerability is expressed as a percentage: if more than 1 per cent of the population is affected, then the vulnerability is low; if between 1 and 10 per cent of the population is affected, then the vulnerability is medium. Why having 9 per cent affected would result in medium vulnerability and 11 per cent in high vulnerability is unclear.

As for its weighting factors, the FEMA 1 model to HRV analysis uses the values (high [10], medium [5], or low [1]) that were calculated for history of the hazard, vulnerability of people and property, maximum threat, and probability. Maximum threat (area of the community impacted) receives the highest weighting factor (10), the next is probability (8), followed by vulnerability (5), and history (2). Based on this, a hazard that affects a large area of the community but has little impact on people or property (e.g., a rural area) would be weighted five times more than would a hazard that affects a small part of the community but causes massive property damage and loss of life (e.g., a tornado). No justification is given for the use of these weighting factors.

FEMA 1's priorities for dealing with hazards are arrived at by calculating a composite score for each hazard. This is done by multiplying each of the four scores by the weighting factor and then totalling the numbers. If the numbers add up to over 100, then the hazard should receive a high priority in terms of planning; if they add up to less than 100, then the hazard should be considered a low priority. How a threshold of 100 was chosen is unclear.

FEMA 1 suggests that the planning committee use risk maps for the various hazards and overlay them onto a community map in order to determine which social groups and which buildings are most vulnerable. Use of this tool does not place an undue financial burden upon the community, but, since the FEMA 1 model does not require participants to document the reasoning used to arrive at the values for the assessment, ease of communication is severely limited.

It is interesting to consider a concrete example of a FEMA 1 HRV analysis. Consider the FEMA 1 analysis that was completed by Public Works (1987) in the Dartmouth region of Nova Scotia. Of the three identified regional hazards (severe weather, radioactive fallout, and aircraft hazards), the only one that surpassed the threshold of 100 was radioactive fallout. Thus, a hazard that has never occurred in the Dartmouth region, and whose probability was assessed at less than 1 in 1,000 (a low rating) because of the heavy weighting on the maximum threat factor, became the number one priority for planning in the tri-city area. Given that Halifax has an international port that is used for the transportation of dangerous goods; that Dartmouth has oil refineries, an industrial park, and a Canadian Forces Base within its boundaries; and that Bedford has experienced a number of floods, to place priority upon planning for radioactive fallout seems rather off the mark.

4.2.4. Review of the FEMA 2 Model for HRV Analysis

FEMA 2 provides a list of twenty-four hazards, which range from avalanche through to civil disorder and hazardous materials incident (transportation). It also provides for each community to add two additional hazards to the list. For each of these hazards, it asks the responder to answer the following:

1. Can the hazard affect the population?
    - (If *Yes* continue)
2. Is the hazard a significant threat?
3. Historically has it affected the jurisdiction?
4. Could loss of property or life result?
5. Would the local emergency management organization be involved if it occurred?; or
6. Does a specific plan exist or is one needed to respond?
    - (If *Yes* continue)
7. Frequency:
   There are seven choices ranging from:
    - once or more a year
      to ...
    - less than once in 100 years and

- has not occurred.

8. Best estimate of the total population that could be seriously affected by hazard, considering peak population if appropriate. (p. 2-2)

9. The responder is then expected to consider the capacity of the jurisdiction in each of six functional areas. The possible answers are:

   - "*Yes*," if the jurisdiction has the capacity to meet the need and "*No*" if it does not. Some areas allow the responder to answer "*No*" if there is no capacity and "*Partial*" if there is some capacity. The six functional areas are:

     (1) Emergency Authorities and Management
       - legal authority, formal plan, staffing, alternates, vital records, pubic education program, etc.

     (2) Direction, Control, and Warning
       - Emergency operations control facility, mobile command posts, alerting and warning systems, etc.

     (3) Population Protection
       - Multi-hazard plan, evacuation plan, shelters, nuclear attack planning base, public information plan, etc.

     (4) Contamination Monitoring and Control
       - Plan for hazard material incident, protective equipment, evacuation routes, specialized teams, etc.

     (5) Hazard Mitigation
       - hazard mitigation plan, mapped hazards and participation in the National Flood Insurance Program.

     (6) Training and Education
       - trained response planners and line staff, school curriculum for fire safety, natural and war-related hazards, training for professionals for flood-related disasters (architects), RADEF training, exercises, etc.

Under each of the six functional areas, the responder must complete a multi-year development plan, which includes a question on what work has priority in this area, the work period slated for this activity, and the costs. These results are entered into a workbook, and FEMA 2 uses a computerized program to process the information and evaluate the hazards, the populations at risk, and the capacity of the community to respond.

4.2.4.1. Evaluation of the FEMA 2 Model for HRV Analysis

The FEMA 2 model is void in strengths vis-à-vis process since it virtually ignores any type of participatory process and the model is to be carried out by a disaster manager in isolation of the community at large. The FEMA 2 handbook states that its purpose is to "guide local jurisdictions through a logical sequence for identifying hazards, assessing capabilities, setting priorities and scheduling activities to improve capacity over time" (FEMA 1987, 1-1).

So, although not explicitly stated, the FEMA 2 model is considered as part of the overall disaster management process. Furthermore, as hazard mitigation is included as part of FEMA 2's overall capability assessment, HRV analysis is recognized as crucial to developing mitigative strategies. However, there is no reference to the ongoing local community planning process, and responsibility for completing the hazard assessment is solely assigned to the disaster planner, making no reference whatsoever to community participation. The FEMA 2 model does not encourage using experts; thus, its priorities, with regard to correcting the deficiencies in the community's capacity to respond to a disaster, tend to be whatever the disaster planner decides they should be. The lack of rigour in making this assessment renders the rationale for priorities questionable.

FEMA 2's methodology is very weak. First of all, the FEMA 2 handbook lists eleven natural hazards, no epidemics or diseases, and eleven person-induced hazards (it leaves space for the addition of more hazards). It does not include hazards that do not fall within FEMA's area of responsibility (e.g., oil spills at sea). The first question asks whether or not a given hazard could affect a given jurisdiction; if the answer is no, then the hazard is eliminated from further consideration. No risk factors are provided to assist in this assessment. Its second question asks whether the hazard is a significant threat. Again, if the respondent answers no, then the hazard is no longer considered. Its third question asks for historical data regarding the frequency of the hazard. No further questions are asked. Without conducting an analysis of the risk factors, it is difficult to assess the accuracy of a person's responses to the question about the likelihood of a hazard affecting her/his community.

In terms of vulnerability, the FEMA 2 handbook only requires that users of the FEMA 2 model answer one question: "What is your best estimate of the total population that could be seriously affected by this hazard? Consider peak population if appropriate" (2-4). The primary focus of the handbook is on the development of disaster plans and on assessing the capacity of the community to respond to a disaster. Over eighty pages in the FEMA 2 handbook are devoted to questions regarding this latter factor. Questions range from "Is there the legal authority to order a curfew?" to "Have incumbent-appointed elected officials received training?"

While the FEMA 2 model does include recommendations for mitigative actions, these recommendations are not linked to any criteria except those involving the capacity of the community to respond. FEMA 2 provides no links between the hazards, risks, number of people affected, and priorities established for mitigative actions.

4.2.5. Review of the NOAA Model for HRV Analysis

The NOAA CD-ROM provides an eight-step process for conducting community-wide HRV analyses. In order to gain access to this information, the user needs Internet browsing software. Although not required to gain access to most of the information on the CD-ROM, users are encouraged to use a GIS and are provided with ArcExplorer® free software in order to view some of the data. Nevertheless, ArcView® software is required to interact with some of the case study data.

The following is a brief summary of the eight steps involved in the NOAA model for HRV analysis:

1. Hazard identification

   a) Users are invited to determine which hazards they will consider.

   b) They are then required to establish the probability, area of potential impact, and magnitude for each hazard selected. The NOAA model for HRV analysis acknowledges that communities are unlikely to have access to quantifiable probability assessments; therefore, users are required to complete a "relative priority matrix" to use as a general guide. For each hazard in the matrix, the following scoring system is used:
   (Frequency + Area Impact) x Magnitude = Total Score

   where each factor is based on a scale of numbers ranging from 1 to 5, where 1 = low and 5 = high.

2. Hazard Analysis

   a) Users are first requested to map "risk consideration" areas (e.g., flood plains) for each hazard in order to identify high potential impact areas.

   b) The second step is to establish relative ranking within the risk areas (e.g., a risk area for ten-year floods would be ranked higher than a risk area for 100-year floods). There is no universal ranking structure, as some risk areas are ranked from a low of 1 to a high of 3 (e.g., wildfires), while others are ranked from a low of 1 to a high of 5 (e.g., floods).

3. Critical Facilities Analysis

   a) The first step is to identify critical facilities categories for the community (e.g., hospitals, schools).
   b) The second step is to complete an inventory of critical facilities.
   c) The third step is to identify situations in which critical facilities are located in high-risk areas.
   d) The final step is to conduct an individual assessment of each critical facility relative to the hazard risk areas and potential structural and operational vulnerability.

4. Societal Analysis

a) The first step is to identify areas of special consideration (e.g., areas that include a high proportion of minority populations or senior citizens).
b) The second step is to identify situations in which special consideration areas are located in high-risk areas.
c) The third step is to complete an inventory (i.e., number of households) in each area of special consideration that is located in a high-risk area.

5. Economic Analysis

a) The first step is to identify primary economic sectors and to locate economic centres.
b) The next step is to identify intersections of economic centres and high-risk areas.
c) The third step is to conduct a general inventory of high-risk economic centres (i.e., count business units and target businesses for structural analysis).
d) The fourth step is to identify large employers and their intersection with risk consideration areas.
e) The fifth step is to conduct a vulnerability analysis on the buildings and structures of large employers as critical facilities.

6. Environmental Analysis

a) The first step is to identify secondary hazard risk consideration sites (i.e., areas with the potential for experiencing secondary environmental impacts from natural hazards) and key environmental resource sites (i.e., hazardous or toxic material sites).
b) The second step is to identify intersections of secondary hazard risk consideration areas, environmental resource sites, and hazard risk consideration areas.
c) The third step is to identify key environmental resource locations (i.e., areas particularly sensitive to secondary hazard impacts) and their proximity to secondary risk sites.
d) The fourth step is to conduct a vulnerability analysis on priority secondary risk sites as critical facilities.

7. Mitigation Opportunities Analysis

a) The first step is to identify areas of undeveloped land and their intersection with high-risk areas.
b) The second step is to complete an inventory of high-risk undeveloped land.
c) The third step is to assess the status of one's existing flood insurance program (only available in the United States).

8. Results Summary

This final section provides a summary of the preceding seven steps and offers recommendations and priorities for completing mitigative actions.

4.2.5.1. Evaluation of the NOAA Model for HRV Analysis

The NOAA model for HRV analysis purports to be "an informational aid" designed to assist communities develop effective hazard mitigation strategies, and the model is introduced via a CD-ROM that is designed as a tutorial to walk users through the NOAA process. The CD-ROM includes not only the methodology for the NOAA model, but also a case study involving New Hanover County, North Carolina. The findings of the case study accompany each phase of the NOAA model, consequently, unlike with the other models (in which I focus first on the strengths and then on the weaknesses), here my analysis follows the case study.

It is disappointing to note that the entire NOAA model for HRV analysis, as outlined on the CD-ROM, is devoid of any mention of the overall HRV process. Since this project was initiated in collaboration with FEMA's *Project Impact* initiative,[21] and since FEMA's model for HRV analysis promotes a cooperative partnership, one might assume that the NOAA model would do the same. Unfortunately, it does not.

In the section of the NOAA CD-ROM that includes the New Hanover case study, reference is made to the New Hanover County Project Impact Risk Assessment and Hazard Identification Sub-Committee. There are only six members of this committee, and they include representatives from: (1) the National Weather Service, (2) the New Hanover County schools, (3) the Occidental Chemical Corporation, (4) the US Army Corps of Engineers, (5) the City of Wilmington engineer, and (6) the US Coast Guard. It is interesting to note that, even though this is a regionally and community-based HRV process, half of the members are from nationally, not locally, based organizations. In addition to the members of this New Hanover County Committee, ten "data providers" are listed, and all are nationally or state-based, with the exception of the New Hanover County schools. Nowhere does the material suggest the need for community- or county-based stakeholders to participate in the HRV process.

Several "Project Partners" are identified: (1) FEMA; (2) NOAA; (3) the North Carolina State Departments of Environment and Natural Resources and Crime Control and Public Safety; (4) the University of North Carolina at Wilmington; (5) the New Hanover County Departments of Planning, Emergency Management; and (6) the City of Wilmington engineer. However, the degree and scope of these partnerships are never clarified.

The case study based in New Hanover County resulted in the identification of seven potential hazards: hurricane storm surge, wind, flood, tornado, coastal erosion, earthquake, and wildfire. Surprisingly, the instructions for completing hazard identification state that the list of hazards can either be comprehensive or limited to specific hazards. No rationale for this statement is provided. NOAA's methodology treats natural hazards differently from

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[21] *Project Impact* is FEMA's national hazard mitigation initiative, and it began with seven pilot communities that were challenged with engaging local government, businesses, and civic leaders in a coordinated effort to reduce hazard vulnerability.

person-induced hazards (which it considers as a vulnerability factor and deals with in a later step). For example, hazardous spills are considered to be secondary hazard impacts resulting from a natural disaster that has affected a solid waste facility. Thus NOAA's method of identifying areas at risk seriously limits the consideration of various types of person-induced hazards (e.g., airplane crash, riot).

Once having identified extant hazards, the NOAA sub-committee establishes the priorities for each. Users of the NOAA model are cautioned that adequate quantitative and qualitative data are not usually available and that there are considerable differences in terms of consistency and accuracy regarding the probability data for various hazards. As a means of dealing with these inconsistencies, the NOAA model suggests using a relative priority matrix as a general guide. The text accompanying the following formula makes it clear that this is a subjective exercise and that the actual scores have no absolute statistical value. The formula used in the NOAA model is *(Frequency + Area Impact) x Magnitude = Total* Score).[22]

For New Hanover County, using the NOAA relative priority matrix, the top three priorities were wind (32), flood (32), and hurricane storm surge (30). The areas of potential impact were mapped and rated for all the hazards, and an overall rating for the risk consideration area was calculated. Since the NOAA model does not use any risk factors, potential impact areas were designated using FEMA's and NOAA's GIS database. As there are no guidelines or risk factors to assist the committee members in determining whether the frequency, area of impact, and potential damage magnitude should be low, moderate, or high, it is impossible to explain to residents why one area is at higher risk of a particular hazard than another (apart from using common sense [e.g., areas near the ocean are subject to hurricane storm surge]). Furthermore, no rationale is provided for adding the frequency scores to the area impact score and then multiplying the total by the magnitude score. So even though the process of actually assigning values to the various factors of the formula is acknowledged to be flawed, errors can be further distorted by the mathematical operations.

The next step is to identify and map high potential impact areas for each of the hazards. Use of ArcView® software is recommended and, in fact, is essential if one is to interact with some of the case study data. Once these

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[22] Each factor is based on a scale of numbers ranging from 1 to 5, where 1 = low and 5 = high.

areas are mapped, it is recommended that scores be assigned in order to establish some relative ranking within risk areas. For example, an area designated as being in a 100-year flood plain would receive a higher rating than would an area in a 500-year flood plain. One problem with this methodology is that the analytical results are impossible to compare accurately because different hazards have different rating scales (e.g., flood impacts are measured on a scale of 1 to 5; erosion risks are measured on a scale of 1 to 3). Thus, the numbers can be quite misleading. For New Hanover County the impact areas for each hazard were combined, and, as would be expected, the areas of highest risk were along the coast.

The sub-committee identified the critical facilities, schools and nursing homes, and infrastructure in New Hanover County, and those that were located in the high-risk areas were targeted for detailed structural analysis. Since NOAA treats hazardous material spills as secondary hazard sites, they do not appear on any of the risk maps.

One of the strengths of the NOAA model is how it deals with vulnerability, specifically with regard to: (1) critical facilities, (2) social factors such as poverty and age of populations, (3) potential disruption to economic sectors and centres, and (4) environmentally sensitive areas. The CD-ROM material provides users with numerous factors to consider in each of these four areas. However, as mentioned earlier, a confusing aspect of NOAA's methodology is that it includes person-induced hazards under the vulnerability section (which deals with environmental analysis).

In New Hanover County, the sub-committee used census data to identify areas that, due to the social vulnerability of the residents, were given special consideration. These were areas with: high percentages of single-parent families, people living below the poverty line, persons over the age of sixty-five, and minority populations. In the case study, the area of most concern is in and around the City of Wilmington – away from high-risk areas.

Wetlands, significant natural habitat areas, and fisheries nursery areas were identified as environmental resource locations. As would be expected, most of the environmental resource locations were in high-risk areas, and most of the hazardous material sites were in low-risk areas. Since the vulnerabilities are compared to the hazard impact areas and not to each other, the user is not warned of the proximity of vulnerable populations to secondary hazard sites. Also, the NOAA model provides no guidelines on how to calculate the approximate vulnerability of the factors covered under the environmental analysis section.

Through the use of a GIS, all of these factors were compared to undeveloped parcels of land. Those areas of undeveloped land in high-risk/high-vulnerability areas were identified. It was suggested that zoning regulations will be amended in order to "minimize development or require additional structural mitigation for future construction in high-risk locations" (NOAA 1999). The findings pertaining to flood hazard led to increased public education programs in high-risk flood areas. Overall, in New Hanover County the NOAA model identified a strong need to develop educational programs, to develop projects for neighbourhoods in special consideration areas, and to develop a plan to target businesses in high-risk areas in order to increase their degree of disaster preparedness.

Since this material has just been published, there has been no opportunity to evaluate its effectiveness with regard to mitigation. My concern is that the NOAA model is devoid of process. And without process, who is going to pay attention to the findings? Who is going to pressure local politicians to put resources towards achieving NOAA's recommendations? Without public participation, and with little local involvement in the HRV analysis, it would be extremely difficult to implement any mitigation strategies.

It should be noted that, while the NOAA model does not require the use of GIS, it would be difficult to complete the analysis as set out on the CD-ROM without it. It is doubtful that many communities would have access to the breadth and scope of the data that were available to New Hanover County; however, lack of resources does not preclude the use of the NOAA model.

4.2.6. Review of the OSLO Model for HRV Analysis

The OSLO model for HRV analysis is divided into six stages: (1) organizing the work, (2) analysis, (3) follow-up by the steering committee, (4) political decision making, (5) areas for follow-up, and (6) updating. The OSLO model begins with the recognition that a politically appointed interdisciplinary steering committee must assume responsibility for day-to-day analytical work. Members of the steering committee would, in turn, appoint several working sub-committees to deal with specific tasks (such as identifying the potential impact of a hazard on the water system). The actual HRV analysis is divided into five steps:

1. Identification of Undesirable Events (those that may affect people, the environment, property, or essential functions [e.g., power supply]).

   A list of fourteen hazards is provided as a checklist, and committee members are urged to make use of local knowledge and to contact experts, to examine inspection and accident reports, and to look at existing emergency plans for more information. Both breakdown of key utilities and war are included in this list.

2. Description of Causes and Determination of Probability

   Committee members are asked to identify causal factors for each hazard (e.g., could an event be triggered by human error, technical factors, etc.?). They are also asked to mention any preventative measures that are in place (e.g., alarms and detection devices, safety practices).

   Probability is determined by estimating the frequency of future hazardous events:

   - Improbable — for events less than once every fifty years
   - Less probable — for events once every 10 to 50 years
   - Probable — for events once every 1 to 10 years
   - Very probable — for events more than once every year

   The guide makes it clear that other options are possible, but it does not present any.

3. Classification of Consequences (the possible effects of an event).

   Committee members are asked, as a first step, to provide a comprehensive inventory of available resources (e.g., emergency equipment and personnel). Next, given the existing resources, committee members are asked to determine the impact on them of any given hazardous event. The consequences of an event are classified as follows:

Class	System	People	Environment	Property
Unimportant	no direct damage to the system, only system delays	No injuries	no damage	damage up to (value...)*
Limited	temporary outages, possible damage if no back-up is available	Few minor injuries	minor damage	damage up to (value...)*
Serious	disruptions lasting for several days	Few, but serious, injuries	extensive damage	damage up to (value...)*
Very Serious	disruptions for a significant amount of time, other dependent systems may be temporarily affected	up to ... dead* up to ... seriously injured up to ... evacuated	serious damage	damage up to (value...)*
Catastrophic	permanent damage	up to ... dead* up to ... seriously injured up to ... evacuated	extremely serious and long-term damage	damage up to (value...)*

*Numbers and dollar values are determined by the community based on its size

4. Systemization of Identified Risk

   Committee members are then asked to develop a matrix, with probability represented on the Y axis and consequences on the X axis. The hazardous event is then placed appropriately (e.g., a flood may be classified as being probable with limited consequences).

5. Development of Strategies for Mitigation

   The final step of the process is to take the results from the systemization of the identified risks and to develop a strategy for adopting and implementing mitigation measures.

   The final four stages of the OSLO model for HRV analysis include the need to consider the monitoring of the process by the steering committee; the political decision-making process; follow-up with regard to developing plans, providing training, and conducting exercises; and acknowledgment of the need to monitor and update the analysis.

4.2.6.1. Evaluation of the OSLO Model for HRV Analysis

There are some strengths in the OSLO model for HRV analysis. The OSLO model recognizes that HRV analysis is a basis for planning. It clearly states that the results must be integrated with community planning and be able to assist communities in systematizing which events can be mitigated and which need to be planned for. The OSLO model also recognizes the importance of the political process, and its guide recommends that the members of the steering committee be appointed by elected political representatives. However, it fails to recognize the importance of widespread public participation in mobilizing political forces to implement sustainable hazard mitigation activities. The steering committee does appoint various working committees, the members of which represent various municipal agencies (e.g., police, public health), volunteers, and industrial safety representatives. and the OSLO model does recommend the use of scientific experts, but only as potential sources of information, not as direct participants in the assessment process. While it should be noted that the OSLO model specifically acknowledges that members of the working committees will need to seek out knowledge and develop a greater awareness of their community, it does not advocate sharing this information with the community-at-large.

Although Stage 4 of the OSLO model is entitled "Political Decision Making," it poses questions rather than offers answers (e.g., "Should the municipality accept the present situation, or should the proposed measures be implemented?" [p. 18]). Since community participation is not incorporated into the overall HRV process, risk communication between local stakeholders and experts is not adequate.

The methodology for the OSLO model is weak, as it includes only seven natural and seven person-induced hazards. Also listed as hazards are an assortment of situations that are generally considered to be secondary events (e.g., disruption of the civil transport network, breakdown of communications). There is no attempt to ensure that the working committee establish a complete list of potential hazards.

Probability is evaluated by considering which hazards may cause a disaster and which preventive measures have already been implemented. No risk factors are provided and, thus, it is left up to the working groups to determine them on a "best-guess" basis. It should be noted that, unlike the other community-based models for HRV analysis, the OSLO model has war as an important focus. The guidebook recommends that members of the working committee consider whether the likelihood of certain hazardous events (e.g., terrorism, disruption to the power system) would be higher during times of war. This information is then (presumably) passed on to those involved in planning for armed conflict. But it is not clear how this affects the day-to-day planning for disaster management.

Much like the FEMA 2 model, the OSLO model focuses on the capacity of the community to respond to a disaster (e.g., what resources exist?). Based on this capacity, OSLO determines the consequences of a disaster (e.g., what will happen to the water system if a particular hazard occurs?). The OSLO model fails to acknowledge either that the information available to committee members may be inadequate or that scientists and experts may not be able to accurately predict potential hazards.

In keeping with a focus on the capacity of the community to respond to a disaster, the vulnerabilities identified by the OSLO model are limited to those involving community infrastructure (e.g., water and power systems). No consideration is given to any environmental or social vulnerabilities, although damage to the environment and number of injuries and deaths is taken into account in developing a risk matrix. No guidelines are offered as to how the impacts of disasters might be categorized (e.g., what constitutes "extensive" versus "serious" environmental damage?).

The OSLO model includes a substantial section on mitigative measures, but, for the reasons listed above, one must question the robustness of decisions made on the best-guess estimates of members of the working committees.

4.2.7. Review of the SMUG Model for HRV Analysis

The SMUG model for HRV analysis is used in Australia (Natural Disasters Organisation 1991), where it was developed primarily to assist community groups in developing a consensus with regard to priority concerns. Research indicates that it has been used by a number of communities in Australia and New Zealand. The SMUG model examines five factors for each hazard (Lunn 1992). These factors, which are listed below, are weighted from 1 (Low) to 10 (High) to reflect their relative importance in terms of community values.

1. Seriousness:
   - The relative impact of a hazard in terms of dollars and people.
2. Manageability:
   - Can the community do anything about the event? If the community can do something before the event, then the rating would be high; if the community can only do something after the event, then the rating would be low.
3. Urgency:
   - Does something need to be done now (High) or can it be done in the "medium" future?
4. Risk:
   - What is the probability of the hazard occurring?
5. Growth:
   - If nothing is done, will the hazard grow worse (High) or will it remain static (Low)?
6. The score for each hazard is calculated by the sum of the weighted factors.

4.2.7.1. Evaluation of the SMUG Model for HRV Analysis

The SMUG model for HRV analysis has a number of strengths. It clearly states that the goal of completing the analysis is to develop mitigative strategies. It uses one of its ratings — "manageability" — specifically to deal with hazards that can be mitigated against. It considers the manageability of mitigation as one of the factors in determining whether or not mitigative actions should be taken. The degree of urgency with regard to taking mitigative action is another factor in determining how the SMUG model prioritizes hazards.

However, given its focus on mitigation, it is somewhat surprising that the SMUG model is not linked to the community planning process. Community participation is only used as part of the consultative process for hazard identification and vulnerability; it is not part of the overall HRV process or decision-making forum. The planning committees only involve those with a background in emergency planning, local government authorities, emergency planners from utility companies, and local welfare officials.

Furthermore, though the SMUG handbook recommends that the members of the hazard and risk subcommittee consist of three or four people who have knowledge of hazards (e.g., geologists, seismologists) and vulnerable populations as well as experience in evaluative techniques, experts are invited to join in the HRV process, and participants of the various sub-committees are encouraged to consult with them.

As do other previously discussed models for HRV analysis, the SMUG model fails to recognize the importance of public participation throughout the process and fails to address the need for political legitimation in order to ensure that priorities for mitigation are actually implemented. Although its use of the public in determining vulnerability is a positive step, the SMUG model does not include any of the social vulnerabilities (save the number of people that would be affected by a disaster).

As has been stated, the SMUG model uses degree of manageability to evaluate whether or not any mitigative efforts can be made before the disaster occurs. If they can be made, then the rating is high; if they cannot be made, then the rating is low. This step requires considerable assessment skills. First, the various mitigative solutions have to be provided; second, the political climate has to be evaluated. The SMUG handbook provides no guidelines concerning how either of these two tasks is to be accomplished.

SMUG methodology is weak. The SMUG handbook provides no hazard information (although it does include a glossary of relevant terms). The method for determining hazards involves having group members visit libraries, government offices, and the general community and then having a facilitator elicit answers from them. There is no way to ensure that all possible hazards have been considered.

The SMUG model does not include any risk factors that may be used in completing the risk assessment. The first question asked of the committee is, "Do we need to do something about this hazard now?" This question assumes that the group has assessed the likelihood of the hazard occurring and that it has already made some judgment as to whether or not it is likely to occur in the near future. The second question assumes that the risk factors for the hazards have been considered: "If we do nothing about the hazard, will it grow worse?" Again, no criteria have been provided to assist the group in answering this question.

The SMUG model measures the impacts of hazards in very basic terms, and the priorities for dealing with hazards are based on the ability to manage them, the need for resources to combat them, and the potential for the worsening of the estimated risk. It would be easy for different persons to come up with different answers. For example, since there are no standards for managing these hazards, it would be easy for one person to feel that they are being managed while someone who applied more rigorous disaster management principles (e.g., annual testing of the disaster plan) would feel quite differently.

The SMUG model uses simple language, and if participants adhere to the caution that all evidence in support of the ratings is documented, then results should be easily communicable. However, since the SMUG model fails to ensure the careful consideration of important elements in the risk assessment – namely, historical data and probability[23] — it would be difficult for those involved in the process to understand how the priorities were identified. As well, since the magnitude of the hazard is considered as a worst case scenario, all of the impacts would be as severe as possible. The resultant degree of unrealistic forecasting makes it difficult to accurately communicate what a community should expect. So while the HRV analysis based on the SMUG model does not require numerous resources to complete, is affordable, and is relatively simple, its simplicity comes at the expense of its validity.

4.2.8. Review of the UNDRO Model for HRV Analysis

UNDRO's *Mitigating Natural Disasters: Phenomena, Effects and Options – A Manual for Policy Makers and Planners* (United Nations 1991) includes a very detailed and comprehensive model for HRV analysis. It limits itself to natural hazards and one technological hazard.

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[23] Probability is only referred to in an indirect fashion; namely, through (1) the growth factor (if we do nothing will it get worse?) and (2) the urgency factor (do we need to do something now?).

The natural hazards are divided into two areas:

1. hydrological, which includes

- floods (due to rain or snow),
- storms, and
- wind storms.

2. geological, which includes

- earthquakes,
- volcanoes,
- tsunamis and seiches, and
- landslides and mudslides.

The technological hazard is:

- pollution from damage to industrial plants (which, presumably, has the same effects as toxic gases, ash falls, and deposits caused by volcanoes).

In the UNDRO model to HRV analysis "hazard is defined as a probabilistic function of magnitude -- or intensity, according to the hazard type – over time" (31). A hazard is further defined as "the probability of occurrence, within a specific period of time in a given area, of a potentially damaging natural phenomenon" (see Figure 3)

The steps for completing the UNDRO HRV analysis are:

(1) Hazards (H) are determined by reviewing past historical records and prevailing geology and topology. A checklist of sites liable to be subject to these hazards is included.

(2) To determine vulnerability, or the elements at risk (*E*), the model requires an inventory of:

- structures:
- special structures, homes, prevalent building types
- infrastructure:
- waterways, telecommunications, sewage systems
- groupings of elements at risk:
- roads, railways, water supplies, electricity supplies, gas and oil supplies

The vulnerability of these elements is determined by considering their ability to withstand damage. Vulnerability (*V*) is expressed on a scale of 0 (no damage) to 10 (total damage)

(3) To determine the risk assessment, the model calculates specific risks (*Rs*); that is, the expected degree of loss due to a hazard and as a function of both natural hazard and vulnerability. The following are specifically included in the risk assessment:

- community services
- infrastructure

- housing areas
- economic areas

(4) Risk mapping is carried out and risks are classified as:

- acceptable (accumulated values are *below* the safety margin)
- marginally acceptable -- warning (accumulated values are *above* the safety margin)
- marginally unacceptable
- high
- very high
- critical
- actual disaster (area is lost)

(5) The maps for the various risks overlap, with the total risk expressed as:

$$Rt = (E)\ (Rs) = (E)\ (HxV)$$

for different categories of elements at risk (*E*) combined (*Et*). Thus,

$$Rt = \Sigma(E)\ (Rs) = (E)\ (HxV)$$

(6) The socio-economic impacts of a disaster are considered in terms of both quantifiable and qualitative costs, which, in turn, are to be considered in terms of direct, indirect, and secondary costs:

Casualties and Personal Injuries
- UNDRO uses the Human Capital Approach -- assessing lives and suffering in economic terms.
- The value to future loss of economic activity is based on 7 to 10 times the Gross Domestic Product of the country per inhabitant per annum.

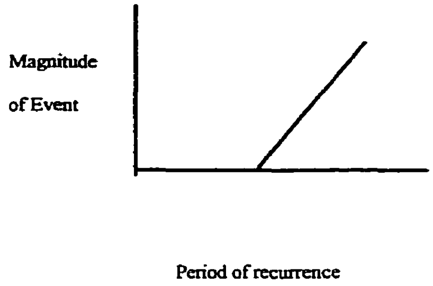
Damage to public investments
- public facilities and infrastructure (direct costs)

Housing Aspects
- direct cost of rebuilding, plus the cost of temporary housing
- indirect costs of added transportation costs

Economic Facilities
- industry, trade, and service sectors (direct costs)
- home production units (e.g., tailoring at home) (secondary costs)

Exactly how all of this is to be calculated and incorporated into the previous assessment data is left unclear. A completed example is never given. The UNDRO model for HRV analysis concludes with examples of methods for mitigating hazards, risks, and impacts (e.g., strengthening of structures and infrastructure, use of land use regulations, etc.).

Figure 3: Hazard (H) as a function of Magnitude over time



Source: United Nations (1991, 31)

4.2.8.1. Evaluation of the UNDRO Model for HRV Analysis

Of all of the models for HRV analysis, the UNDRO model is the most comprehensive and complex. While its process is weak, as will be demonstrated, the UNDRO model is rigorous. Unfortunately, it is rigorous to the point at which the amount of information and resources required is just too great to provide efficient results.

Although not explicitly stated, the UNDRO model implies that the data derived from it should be used to develop mitigative strategies. The UNDRO model does not advocate community participation, and, with its focus on providing assistance to developing countries, it appears to present its information in a rather paternalistic fashion. The idea that the West needs to "teach" developing countries is reflected in the large amount of educational material that is included in the UNDRO handbook, which includes pages of information on risk perceptions; figures and diagrams explaining the dynamics of such things as various weather formations and geological features; definitions; such factors as the depth, duration, and seasonality of various hazards; and references. It is unfortunate that, while it acknowledges the political process required in order to implement mitigative strategies, the UNDRO handbook simply states that typically, after a disaster the government intervenes and then is criticized for its inadequate response and that, by engaging in a disaster management process, it could maintain a better public image. In other words, the UNDRO model to HRV analysis fails to recognize the role that public participation could play in encouraging the adoption of sustainable mitigative strategies.

The UNDRO model is very expert-driven, but it does mention that dissemination of information between experts in different disciplines often causes immense problems. The UNDRO handbook also states that there are communication problems between the geoscientists and land-use planners and that the only solution to this is to bring the parties together during the HRV analysis and to treat the situation as a learning process (12).

The UNDRO model recognizes the importance of integrating the HRV process with community planning. However, although the UNDRO handbook states that the HRV process "does not mean that the final product should only consist of simplified presentation readily grasped by the layman, but that the data presented should be sufficiently user-oriented" (13), it offers no suggestions as to how the experts would accomplish this. So while the need for adequate communication between experts and local stakeholders is recognized, the means of realizing this objective are left unstated. For example, in identifying volcanic hazards, the UNDRO model advocates using geomorphical maps that include fifteen different factors (including ladus, lahars, scarps, scars, etc.). While all of this information is useful, it would be overwhelming to the non-expert.

UNDRO methodology is complex and difficult to explain. There are no examples of completed assessments, and it is not clear what they would look like or how they would be followed. UNDRO methodology emphasizes the production and assessment of hazard mapping. In establishing the criteria relevant to setting up a multidisciplinary team of experts, the UNDRO (1991, 11) manual states that "full use of available maps, aerial photographs, satellite images and statistical data of all settled land should be guaranteed without restriction." Given the severe financial restrictions in most local communities, it is unlikely that this degree of technological sophistication can be made available to many community-based HRV assessment teams. When such maps are not available, the methodology is extremely difficult to follow.

The UNDRO model only mentions ten natural hazards and one person-induced hazard (pollution). There is no mention of the need to include any hazards other than those presented. It certainly recognizes the need to use risk factors to arrive at an estimation of risk and contains much information regarding them. In fact, few communities would have the resources to complete such an assessment, and UNDRO offers no guidelines indicating which risk factors are the most important (should one wish to complete a less comprehensive analysis). This level of detail exists for each hazard, so that, while the risk factors are certainly identified, the sheer volume of information reduces UNDRO's usefulness. For example, in providing the risk factors for evaluating the likelihood of a flood, the handbook provides seven categories in its flood assessment checklist: topography, drainage, bedrock, soils, landslides, legacies from the past, and human-made features. When one adds up the individual items under these seven categories, the checklist includes over fifty different factors that have to be assessed (e.g., valley floor width, complexity of river feeding, depth of river, vegetation catchment area, etc.). It is so comprehensive that the ordinary disaster planner in a medium-sized community would probably abandon the project.

On the positive side, the UNDRO model recognizes that, in many cases, the scientific and expert community cannot accurately predict potential hazardous events. The UNDRO handbook states that although "it may not be possible at the present stage of scientific knowledge to forecast when they [disasters] are going to happen, it is often possible to predict with reasonable accuracy where they are likely to occur" (12). Thus attention is given to determining *where* hazards are likely to occur as opposed to *when* they are likely to occur.

Interestingly, for an HRV model focused on developing countries, except for socio-economic status, the UNDRO model does not include social vulnerabilities. Economic loss is a key component of the UNDRO model, and, in order to complete the steps needed to evaluate economic impact, the analysis requires that experts take into account consequential losses (such as loss of function of essential services, loss of industrial production, loss of markets, loss of medical costs, the dependency of victims on relief goods, etc.). This list appears endless, and to calculate all of these items for each hazard, even if the requisite resources were available, would take so long that it is doubtful the results would be available within a decade.

4.3. Summary and Conclusions

> It is time to adjust to risk and cope with losses from disasters in a manner that takes the resiliency of a community and a sustainable environment into consideration. (Myers and Mileti 1995, 4)

As has been shown, there are more weaknesses than strengths in the foregoing eight models for HRV analysis (see Table 5). Only half of the models for HRV analysis include the integration of disaster management with that of community planning, and most focus on the use of experts and ignore the importance of public participation. All eight models are particularly weak with regard to recognizing: (1) the importance of risk communication; (2) the need to address equity issues; (3) the need to empower the vulnerable members of a community; (4) the lack of scientific knowledge regarding many hazards; (5) the importance of dealing with uncertainty; and (6) the need to recognize that the adoption of mitigation strategies involves an inherently political decision.

With the exception of the NOAA and UNDRO models, methodology is weak and does not stand up to scrutiny. There tends to be more strengths in the hazard identification phase, which is the easiest phase to address with regard to complexity. The risk assessment phase is slightly better handled than is the vulnerability assessment phase -- probably a reflection of the greater awareness of the issues around risk assessment. However, most models did not fully incorporate even the basics of risk analysis (such as including risk factors) into their processes. The vulnerability assessment is poorly dealt with by all of the HRV models (other than that of NOAA). A general lack of robustness ensures that the risk management phase of HRV analysis reflects the truth of the principle that when the inputs are not adequate and easily communicable, the outputs will not be supported and will not be valid.

Thus, in answer to the question posed at the beginning of this chapter, "Do extant models for HRV analysis take into account the fourteen key objectives of HRV analysis identified in Chapter 3?" the answer is "No." The challenge now becomes to develop an HRV model that *does* take these objectives into account. Chapter 5 looks at a new model for HRV analysis: the Hazard, Impact, Risk and Vulnerability (HIRV) model.

Table 5: Summary of Extant Models for HRV Analysis and Their Ability to Meet the Fourteen Key Objectives of of an Adequate Model for HRV Analysis

Objective	APELL	EPC	FEMA 1	FEMA 2	NOAA	OSLO	SMUG	UNDRO
1. integration of disaster management & community planning	explicitly included	focus on disaster management	focus on disaster management	focus on disaster response	explicitly included	explicitly included	focus on disaster response	explicitly included
2. public participation	focus on experts	focus on experts as a resource	public used as a resource	not included	focus on experts	focus on experts	public used as a resource	focus on experts
3. adequate risk communication	not addressed	not addressed	not addressed	not addressed	not addressed	not addressed	not addressed	acknowledged but no process to address
4. lack of adequate data	not addressed	not addressed	not addressed	not addressed	addressed	not addressed	not addressed	addressed
5. risk perception needs to be taken into account	not addressed	component on risk perception included	not addressed	not addressed	not addressed	not addressed	not addressed	component on risk perception included
6. evolving educational process	yes - materials provided	somewhat - some material provided	not included	not included	not included	somewhat – need to seek out data mentioned	not included	strong educational component
7. issues of equity & fairness	not addressed	not addressed	not addressed	not addressed	not addressed	not addressed	not addressed	not addressed
8. empower the vulnerable	not addressed	not addressed	not addressed	not addressed	not addressed	not addressed	not addressed	not addressed
9. state of knowledge needs to be determined	not addressed	not addressed	not addressed	not addressed	addressed	not addressed	not addressed	addressed
10. identification of hazards	weak - focus on hazardous material spills	fairly comprehensive list provided	self-selected	includes 11 hazards	includes 8 hazards - six natural	7 natural hazards & 7 person induced	self-selected	includes 11 hazards – ten natural
11. risk factors need to be identified	weak links between risk factors & probability	not included – best-guess approach	not included – best-guess approach	not included – best-guess approach	not included – best-guess approach	not included – best-guess approach	not included – best-guess approach	included – but requires huge amounts of data
12. deal with uncertainty	not addressed	not addressed	not addressed	not addressed	acknowledged	not addressed	not addressed	addressed
13. affordable & low technology	low cost & low technology	low cost & low technology	low cost & low technology	low cost & low technology	moderate cost & moderate technology	low cost & low technology	low cost & low technology	high cost & high technology
14. political legitimation in order to implement mitigative strategies	not addressed	focus on response & planning not mitigation	focus on response not mitigation	focus on mitigation but not process	focus on mitigation but not process	acknowledged but not addressed	not addressed	acknowledged but not addressed

5. The Development of HIRV: An Integrated Model for Community Hazard, Impact, Risk, and Vulnerability Analysis

As discussed in Chapter 4, extant models for HRV analysis are deficient in many ways; thus, the need for a new model. The HIRV model is based on addressing the following:

1. the fourteen key objectives of an adequate HRV analysis (identified in Chapter 3);
2. the critiques of extant models for HRV analysis (conducted in Chapter 4); and
3. the findings that emerged from the exploratory studies (described in Chapter 6).

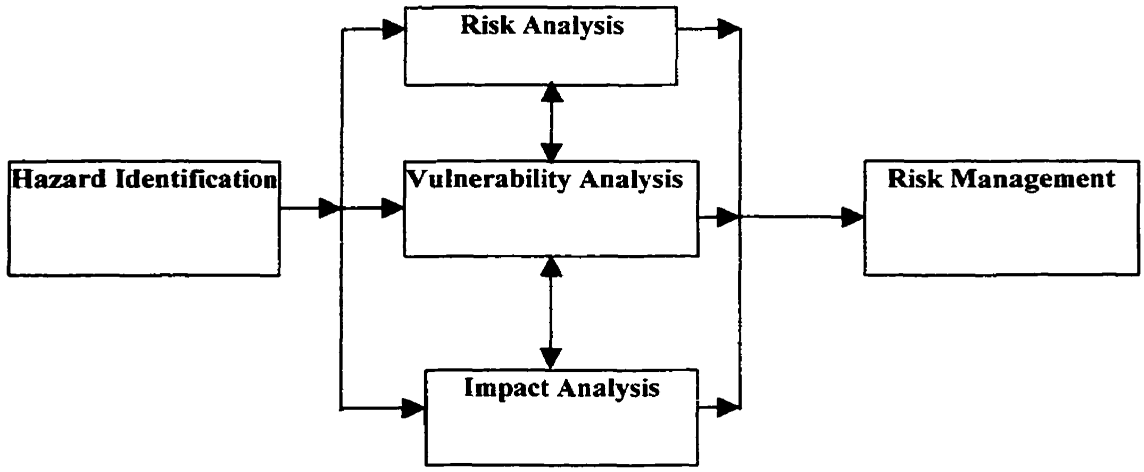
In order to meet the key objectives of HRV analysis, the HIRV model utilizes the findings of an extensive interdisciplinary literature review as well as several of the positive features of extant models for HRV analysis. I developed the HIRV model over several years and presented it in several educational and professional venues during the research for this dissertation. Classroom feedback contributed immeasurably to its development, as did the use of exploratory studies (see Chapter 6). Where the contribution of preliminary studies was particularly relevant to the development of HIRV I mark the text with an asterisk (*) to indicate that it will be expanded upon in the following chapter.

The next section of this chapter offers a brief overview of the HIRV model then presents the details, beginning with the overall process and progressing though its five phases: (1) hazard identification, (2) risk analysis, (3) vulnerability analysis, (4) impact analysis, and (5) risk management. HIRV is a new model for HRV analysis, and, as is well known, many organizations and individuals resist change. Given this, in the next section I offer a brief overview of some of the reasons why organizations resist change and some of the strategies the HIRV model utilizes in anticipation of the need to overcome this resistance. Finally, I summarize the unique features of the HIRV model and reiterate its contribution to the field of disaster management.

5.1. An Overview of the HIRV Model

The HIRV model follows the five phases outlined in Figure 4.

Figure 4: The Five Phases of the HIRV Model



The first phase of the HIRV model is **Hazard Identification**. During this phase, a committee composed of both laypersons and experts reviews a comprehensive list of potential hazards (which is included in the HIRV handbook), reviews the definitions and discussions of hazards, and compiles historical data about past disasters in their given community or region.

The second phase of the HIRV model is **Risk Analysis**.[24] One of the first tasks the HIRV committee must consider is whether or not the community should be divided into neighbourhoods for the purposes of completing the HRV analysis. This step, which is unique to the HIRV model, is critical in setting the groundwork for addressing issues of equity. The next task is to determine, for each location in the community, the risk of the occurrence of a potential hazard. This is done by using the historical data collected in the hazard identification phase as well as the risk factors that are included in the HIRV handbook. Another unique feature of HIRV is that, once the assessment is complete, the participants have an opportunity to state how certain they are about the decisions they have made. This addresses the problem of uncertainty and the inability of the scientific and expert community to accurately

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[24] Although the next three phases are presented in a linear fashion, it is expected that participants will move back and forth between the risk, vulnerability, and impact analysis phases as information becomes available.

predict potential hazardous events. A completed risk analysis for an air crash might look like the one outlined in Table 6.

Table 6: Sample of a Completed Risk Analysis

Name of Hazard	Historical Data	Risk Factors	Certainty of Data	Risk Rating
Air Crashes	*Listing of previous events*	*4/8 risk factors apply*	*Well established*	*+2*

where:

Table 7: Scale for Determining the Likelihood of a Disaster Occurring due to a Specific Hazard

+3	Hazard is very likely to occur.	-1	Hazard has a slight chance of not occurring
+2	Hazard is likely to occur	-2	Hazard is unlikely to occur.
+1	Hazard has a slight chance of occurring	-3	Hazard is very unlikely to occur.

The third phase of HIRV is **Vulnerability Analysis.** In this phase participants use the vulnerability factors included in the HIRV handbook. As in the risk analysis phase, participants have an opportunity to assess how certain they are of the decisions they have made. With regard to air crashes, a vulnerability assessment for a specific location may look like that presented in Table 8.

Table 8: Sample of a Completed Vulnerability Analysis

Name of Hazard	People	Place	Preparedness	Time[25]	Certainty of Data	Vulnerability Rating
Air Crashes	2/5 factors apply	*5/11* factors apply	*3/4* factors apply	*Summer & Christmas* *During the day*	*Well established*	*+2*

Where:

Table 9: Scale for Determining the Vulnerability to a Disaster Occurring from a Specific Hazard

+3	High degree of vulnerability	-1	Slight degree of invulnerability
+2	Moderate degree of vulnerability	-2	Moderate degree of invulnerability.
+1	Slight degree of vulnerability	-3	High degree of invulnerability.

[25] Time pertains to periods of time (e.g., hour of day, day of week) during which certain parts of the community may be more vulnerable than during other times.

The fourth phase of HIRV is **Impact Analysis.** Impacts are assessed through the use of: (1) social factors, (2) environmental factors, (3) economic factors, and (4) political factors. This is another unique contribution of the HIRV model. These impacts can be recorded for each location and hazard, as is illustrated in Table 10.

Table 10: Sample of Impact Analysis for Air Crash

Social	**Environmental**	**Economic**	**Political**
[3] Number of deaths [3] Number of injuries [1]Loss of housing etc.	[1] Quality of air [1] Quality and quantity of water [1] Quality and quantity of soil etc.	[1] Structural damage [1] Non-structural damage [1] Loss of jobs etc.	[1] Coerced risks [3]Government control [1] Unfair risks etc.

where

Table 11: Scale for Determining the Degree of Impact of a Disaster Occurring from a Specific Hazard

+3	High degree of impact
+2	Moderate degree of impact
+1	Low or no degree of impact

The fifth and final phase of HIRV is **Risk Management.** At this point participants evaluate the data for both the risk analysis and the vulnerability analysis phases, and they also provide an impact analysis. The output of the HIRV model is a combined value illustrating those areas of high risk, high vulnerability; low risk, low vulnerability; medium risk, medium vulnerability; and so on. A completed risk management analysis for an air crash at a specific location can be illustrated as follows:

Table 12: Sample of Completed Risk Management Analysis

Hazard	**Risk Rating**	**Certainty**	**Vulnerability Rating**	**Certainty**	**Impact Analysis**	**Certainty**	**Risk & Vulnerability Analysis**
Air Crashes	+2	Well Established	+2	Speculative	En=1 S=2 Ec=1 P=2	Well Established	R=Moderate V=Moderate

where:

S = Social Impact
Ec = Economic Impact
En = Environmental Impact
P = Political Impact

Were this an actual analysis, it would illustrate that, for this specific location, there was (1) a moderate risk of a crash, (2) a moderate degree of vulnerability, (3) low environmental and economic impacts and moderate social and political impacts, (4) a high degree of certainty regarding the risk assessment but a low degree of certainty regarding the vulnerability assessment, and (5) combined moderate risk and vulnerability. It is the comparison of the risk and vulnerability assessments (taking into consideration the impact analysis) for the various hazards and for each location that results in the prioritization of hazards, risks, and vulnerabilities for the purposes of mitigative action.

5.2. The Overall HIRV Process

As one may gather, both from the literature and from practice, the HIRV model is just one part of an ongoing disaster management process. As defined in Chapter 2, disaster management is a process that assists communities to respond, both pre- and post-disaster, in such a way as to save lives; to preserve property; and to maintain the ecological, economic, and political stability of the impacted region.

The HIRV model is community- and region-based: it is first and foremost a tool for local communities and regional governments. It is based upon local knowledge supplemented by experts, and it is to be used by both large and small communities. Given the great differences between large metropolitan areas and small communities, an HRV model must be adaptable. The HIRV model can be used to analyze neighbourhoods within a community and/or within a regional district (see discussion of risk analysis below).

Although the disaster management process is never complete, and while various activities may occur simultaneously, its cornerstone is the HRV analysis. The findings of this analysis lead to the development of mitigation strategies, improved emergency response plans, and community and responder education and training programs. The goal of the HIRV model for HRV analysis is to assist any given community to develop sustainable mitigative strategies vis-à-vis hazards. Mitigation is interpreted in the broadest possible sense and includes both pre-disaster projects (such as structural retrofitting, adopting non-structural mitigation measures [e.g., strapping a hot-water tank to a wall], supporting neighbourhood emergency plans, and developing warning messages) and post-disaster activities (such as setting up counselling services for vulnerable populations, improved building codes, zoning changes, and debris management policies).

5.2.1. Public Participation in the HIRV Model

The need for public participation in HRV analysis is set out in Chapter 3. There are, of course, many ways in which public participation can be incorporated into the HRV process (e.g., public meetings, surveys, advisory committees, citizen contacts, and so on [Thomas 1995]). Which way would be most effective, in which circumstances?

Recent work by Dorcey and McDaniels (1999), while focusing on public participation[26] in Canadian environmental issues, has much to offer in terms of HRV analysis: both environmental risk management and HRV analysis deal with complex issues concerning risk, and both concern themselves with sustainable development. Using British Columbia as an example, Dorcey and McDaniels document the plethora of multi-stakeholder consensus processes that proliferated in the early 1990s; however, by the mid-1990s enthusiasm had waned, and many processes ceased operating as funding dwindled and stakeholders (including governments) became fatigued by, and disenchanted with, the process. In many cases, public participation was seen to contribute to the problem rather than to aid in the solution.

Dorcey and McDaniels (1999) state that, while the need for public participation was questioned in the 1980s and 1990s, in the twenty-first century the question is not "if" public participation should be utilized, but "how." They argue that there has been a general shift, at least in principle, from a managerial perspective (which trusts elected officials and administrators to act in the public good) to a pluralist perspective (which views government as an arbitrator among various organized interest groups). Citizens have become increasingly interested in a popular perspective (which calls for the direct participation of citizens, rather than their representatives, in making policy). Thomas (1995) sees the increased education of citizens as a root cause of this shift. Accompanying this change in perspective has been an increasing interest in applying negotiation, facilitation, and mediation techniques to the public participation process. There has also been increasing interest in co-

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[26] Dorcey and McDaniels (1999, 6) use the term "citizen involvement" to mean "processes for the involvement of citizens in advising and making decisions on matters under government authority, that augment or supplant decision making through established channels of representative government." It encompasses such phrases as "public participation," "stakeholder involvement", and other similar terms.

management,[27] which displays a move towards a related perspective – the shared power perspective, which is based on citizen empowerment. According to Dorcey and McDaniels (1999, 23):

> Participation in voluntary associations, embodying norms of trust, reciprocity, tolerance, and inclusion, and activating networks of public communication, are believed to build and maintain the social capital upon which the vitality of the governance system and sustainable development are dependent.

The British Columbia Round Table produced a report that suggested that public participation needed to be used more effectively and that multi-stakeholder consensus processes should be reserved for selected purposes (Dorcey, cited in Dorcey and McDaniels 1999). Clearly there are many stakeholders with an interest in HRV analysis, but should a consensus process always be used? Dorcey and McDaniels state that many of the difficulties in applying consensus processes have occurred when the participants have expected that they would be empowered to make decisions and then this has not happened. They argue that it is essential that stakeholders understand their task as that of making recommendations when that is all they are empowered to do (31). Using the definition of risk management as set out in Chapter 2, the goal of the HRV process is to do just that — to make recommendations as to the priorities for the consideration and implementation of mitigation strategies. Thus, I would argue that, although a consensus-based approach to HRV analysis is always desirable in so far as it is preferable to have group agreement, it may not always be possible. As will be discussed later, while HIRV's use of a facilitator as well as risk and vulnerability factors should assist participants in reaching consensus, consensus may, in fact, not be attainable.

To decide when a consensus-based approach to public participation should be used, Dorcey and McDaniels (1999) refer to the contingent approach developed by Thomas (1995), based on the work of Vroom and Yetton (1973), and Vroom and Jago (1978). Thomas argues that effectively dealing with public issues amounts to attaining a balance between "quality" and "acceptability". His "Effective Decision Model" (38) provides the manager with some guidelines in the form of a series of questions that need to be asked in order to identify which of five basic public participation approaches best suits the issue at hand (Figure 5):

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[27] The National Round Table of the Environment and the Economy, 1998, (cited in Dorcey and McDaniels 1999) adopted the following definition of co-management: "co-management is a system that enables a sharing of decision making power, responsibility, and risk between governments and stakeholders, including but not limited to resources user, environmental interests, experts, and wealth generators."

Use of The Effective Decision Model provides managers with five decision-making options:

1. Autonomous managerial decision. The manager solves the problem or makes the decision alone without public involvement.
2. Modified autonomous managerial decision. The manager seeks information from segments of the public, but decides alone in a manner that may or may not reflect group influence.
3. Segmented public consultation. The manager shares the problem separately with segments of the public, getting ideas and suggestions, then makes a decision that reflects group influence.
4. Unitary public consultation. The manager shares the problem with the public as a single assembled group, getting ideas and suggestions, then makes a decision that reflects group influence. (This approach requires only that all members of the public have the opportunity to be involved, such as in well-publicized public hearings, not that everyone actually participates.)
5. Public decision. The manager shares the problem with the assembled public, and together the manager and the public attempt to reach agreement on a solution. (Thomas 1995, 39-40)

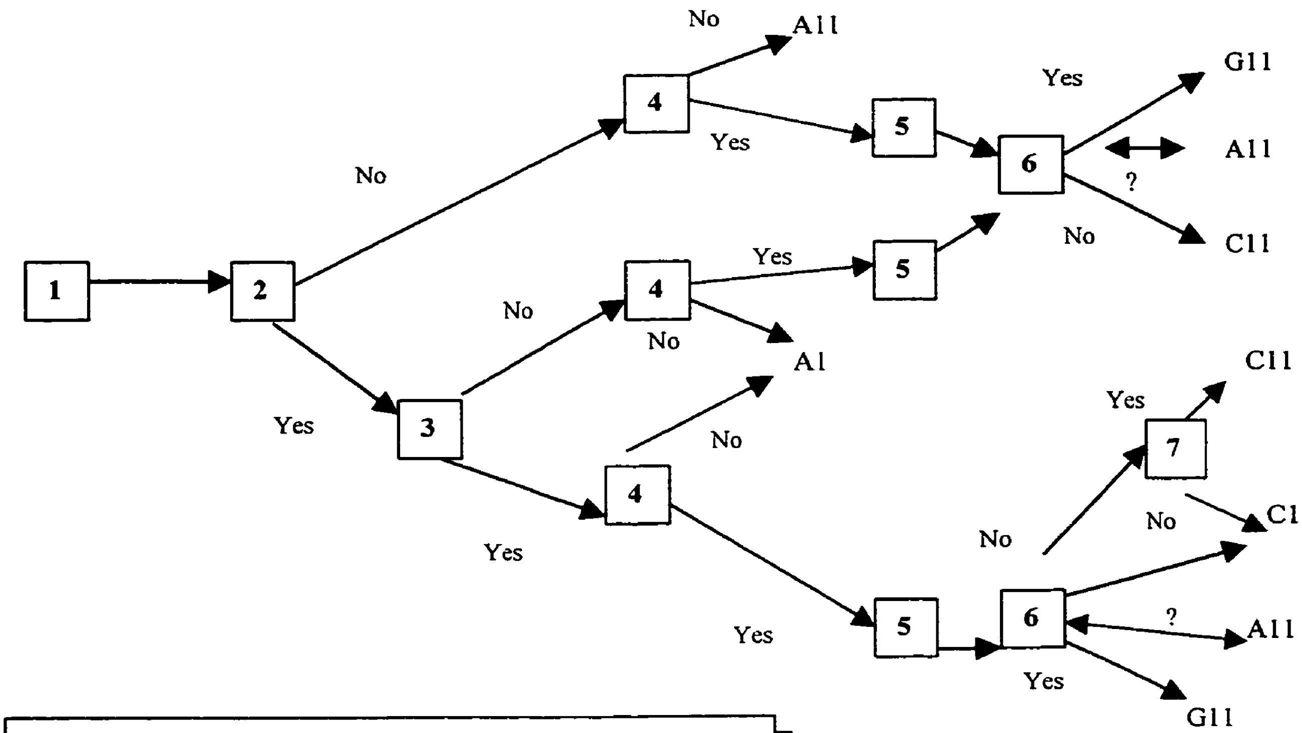
Before examining how communities can use Thomas's model to develop an HRV process, it is interesting to use it in order to examine how HRV analyses are often conducted.

- With regard to question 1 ("What are the quality requirements?"), Thomas states that they can refer to regulatory, budgetary, or technical constraints. Most relevant to the HRV process are the technical constraints: do we need to consider the need for quality, or accuracy, of information? For planning purposes, the completion of an HRV analysis does not require the same degree of accuracy as would, say, the completion of an analysis of the degree of earthquake resistance necessary for the completion of a high-rise building. In other words, if we assume that, for the HRV analysis, the quality requirements are not precise, then the answer to question one would be "few."
- With regard to question 2 ("Do I have sufficient information?"), we already know that completing an HRV analysis is a complex process and that no single person could possibly have sufficient information to do so on her own. Thus the answer to this question would be "no."
- Thus we move to question 4 (is public acceptance necessary for implementation and unlikely without involvement?). We know from the literature review and case studies that there are numerous challenges facing communities that wish to adopt mitigation strategies. In most cases, without public acceptance, little progress can be expected; and yet, as has previously been discussed, many disaster managers neglect to carefully

consider question 4. Because they work in isolation, disaster managers often fail to take into account the importance of public acceptance and so simply come to think that it is unnecessary. Thomas's model suggests that the best approach to public participation involves a modified autonomous managerial decision (A11: see Figure 5, Key). The disaster manager consults with other emergency responders and may also consult with hazards experts in the community but, ultimately, decides the priorities on her/his own.

Figure 5: The Effective Decision Model of Public Involvement

1	2	3	4	5	6	7
What are the quality requirements?	Do I have sufficient information?	Is the problem structured?	Is public acceptance necessary for implementation and unlikely without involvement?	Who is the public?	Does the relevant public agree with the agency's goals?	Is the conflict on the preferred solution likely within the relevant public?



Key

A1 = Autonomous managerial decision
A11 = Modified autonomous managerial decision
C1 = Segmented public consultation
C11 = Unitary public consultation
G11 = Public decision

Source: Thomas (1995, 74).

Thomas's model helps us to understand why the actions of a disaster manager may appear to have involved good choices but in fact involve poor and ineffective ones. The wrong approach to public involvement can result in HRV analyses that may meet some regulatory requirement but that fail to generate any changes in how communities assess existing and potential hazards and risks.

If we continue with Thomas' model, and assume that the answer to question 4 is that public involvement is necessary, we would then move on to question 5.

- "Who is the relevant public?". In this case the public consists of a combination of unorganized groups (e.g., concerned citizens) and organized groups (e.g., land developers).
- With regard to question 6 ("Does the relevant public agree with the agency's goals?"), in many communities one could safely assume that the goal of sustainable mitigation is likely to be endorsed by most. This takes us to GI I (see Figure 5, Key), shared decision making with the public (public decision).

However, it is also possible that the disaster manager may believe that there would be considerable disagreement over the goal of sustainable mitigation. Perhaps the community has recently undergone financial hardship (e.g., a major employer has dramatically downsized operations and staffing); the disaster manager might well believe that the community would be willing to sacrifice the long-term goals of sustainable mitigation in favour of short-term goals that would provide economic relief. In this case, the answer to question 6 would be "no." Thus, in order to protect the overall goal of disaster management, the disaster manager may consult with the public but not share the decision making (C1: unitary public consultation). Residents could be invited to attend a public meeting where the issues would be discussed, but they would not be expected to actually participate in the process of making those decisions.

In yet another circumstance, the disaster manager may be unsure of the overall community's level of agreement. Thomas's model, as it relates to question 6, would identify a modified autonomous managerial decision (AI I) as the best use of public involvement. The disaster manager could use surveys, or other tools, to determine the public's beliefs. If, after these steps, there is still no clear picture of where the community stands, then the disaster manager would make the decision alone. If, however, the disaster manager were to discover, through surveys or other mechanisms, that the public was fully supportive of the disaster management goal of sustainable mitigation, then Thomas's model also permits her/him to move backwards (in this case to question 6). Now that question 6 can be answered in the affirmative, the most effective use of public involvement involves shared public decision making (G11).

However, in yet another community, Thomas's model may lead the disaster manager to a very different degree of public involvement. For example,

- With regard to question 1 ("What are the quality requirements?"), we will assume that, as in the previous example, the quality requirements are not precise and that the answer to question 1 would be "few."
- With regard to question 2 ("Do I have sufficient information?"), let us assume that in this case we are dealing with a large city that makes extensive use of GIS technology, faces few major hazards, and has considerable data. Here substantial information would be available, and the answer to question 2 would be "yes."
- This answer then brings us to question 3 ("Is the problem structured?"). Thomas cautions managers to hesitate before defining problems as structured. They should first be very sure that alternatives are not open to redefinition (p. 45). As has been previously discussed, in completing HRV analyses, there is a great deal of uncertainty, and there may well be a number of ways of interpreting the data. Thus, the answer to question 3 might well be "no."
- Thus we move to question 4 (is public acceptance necessary for implementation and unlikely without involvement?). In this case, if the disaster manager has the strong support of city council and other response agencies, and if she/he believes that public involvement is best reflected in the mitigation process, then Thomas's model indicates that the most appropriate public participation approach would be an autonomous managerial decision (A1). In other words, the disaster manager would set the priorities on her/his own.

In another case, a disaster manager may find that segmented public consultation (C1), which involves her/him meeting separately with various neighbourhoods, is the logical result of applying Thomas's model. The manager's recommendations for mitigative strategies would reflect the concerns of each of the neighbourhoods. In yet another community, say a very small town, it may be more appropriate to use the unitary public consultation approach.

Thomas presents a number of ways of involving the public in the decision-making process, and, depending upon the degree of public involvement, different implementation methods (e.g., public meetings, surveys, etc.) will be appropriate. Although it is not always possible (as will be discussed below), many communities find the use of an advisory committee to be a useful exercise. According to Thomas, the advisory committee can be composed of "representatives from interested groups, including business, labor unions, and agency staff as well as citizen groups" (125). The committee typically holds a series of meetings and hearings involving experts and policy makers on the one hand, and selected members of the public and interest groups on the other (Keeney et al. 1990, 1,013).

Thomas's findings suggest that the use of an advisory committee has several advantages: (1) when there are multi-stakeholders involved, it may be easier to reach consensus through an advisory committee than through a public meeting; (2) the honour of membership encourages participants to think on behalf of the entire community rather than on behalf of their own special interest group; and (3) it can serve as an important vehicle for building public acceptance. While the use of an advisory committee may be appropriate for communities that contain a number of interested individuals and groups, it may not be appropriate for very small communities where there is little public interest in disaster management. In yet other communities, particularly those that have recently had a disaster, there may be large numbers of stakeholders who have an interest in participating in the HIRV process. In this case, additional implementation methods (e.g., public hearings) may be required to supplement the advisory committee.

In what follows I outline some of the key factors involved in establishing an effective HIRV committee. As Thomas has shown, the greatest risk to an advisory committee's success has to do with how well its members represent the public. One must be very careful when (1) choosing the size of the committee, (2) choosing the members of the committee, and (3) choosing how to implement the committee.

5.2.1.1. The Size of the HIRV Committee

Much of organizational behaviour literature focuses on determining the appropriate size of work groups. There are both advantages and disadvantages to having larger rather than smaller groups. A group having fewer than five members results in: (1) fewer people to share task responsibilities, (2) more personal discussions, and (3) more participation. More than seven members results in: (1) fewer opportunities to participate, (2) more member inhibition, (3) domination by aggressive members, and (4) a tendency to split into subgroups (Callahan et al. 1986, 215). Callahan et al. do warn, however, that members of larger groups can generate greater differences of opinion than can members of smaller groups.

Efficiency differs according to size of group. Robbins (1998, 260) states that smaller groups are faster at completing tasks than are larger ones; however, he points out that large groups do better if engaged in problem solving. Robbins also contends that groups having over a dozen members are excellent at gaining diverse input and fact finding, while groups having seven members are better at taking action. Similarly, Senge (1990) argues that the potential of collaborative learning is that it allows us to be more insightful and more intelligent than we can possibly be individually; however, at a certain point social loafing, "the tendency for individuals to expend less effort when working collectively than when working individually," (Robbins 1998, 260) reduces the effectiveness of the group.[28]

Since a key role of the advisory committee is to gain diverse input and to engage in fact finding, for the most part a larger rather than a smaller committee would be most appropriate. Thomas (1995, 121) suggests that the optimal size for an advisory committee is no more than fifteen people -- "large enough to represent a variety of interests, small enough for everyone to be involved without decision making dragging on interminably." Since groups with even numbers have great difficulty in obtaining a majority (Callahan et al. 1986; Robbins 1998), it appears that it would be best to establish odd-numbered groups. Again, as was discussed earlier, although consensus is desirable, it may not always be attainable.

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[28] Robbins does point out that there is a definite North American bias towards these findings, and they have been contradicted in studies carried out in China and Israel.

Very small communities are unlikely to have the diversity and expertise of large communities. While the core committee membership in very small communities may be much smaller than fifteen, use of ad hoc members (brought in from nearby communities, regional governments, or provincial or federal agencies) may supplement the group's lack of diversity and proficiency. Another strategy may involve having a small steering committee as opposed to a large advisory committee. The public could be kept informed of the progress of the steering committee through newsletters, open houses, and public meetings (Integrated Resource Planning Committee 1993).

When there are large numbers of interested stakeholders – more than could be efficiently involved in an advisory committee – a number of strategies may be employed. One strategy is to request the selection of a group representative (Integrated Resource Planning Committee 1993, 13). For example, the Chamber of Commerce could nominate a business person to represent its interests. Another strategy is to hold a public meeting or workshop prior to the actual implementation of the HIRV process. The Integrated Resource Planning Committee (IRPC) (1993 14-15) suggests a number of functions that may be carried out at these preliminary sessions: (1) develop a registration system for preparing a mailing list; (2) describe the public participation options; (3) provide public comment forms or questionnaires; and (4) request suggestions for participants, facilitators, meeting times, etc.. Breaking the large group into smaller working groups or holding special workshops during the HIRV process may also facilitate the handling of large groups of interested parties.

5.2.1.2. Composition of the HIRV Committee

The Committee on Risk Characterization, which was struck by the Commission on Behavioral and Social Sciences and Education (National Research Council 1996, 2), argues that "coping with a risk situation requires a broad understanding of the relevant losses, harms, or consequences to the interested and affected parties." The committee also indicates that "the risk characterization process must have an appropriately diverse participation or representation of the spectrum of interested and affected parties, of decision makers, and of specialists in risk analysis, at each step" (3). Diversity is an important factor, as Robbins's (1998) findings indicate that heterogeneous groups, due to their having access to more information and different perspectives, tend to be more effective than homogeneous groups. The former may be less expedient and have more conflicts, but it performs more effectively than does the latter. Robbins also found that while culturally dissimilar groups have greater difficulty initially, these difficulties tend to disappear after about three months.

As there are a number of persons whose day-to-day roles would strengthen the capabilities of the HIRV committee, it is important to determine the process by which participants are selected. The Land Use Coordination Office of British Columbia has published a set of guidelines relating to public participation; these provide useful information with regard to determining the membership of a HIRV committee (Integrated Resource Planning Committee 1993). The IRPC identifies a number of steps that, if followed, should ensure the identification of all potential public participants. These steps can be summarized as follows:

1. make a preliminary list of interest groups and individuals who may wish to be involved in the process;
2. set up informal, low-key meetings with these groups and other parties;
3. request the selection of a group representative to participate in an initial joint meeting of all the groups;
4. ask these interested parties if they know of others who should be involved in the process; and
5. look for missing interests (IRPC 1993).

The following are some of the representatives who may enhance the effectiveness of the HIRV committee:

- disaster manager
- community planner
- local resident
- business representative
- industry representative
- land developer
- environmentalist
- engineer
- insurer
- utilities representative
- hazards expert
- representative from the third sector[29]
- media representative
- public relations officer
- elected official

Appendix D includes an in-depth discussion of the merits of selecting representatives to sit on the HIRV committee, and it also discusses how these people can use their roles to increase public awareness. By ensuring that the public participates in each step of the HRV process, the HIRV model increases the likelihood that the public

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[29] Paterson (1998, 204) defines the third sector as the nonprofit, nongovernmental, independent, or voluntary sector.

will provide the political impetus to allocate resources towards mitigative actions – especially given so many competing interests (e.g., recreational space, infrastructure maintenance, policing, etc.). It is important to remember that the size and composition of the committee will vary with the size of the community.

5.2.1.3. Implementation of HIRV

It is difficult to find models of group development when the committee is, by nature, ongoing; however, the approach taken by Callahan et al. (1986) is useful. They state that there are four stages to the development of a group: (1) orientation, (2) differentiation, (3) integration, and (4) maturity. The orientation phase is a time for members to become familiar with the task of the group, the initial ground rules, and each other. It is often a time of "niceness," as members test boundaries and identify the leader (222). The differentiation phase reflects the process of becoming familiar with the norms and roles within the group, and the emergence of interpersonal conflicts and competing values. The integration phase is marked by the development of cohesiveness and procedures for accomplishing tasks. During the maturity phase, members become aware of each other's strengths and weaknesses, appreciate the need to be flexible and to become more tolerant of differences, and the need to concentrate on a positive approach to tasks.

There are any number of guides that can facilitate the implementation of the HIRV model. Three of these are: (1) the Federal Emergency Management Agency's (Region 8) and the National Park Service's (Rocky Mountain Region) (1994, 8-11); (2) *A Multi-Objective Planning Process for Mitigating Natural Hazards*; and (3) the *Public Participation Guidelines for Land and Resource Management Planning* (IRPC 1993). These guides are designed to maximize the efficiency and effectiveness of group participation in multi-objective planning sessions.

Table 13 represents the adaptation and integration of the aforementioned planning guidelines, and it serves as a sample implementation guide. Depending on the community, other planning approaches may also be acceptable; however, there are several key points to be emphasized with regard to adopting an implementation guide that is appropriate to the HIRV process. It is suggested that either the disaster manager or the community planner take the lead in implementing the HIRV model of HRV analysis. One of their responsibilities will be to make use of a facilitator (which is in keeping with a general increase in the use of such people [IRPC 1993, Dorcey and

McDaniels 1999]). A facilitator is "an individual who enables groups and organizations to work more effectively; to collaborate and achieve synergy" (Kaner et al. 1998, 18). Certainly, during the orientation phase, as is seen in Callahan et al.'s (1986) approach, a facilitator assists each committee member to become familiar with the others, sets the ground rules, and reviews the HIRV structure. The facilitator is also able to act as a neutral party and can assist in conflict resolution, a factor in the differentiation stage of Callahan et al.'s approach. Thomas (1995) suggests using a facilitator who can not only assist in moving the group towards consensus, but who can also empower its members.

There is also a need to develop community partnerships with a variety of governmental agencies and the private sector (beyond those representatives who are invited to participate as HIRV committee members). For example, partnerships should involve experts from various local or regional governments (e.g., a medical health officer, the British Columbia Centre for Disease Control), various provincial government departments (e.g., Ministry of the Environment), various federal government departments (e.g., Department of Fisheries and Oceans Canada), the third sector, and the private sector (e.g., CN Rail).

All of the steps involved in the HIRV model have to be completed; however, it allows for considerable latitude with regard to how the disaster management process is conducted. It is probable that as the participants work through the process, they will adapt certain steps to suit their specific working environment. For example, the committee may choose to break into subcommittees to complete some of the tasks. It is important, however, that all participants share with each other their knowledge of the community and that ratings not be made in isolation. As well, the committee can either follow one hazard through all five phases of HRV analysis (hazard identification, risk analysis, vulnerability analysis, impact analysis, and risk management) or it can examine a number of hazards concurrently.

Table 13: Implementation of HIRV Program

Time Frame	Tasks:
At least six months before the first planning session	• Identify the area for which planning is to be done. • Find and meet with potential project partners from local, regional, state and federal government, and private organizations. • Set a date and location. • Begin notifying potentially interested groups and individuals about the planning session. • Start identifying planning issues by meeting or speaking informally with local groups and individuals. • Begin area reconnaissance and logistics. • Draft a planning session agenda.
At least three months before the planning session:	• Find and invite committee members. • Find and invite recorders. • Draft guidelines for facilitator and recorders. • Find and invite a keynote speaker or emcee. • Find and invite individual members of the community. • Finalize the agenda. • Get ready to document. • Maximize public involvement. • Make sure public affairs work is under way.
At least one month before the planning session:	• Ensure local publicity is arranged for the first committee meeting.
The day before the planning session:	• Do a last-minute check. • Meet with facilitator.
First day of the planning session:	• Prepare the meeting place. • Follow the agenda. • Convene the introductory session. • Get committee ready to begin identifying issues. • Continue media coverage. • Become familiar with the educational material provided.

Source: Adapted from Federal Emergency Management Agency (Region 8); the National Park Service (Rocky Mountain Region) (1994, 8-11); and the Integrated Resource Planning Committee (1993)

The last point is an important one. In many cases, participants will have relatively little information on the issues to be discussed (Thomas 1995). They will require information before they can participate intelligently, and the IRPC (1993) , for one, stresses the importance of ensuring that participants are adequately trained and educated.

It also suggests that participants be trained in the use of consensus-building techniques. One of the unique benefits of the HIRV model is that it is designed to facilitate an evolving educational process. Both those involved directly in the analysis and the community at large will have an opportunity to develop a neighbourhood or community profile of both potential and extant hazards, risks, and vulnerabilities. This information is not provided on a one-time basis but emerges as the process goes on. Hayes and Nolan (1974, 110) argue that

> the real value of a model comes not just from using it but from creating it. Just as the person advances his understanding of a situation under the tutelage of experience, so does his understanding evolve during the modeling process. Over 50 per cent of the value comes from "getting there"; a model provides an opportunity to gain synthetic experience. As the model is developed and used, it will begin to challenge the implicit assumptions of the user and suggest opportunities for improvement.

Another way in which the HIRV model facilitates an evolving educational process is through the HIRV handbook* (See Appendix E). All extant models of HRV analysis are published in some sort of handbook, and all differ greatly regarding the quality and quantity of information they provide. The HIRV handbook begins by introducing key concepts and definitions. It also includes a section on such topics as risk perception and risk communication. As was discussed in Chapter 3, it is extremely important to ensure that participants are aware of how risk is perceived and accepted. The HIRV handbook also includes:

- a comprehensive list of hazards,
- definitions and descriptions of a sample of seventeen hazards,
- key risk and vulnerability factors for the same hazards, and
- a bibliography and reference section.

I review details concerning the above information in my discussion of each of the five phases of the HIRV model.[30] The HIRV committee should be provided with maps (i.e., of basic topography and geology, high-level utility and infrastructure networks, major roadways, community zonings, locations of critical facilities, and

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[30] For the purposes of this dissertation, and to provide participants with guidelines for the evaluation of HIRV, seventeen hazards have been identified and elaborated upon. One of the areas for future research would entail completing the research on all of the remaining hazards so that the HIRV handbook would finally be complete.

population demographics). The relevance of these materials will be further commented upon as the HIRV model unfolds; for now, however, I continue with the HIRV implementation guide, beginning at the end of the first meeting.

Table 14: The HIRV Process

Phases	Tasks: The following steps are to be completed over several months
Hazard Identification:	• Become familiar with the educational material provided. • Identify all potential hazards. • Attempt to identify potential multi-hazard events. • Obtain historical data on potential hazards. • Conduct field reconnaissance. • Publish and provide access to information for the community at large.
Risk Analysis:	• Become familiar with the educational material provided. • Eliminate all hazards for which there is no possibility of occurrence. • Conduct field reconnaissance. • Establish the location of the potential hazard and the area of impact. • Determine whether the community is equally affected by most hazards or whether it should be divided into significant areas for comparative purposes and ease of analysis. • Review the risk factors for each hazard, using experts to justify the evaluation of risk whenever possible. • Determine the likelihood of a specific hazard occurring. • Complete the risk analysis recording sheet with all ratings. • Publish and provide access to information for the community at large.
Vulnerability Analysis:	• Become familiar with the educational material provided. • Review the vulnerability factors for each hazard and rate each factor in terms of whether or not the area is highly vulnerable. • Complete the vulnerability assessment recording sheet with all ratings. • Publish and provide access to information for the community at large.
Impact Analysis	• Become familiar with the educational material provided. • Review the ratings for vulnerability and determine and rate the social, environmental, economic, and political impacts for each hazard and area. • Complete the Impact Assessment recording sheet with all ratings • Publish and provide access to information for the community at large.
Risk Management:	• Become familiar with the educational material provided. • Compare the risks and impacts for all hazards and study areas. • Using the risk management recording forms, determine the high and low priorities for application of mitigation strategies. • Group remaining hazards and study areas into areas of secondary priority (if desired, additional levels may be used). • Get committee ready to formulate specific aspects of its recommendations. • Publish and provide access to information for the community at large.
Prior to Initial Presentation:	• Have the committee revise and update its suggested solutions. • Combine the committee's written materials into a draft plan. • Make copies of the finished draft plan.

Presentation to Elected Officials and Policy Makers:	• Distribute copies of the draft plan. • Have experts stand by to answer questions on recommendations. • Present the draft plan to local officials. • Have a meeting of project partners. • Obtain public input through public meeting and broadcast. • Encourage public involvement. • Publish and provide access to information for the community at large.
Ongoing Sessions:	• Establish a monitoring system to evaluate how the recommendations are being acted upon. • Continue to update the analysis.

Source: Adapted from Federal Emergency Management Agency (Region 8) and the National Park Service (Rocky Mountain Region) (1994, 8-11) and the Integrated Resource Planning Committee's (1993)

As will be noted, each of the phases concludes with the need to publish and provide access to information for the community at large. There are many ways in which this can be done. Thomas (1995) and the IRPC (1993) both suggest the use of public meetings, working shops, displays at community centres or malls and storefront offices, and newsletters as ways of communicating and sharing information with the public. Whether the HIRV committee is composed of an advisory committee or a steering committee (as per Thomas [1995]), it must follow the same steps.

Although the difficult decisions regarding trade-offs between potential costs and benefits are made during the mitigation phase of disaster management, the use of Hammond et al.'s (1999) work (which deals with smart choices and good consequences) may be helpful. They suggest using risk profiles in order to simplify decisions involving uncertainty. A risk profile answers four key questions:

1. What are the key uncertainties?
2. What are the possible outcomes of these uncertainties?
3. What are the chances of occurrence of each possible outcome?
4. What are the consequences of each outcome? (Hammond et al 1999, 112)

In this case the uncertainty would not be in relation to the applicability of risk or vulnerability factors but, rather, in relation to whether or not a particular hazard should be listed as a priority. As Hammond et al. (1999) state, most uncertainties do not influence consequences enough to matter. However, by first listing the uncertainties that might significantly influence the consequences of any alternatives and then considering to what degree their possible outcomes might influence one's decision, it becomes possible to define each outcome. For example, in debating whether or not a community should give high priority to the possible occurrence of a snowstorm, one should evaluate the consequences of making it a high rather than a medium priority and then, in light of the number of high priorities already established, determine whether or not doing so would have much (if any) consequence. This exercise may make it easier to reach consensus.

As the participants involved in the HIRV process reach conclusions regarding the priorities for mitigation strategies in their community, and as the mitigation strategies are adopted one by one, the profile of the neighbourhoods and communities will change and the overall community will benefit from increased resiliency.

5.2.2. A Summary of the HIRV Process

The HIRV process is participatory in nature, and Thomas's (1995) Effective Decision Model of Public Involvement supports the view that shared public decision making is crucial to any effective model for HRV analysis in most situations. Of the numerous choices available with regard to how to involve the public, one that seems to work for a number of communities is to form an advisory committee. Organizational behaviour literature indicates that an advisory committee of no more than fifteen members is optimal; however, there may be situations in which the HIRV process will have to accommodate larger numbers of participants. Both the local media and public relations officers can play a key role in ensuring that the findings of the committee are made available to the public; however, in smaller communities, others (e.g., the disaster manager, town administrator) may have to take primary responsibility for this.

Of the various available alternatives, the implementation guidelines based on the adaptation and integration of *A Multi-Objective Planning Process for Mitigating Natural Hazards* and *Public Participation Guidelines for Land and Resource Management Planning* include many of the key points appropriate to the HIRV model. These guidelines encourage using a facilitator to work with the committee and promote the formation of partnerships with various governmental agencies and the private sector. They also have a strong educational component.

5.3. The Hazard Identification Phase of the HIRV Model

The first task of the HIRV committee is to identify potential hazards. As stated in Chapter 2, a hazard is a threat to humans and what they value: life, well-being, material goods, and environment.

To qualify for inclusion in the HIRV list, a hazard must be capable of leading to a disaster. As will be remembered, in this dissertation, a disaster is defined as a non-routine event that exceeds the capacity of the affected area to respond to it in such a way as to save lives; to preserve property; and to maintain the ecological, economic, and political stability of the impacted region. This being the case, numerous hazards are not included in the HIRV list (e.g., asbestos [commonly used as an insulator in buildings] and radon gas).

Accurate identification of hazards is important, and this is the key objective of the hazard identification phase of HIRV. As discussed in Chapter 4, all of the extant models of HRV analysis fail to provide an adequate list of hazards. Since it is crucial that the HIRV committee not omit any hazards from its analysis, the HIRV handbook contains a comprehensive list of them* (see Appendix E). This list classifies hazards as (1) natural; (2) diseases, epidemics, and infestations; and (3) person-induced (see Chapter 3). Natural hazards are those that are normally thought of as "acts of God" (e.g., earthquakes and hurricanes). Diseases, epidemics, and infestations are self-explanatory and may apply to people, animals, or plants. Person-induced hazards are those that are caused either by acts of commission (e.g., the building of bombs) or acts of omission (e.g., the failure to build a dam able to withstand an earthquake). Given that the goal of the disaster management process is to develop mitigative strategies, it is important to look at the causes of disasters. Strategies will differ, depending upon the cause of the event in question. For example, if the effects of a flood are exacerbated by poor logging practices upstream, then those involved in the logging operations need to address this.

It is not enough to simply list each hazard; one must also ensure that participants understand the definition, cause, and scope of each hazard.* The HIRV handbook (see Appendix E) provides definitions for, and descriptions of, seventeen different hazards. Its purpose is not to provide an exhaustive account of all hazards but, rather, to provide enough information so that non-experts on the HIRV committee can understand the cause and scope of each. Experts can assist each community in defining and describing other potential hazards.

The following sections present and discuss the development and inclusion of the three types of hazards. The HIRV model is the only model to provide a comprehensive list of potential hazards, along with a definition and description of each.

5.3.1. Natural Hazards

Appendix E lists sixty-five potential natural hazards. The HIRV committee should be advised that no one community or region will ever have to deal with all sixty-five. While it may seem obvious to the committee that a particular hazard could not possibly occur in its community (e.g., a tsunami in communities situated mid-continent), it should not be eliminated from the list until the risk-assessment process has been completed. It is dangerous to start eliminating hazards just because someone thinks that "they couldn't happen here." The risk analysis process will quickly identify those hazards that can be safely excluded.

5.3.2. Diseases, Epidemics, and Infestations

Appendix E also provides a list of factors relating to diseases, epidemics, and pest infestations. This list is based on information taken from Pearce et al. (1997). Even though they are not usually considered in models for HRV analysis, because they can have devastating social and economic consequences diseases, epidemics, and pest infestations should be considered during the hazard identification process.

Diseases, epidemics, and pest infestations are so geographically specific that it is not useful to produce a complete list of them for every area. However, Appendix E provides a select list that may serve as a guideline to HIRV committees. Members of HIRV committees are encouraged to talk to those in medical and agricultural fields in order to develop a relevant list of such hazards. As a start, experts should be asked the following questions:

1. What diseases/pest infestations capable of leading to a disaster are you most concerned about today?

2. Why are you concerned?
3. What are the symptoms?
4. What are the direct consequences (e.g., death)?
5. What are the indirect consequences (e.g., trade embargo)?
6. What diseases/pest infestations have we experienced over the last fifty years?
7. Are any of these still a concern today?

5.3.3. Person-Induced Hazards

Appendix E includes a list of person-induced hazards, a number of which appear in the list of natural hazards (e.g., both lightning and careless campers can cause forest fires). It is important to remember that many accidents, from car crashes to chemical spills, occur every day. Those that should concern the HIRV committee are those that comply with our working definition of disaster. As Guarnizo (1992, 98) says: "Communities also have their own ways of defining what a disaster is – when conditions pass their boundaries of usual stress to become crisis. This is often different for different communities – a disaster for one, may be another's usual flooding." As will be remarked, it is not necessary, and in fact would be impossible, to list every known hazardous material. It is sufficient, for the purposes of the HIRV analysis, to simply list the category. Local firefighters, managers of industrial plants, owners of commercial enterprises, and residents can determine the specifics.

5.3.4. A Historical Review of Disasters

The final step in the hazard identification phase is to review each hazard and to document any known historical information. It is important to provide detailed descriptions of historical events that led to disasters (Foster 1988; Godschalk 1991; Collier 1994; Burby 1998). In the case of natural disasters such as landslides, the location of previous disasters is a valuable indicator of where the next disaster will likely take place (United Nations Disaster Relief Organization 1991). As stated in Chapter 4, most of the models for HRV analysis include the use of historical data.

It is extremely important not to rely on the collective information and memory of the HIRV committee but, rather, to take the trouble to identify and use alternate sources of disaster information. Numerous researchers (Covello, cited in Drabek 1986; Auf der Heide 1989) state that, in many cases, even when disasters have occurred relatively frequently, public awareness of these events is generally poor. Slovic et al. (1991) explain that this is often due to the availability heuristic.[31] In many cases, since frequently occurring events are generally easier to recall, the availability heuristic is appropriate; however, as Slovic et al. argue, in many cases using the availability heuristic can seriously distort people's judgements: typically, people overestimate events that are dramatic and sensational and underestimate events that claim one victim at a time or that do not result in fatalities.*

It is important, therefore, in addressing each hazard that the HIRV committee make serious efforts to carefully review all available historical data. Aside from asking residents to contribute whatever information they might have (a further means of ensuring public participation), the HIRV committee should consult:

- Newspaper articles
- Magazines
- Scientists and universities
- Long-time residents
- Local departmental files
- Research reports
- Emergency management files
- Industrial records
- Government archives and data bases

(Foster 1988).

If they are not familiar with a particular hazard, then HIRV committee members should consult with available experts. Although the HIRV model is not designed to accommodate chain events and multi-hazard situations, during its risk assessment phase it can certainly assist communities in coping with these situations. For this reason, the committee should attempt to identify potential multi-hazard situations. See Appendix E for some possible scenarios.

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[31] Slovic et al. (1991) define heuristics as a number of general inferential rules that people use when they do not have enough evidence to determine the actual facts.

5.4. The Risk Analysis Phase of the HIRV Model for HRV Analysis

As stated in Chapter 2, for the purposes of this dissertation, risk is defined as the probability, based on available data and scientific knowledge, of a disaster occurring in a particular place. Using the hazards and historical data identified in the previous section, HIRV's risk analysis phase considers the risk factors for each particular hazard. Of the extant models for HRV analysis, only the UNDRO model uses risk factors in assessing the likelihood of a disaster. One of the problems with the UNDRO model's list of risk factors is that the latter are so numerous and require such vast amounts of complex data that the likelihood of any community being able to complete the analysis is remote. The HIRV handbook identifies a less complicated, but reliable, list of risk factors for each hazard. Two unique features offered by the HIRV model to risk analysis are: (1) a basic structure by which to acknowledge and address issues of equity, and (2) a process by which it is possible to acknowledge the uncertainty surrounding the ability of experts to accurately predict potential hazards.

Before deciding which hazards are likely to occur and which are not, the HIRV committee must consider the scope of the potential disasters that have been reviewed in the hazard identification phase. This is one area in which experts will be of assistance, but it is important to realize that pinpointing the possible magnitude of a disaster is often not as important as knowing that there is a strong likelihood that one will occur. For example, while it is important for an engineer to know if a future earthquake will be of magnitude 8.2[32] as opposed to one of magnitude 7.2, for planning purposes simply knowing that a major earthquake is expected is often sufficient.

5.4.1. Dividing the Community Into Zones: A Step Towards Equity

The next step in the risk analysis phase of the HIRV model is to consider dividing the community into significant areas. If the community is very small, then it could be assessed as one entity (or it may be more feasible to take a regional approach). However, for the purposes of analysis, whenever possible, communities should be divided into significant areas. Friedmann and Weaver (1980, 31) state that "the region, as a unit of geographic individuation, is given: as a unit of cultural individuation it is partly the deliberate expression of human will and

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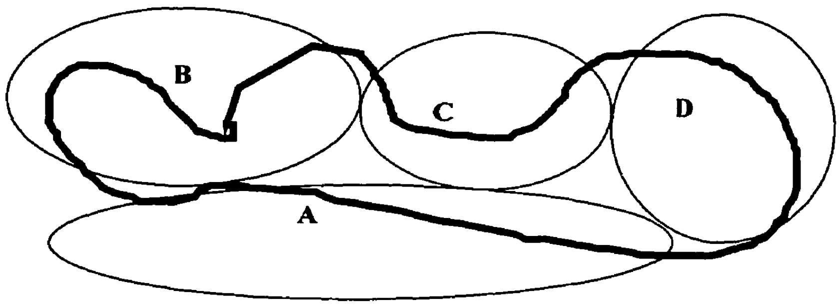
[32] In this example, relative magnitude is measured on the Richter Scale (a logarithmic scale, to the base 10, of wave amplitude as defined by Charles R. Richter in 1935) (United Nations 1991).

purpose." Geddes (cited in Hodge 1991, 277) developed "a trinity of factors to be taken into account in spatial planning: Folk (the people of the region; Work (the economy of the region); and Place (the geographical dimensions of the region);" Hodge (1991) adds to that trinity the use of political boundaries. Each community is unique, and there is no ideal way to regionalize a community (Hodge 1991). Thus, it will be up to the HIRV committee to determine the best way of dividing the community into various zones. If it is a large community, then it may be divided into recognized neighbourhoods (which are often homogenous in terms of lifestyle, culture, ethnic background, socio-economic status, etc.). In other cases it may make sense to divide the community in terms of fire districts, electoral districts, or geographical factors. In yet other cases it may make sense to divide the community into such areas as industrial, residential, river frontage, commercial, and so on. If the figure below were to represent a community built along the banks of a river, then Area A might represent river frontage area, Area B a commercial area, Area C a residential area, and Area D a recreational area.

Figure 6: Dividing the Community



In smaller communities the division may be as simple as east and north of the railroad tracks, the river, or "Main Street."

Dividing the community into "zones," or "parcels," for the risk analysis phase is the first step in establishing base lines for a comparative analysis of risks and hazards amongst the various areas. As the National Research Council (1996, 157) states: "risk characteristics should, when appropriate, address outcomes for particular populations in addition to risk to whole populations, maximally exposed individuals, or other standard groups." Dividing the community into zones enables it to address the risks, vulnerabilities, and impacts of certain hazards for specific populations. There will be some areas that are more vulnerable and that have a greater likelihood of being affected by a disaster than do others. Hodge (1991) states that, in Canada, the awareness of unequal development between regions began to capture people's attention in the 1960s (especially in the "have-not" regions). Various initiatives (e.g., the Agricultural Rehabilitation Act) were carried out in order to remedy regional disparities. As with regional disparities, so with issues of inequity: in order to involve community residents it is critical that the HIRV process establish how and why certain areas are more hazardous than others. In doing this, information that may be perceived as nebulous and non-specific becomes personalized. Because it is at the grass-roots level that information becomes personalized, researchers such as Morrow (1997) argue that, for the purposes of disaster management, "neighbourhood" is a better organizing concept than is "community."

As information is acquired and communicated to the residents, people will begin to personalize those hazards and risks that they face on a daily basis. As stated in the previous section, the availability heuristic contributes to both officials and residents underestimating the number of disasters that have occurred in their region (Wenger et al. 1980). This problem is further exacerbated by the fact that, not only do people typically underestimate risk, but they also overestimate the accuracy of their assessments (Slovic et al. 1991). Other factors, such as denial ("It can't happen here"), also result in underestimating disasters (Auf der Heide 1989). I propose that documenting historical disasters, indicating where they took place, and inviting the public to contribute to data will be of great assistance in enabling the general public to reach an accurate assessment of their situation vis-à-vis potential disasters.

As Kasperson (1992, 157) states, the underlying thesis of social amplification of risk is that "events pertaining to hazards interact with psychological, social, institutional , and cultural processes in ways that can heighten or attenuate perceptions of risk and shape risk behaviour." Of course, ideally the desired risk behaviour should lead to political pressure to initiate and implement mitigative strategies. It is proposed that accurate and personalized information concerning hazards can accomplish this end. The primary stages for risk amplification and attenuation – information flow and behavioural responses – are established.

One of the objectives of a successful risk analysis is that it take into account how a risk is perceived by the people whom it directly affects. As discussed in Chapter 2, people perceive risk in many different ways. I suggest that, until residents are clearly aware of which hazards and risks they potentially face, it is impossible for any community to take them properly into account. In some cases, residents may view certain risks as acceptable in order to gain certain benefits (e.g., prime river-front property is worth the risk of flooding); in other cases, they may not (e.g., cheap housing is not worth personal safety). In any event, it is critical that the members of the HIRV committee understand risk perception and how it may affect their judgement regarding whether or not a hazard is of greater or lesser risk.* The HIRV handbook, which includes specific texts and references to readings on risk perception, helps HIRV committee members educate themselves about risk perception.

5.4.2. Why the Need for Risk Factors?

What will influence how people perceive risk? According to Slovic et al. (1991), the answer is: (1) perceived risk compared to frequency of death, (2) faulty fatality estimates, (3) disaster potential, (4) qualitative characteristics, and (5) judged seriousness of death (e.g., is dying in a nuclear accident considered worse than being shot to death?). Regarding (1), it is important to realize that, while experts associate the risk of a disaster with the number of deaths that typically result from it, laypeople do not (Slovic et al. 1991, 68). As to (2), laypeople's fatality estimates tend to be moderately accurate (p.69). Regarding (3), generally speaking, laypeople considerably overestimate the number of deaths from causes that are seen as high-risk (e.g., nuclear power) (p. 70) and in relation to (4), generally, laypeople rate risk as high when it is seen to be involuntary, delayed, unknown, uncontrollable, unfamiliar, potentially catastrophic, dreaded, and/or severe (p. 72). Regarding (5), findings indicate that there is no relationship between type of death and laypeople's perception of risk (p. 72).

So, we can conclude that if people's perception of risk is such that it tends to lead them to make faulty judgements, then it is crucial that any approach to risk analysis take this into account. Identifying risk factors is one way of doing this, for it enables people to become aware of the likelihood of the occurrence of disastrous events. For example, proximity to an earthquake fault increases the risk of being affected by an earthquake, while moving homes away from the banks of a river decreases the risk of being affected by a flood. Risk factors need to be considered for each zone or neighbourhood within the community.

The risk factors that the HIRV handbook (see Appendix E) provides serve as a basic guideline. Experts should be invited to partake in the process of determining whether or not these and other risk factors exist.* They will have to assist in "translating" what may be very technical jargon (e.g., soil stability analyses) into language that committee members can understand and to which they can easily relate. Using the risk factors facilitates this process: it enables the general public to understand that *Zone X* is more likely than is *Zone Y* to experience the impact of an airplane crash because it is, for example,:

1. near an airport that handles large numbers of flights,
2. near flight paths that are near mountains,
3. near flight paths that are near areas subject to poor visibility due to weather conditions, and
4. near aircraft training stations (see Appendix E)

As each risk factor is considered, the HIRV committee should mark those that seem relevant. After carefully considering the risk factors, the committee should delete hazards that have no possibility of occurring in the community (this does not, of course, include hazards for which information is unknown). For example, an inland community surrounded by flat prairie land could safely delete tsunamis and avalanches from its list of potential hazards. The risk factors that are marked indicate the risk to the community. Experts on the committee can advise HIRV committee members as to the weighting of the risk factors, depending upon local conditions. For example, the fact that a landslide has previously occurred in the area is so significant that even in the absence of many other factors, it may indicate a strong likelihood of a future landslide (United Nations Disaster Relief Organization 1991).

Risk factors are an important tool in ensuring that community stakeholders have access to adequate data. As risk factors are identified, they will assist in determining exactly why a particular hazard is more (or less) likely to occur in a particular area. In many cases, answers to questions regarding the risk analysis will not be known, and it is important for these uncertainties to be recorded.

5.4.3. Dealing with Uncertainty

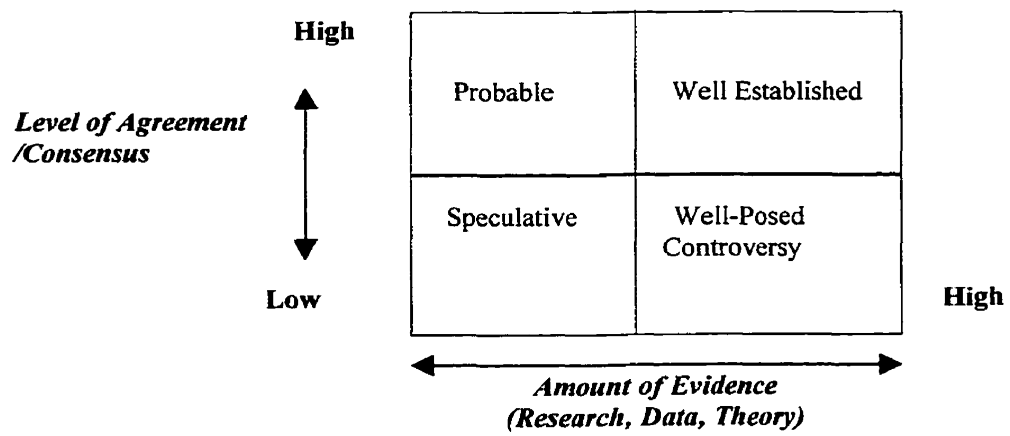
Dealing with uncertainty and the inability of scientists and experts to accurately predict potential hazards is another unique contribution of the HIRV model. There is often a mistaken belief that "science has all of the answers." While science can, and does, provide many answers, estimating the risk of a potential disaster involves a great deal of uncertainty. The National Research Council (1996) has identified five challenges to accepting technical and scientific input regarding risk: (1) the lack of inter-disciplinary expertise, (2) the inability to integrate valuable information and knowledge from laypeople, (3) the lack of objectivity and neutrality, (4) the ability of scientists to unduly influence others due to the often highly technical information that forms part of the risk assessment, and (5) the sole reliance on science in making risk decisions.

In many cases "the probabilities of occurrence and impact are not known with certainty; they are usually highly uncertain" (National Research Council 1996, 107). The NRC's findings indicate that the "most important need is to identify and focus on uncertainties that matter to understanding the risk situations and making decisions about them" (109). In order to deal with the issue of uncertainty and the state of scientific knowledge, the HIRV model uses the Subjective Probability Ratings Model (SPR), which was developed by Moss in 1996 as part of the Intergovernmental Panel of Climate Change (see Figure 7). This model is described in Moss and Schneider (1997). Although not specifically designed to deal with an all-hazard approach to disasters, their work is certainly useful to the HIRV committee. Their categories are as follows:

> **Well-Established:** This category denotes wide agreement, based on multiple findings through multiple lines of investigation. A finding could be removed from this category not by a single hypothesis, observation or contention, but only by a plausible alternative hypothesis, based on empirical evidence or explicit theory, and accepted by a substantial group.
>
> **Well-Posed Controversy:** a well-established finding becomes a well-posed controversy when there are serious competing hypotheses, each with good evidence and a number of adherents.
>
> **Probable:** This category indicates that there is a consensus, but not one that has survived serious counter-attack by other views or serious efforts to "confirm" by independent evidence.
>
> **Speculative:** Speculative indicates not so much "controversy" as the accumulation of conceptually plausible ideas that haven't received serious attention or attracted either serious support or serious opposition. (Moss and Schneider 1997, 121)

The SPR model enables the HIRV committee to determine when: (1) information is well accepted and established, (2) more evidence is needed (e.g., flood plain maps, soil testing), (3) the experts or the residents disagree (e.g., regarding the likelihood of a nuclear accident), and (4) there is little evidence and consensus. In other words, the SPR model enables the HIRV committee to document degree of certainty, thus allowing the process of analysis to continue while earmarking specific areas for additional consideration. Application of the SPR model also serves to indicate areas in which additional studies or discussions need to occur.

Figure 7: Subjective Probability Ratings Model (1996)



Source: **Moss and Schneider (1997, 121)**

The rationale for incorporating the SPR model into risk analysis is that it is simple and easy to understand. As Moss and Schneider (1997, 123) state:

> At a minimum, employing such consistency tables would force participants to think more carefully and consistently about their subjective probabilities, and help to translate words like high, medium, and low confidence into reasonably comparable probability estimates. This step would be relatively straightforward to implement, and could improve the consistency of the subjective estimates in future assessments.

Other models could be used, but I believe that given the number of evaluations that have to be carried out and the degree of sophistication of members of the HIRV committee, the SPR model lends itself well to the problems of evaluating risk and vulnerability factors and impact analysis. Furthermore, being "up front" about how the risk analysis was conducted and where uncertainties lie should assist in dealing with various competing interests.

Once the risk factors have been considered, the HIRV committee should complete the risk analysis. From historical records and known risk factors, some disasters will immediately be seen as likely to occur while others will be seen as unlikely. With regard to those that do not fall clearly into either category, a careful assessment must determine their likelihood. The results of the risk analysis may be represented by a simple scale (see Table 15). Note that, in and of itself, each number is of little importance; what is of importance is how each number stands in relation to others.

Table 15: Table of Scale Used to Evaluate Risk

+3	Hazard is very likely to occur	-1	Hazard has a slight chance of not occurring.
+2	Hazard is likely to occur	-2	Hazard is unlikely to occur.
+1	Hazard has a slight chance of occurring	-3	Hazard is very unlikely to occur.

The numbers used in Table 15 reflect the risk of a disaster occurring. The extant models for HRV analysis evaluated in Chapter 4 weight different aspects of the risk assessment process in different ways. Some weight historical data as more relevant than the evaluation of risk. I propose that, given that each hazard is different, it is not possible to prescribe a weighting to hazards. For example, information that the last earthquake occurred forty years ago may be as historically relevant as the fact that the last major chemical spill took place twenty-four hours ago. Clearly, to assign an identical weighting for one aspect of risk assessment across every hazard makes little sense from a disaster management perspective and compounds the difficulty of explaining one's rationale to the community at large. Using the best data possible, given the scope of the project, the HIRV committee makes a best-guess assessment. For example, at this point of the assessment, the HIRV committee could end up with the kind of product illustrated in Table 16.

Table 16: Sample of a Completed Risk Assessment

	Area 1 Riverside				Area 2 Downtown Core			
Hazard	**Historical Data**	**Risk Factors**	**Certainty of Data**	**Risk Rating**	**Historical Data**	**Risk Factors**	**Certainty of Data**	**Risk Rating**
Earthquake	*1946 1965 1992*	*5/8 risk factors apply*	*Well establishe d*	+2	*1946 1965 1992*	*2/8 risk factors apply*	*Well establishe d*	+*1*
Flood	1960 1968 1970 1985 1990	*7/8 risk factors apply*	*Well establishe d*	+3		*1/6 risk factors apply*	*Well establishe d*	-*1*

As can be seen from Table 16, the risk of earthquake and the risk of flood, respectively, differ for the two different areas of the community. Were this to be the completed analysis, the outcome would be that the area along the river is at higher risk than is the downtown core.

As discussed in Chapter 2, given the complexities and uncertainties of risk assessment, the best that can be expected is the careful collection of available data concerning which hazards are most and least likely to occur, and where they are likely to occur. The remainder of the hazards can be grouped together somewhere in between these two poles. The risk ratings provide a means for the HIRV committee to consider those hazards that are high risk versus those that are low risk as well as to assess the degree of certainty attached to those ratings.

HIRV's risk analysis takes into consideration the resources that are available to various communities. In a large community, equipped with a well-resourced GIS and access to technological equipment and processes, the collected data can easily be incorporated into HIRV's risk analysis. In a small community, with access to topographical maps and local and expert knowledge, the community can still proceed with the HIRV analysis. As new information becomes available, risk factors can be reconsidered and ratings adjusted. Once a risk analysis is completed for each of the hazards, the ratings should be transferred to a risk assessment sheet (see Appendix F).

The samples of compiled risk factors that are included in the HIRV handbook serve as an educational tool for those on the HIRV committee. It is hoped that as the committee members review and come to understand each of the risk factors, they will gain an awareness of what conditions increase or decrease risk. The handbook also contains references, but it is likely that experts within the community will provide most of these. As each hazard is considered, additional experts may be brought in to develop the risk factors for other potential hazards.

5.5. The Vulnerability Analysis Phase of the HIRV Model

As set out in Chapter 2, I define vulnerability as the susceptibility of people, property, industry, resources, ecosystems, or historical buildings and artefacts to the negative impact of a disaster. When completing the vulnerability analysis, the HIRV committee must examine hazards in terms of extant and potential vulnerabilities. The tasks are to: (1) assess each chosen location in terms of the four vulnerability factors (people, place, time, and preparedness) presented in Chapter 2, and (2) document degree of certainty regarding the ratings.

It is important that residents understand where their vulnerabilities lie; understanding extant vulnerabilities is the first step towards developing effective mitigative strategies. A comprehensive literature review relating to vulnerability and its applicability to an all-hazard HRV process was disappointing in that, in most cases, the literature is highly specialized (e.g., earthquake engineering) and does not take an interdisciplinary approach. According to Buckle (1999, 21):

> Despite the need to understand communities and affected populations so that services can be targetted and priorities for programs established there is virtually no assessment of need or vulnerability analysis currently undertaken.
>
> Our current, simplistic notion of community as all the people in a given area (ignoring internal diversity and external links and relationships) is not adequate to meet the needs either of emergency managers or of local people themselves.

Mileti (1999) agrees, also listing vulnerability assessments as one of the key areas in which additional research is badly needed. For the most part, the literature dealing with vulnerability can be categorized into six main areas:

(1) Literature dealing with the effects of specific hazards on specific populations. This includes books and papers such as *Race, Religion and Ethnicity in Disaster Recovery* (Bolin and Bolton 1986) and "The Public Health Impact of Hurricane Mitch in Central America" (Perez-Calderon 1999). In some cases the literature is all-hazard in approach but focuses on a specific population. Papers delivered at conferences such as "Women in Disasters" (Justice Institute of British Columbia 1998) would be representative of this type of literature.

(2) Literature dealing with how specific hazards affect the vulnerabilities of buildings and other structures. This includes articles such as "Houses That Stand Up to Hurricanes" (Ross 1995) and "Impacts of the Los Angeles

Retrofit Ordinance on Residential Buildings" (Comerio 1992), which are published in the Earthquake Engineering Research Institute's (EERI) journal, *Spectra*. Most of the literature in this area has to do with earthquakes and hurricanes.

(3) Literature dealing with the vulnerabilities of businesses and focusing on business continuity planning. Each quarterly issue of the journal *Disaster Recovery* includes a variety of articles such as "Assessing the Effectiveness of a Contingency Plan for an Individual Business Unit" (Swanson 2000).

(4) Literature dealing with the vulnerabilities of the environment or ecological sites. This includes articles such as "Coastal Hazard Mapping and Risk Assessment" (Bush 1994) and reports on projects such as the PRECUPA Project, which was developed to assess the fragility of the Paute River Basin in Ecuador (Basabe 1999).

(5) Literature dealing with the capability (or lack thereof) of a community to respond to a disaster. This includes books such as *Coping with Catastrophe* (National Academy of Public Administration 1993) and case studies such as "Port Arthur: Lessons for Early Disaster Management" (Sale and Hessman 1998).

(6) Literature on mitigation. The number of published articles and books in this area has increased dramatically in the past few years. Articles such as "Local Earthquake Mitigation Programs: Perceptions of Their Effectiveness Following the Loma Prieta Earthquake" (Bolton and Orians 1998) and "Higher Ground: A Report on Voluntary Property Buyouts in the Nations' Floodplains – A Common Ground Solution Serving People at Risk, Taxpayers and the Environment" (National Wildlife Federation 1998) are good examples of this type of literature.

The diversity of the literature and its specialized focus complicates the task of identifying key vulnerability factors. However, it is as important for community residents to be able to identify the factors that lead to increased or decreased vulnerability as it is for them to understand the reasons why they are more at risk from the impact of one particular hazard than another. Hence the need to develop vulnerability factors for each hazard – another unique aspect of the HIRV model. The key vulnerability factors to be considered for all hazards are listed in Table 17.

Table 17: Key Vulnerability Factors

People	Place	Preparedness	Time
• age • density • gender • ethnicity and language • socio-economic status	• buildings • critical facilities • ecological sites • economic sectors • historical and cultural sites • lifelines and infrastructure • non-structural property • recreational land • structures	• capability to respond • community education and training • mitigation program • warning systems	• population density re: time of day • population density re: day of the week • population density re: time of year • population density re: holidays

These vulnerability factors are derived from a literature review that includes Bolin and Bolton (1986); Drabek (1986); Perry and Mushkatel (1986);). the United States Department of Health and Human Services (1989)); Aysan (1990); Burkhart (1991); Coburn et al. (1991); the Department of Regional Development and Environment Executive Secretariat for Economic and Social Affairs, General Secretariat of the Organization of American States (1991); Parker (1992a); and Bolin (1993). They also derive from a review of the extant models for HRV analysis and a post-disaster reconnaissance study that I conducted nine weeks after the Northridge earthquake (Pearce and Pearce 1994).

With the exception of the NOAA model, the extant models for HRV analysis did not consider vulnerabilities other than in a superficial fashion. While the publishing of the NOAA project was too late (1999) to aid in the development of the vulnerability phase of the HIRV model, it did confirm a number of the extant vulnerability factors included in Table 17. And the *Earthquake Vulnerability Analysis for Local Governments* (Bay Area Regional Earthquake Preparedness Project [BAREPP] 1992) did contribute to the development of key vulnerability factors. Although the BAREPP guide is weak in terms of people vulnerabilities, it is very strong in terms of critical facilities and lifeline networks.

Each of the vulnerability factors listed in Table 17 needs to be considered in relation to each potential hazard (e.g., people aged sixty-five and over have an increased death rate due to decreased systemic vascular resistance in hot weather). As has been stated, it is important for residents to understand why they are more (or less) vulnerable than others. As in the risk analysis, so in the vulnerability analysis: as the HIRV committee reviews the vulnerabilities* for each designated area in the communities, inequities will become apparent.

A vulnerability analysis provides us with an estimate of how vulnerable an area is to a particular hazard. A scale similar to that used for risk analysis can be used to indicate degree of vulnerability (see Table 18).

Table 18: Scale for Determining the Vulnerability to a Disaster Occurring from a Specific Hazard

+3	High degree of vulnerability	-1	Slight degree of invulnerability
+2	Moderate degree of vulnerability	-2	Moderate degree of invulnerability.
+1	Slight degree of vulnerability	-3	High degree of invulnerability.

As in the case of the risk analysis, the HIRV handbook includes, as a guide, a list of vulnerability factors for the seventeen chosen hazards. The HIRV committee needs to carefully determine the vulnerability factors for each of the other potential hazards that faces the community. The following is a brief overview of the various vulnerability factors and how they are applied within each function (i.e., people, place, preparedness, and time).

To begin with, as mentioned in Chapter 2, an important vulnerability factor is a function of people – specifically, their age, density, gender, ethnicity, and socio-economic status (Buckle 1999). Accordingly, in keeping with the risk analysis phase, the HIRV vulnerability analysis phase includes a list of people-based vulnerability factors for each hazard. For example, Appendix E illustrates the basic vulnerabilities for an earthquake. As the participants analyze the demographics of each location, their task is to consider whether or not the vulnerability factor is such that it creates a greater vulnerability than should be expected. For example, if a neighbourhood had an average number of senior citizens, then vulnerability would not increase; however, if there were several senior citizens' homes, or if the neighbourhood were a residential area for retirees, then vulnerability would increase.

The vulnerability analysis phase of the HIRV model also provides vulnerability factors for each hazard as a function of place (see Appendix E). Keeping in mind the example in the table below, the HIRV committee, using the best data available, would evaluate each location according to the vulnerability factors. For example, the earthquake example, if there were a large number of critical facilities in the area – or if the schools, hospitals, and other emergency response buildings were not seismically retrofitted – then that particular location would be very vulnerable.

Two factors, both of which were identified in the NOAA model, are worthy of special mention. The first factor is ecological sites. These sites are important, and we know that environmentally sensitive areas are of global as well as local concern. Participants in the vulnerability analysis phase of the HIRV model need to take pains to ensure that adequate environmental assessments are completed, and local environmentalist groups would be a useful resource during this part of the analysis.

The second factor is economic sectors. These include: (1) agriculture, (2) commerce, (3) industry, (4) natural resources, and (5) tourism.[33] When economic sectors are included in the vulnerability assessment, they are considered in terms of their contribution to the community or region as a whole. So, for example, a nuclear power plant would not be considered in terms of the risk it posed to the community, but in terms of its contribution to the economy. Likewise with the hazardous waste site if, for example, it were the repository of hazardous wastes from outside the community. Thus, for analytical purposes, economic sectors are vulnerability factors as a function of place.

The vulnerability analysis phase of the HIRV model provides vulnerability factors for each hazard as a function of preparedness (i.e., the capacity of the community to respond). The HIRV vulnerability analysis includes four measures of preparedness. As is clear from a number of case studies, the greater the degree of preparedness, the more resilient the community (US Geological Survey 1998; FEMA 1998).

Finally, the vulnerability analysis phase of the HIRV model provides vulnerability factors for each hazard as a function of time. A particular day, week, or year can increase one's vulnerability to a particular hazard. Most case studies of the Northridge earthquake acknowledge the benefits of the earthquake having occurred at 0431h on a statutory holiday. Unlike the other functions, time requires participants to actually write in which time of day, month, or whatever is a factor (and why) rather than simply tick off a box. In some cases, such as an earthquake, there may be a number of significant factors (see Appendix E). Foreknowledge of vulnerabilities related to time can

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[33] Drabek (1996) was one of the first to recognize the importance of developing plans to deal with tourists during a disaster.

assist in post-disaster response, can be added to the disaster plan, and can lead to the development of mitigative strategies. For example, if overpasses and bridges are highly vulnerable in a particular community, and if an earthquake occurs during rush hour, then emergency response teams should immediately head to these specific locations.

Use of vulnerability factors assists in ensuring that community stakeholders have access to enough quantitative and qualitative data to determine the extant and potential vulnerabilities for the various neighbourhoods in their community. Engineers, insurance representatives, utility company representatives, industry, and so on all have an important role to play during the vulnerability analysis phase of the HIRV model. Not only can they share their own corporate vulnerability analyses with the HIRV committee, but they can benefit from the findings of the latter. For example, the water inspector may reveal to the committee that the water mains are in poor condition in certain areas, thus increasing their vulnerability. In turn, the committee may find out that those same areas are at high risk for a number of hazards that had not been considered.

Nevertheless, it is important for committee members to make their own decisions and not to be constrained by corporate or government officials who wish to paint a rosy picture of the community's state of vulnerability. The inclusion of basic vulnerability factors should assist in ensuring that key vulnerability issues are considered. Use of the SPR model, as in the risk analysis phase, enables the HIRV committee to document degree of certainty for vulnerability factors (see Table 19).

Table 19: Summary of Sample Vulnerability Analysis for an Earthquake for a Given Location

Hazard	People	Place	Time	Preparedness	Certainty
Earthquake	+2	+1	+1	+2	Well established

As information at the community level becomes available, residents should become keenly aware of their vulnerability to certain hazards. When people can readily see by looking at a map that should a particular hazard occur in their neighbourhood they would be very vulnerable while others would not, they will become increasingly aware of extant inequities. According to Buckle (1999), special attention should be given to seven categories of vulnerability: (1) the capacity to deal with one's own affairs and meet one's needs, (2) availability of resources, (3) cultural attitudes and values, (4) access to services, (5) social isolation, (6) significant changes over a short time span (e.g., unemployment), and (7) pre-existing stressors (such as previous exposure to a disaster). Buckle suggests that social audits, social analyses, and other tools need to be developed in order to identify social vulnerabilities and, thus, to understand more effectively the groups that make up our communities (26). The vulnerability factors that have been developed as part of the HIRV model function as one such tool. As Quarantelli and Walter (1997, 40) state: "Given the diversity in our society, special attention needs to be given to equity issues to ensure that no groups are marginalized with regard to involvement in natural disaster reduction activities."

The HIRV vulnerability analysis is not highly dependent upon technology, although a number of the tests for extant equipment, structures, and so on may be highly technical in nature. At its simplest, the HIRV vulnerability analysis requires some basic demographic data (i.e., number, density, and ages of residents); some information about critical facilities and the state of disaster planning in the community; and some information about buildings, lifelines, and infrastructure. At its most complex, the HIRV vulnerability analysis utilizes engineering assessments of extant buildings, critical facilities, and infrastructure; insurance ratings; assessments by fire departments, GIS technology; and so on. One of the benefits of using the HIRV vulnerability analysis is its flexibility in adapting to local conditions. Use of the SPR model when evaluating the certainty of data also assists in pinpointing areas where additional research and evaluation is needed.

Finally, the HIRV vulnerability analysis ensures that the educational process continues to evolve. The compilation of the numerous vulnerability factors as they apply to each hazard contributes to a body of knowledge that is not considered in most research projects and that is certainly far more comprehensive than are those identified in most of the HRV models reviewed in Chapter 4.

5.6. The Impact Analysis Phase of the HIRV Model

The fourth phase of the HIRV model for HRV analysis involves evaluating impacts. If the elderly are more vulnerable to a certain hazard than are the young, then this will be reflected in, and measured in terms of, the increased deaths and injuries of the former. Likewise, if a building's construction type renders it highly vulnerable to an earthquake, then this will be reflected in the damage that it sustains. And the impact of this damage will be measured in terms of economic loss. The underlying principle of the impact analysis is that by considering the impact of each hazard and comparing it across different areas of the community, the HIRV committee will be able to determine those areas that are at risk for high losses. Generally speaking, those areas with a high degree of vulnerability will suffer the greatest impact following a disaster. And, of course, it is those areas that become a priority for mitigation. If we understand the risk and vulnerability factors, then we can develop mitigation strategies in order to reduce the risk, impact, or consequences of the hazard. The same key objectives that were identified in the vulnerability analysis phase of the HIRV model are also addressed in the impact analysis phase.

Vulnerabilities have been described as being a function of people, place, preparedness, and time; and impacts can be viewed as being social, environmental, economic, or political. It can be argued that insofar as they will affect all of the people in a given community, all impacts are social; however, for the purposes of this analysis, impacts will be considered in terms of their primary effect. Thus, for example, a death or injury would clearly be categorized as a social impact, while damage to a commercial building would be categorized as an economic impact. Some events cross over into more than one impact area. For example, losing one's home qualifies as an economic loss, but it also qualifies as a social loss, as it has a serious impact on one's ability to continue to function within society.

Most impact analyses have been conducted because of the desire to build a dam, log a forest, build a development, or introduce a new service or infrastructure (Wolf 1974). Unfortunately, little work has been conducted on pre-disaster impact analysis; most of the work on disasters has been conducted post-disaster. A literature review pertaining to the impacts of disaster finds that they are usually specific to a certain type of hazard or that they are based on a case study (e.g., *The Environmental Impacts of Flooding in St. Maries, Idaho* [Montz and Tobin 1997]).

Furthermore, impact analysis has focused on economic losses; even when a publication claims to be concerned with "socio-economic" impacts, in reality, most of it is usually devoted to economic impacts rather than social impacts (United Nations Centre for Regional Development 1990; Central United States Earthquake Consortium 1993). Economic losses have been the primary focus of insurance companies (Insurance Bureau of Canada 1994) and the driving force behind mitigation efforts and projects such as Project Impact (FEMA 2000). Reports on recovery and those dealing with housing losses and other socially-related impacts have tended to ignore social consequences and focus on economic consequences (Mader 1994). Little work has been done on pre-disaster environmental impacts and political impacts.

The challenge for the HIRV committee is to consider hazards and vulnerabilities and to "translate" them into impacts. For example, during an earthquake, an aged population "translates" into increased deaths and injuries. As is demonstrated in the following text, the HIRV impact analysis facilitates this process by providing the necessary links between vulnerabilities and hazards. Table 20 provides a simple scale to categorize the degree of impact. Again, it is important to remember that the numbers, in and of themselves, are unimportant: what is important is the comparison between the various areas.

Table 20: Scale for Determining the Degree of Impact to a Disaster Occurring from a Specific Hazard

+3	High degree of impact
+2	Moderate degree of impact
+1	Low or no degree of impact

The next four sections provide a brief overview of how HIRV determines the impact rating of each community zone.

5.6.1. Social Impacts

Social impact analysis expresses the impact of the hazard in terms of its social effect on the population. Vulnerabilities may be used to evaluate social impacts, as is indicated in Table 21. In social impact analysis, the loss of housing, schools, and so on is not measured in terms of economic loss but in terms of societal loss. For example, as stated by Howe and Cochrane (1993, 12):

> Every community, region and country has certain assets that are valuable in giving that society a sense of historical continuity and cultural identity. Such cultural assets often are unique and irreplaceable, and also have the character of public goods; therefore, market prices either are unavailable or inappropriate to use in valuing the assets.

Table 21: Vulnerabilities and Social Impacts

Vulnerabilities	Social Impacts
• age • gender • ethnic and cultural background • population density • time of day, week, year	• number of deaths • number of injuries
• buildings	• loss of housing • disruption of family life • loss of schools or educational opportunity • loss of a historical site • loss of a cultural site • loss of health services • loss of critical facilities
• recreational land	• loss of recreational opportunities

In cases where the time factor leads to considerable differences in vulnerability (e.g., downtown on a Friday as opposed to on a Sunday), the HIRV committee may wish to include a couple of scenarios for each study area (e.g., what would happen on a weekday as opposed to what would happen on a weekend). Completing a social impact analysis allows the HIRV committee to gauge the impact of a disaster upon a given community.

Communities can use local experts to assist them in determining what the actual impacts would be. In many cases answers will be subject to local values. What one community may find a high degree of impact (e.g., 10 deaths) another may consider a moderate degree of impact. As long as the evaluation is consistent across all hazards, the basis for comparison will remain valid. A sample social impact assessment for air crashes is illustrated in Table 22. As is shown, a plane crash which took place in a rural area might entail a moderate to high number of deaths and injuries and little loss of housing.

Table 22: Sample from a Social Impact Analysis for an Air Crash in a Given Area

Social
[3] Number of deaths
[3] Number of injuries
[1] Loss of housing
etc.

It is anticipated that as residents recognize just how many lives will be lost and homes destroyed, there will be a strong demand to mitigate the situation

5.6.2. Economic and Environmental Impacts

The HIRV impact analysis also takes into account environmental and economic impacts. Tourism and natural resource-based industries are especially vulnerable to disasters. Oil spills and other hazardous material spills can quickly end a successful fishing or shellfish industry. Tourists will not come to see parks that have burned to the ground or beaches that are covered in oil. But with the increased attention given to environmental concerns in the past few years, people have realized that it is not sufficient to represent these losses in simple economic terms. "Some damages to natural capital (e.g., rivers, lakes, forests, and other natural areas) can be included with the economic damages due to loss of household and market-related productivity.... However, current concern for the environment goes beyond monetized ecosystem damage" (Howe and Cochrane 1993, 13).

Hazardous spills, toxic gas releases, pipeline breaks, and explosions can also have a devastating impact on the local environment. Many ecological sites are already in a fragile state, and any disaster can have a permanent impact on their viability.

Again, little work has been done in this area and, as Howe and Cochrane (1993, 14) say: "Assessment of ecological damage following a disturbance will be considerably more accurate and informative if baseline data have been gathered prior to the event and if monitoring continues during the recovery phase."

Table 23: Vulnerabilities and Environmental Impacts

Vulnerabilities	Environmental Impacts
• industrial sectors • lifelines and infrastructure • ecological sites • agricultural sectors • natural resources sector	• quality of air • quality and quantity of water • quality and quantity of soil • destruction to plant life • deaths and injuries to wildlife • destruction of natural resources • destruction of eco-systems • loss of bio-diversity

Using the same scale as was described in the previous section, a sample of the environmental impact of an air crash might look like that illustrated in Table 24.

Table 24: Sample Environmental Impact Assessment for an Air Crash in a Given Area

In this example, the plane would not have been carrying any hazardous materials and would not have crashed in a lake or river or near an ecological site of any significant importance.

Environmental
[1] Quality of air
[1] Quality and quantity of water
[1] Quality and quantity of soil
etc.

More research has been completed on the economic impacts of disasters than on any other type of impact (Castanos and Lomnitz 1995), and they can be calculated in a number of ways. Howe and Cochrane (1993, 5) present four possible scenarios:

- market prices exist for many assets, commodities, and services ... [and] correctly reflect social values;
- market prices exist, but need to be adjusted to reflect social values correctly;
- market prices do not exist, but credible methods exist for estimating the prices needed for program or project evaluation; or
- market prices do not exist, and no general, credible methods for simulating those values exist.

Unfortunately, even when market prices do exist, using them to calculate economic impact is not easy. As the following quote illustrates, calculating the economic impact of a disaster-related injury is a complex task.

> When an individual is injured or becomes ill due to a natural hazard event, the major impacts take the form of 1) the loss of the individual's productivity in the household, 2) the loss of the individual's productivity in market-related production activities, and 3) the disutility of physical and psychological malaise .... Whenever there is significant damage to residences, household production processes are interrupted: food preparation, laundry, provision of rest, relaxation, and recreation. The reduction in household value added occasioned by natural hazard events should be included in damages. (Howe and Cochrane 1993, 10 and 12)

For the purposes of estimating damages following a disaster, Howe and Cochrane produce a list of over thirty standard industrial classifications of economic activities (see Table 25 below). Obviously, this type of analysis is well beyond the scope of most HIRV committees; however, these committees *can* carefully review what is known in order to assess degree of economic damage.

Table 25: Standard Industrial Classification of Economic Activities for the Purposes of Damage Data Classification

• **Agriculture, Forestry and Fishing** • **Finance, Insurance and Real Estate** • **Other**	• **Transportation and Public Utilities** • railroad • passenger • trucking • mail • water • air • pipelines • transportation services • communication • electric, gas and sanitary	• **Services** • hotels • personal • business • auto repair • movies • amusement and recreation • health • legal • educational • social services • cultural • engineering and management • private households • membership organizations	• **Mining; including oil and gas extraction** • **Wholesale Trade** • **Public Administration** • **Construction** • **Retail Trade** • **Manufacturing**

Source: Howe and Cochrane (1993, 10-11).

As demonstrated by Dore and Etkin (1999), use of traditional "accounting" methods when calculating the economic cost of a natural disaster can result in unexpected outcomes. They found that when the Conference Board of Canada calculated the cost of the 1998 ice storm in Quebec and Ontario, the outcome indicated a "net increase of

0.4% GDP," or $1.4 billion; whereas when losses were calculated as loss of output in a dynamic context, they were estimated at $4.2 billion (1).

How should economic impacts be calculated? It is important to remember that the criteria used to answer this question for the purposes of planning and mitigation need not be as stringent as the criteria used by, for example, insurance companies who are attempting to set premium rates. At its simplest, the HIRV impact analysis can be used to provide a best-guess estimate of the degree of economic impact (i.e., high, moderate, or low). If one knows that a large percentage of the buildings in a particular area will be seriously damaged, then it is not really necessary to know the exact value of that damage. An estimate that there would be significant economic damage, or that the level of economic damage in comparison to other parts of the community would be high, is sufficient for an analysis of this type. As White (1988, 173) says: "The use of benefit-cost analysis to appraise the efficacy of proposed methods of handling risk has severe limitations and may be misleading rather than helpful in providing tools for decision." The HIRV impact analysis also provides a means for HIRV committee members to translate extant vulnerabilities into economic impacts (See Table 26).

Table 26: Vulnerabilities and Economic Impacts

Vulnerabilities	Economic Impacts
• buildings • structures • critical facilities • historical and cultural sites • lifelines and infrastructure • property	• structural damage • non-structural damage
• economic sectors • recreational land • lifelines and infrastructure	• loss of jobs • loss of revenue • loss of service • deaths and injuries to livestock and domestic animals • destruction of crops

Continuing with the air crash example, a sample economic impact for a given area might look like what is reflected in the accompanying table if the plane were to crash in an uninhabited rural area.

Table 27: Sample Economic Impact Assessment for an Air Crash in a Given Area

Economic
☐ Structural damage
☐ Non-structural damage
☐ Loss of jobs
etc.

5.6.3. Political Impacts

According to Parker (1992b, 238), "technological disasters can ... have political and career ramifications on those in public office who are in positions of trust and who do not measure up to their responsibilities." However, a standard HRV analysis does not usually measure the political impact of a disaster. That the HIRV impact analysis includes political impacts is yet another unique feature of the HIRV model. Ultimately, whether or not mitigative strategies are adopted is dependent upon the political will of the elected officials. One reason for including the political impact of hazards is to assist politicians in determining how the voters will judge their actions regarding whether or not mitigative strategies are implemented. Some politicians have worked to ensure that their communities were well prepared when a disaster occurred (e.g., by testing warning systems and emergency response plans, providing community-based training and education, and implementing mitigation programs). Whenever this has been the case, the community has been supportive of its politicians.

> After the Loma Prieta earthquake *Newsweek* magazine estimated that former San Francisco mayor Art Agnos had "made a name for himself as a formidable leader with state and perhaps national potential" through "his compassion and high-profile performance" (Salholz 1989, 37 cited in Stallings 1995, 7)

When a community feels that its local politicians have not acted adequately in order to reduce either the risk or consequences of a disaster, these officials can be in serious trouble. As Stallings (1995, 7) points out, "There can ... be grass-roots protest in the aftermath of an earthquake. Citizens often do angrily confront public officials, write letters to their congressional representatives, and lobby for change." I propose that, combined with public participation and the public pressure that derives from the HIRV impact analysis, awareness of potential political impacts will increase the willingness of elected officials to approve the implementation of mitigative strategies.

Following a disaster, people always ask, "How could this have happened here?" There are a number of different factors that may help to determine what the degree of community outrage might be over having been subjected to particular risks. Those factors used by the HIRV impact analysis have primarily been derived from two sources: Bernstein 1987 and Sandman 1991.

- Voluntary risks are accepted more readily than are those that are imposed (voluntary versus coerced).
- Risks under individual control are accepted more readily than are those under government control.
- Risks that seem fair are more acceptable than are those that seem unfair.
- Risk information that comes from trustworthy sources is more readily believed than is risk information that comes from untrustworthy sources.
- Risks that seem ethically objectionable will seem more risky than will those that do not.
- Natural risks seem more acceptable than do industrial risks.
- Exotic risks seem more risky than do familiar risks.
- Risks that are associated with memorable events are considered more risky than are risks that are not so associated.
- Risks that are "dreaded" seem less acceptable than do those that are not.
- Risks that are undetectable create more fear than do those that are detectable.
- Risks that are well understood by science are more acceptable than are those that are not.
- Risks that are chronic are better accepted than are those that are catastrophic.
- Risks that occur within the context of a responsive process are better accepted than are those that are part of an unresponsive process.

The greater the number and seriousness of these factors, the greater the likelihood of public concern.

As with social, environmental, and economic impact analyses, so with political impact analysis, the HIRV committee examines the hazards and vulnerabilities and determines their effects. Vulnerabilities and political impacts are indicated in Table 28.

Table 28: Vulnerabilities and Political Impacts

Vulnerabilities	Political Impacts
• capacity to respond • community education and training • warning system • number of potential technological hazards	• public perception of blame

Here the HIRV impact analysis uses the same scale as it did for the other impact assessments. Committee members then review the political impact, using the various factors mentioned above. In the example below, because aviation is under government control (i.e., Transport Canada), the latter would receive a higher rating than would coerced risks and unfair risks, respectively.

Table 29: Sample Political Impact Assessment for an Air Crash in a Given Area

Political
[1] Coerced risks
[3] Government control
[1] Unfair risks
etc.

5.6.4. Completing the Impact Rating

Once the HIRV committee has agreed upon a value for the degree of impact of a particular hazard, it is important to use the SPR model to ascertain degree of certainty. For most hazards, as stated, very little research in the area of pre-disaster impact analyses has been completed. Generally speaking, while it is relatively easy to consider how many homes will be inundated in a major flood (if the flood plain is known), it may be very difficult to calculate how many lives would be lost in a major tornado or hazardous material spill. It is anticipated that in many cases the HIRV committee's assessment may be speculative. Once the social, environmental, economic, and political impacts are determined, the HIRV committee can complete an impact rating, as indicated in Table 30.

Table 30: Summary of Sample Impact Assessment for an Air Crash for a Given Location

Hazard	Social	Environmental	Economic	Political	Certainty	Impact Rating
Air Crash	+2	+1	+1	+2	Well established	+2

Another method of illustrating the impact assessment is indicated in Table 31 and Figure 8, respectively.

Table 31: Illustration of the Recording of the Impact Analysis

Hazard	Impact Analysis
Air Crash	

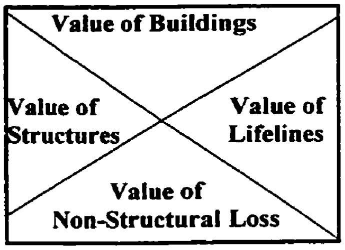
where: and the impacts would be recorded as:

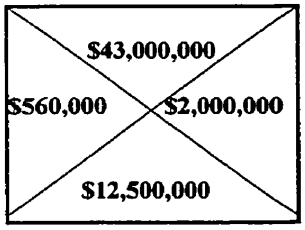
Figure 8: Detailed Illustration of Rating for the Four Impacts

Impacts can be recorded by a numeric label or by a colour-coding system (e.g., red = high, orange = moderate, and yellow = low or no impact). The numeric value of the numbers is not important; what is important is the relative value of the impact.

The HIRV impact analysis can also be adapted to more sophisticated analyses. For example, if a community had access to tax assessment data, insurance data, and data from utility companies, then it could calculate economic losses in terms of dollars and cents. After a few calculations, the HIRV committee could decide upon some threshold levels with regard to what values constitute a high, moderate, or low impact. The analysis for each impact could then be broken down into greater detail. For example, an economic impact analysis could be calculated (see Figure 9). Similarly, a social impact analysis could reflect the actual number of expected deaths, injuries, and destroyed homes and schools. The degree of detail is only limited by the available data, community resources, and skills. In most instances, it is assumed that relatively few communities will wish to accumulate an enormous amount of detail.

Figure 9: Detailed Illustration of Rating an Economic Impact





The HIRV impact analysis may be adapted to a more sophisticated community, and the HIRV committee can calculate potential economic losses in great detail through the use of property tax assessment records, insurance data, and so on.

5.7. The Risk Management Phase of the HIRV Model

> To be effective and meaningful, risk management must be an integral part of the overall management of a system. (Haimes 1995, 4)

The risk management phase of the HIRV model is based on integrating the results of the hazard, risk, vulnerability, and impact analyses, as identified in Chapter 2. It is useful to consider the National Research Council's (1996, 27) definition of risk characterization, as it sets the stage for the risk management phase.

> Risk characterization is a synthesis and summary of information about a potentially hazardous situation that addresses the needs and interests of decision makers and of interested and affected parties. Risk characterization is a prelude to decision making and depends on an iterative, analytical-deliberate process.

The risk management phase culminates in establishing priorities and making recommendations to those involved in determining and establishing strategies for mitigation. The HIRV committee needs to understand that determining what mitigation strategies are available to any given community, and how resources will be allocated for carrying them out, is part of the mitigation process, not the risk management process.

Although adequate risk communication has been an objective of the entire HIRV model, it is especially important in the risk management phase. How the data and accumulated information are presented to the elected officials and the community at large is a critical factor in ensuring that the goals of the analysis are met. The HIRV committee brings together those ratings based on the findings of the hazard, risk, vulnerability, and impact analyses. This is illustrated in Table 32.

Table 32: Sample of Risk Management Analysis

Hazard	Risk Rating	Certainty	Vulnerability Rating	Certainty	Impact Analysis	Certainty	Risk & Vulnerability Analysis
Air Crashes	+2	Well Established	+2	Speculative	En=1 S=2 Ec=1 P=2	Speculative	R=Moderate V=Moderate

where S = Social Impact; En = Environmental Impact; Ec = Economic Impact; P = Political Impact

By completing this process for each of the hazards and each of the specified locations, the HIRV committee should initially be able to determine:

- those hazards that are likely to occur and will have a high impact upon the community,
- those hazards that are unlikely to occur and will have a low impact upon the community,
- those areas in the community that are at greatest risk and the most vulnerable, and
- those areas in the community that are at least risk and least vulnerable.

This is illustrated in Table 33. High-risk/high-vulnerability hazards should be put at the top of the HIRV committee's priority list, while low-risk/low-vulnerability hazards should be put at the bottom. Likewise, the areas of the community that are most at risk and that are most vulnerable should be targeted for mitigation strategies (especially community education and neighbourhood preparedness programs). The areas that are at least risk should be considered as sites for future critical facilities, the stockpiling of emergency supplies, and other mitigative activities.

Table 33: Example of Possible Results of Risk and Vulnerability Analysis

Hazard	Area 1	Area 2
Earthquake	High risk High vulnerability	High risk Moderate vulnerability
Flood	Low risk Moderate vulnerability	Low risk Low vulnerability
Explosion	High risk High vulnerability	Low risk Low vulnerability

As an aid to the disaster management process, the numeric values for risks and for vulnerabilities can be totalled separately for each hazard (across each row) and for each area (down each column). These totals do not provide a definitive priority rating (i.e., a total of "12" for one hazard does not necessarily mean that it should be given a higher priority than the hazard for which the total is "10"), but they can be useful for giving the committee a general sense of the concerns.

While high-risk/high-vulnerability and low-risk/low-vulnerability hazards and areas are relatively easy to prioritize, other combinations of risk and vulnerability will be more difficult to assess. This is where the impact analysis can influence how hazards are prioritized. For example, a risk may be very low but have a catastrophic impact (e.g., nuclear power plant explosion). In other cases the risk may be high but the impacts low (e.g., small airplane crash outside of the city limits). As well, depending upon community values, the HIRV committee may choose to give higher priority to hazards with high social impacts than it does to hazards with high economic impact. It is the combination of risks, vulnerabilities, and impacts that helps the users of the HIRV risk management analysis to make their decisions. These will not be easy for the HIRV committee to address, and expert advice may be helpful; however, in many cases the prioritizing will be dependent upon how the HIRV committee perceives the risks and judges the trade-offs between probability and consequences. It is important to remember that the HIRV committee does not have the job of deciding to implement mitigation strategies or of determining whether implementing them is financially acceptable. The job of the HIRV committee is to identify those hazards, risks, and vulnerabilities that warrant consideration by those involved in mitigation.

It is not always necessary to prioritize one hazard over another. According to Hattis and Goble (1995, 108), for example, "no priority system should be applied too strictly in the allocation of resources; a 'portfolio approach' is desirable that spreads some efforts to lower-priority candidates." It is quite acceptable for the HIRV committee to group together priorities and simply state that given the degree of risk and vulnerability, these items warrant consideration for mitigation. Those involved in determining mitigation strategies can decide whether known mitigation techniques exist and whether it is economically feasible to implement them.

In many cases, the risk and impact analyses will be based on imperfect knowledge, as is illustrated by the certainty ratings.

> Uncertainty and variability in priority scores have different implications for a priority-setting system. Large variability (true heterogeneity in the actual results of allocating effort to different categories) will tend to enhance the desirability of allocating resources preferentially to relatively high-priority categories. Categories for evaluation should therefore be created that tend to maximize this variability. By contrast, large uncertainty (imperfection in knowledge of the actual results of allocating effort to different categories) will tend to increase the desirability of measures to obtain better information and some spreading of efforts towards lower-priority categories. (Hattis and Goble 1995, 108)

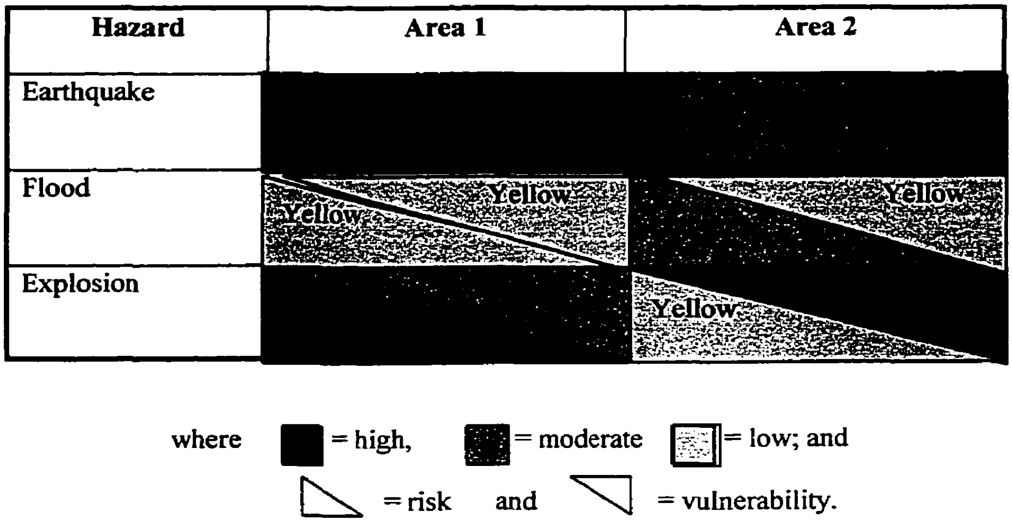
The HIRV committee should highlight information-poor areas of apparent high risk and high vulnerability as research priorities. The National Research Council (1996) emphasizes that making decisions that involve uncertainty is not easy and that participants need to carefully consider the magnitude of uncertainty as well as its sources and character. A benefit of the HIRV model is that new information, as it becomes available, can be added to the HIRV risk management analysis. In some cases, even though the risk and impact of the hazard is high, there is little the community can do to mitigate the situation. For example, events such as the Tunguska meteor explosion, which devastated 2000 km^2 of Siberian forest in 1908, occur at an estimated frequency of once every few hundred years (Basham et al. 1995). As catastrophic as the impact of a meteor collision with earth might be, there is no known way to reduce the risk. In yet other cases, although knowledge may be available, costs may be prohibitive. The goal of the HIRV committee is, on the basis of the best knowledge available, to make recommendations for action. For this reason, it is vital that the HIRV committee identify the underlying risk factors and vulnerabilities for each of the hazards and areas it prioritizes. Without this information, those responsible for developing mitigative strategies will be unable to focus on critical areas. It must be remembered that the most important output of planning is not a plan as such but action.

The task of the HIRV committee is never complete, for new material will always need to be incorporated into the overall HIRV process, and this means that priorities may change over time. It is important for the committee to establish a monitoring system, both in order to evaluate how well its priorities are being carried out and to aid it in continuing to work on its analysis.

Williams and Mileti (1986) contend that two basic values (earlier identified by Payne and Williams [1985]) are vital to the decision-making process: (1) participatory democracy, and (2) equity. As Fischhoff (1984, 2) points out, "it is only by making the most of these ... that the full potential of risk assessment can be realized." And, one might add, that lives can be saved; property preserved; and the ecological, economic, and political stability of the impacted region maintained. The HIRV model accomplishes this.

The risk management process is simple in that it consists of bringing together the results of the previous phases of the HIRV process. It is important to remember that completing the HIRV risk management analysis is not a project but a process. The "final" results are not just to be tabulated in a report, they are to be presented to officials and politicians as well as to the general public. It is, therefore, critical that both the process and the findings be easily communicable. While numbers may be used, findings may also be illustrated through the use of colour. If this were done, then the risk management chart could visually highlight those hazards and areas of highest risk and vulnerability. Colours may also be used on overlay maps to pinpoint areas of concern (see Figure 10).

Figure 10: Illustration of Use of Colour for Identifying the Risk and Vulnerability of Given Areas



It is important to have experts on hand when presenting the risk management findings, as this brings credibility to the process and enables the introduction of any supporting data (should this be necessary). It is hoped that the HIRV process, which is not so technologically driven that it cannot be understood by the public at large, may be the mechanism for integrating HRV analyses at the community and regional level. The HIRV process is not so rigid that all of the hazards have to be completely analyzed before its findings are useful (although that is the goal of the process). Findings can first be developed for those hazards that are best known and understood and then, with more time and resources, additional hazards can be evaluated. Because of the way it handles uncertainty, the HIRV process is easily adaptable as new information becomes available.

Even though the HIRV model promises to be powerful, before people will agree to its use, it has to overcome both individual and organizational resistance to change.

5.8. Overcoming Resistance to Change

Organizational change literature abounds with findings that indicate that organizations and individuals resist change (Umstot 1984; Robbins 1996; Ivancevich and Matteson 1987; Robbins and Langton 2000). Robbins and Langton (2000) summarize individual sources of resistance to change as follows: (1) habit, (2) security (people with a high need for security are likely to resist change), (3) economic factors, (4) fear of the unknown, (5) selective information processing,[34] and (6) cynicism. As discussed in Chapter 3, disaster managers have been primarily responsible for the implementation of HRV analyses. Given that these people often have a para-military background, it is not surprising that they are strongly resistant to change. They usually complete HRV analyses in isolation and, therefore, it is not surprising that they often express a certain degree of cynicism when it comes to adopting an approach to HRV analysis that emphasizes public participation and a desire to empower vulnerable populations.

Robbins and Langton (2000) argue that the sources of organizational resistance are: (1) structural inertia, (2) limited focus of change,[35] (3) group inertia, (4) threat to expertise, (5) threat to established power relationships, and (6) threat to established resource allocations. Again, the HIRV model might seem problematic for some disaster managers and community planners. In most communities, these people have held separate positions and their areas of responsibility have not overlapped. The use of the HIRV model would change this. A HIRV committee could easily be seen as a threat to the expertise of both the disaster manager and the planning department. Shared decision making can threaten the long-established power relationships that exist in the community, and recommendations that will affect the way in which resources are allocated to mitigation projects will also threaten the authority of those who are currently responsible for allocating finances.

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[34] "Individuals shape their world through perceptions. Once they have created this world, it resists change. Individuals are guilty of selectively processing information in order to keep their perceptions intact." (Robbins and Langton 2000)

[35] Most organizations are comprised of a number of interdependent systems: changes to one subsystem will undoubtedly affect other subsystems.

Lewin (1951) argues that, in order to successfully introduce change, one must take the following steps:

Figure 11: Lewin's Three-Step Model

Source: Lewin (1951), cited in Robbins and Langton 2000 (n.p.)

These steps involve unfreezing the status quo, moving to a new state, and refreezing the new state so as to make it permanent. The unfreezing can occur by increasing driving forces (which direct behaviour away from the status quo), by decreasing restraining forces (which hinder movement from the status quo), and/or by doing both (Robbins and Langton 2000). Forming a HIRV committee assists in unfreezing the status quo because it offers a combination approach to HRV analysis: the HIRV process, which increases driving forces, moves behaviour away from the status quo; while the HIRV methodology, which decreases restraining forces, prevents a return to the status quo.

The key is to ensure that the HIRV model is implemented. There are six generally accepted ways of overcoming resistance to change (Callahan et al. 1986; Stoner et al. 1995; Robbins and Langton 2000): (1) education and communication, (2) participation, (3) facilitation and support, (4) negotiation, (5) manipulation and cooptation, and (6) coercion. The design of the HIRV model incorporates most of these tactics. The HIRV model has a strong educational component, and the HIRV process embodies the principles of open and widespread communication. Public participation is fundamental to the HIRV process and, since stakeholders have a say in any decisions that are made, this should decrease any potential resistance to change. The HIRV model uses a facilitator to assist in the implementation process, and having an elected official as a member of the HIRV committee should assist in ensuring that it has the necessary government support (although, of course, it is no guarantee). The HIRV model also practices negotiation. Although it avoids tactics such as manipulation and coercion, the inclusion of key stakeholders in the decision-making process is certainly a form of cooptation. Not only will these stakeholders have an opportunity to contribute to the committee arriving at a good decision, but their combined endorsement should assist in putting pressure on community decision makers to implement its recommendations.

The HIRV model is well suited to overcoming resistance. Robbins and Langton (2000) argue that in order for change to be communicated effectively, several conditions need to be met. The findings and recommendations of the HIRV committee are designed to meet these conditions, as they ensure that: (1) the rationale for underlying decisions is clear, (2) information is timely (findings are communicated as they are determined), (3) communication is ongoing, and (4) the "big picture" (the community or regional district) is linked with the "little picture" (the neighbourhood or established zone). The final section of this chapter summarizes HIRV's unique contribution to the field of disaster management.

5.9. Summary and Overview of HIRV's Contribution to the Field of Disaster Management

Chapter 3 concludes with a synthesis of the factors derived from Renn's framework and the factors that emerged from the literature review. This synthesis enabled me to arrive at the fourteen key objectives of an adequate HRV analysis. Chapter 4's review and evaluation of eight models for HRV analysis from around the world indicate that none meets all of the stated objectives and that most meet very few. As developed in this chapter, the HIRV model meets all fourteen objectives. Why is it able to do so when others have not? What is unique about HIRV?

First, HIRV explicitly states that its goal is to focus on sustainable hazard mitigation. It relies on the findings of its five phases: (1) hazard identification, (2) risk analysis, (3) vulnerability analysis, (4) impact analysis, and (5) risk management. Successful sustainable hazard mitigation is dependent upon the integration of community planning with disaster management. The HIRV model does this; the other models do not.

Perhaps HIRV's greatest contribution to the field of disaster management is that it explicitly acknowledges that the HRV process is as important as is the HRV methodology. While in most cases the methodology of the eight extant models is weak, their overall HRV process is even weaker. In light of the synthesis of the literature review and Renn's (1992) framework, the research findings are clear: in order to succeed, the HIRV model needs to involve widespread public participation and to recognize that political legitimation is crucial to ensuring the adoption of mitigative strategies. The HIRV model, using Thomas's Effective Decision Model of Public Involvement, is designed to share decision making with the public. Many communities will find that an advisory committee, comprised of experts, members of high technology/high risk industry, the media, community residents, and others, will be an effective application of Thomas's model. In other cases, where there are numerous stakeholders, public meetings, displays, and other methods may supplement the use of an advisory committee. In yet other cases, in very small communities, use of a small steering committee may be the most applicable use of Thomas's model.

The HIRV model is also unique in recognizing that sustainable hazard mitigation occurs within a political climate that often places the greatest value on expenditures with a high political profile and immediate payoffs (e.g., increased policing or improved transportation networks). Based on Kasperson's (1992) ideas concerning the "social amplification of risk," the HIRV model acknowledges the importance and value of adequate risk communication and the necessity of establishing a dialogue between local stakeholders and experts. Its entire process and methodology is founded on the belief that data must be shared, must be accessible, and must be understandable. If this is the case, then the amplification process will be dynamic and will promote continued learning and social interaction. The HIRV model is unique in how it handles risk communication. First, the media are key players in the overall HIRV process, thus ensuring that information is shared with the community at large. Second, the methodology and the style of presenting findings are specifically created so as to ensure ease of communication. Third, the HIRV process is grounded in the belief that it is only when the public understands potential hazards and their consequences that sufficient public pressure will be directed towards elected officials to ensure that mitigative steps will be taken. While some of the other models to HRV analysis recognize the importance of completing social, environmental, and economic impact analyses, the HIRV model is the only one whose methodology incorporates the need to complete a political impact analysis.

Disasters do not affect all residents equally. The poor often lose everything they own, while home owners and those who are able to afford insurance, are able to replace at least a portion of their possessions. The HIRV model is the only one whose process is designed to empower those most vulnerable through providing a forum within which it is possible to acknowledge issues of equity by its method for selecting participants. It is also the only model, as compared to the eight extant models that are evaluated in Chapter 4, that uses neighbourhoods, or zones, to divide a community for comparative purposes.

The HIRV model is also unique in the way that it handles the steps contained in each of its five phases.

(1) It is the only model that provides communities with a comprehensive list of hazards. Only by considering all of these hazards can members of a community feel assured that they have not omitted an important one.

(2) It is the only model that makes broad use of risk and vulnerability factors. Not only does use of these factors make the evaluative process seem less burdensome, it also makes the rationale for the ratings more apparent, thus adding to the robustness of the analysis.

(3) It is the only model that classifies vulnerability factors as functions of people, place, time, and preparedness.

(4) In comparison to the eight extant models previously evaluated, HIRV is the only model that incorporates the need to acknowledge and deal with uncertainty. Adaptation of Moss's SPR model to the HIRV risk, vulnerability, and impact analyses is important, and it assists in pinpointing areas of future research as well as areas of agreement and disagreement.

(5) Finally, HIRV is not dependent upon expensive tools and technology. All communities can afford to implement it. However, should communities have access to GIS, satellite-based intelligence, and so on, HIRV is adaptable and can accommodate sophisticated data.

In the next chapter I offer the reader a reflective description of my exploratory studies and assess their contribution to the HIRV model.

6. Exploratory Studies: A Reflective Examination

As Maxwell (1996, 45) says, qualitative research is an iterative process. Bearing this in mind, I offer here a reflective look at a series of exploratory studies that I began in the early 1990s. The feedback from these studies played a critical role in enhancing the HIRV model.

There are two stages to the exploratory studies. The first involves the participants of a series of Mayors and Elected Municipal Officials courses at the Canadian Emergency Preparedness College (CEPC) in Arnprior, Ontario. These courses were given from the early to mid-1990s, and during this time I offered participants an overview of the basic concepts of the HIRV model. I also presented the HIRV model in CEPC's Emergency Preparedness and Post-Secondary Institutions course, which was offered in 1996. Here, the HIRV model was used to help college and university planners determine mitigation priorities on their respective campuses.

The second stage of exploratory studies began in the late 1990s and involved presenting the HIRV model in much greater detail than at Arnprior. This stage was marked by a series of workshops: (1) a half-day workshop at the 1997 Emergency Preparedness Conference;[36] (2) two all-day invitational workshops that were held in Burnaby and Victoria, British Columbia; (3) an all-day workshop that was held for participants from the Sooke Electoral District and surrounding municipalities; and (4) a two-day workshop hosted by Emergency Preparedness Canada for interested participants from across Canada.

After discussing stages 1 and 2, I summarize the contributions of the exploratory studies to the HIRV model.

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[36] A three-day Emergency Preparedness Conference is held in Vancouver on an annual basis.

6.1. Stage 1: Exploratory Studies at the Canadian Emergency Preparedness College

6.1.1. Mayors and Elected Municipal Officials Course

In 1990, I was invited to teach the Mayors and Elected Municipal Officials course at CEPC. This three-and-a-half-day course is held several times a year, and each province and territory in Canada can, at the expense of the federal government, send interested mayors and elected officials.[37] The purpose of the course is to make elected officials aware of their respective responsibilities vis-à-vis disaster management issues both prior to and following a disaster. Local politicians come to the course from very large cities as well as from very small villages.

The various topics are presented in a number of different training sessions (referred to as modules). Guest lecturers are brought to CEPC to teach those sessions in which they have some expertise. In the classroom, participants are seated in small groups of five to six persons. In 1990, the Mayors and Elected Municipal Officials course was being amended and updated, and college instructors wanted to include a training session on the community disaster management process, with special emphasis on hazard and risk analysis. At that time, CEPC was using the EPC model (see Chapter 4). Prior to 1990, when presenting the EPC model to course participants, CEPC instructors had noted some difficulties in explaining how to complete the hazard and risk analysis. They believed that the fact that the EPC model omits vulnerabilities led to inaccurate assessments.

It is important to note that course participants were not expected to be able to return to their communities and to complete an HRV analysis; rather, the purpose of the course was to create for elected officials an awareness and understanding of the disaster management process. From April 1991 to February 1996, 613 mayors and elected officials were presented with an overview of the HIRV model (see Appendix G, Table 39). I presented this overview during a two-hour-and-fifteen-minute period on the first day of the course, and this gave me the

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[37] Due to differences of opinion between federal and provincial governments regarding CEPC's mandate, the Mayors and Elected Officials courses were eliminated in April 1996.

opportunity to explore the general viability of the HIRV model. Over the years, classroom feedback contributed immeasurably to the HIRV model being what it is today. In what follows, I summarize how HIRV evolved through being taught at various Mayors and Elected Municipal Officials courses between 1991 and 1996.

On the morning of the first day of the course, participants were introduced to the disaster management planning process, and I identified HRV analysis as the cornerstone of disaster management. Course participants were led through the hazard identification phase of the HIRV model and had an opportunity to identify potential hazards in their respective communities. Each group compiled a list of hazards that was then shared with the class.

One of the participants in each group would choose a hazard from this list (in later years they would choose a hazard from a circulated list). They were asked to determine if the risk to their community from this hazard was high, moderate, or low, and they were also asked to provide their rationale. Borrowing from the EPC model, participants were asked to determine whether the risk was external (occurring outside of the community but with the possibility of affecting the community internally [e.g., earthquake]) or whether the risk was internal (occurring within municipal boundaries [e.g., a propane explosion at a local gas station]). Once the results of this exercise were shared among all class participants, I introduced the possible negative social, environmental, economic, and political impacts of hazardous events. Course participants were given a fictional community — "Someplace" – and each group was assigned a zone (i.e., port, business area, park, or residential area) and asked to complete an impact assessment for the hazard of their choice. They were told that the event would occur at 1400h on a Saturday afternoon in July. The results of this exercise were then shared among all class members. Based on the findings, participants were asked to identify the vulnerable areas of their community and then, by determining the areas of high risk and high vulnerability, they were asked to prioritize the various areas that would be targeted for mitigation strategies.

Over the first year, class response (in the form of general feedback, questions, and comments) pointed to a number of problems with the HIRV model.

(1) It was found that, in every case, participants were unable to identify many of the potential hazards. As outlined in Chapter 1, simply relying on people's collective wisdom regarding the existence of potential hazards is problematic. This is partially due to the availability heuristic (see Chapter 5) and partially due to the inexperience of classroom participants. This concern was supported by the failure of the course participants to identify any more than thirty hazards. It was apparent that a comprehensive list of hazards had to be an essential component of the HIRV model, and in 1992 I began to compile such a list. This "list" was then used in all of the further exploratory studies, and participants were asked to contribute to its contents.

(2) In some cases, participants were unclear as to the identity of various hazards. For example, there are significant differences between a blizzard and a snowstorm, and yet many participants were unable to differentiate between the two. It became apparent that in dealing with even common hazards, participants needed to have access to good definitions.

(3) During the risk analysis process, participants had difficulty identifying, even at a very basic level, a high risk as opposed to a low risk. While I did not develop the idea of incorporating risk factors in to the HIRV model until some time later, I did offer participants a concrete example of how to complete a simple risk assessment. I suggested that, in the Lower Mainland of British Columbia, the use of historical data and knowledge of how the effects of an earthquake would differ in various areas due to soil conditions and so on, would all affect level of risk. This was of some help, but differentiating between high and low risk remained a major problem.

(4) Participants had difficulty distinguishing external hazards from internal hazards. Participants had difficulty because many of the hazards could occur both externally and internally (e.g., the epicentre of the earthquake could be under the centre of the town or two kilometres away). Ultimately, I decided that the distinction was unimportant and discarded it.

(5) Impacts were difficult to determine without completing a vulnerability assessment. It became apparent that (a) understanding and identifying vulnerabilities was an important factor in identifying the actual impact of a hazard and that (b) the vulnerability analysis needed to occur prior to determining the impact of a hazard. At

this point in the development of the HIRV model, the only vulnerabilities that were discussed were socio-economic status, age, building types, and ecological sites.

Over the next few years, participants in these courses continued to have two major difficulties with the HIRV model:

(1) They had trouble separating risk factors from vulnerabilities. For example, the fact that a community is close to a river does not increase the likelihood of flooding, but it does increase the community's vulnerability to flooding.
(2) They had trouble grasping the idea that activities that occurred outside of the community could increase the likelihood of a disaster occurring inside the community (e.g., forestry practices occurring outside of the community could increase the risk of a flood occurring inside the community).

It became apparent to me that I had to figure out some way of helping the participants to assess what factors led to an increased (or a decreased) risk of a hazard taking place. This is how the idea of developing risk factors – a key feature of the current HIRV model – came to me. Over the next several years, I conducted a thorough literature review in order to identify key risk factors for all potential hazards. The sample risk factors for seventeen hazards (which are included in the current HIRV handbook) arose from this initiative.

Furthermore, through my readings, and based on the comments I received at CEPC, I became aware that there were considerably more vulnerabilities than I had originally thought. Over the next two years vulnerabilities were first identified as a function of three factors: (1) people, (2) place, and (3) time. When I realized that this did not sufficiently address the degree to which the community was vulnerable (based on preparation and planning), I added (4) capacity of the community to respond (or degree of community preparedness). With vulnerability factors categorized in this way, course participants found it easier to differentiate between vulnerabilities and impacts. For example, participants were now able to understand that the destruction of one's home (a factor of place) had both social and economic impacts.

From 1991 to 1995, CEPC asked course participants to complete an overall course evaluation for each of the three and a half days of instruction. Although there was no specific place on this evaluation for any comments regarding the module dealing with the HIRV model, a review of the evaluations indicates that many mayors and other elected officials found the HIRV model useful. A complete list of these comments is included in Appendix G (Table 40), and, as will be seen, only two persons found the HIRV model to be the least interesting part of the course. Many found it to be one of the most interesting.

On 19 February 1996, at the final Mayors and Elected Municipal Officers course, I distributed a simple questionnaire (see Appendix G, Table 41). The intent of this questionnaire was to gain an awareness of how the participants perceived the overall HIRV model at that stage of its development (it is important to remember that participants did not have the opportunity to actually apply the HIRV process – merely to attempt to gain an understanding of its overall methodology). Of the twenty-four people registered in the course, twenty-one were in attendance for the training module on the HIRV model for HRV analysis. The results of this questionnaire are tabulated in Appendix G, Tables 42 and 43.

As can be seen, the ratings the students gave for all the questions have a mean value of eight or higher (out of a possible rating of ten), with the median value very close to eight (with the exception of question 2, which deals with the risk analysis portion of the process [median 7.24]). The key findings may be summarized as follows:

(1) A comprehensive list of all hazards is very useful.

(2) The need for a vulnerability analysis is easily understood.

(3) Calculating the risk of a specific hazard presents some challenges.

(4) There is some difficulty in conceptualizing the shift from vulnerabilities to impacts.

(5) It is useful to divide communities into sectors.

(6) The risk management portion of the process (determining the priorities) is useful.

(7) The HIRV model is a very useful aid to the development of an effective and efficient mitigation program.

Given the time constraints under which the HRV training session was delivered (two hours and fifteen minutes), it was not possible for participants to spend much time on any one section. Nor was there enough time for them to give much attention to risk factors when they completed the risk analysis portion of the questionnaire. Still, the slightly lower ratings for risk analysis suggested that more work needed to be put into this area.

In summary, the overall results of the questionnaire indicate that the participants in the Mayors and Elected Municipal Officials course found the HIRV model to be useful. Generally, they found it easy to understand, and they believed that it would assist them in developing effective disaster mitigation strategies for their respective communities. They strongly encouraged me to pursue this particular model for HRV analysis.

6.1.2. The Post-Secondary Institution Course

The versatility of the HIRV model became apparent during the Post-Secondary Institutions course, which, in November 1996, was first offered to emergency planners from various universities and colleges at CEPC. The HIRV model was used to help these planners to determine the disaster management priorities on their respective campuses. It was easily adapted to this purpose as, in many cases, Canadian campuses resemble local communities. For example, many have their own emergency response personnel, residences, and commercial services (e.g., banks and restaurants). Many also cover a fairly large geographical area. The main differences between campuses and local communities have to do with governing and educational structures, population fluctuations, and age of population.

As this was a pilot course, CEPC requested that participants comment on each module of the course. All of the comments dealing with the HRV analysis are tabulated in Appendix G, Table 44. As can be seen from their comments, almost all of the thirty course participants found that the HIRV model aided them in determining planning priorities and in establishing mitigation strategies.

It was now time to develop a workshop format that would provide the participants with the opportunity to apply the HIRV model to a specific community.

6.2. Stage Two: Exploratory Studies and Workshops

I divide this section into two parts. The first part offers a brief overview of some of the academic studies I pursued in 1996 and 1997 as well as a "thought experiment."[38] I abandoned the latter in 1998 in order to pursue the initiatives that led to the development of the current HIRV model for HRV analysis. The second part presents the findings of the exploratory studies. While generally positive, these indicated that there were some key flaws in the conceptual basis of the HIRV model. It was attending to these flaws that led to the development of the current HIRV model.

6.2.1. Search for a Conceptual Framework

From 1996 to 1997 I continued to work on developing the risk factors for the HIRV model for HRV analysis. As I continued with my work on determining the relationships between vulnerabilities and impacts, I also became aware of the benefits of developing vulnerability factors. Thus, much of my time was taken up in conducting an extensive interdisciplinary literature review that enabled me to identify these factors. I also needed to develop a workshop format that would allow participants to go through the various phases of the HIRV model and to apply it to an actual community. This was a shift from the previous focus of the courses at CEPC, which concerned themselves with providing an overview of the HIRV model rather than with concrete examples of how it might be applied.

I also began to focus primarily on the methodology of the HIRV model. In attempting to determine the critical aspects of this methodology, I started to read the literature on model structuring. There are two main types of models: (1) normative models (which are concerned with establishing the most important factors in any given

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[38] Maxwell (1996, 45) defines a thought experiment as "a practical guide to speculation," an opportunity to "draw on both theory and experience to answer 'what if' questions to seek out the logical implications of various properties of the phenomena you want to study. They can both test your current theory for logical problems and generate new theoretical insights."

system) and (2) predictive, or adaptive, models (which are used in forecasting). I believed that since the HIRV model had elements of both normative and predictive models, this line of research might prove to be useful. And so I followed some of the work of Lave and March (1975), Hammond (1978a, 1978b), Little (1978), Rivett (1980), Camacho (1982), Fischhoff (1984), Rivlin (1995), and others who are interested in determining what constitutes "good" models. This literature led me to attempt to identify the criteria necessary for a "good" HRV model (see Appendix G, Table 45). The problem with this approach was threefold: (1) without a framework it was impossible to determine when all of the various criteria had been identified (I identified forty-nine different criteria that applied to various phases of the HIRV model); (2) it was sometimes difficult to reconcile certain criteria for good models (e.g., models need to be simple) with the HIRV model (e.g., completing an HRV analysis is not a simple process); and (3) the sheer number of criteria tended to overwhelm participants and made it difficult for them to assess the ability of the HIRV model to meet them.

As I discuss in the next section, although I improved on the original workshop (which was held at the Emergency Preparedness Conference), and although the responses to some of the questionnaires showed overall improvement, the comments and findings remained generally unsatisfactory. I also found that, in focusing so intensely on methodology I had lost sight of the importance of process. So in 1998 I abandoned my first line of research and embarked on the line that resulted in this dissertation. Nevertheless, conducting that original HIRV workshop was a valuable experience, and all the workshops contributed to enabling me to improve the HIRV model.

6.2.2. Exploratory Workshops

Between 1997 and 1998 I conducted a number of exploratory workshops: (1) one was held at the Emergency Preparedness Conference in Vancouver; (2) two were invitational and were held in Burnaby and Victoria, British Columbia; (3) one was conducted for the Sooke Electoral District; and (4) one was held at CEPC and involved participants from across Canada. I begin with a brief overview of the development of the workshop format and then provide a brief discussion of the workshops and their findings.

6.2.2.1. Pre-Workshop Planning

Workshop participants need to be able to: (1) understand the HIRV model, (2) apply the HIRV model to a community, and (3) evaluate the effectiveness of HIRV according to specific criteria. Since the workshops were going to be presented to adults, it seemed appropriate to examine some of the literature on adult education. Some of the key points that emerged from the literature were: (1) a facilitative and collaborative style is preferable; (2) a lecture-demonstration format is the most beneficial with regard to introducing participants to what they need to learn; (3) the workshop objectives should be shared with the participants; (4) tools and techniques need to be varied (e.g., workbooks, flip charts, overheads); and (5) an informal setting is most conducive to adult learning (Heimlich and Norland 1994; Brookfield 1986; Gagne 1987; Lowman 1995; Williams 1996).

A list of adult education principles (Williams 1996, 57) served as a good base for the HIRV workshop:

> Adult learning is enhanced:
>
> - When the learning climate fosters self-esteem and interdependence.
> - When people's expectations are that the learning outcomes will have meaning for them and their lives.
> - When people play an active role in decision-making and planning for the learning experience, and when authority is shared.
> - When a synergistic view of knowledge and learning prevails.
> - When people have opportunities to work with the ideas and the experiences they have in learning situations.
> - When learners evaluate their own learning outcomes, learning skills and need for more learning.

Accordingly, I ensured that the original workshop:

- seated participants in groups so as to facilitate interaction;
- offered a series of short lectures followed by an opportunity for participants to discuss and apply the key points of the lectures;
- offered participants a workbook that they could follow;
- offered a series of different tools (e.g., overheads, flip charts);
- offered a list of the criteria for determining the adequacy of the HIRV model for HRV analysis;
- offered other relevant material in the form of handouts (e.g., risk factors and vulnerability factors); and
- offered the opportunity to apply the material to an actual community.

In order to facilitate the last point, given that the participants were from different communities, I persuaded the emergency coordinator for the North Shore,[39] Ross Peterson, to assist me in developing a map that could be used in the workshop. This large map (6 feet by 4 feet) was especially designed to depict some of the key elements that would be crucial to completing an HRV analysis in a typical community. For example, the map for the City and District of North Vancouver contained the following:

- contour lines;
- coloured zoning areas (i.e., industrial, commercial, residential);
- coloured areas depicting all federal, provincial, and district parks and Native reserves;
- main transportation corridors;
- bridges, rivers, and streams;
- schools (i.e., elementary schools, middle schools, high schools, colleges);
- critical facilities (e.g., hospitals, police stations, fire halls);
- shopping malls;
- neighbourhood names (e.g., Deep Cove, Edgemont Village);
- key industrial sites (e.g., chemical production plant);
- railways;
- ferry terminals and marinas; and
- key infrastructure sites (e.g., dams, a power sub-station).

For the purposes of the workshop, the map was altered to show a fictitious airport just outside the immediate municipal boundaries.

I then developed the workshop structure. The first three sections of the workbook (definitions, implementation of HIRV, and overview of extant models to HRV analysis), along with the list of criteria, were presented to all participants through a lecture that was followed by an informal discussion. Once the section on hazard identification was introduced, the participants began to work in groups. Their first group task was to identify as many potential hazards as possible and then to review the comprehensive list of hazards that was included in the HIRV model.

The next step involved each group examining the map of North Vancouver City and District and

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[39] The North Shore includes three separate municipalities: West Vancouver, the City of North Vancouver, and the District of North Vancouver.

determining how to divide that community into planning zones appropriate to the implementation of the HIRV model. Once this task was complete, each group was able to review the definitions and discussion material related to the seventeen selected hazards. Upon completing this review, each group was asked to choose two of the selected hazards and at least one of the identified areas on the community map. The community risk, vulnerability, impact, and risk management analyses were based on these choices. Using their knowledge of the community (supplemented by oral information from myself and others), group members applied the risk and vulnerability factors for their chosen hazards and area. They then determined the certainty of their analysis, thereby arriving at a risk and vulnerability rating for their respective areas. Their findings were compared and discussed on a group-to-group basis. The groups then completed the impact analysis, discussed their findings on a group-to-group basis, arrived at the impact rating, and completed the risk management phase.

6.2.2.2. The Emergency Preparedness Conference Workshop

On Wednesday, 22 October 1997, I had the opportunity to present a half-day workshop on the HIRV model at the 10th Annual Emergency Preparedness Conference held in Vancouver, British Columbia. The workshop was scheduled from 1330h to 1630h, with a twenty-minute coffee break. Participants were to be seated at round tables in groups of six to eight.

The workshop was originally planned for approximately thirty participants; however, registration was not capped, and over seventy people registered for it. On the one hand, the registration numbers were a strong indicator of the widespread interest in HIRV; on the other hand, the number of participants was too large to easily handle (e.g., it was impossible to answer all the questions and give enough attention to each group as it worked its way through HIRV). Furthermore, there were complications due to the fact that some participants were well versed in disaster management terminology while others were not. Nevertheless, although participants felt that there were too many people and that there was not enough time to fully understand the HIRV model, the overall oral comments regarding the latter were generally favourable.

Like the participants in the earlier Mayors and Elected Municipal Officers course, the participants in this workshop were unable to identify many hazards. All of the groups chose an existing neighbourhood as their "zone," and most of the groups were able to calculate whether it was of high or low risk and vulnerability.

Fifty[40] stamped and self-addressed envelopes, which included a questionnaire, were given to participants as they left the workshop. The questionnaire was simple in structure: it asked participants if they believed that the HIRV model had met each criterion (see Appendix G, Table 45). They could answer simply "yes" or "no." The questionnaire also asked whether they were using any of the extant models for HRV. Most of the replies indicated that the respondents were either using some sort of in-house method or were unclear as to what (if anything) they were using.

Unfortunately, only nine questionnaires (18 per cent) were returned. This fact may well be related to the three-week Canadian postal strike that occurred shortly after the workshop. Nevertheless, those nine questionnaires did provide some useful information (see Appendix G, Table 46). Overall, the nine respondents answered fifty-six questions relating to forty-nine criteria (several of the criteria had multiple parts). Of these questions, in 84.4 per cent of the cases, respondents thought that HIRV adequately addressed the criteria; in 6.1 per cent of the cases, respondents were unsure; and in 9.5 per cent of the cases respondents answered negatively. Participants had a great deal of difficulty with two criteria: whether HIRV was "simple and easily communicable" and whether it was "robust and easy to control." Also, a number of respondents said that they had difficulty with the vast amount of paper handouts provided for the workshop. One participant commented that the process would have been much simpler and clearer had it been computerized. Recording the findings for each of the various processes onto separate forms also seemed to be confusing, as did the differences in rating scales. For example, impact analysis used a scale of 1 to 4, while vulnerability analysis used a scale of -3 to +3.

Feedback was useful and led me to make a few changes in the HIRV model (see next section). This workshop made it clear to me that in order to get more useful feedback: (1) the participants needed to be more knowledgeable about disaster management; (2) the workshop needed more time; and (3) the groups needed to be smaller. My goal for the two future workshops, which were to be by invitation-only, was to make them more effective and, in so doing, to reduce the number of negative responses to the HIRV model.

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[40] It had been anticipated that no more than fifty participants would sign up for the workshop.

6.2.2.3. The Invitational Workshops

Given the above, I decided to: (1) hold two invitation-only workshops in order to get an evaluation of the HIRV model from people with experience in disaster and community planning; (2) plan for smaller working groups; and (3) avoid the kind of rushed presentation that had occurred during the Vancouver workshop by lengthening the time allocated for the workshops from three hours to five hours as well as by including another half an hour for participants to complete the questionnaires. Refreshments and a "working" lunch were to be provided, along with all materials and maps. Accordingly, the workshops were scheduled from 0830h to 1400h.

Invitations were sent to local disaster managers, city planners, first responders, and other potentially interested persons. Of the thirty-two people who were invited, twenty-six attended: fourteen for the 1 December 1997 workshop (held at the Greater Vancouver Regional District Building in Burnaby) and twelve for the 9 December 1997 workshop (held at Victoria City Hall). Appendix G, Tables 47 and 48, contain a list of the participants for each workshop.

It was difficult to determine, given the small number of responses I received, how the quality of the Vancouver workshop (as opposed to the actual content of the HIRV model) had affected the ratings. Given the timing of the workshop and the lack of available funding for a computerized design, it was not possible to cut down on the number of paper handouts. Still, for the Burnaby/Victoria workshops I made several changes based on the comments from the Vancouver workshop:

1. The workbook was expanded to include a more in-depth presentation of the overall HIRV process (to, as it were, present participants with a "road map").
2. The workbook was modified to include more references to the sample forms, and the sample forms were included in Workbook #2 in order to facilitate the recording process.
3. The rating scales were made more explicit, and the forms were streamlined.

At the Burnaby workshop a number of participants commented that their lack of knowledge regarding North Vancouver City and District made it difficulty for them to complete the risk and vulnerability analysis.

Therefore, in order to make the invitation-only workshop in the Capital Regional District more realistic, I decided to provide the participants with maps of the City of Victoria. Two of the three groups chose to use these maps.

Like participants in previous workshops, the participants in the invitation-only workshops were unable to identify many hazards, and all of the groups chose an existing neighbourhood as their "zone." All of the groups completed the exercise, and it was possible to discuss some of the findings from a comparative perspective (e.g., comparing areas of higher risk and vulnerability to those of lower risk and vulnerability).

The same questionnaire format was used in the Burnaby and Victoria as was used in Vancouver, and the findings indicated that the workshops were generally favourably received by the participants (see Appendix G, Table 49). There were fewer negative responses than there were in the Vancouver workshop (6.4 per cent versus 9.5 per cent), and respondents indicated a slightly lower degree of uncertainty (5.9 per cent versus 6.1 per cent). Like the participants in the Vancouver workshop, participants in the Burnaby/Victoria workshops found that at least one of two criteria (i.e., "is simple and easily communicable" and "is robust and is easy to control") was lacking in each phase of the HIRV model.

It was still unclear as to whether responses were due to: (1) a problem with the criteria, (2) how the criteria were communicated via the workshop format, or (3) to the need for additional time to reflect upon HIRV's format. Although the results in these two areas were somewhat disappointing, the respondents did suggest that such concerns could be addressed by:

1. developing a concise handbook and implementation guide that clearly explains specific phases of the HIRV process;
2. reviewing the HIRV process prior to and following each of its phases;
3. providing a better way to handle the large number of handouts;
4. developing better forms and better means of transferring the data to the assessment forms; and
5. computerizing the HIRV process.

During the Burnaby/Victoria workshops a number of participants made suggestions for minor changes to the formatting of the workbooks, overheads, and other materials. Even though many of the participants in the Victoria workshop worked or lived in (or near) that city, they found that their lack of knowledge regarding the community detracted from the effectiveness of the HIRV model. (It should be noted that most of the attendees were management staff and not closely involved with disaster management per se.)

I implemented the suggestions that emerged from these two workshops and was pleased when the emergency coordinator from the Sooke Electoral District contacted me to conduct a workshop for interested persons in his region.[41]

6.2.2.4. The Exploratory Study in the Sooke Electoral District

The exploratory study in Sooke was held on 25 March 1998. It was my first opportunity to present the HIRV model in an appropriate regional setting. In March 1998, Sooke was not yet incorporated as a municipality; it was part of the Sooke Electoral District, along with the communities of Jordan River and Port Renfrew. These communities are located on the extreme southwestern tip of Vancouver Island. As well as inviting people from the Sooke Electoral District, the Sooke emergency coordinator had also invited interested parties from the nearby communities of Langford and Metchosin (see Appendix G, Table 50) as well as three undergraduate geography students from the University of Victoria.[42] These students were invited as "experts" in the area of dam safety and tsunamis. One unexpected attendee was a newly arrived resident to the community of Sooke who had read about the workshop in the local newspaper and had decided to attend – much to the surprise of the other participants.

The Sooke workshop was formatted as were the previous workshops; however, there were some interesting differences. The participants in the Sooke workshop were much more involved with dealing with potential hazards on a day-to-day basis (e.g., the fire chief) than were those in previous workshops, and this contributed to a more

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[41] The emergency coordinator had been invited to attend the invitational workshop in Victoria, but he had been unable to do so.

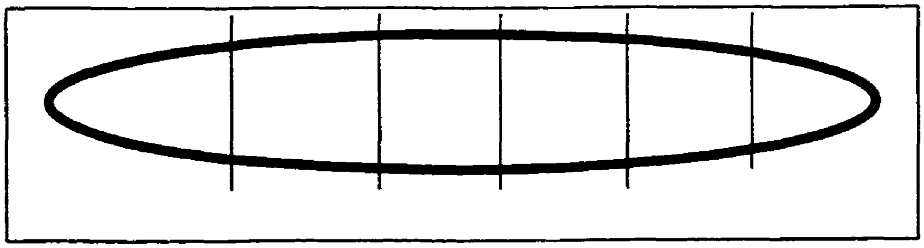
[42] These students were enrolled in an undergraduate course on disasters (taught by Dr. Harold Foster).

focused discussion and debate. As the participants could closely identify with the community, they were able to discuss matters realistically.

The discussion surrounding historical data pertaining to identified hazards was interesting. Even persons who professed to be very familiar with the community were unaware of certain historical incidents (e.g., the occurrence of a major tsunami over 100 years ago). This discussion also proved the importance of providing participants with material on risk perception and risk acceptance. In some cases (e.g., when discussing potential dam failures), certain participants were reluctant to view the risk as significant whereas others were overly concerned, envisioning a catastrophic situation.

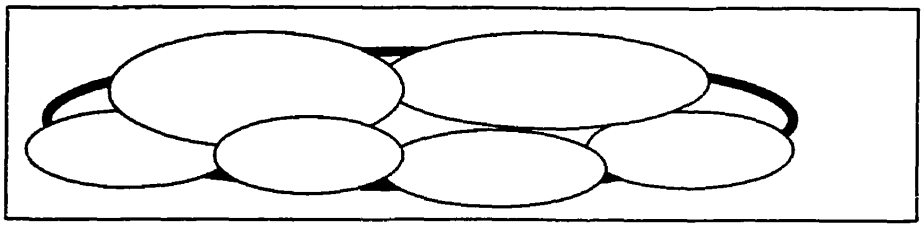
When the time came to divide the community into zones, I divided the participants into two groups. Group 1 was led by one of the fire chiefs and contained a number of emergency response personnel. Group 2 had a high percentage of community residents and Emergency Social Services volunteers. Paralleling the coastline, the Sooke Electoral District stretches for seventy kilometres from Sooke to the east and Port Renfrew to the west. The inhabited areas of the electoral district are close to both sides of the highway; north of the highway are large mountainous tracts of forested property. Group 1 decided to divide the electoral district into six zones, which paralleled the fire zones. These zones were basically formed by drawing relatively straight vertical lines approximately every fifteen kilometres from the north boundary of the electoral district to the coastline (see Figure 12).

Figure 12: Approximation of How Group 1 Divided the Sooke Electoral District



Group 2 divided the electoral district according to where people lived. Consequently, they divided it into six areas comprised of the four main populated areas along the highway and the two larger unpopulated areas to the north (see Figure 13).

Figure 13: Approximation of How Group 2 Divided the Sooke Electoral District



The debate was vigourous, and eventually, as Group 1 were persuaded as to the benefits of focusing on more meaningful zones, they agreed to use the approach taken by Group 2 . Both groups were able to complete the risk management phase of the HIRV model, and there were some useful discussions concerning the comparative risks and vulnerabilities of the less populated areas as opposed to the more populated areas.

Fourteen questionnaires were completed.[43] The results were generally positive (see Appendix G, Table 51), with the exception of those pertaining to the same two criteria that proved difficult in all of the workshops – "is simple and easily communicable" and "is robust and is easy to control." Two other criteria also received low ratings: "includes public participation" and "includes only hazards that are likely to lead to a disaster."

6.2.2.5. The CEPC Workshop

At the request of Emergency Preparedness Canada (EPC), I was given an opportunity to conduct a two-day workshop at CEPC in September 1998. This workshop gave me an opportunity to gain a cross-Canada perspective on the HIRV model. The twelve participants came from across the nation (see Appendix G, Table 52), and three CEPC instructors also attended.

Unfortunately, due to the illness of an instructor,[44] the attendance of the CEPC instructors was not consistent, and this created some disruption of the work groups. As well, one person from Quebec had to leave at the end of the first day due to a local emergency, and another person left prior to completing the questionnaire.

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[43] Neither the students nor the newly arrived resident chose to complete a questionnaire

[44] This instructor had been teaching another course at CEPC.

There were also some difficulties with translation: the participants from Quebec had expected to have access to translation services and were at a disadvantage when they were not available.

Although I would have liked to have had an opportunity to conduct the workshop with members from one community, I believed that this was a good opportunity to gain a cross-Canada perspective on the HIRV model. Therefore, I made a concerted effort to provide the course participants with as much information as possible regarding the City and District of North Vancouver. In addition to having the original maps of the City and District of North Vancouver, participants were shown a series of slides that depicted scenes from each of the neighbourhoods and key community sites (e.g., large shopping mall, local college). These were provided in the hope that the slides would assist them in identifying more closely with the area. Participants were also provided with detailed printed information on existing neighbourhoods (e.g., geographical area, demographic, and economic data).

Despite the disruptions, the workshop appeared to go well; however, the lack of familiarity with the chosen community remained problematic. A number of the participants believed that there was too much information to digest, and the printed information on the various neighbourhoods and demographic data simply contributed to an already burdensome number of paper handouts.

Eleven people completed the questionnaire,[45] although one person had to leave early to catch a plane and began, but did not finish, the questionnaire. The findings were disappointing (see Appendix G, Table 53). Although the number of negative responses had dropped to 4.7 per cent, the number of uncertain responses had soared to almost 20 per cent. Participants continued to have difficulty with the same two criteria (i.e., "is simple and easily communicable" and "is robust and is easy to control"). Furthermore, concerns were expressed in several new areas: (1) the true educational nature of HIRV (as opposed to simply providing educational information based on the communities of North Vancouver City and District, (2) the use of experts, and (3) the flexibility of the HIRV model, And an added problem – one that was not reflected in the questionnaire: now that participants had a lot of factual data on vulnerabilities, they were having difficulty completing the vulnerability and impact analysis in one step.

[45] None of the instructors completed the questionnaire.

It became clear to me that focusing on developing a "good" model was not an effective way of either developing or evaluating the HIRV model. First, it meant that the goal of moving the community towards sustainable hazard mitigation was no longer a key factor in HIRV, and the issue of equity also disappeared. The rationale for dividing the community into zones was no longer explicit, and the means of empowering vulnerable members of the population was absent. While the need for public participation remained a criterion, the *importance* of public participation was overshadowed by methodology and outcome.

The reality is that completing an HRV analysis is *not* a simple process: it requires decision makers, community officials, local stakeholders, and experts to invest their time and resources. The results of the HIRV model *can* be made easily communicable: establishing risk and vulnerability factors assists in this process, but making the results publicly available and understandable is not accomplished without effort. I had envisioned the HIRV model as entailing a dynamic and empowering process, but by focusing on model structuring I had rendered it lifeless. It was time to abandon this approach and to look in new directions: ultimately, I came upon the approach described in this dissertation.

6.3. Summary and Conclusions

The exploratory studies presented the basics of the HIRV model for HRV analysis. I began to teach the HIRV model to those who attended the Mayors and Elected Municipal Officials courses at CEPC. Over the years, feedback from these people greatly enhanced the HIRV model by demonstrating the need for: (1) a comprehensive list of hazards, (2) a definition and discussion of potential hazards, (3) risk factors, and (4) vulnerability factors. It also became clear that the HIRV process needed to ensure that the vulnerability analysis was completed prior to the impact analysis and that the capacity of the community to respond to a disaster be included as a category of vulnerability.

Initially, focusing on the criteria necessary to come up with a good model seemed an appropriate approach to take towards the development of HIRV; however, as was demonstrated in the exploratory workshops, this approach was conceptually flawed. By focusing on such criteria, the essence of the HIRV model was lost. It ceased being a dynamic, community-based process and became, instead, an outcome-oriented method. Once I realized this, I abandoned this track and started afresh.

Nevertheless, the feedback and comments from the participants of the exploratory workshops made a number of positive contributions to the development of the HIRV model. I came to realize that:

1. in order to be effective, workshops need to be community-based;
2. participants need to have a personal investment in the outcome of the HRV analysis;
3. greater focus needs to be given to the HIRV process (i.e., the HIRV committee, the key concepts of the HIRV model);
4. it is very important not to rely on participants' memories of historical data;
5. the vulnerability analysis needs to be separated from the impact analysis;
6. it is very important to make use of experts;
7. the HIRV workbook needs to be presented in a simple format;
8. the workshop needs to use audio-visual aids in order to help people comprehend disastrous events; and

9. there should be a single handbook rather than numerous handouts.

I incorporated all of these changes, and many others, into the HIRV model, and this resulted in the approach that I describe in Chapter 5. Chapter 7 goes on to discuss the participatory case studies that were held in three communities in British Columbia to assess the revised model.

7. Participatory Case Studies: On the Right Path?

Clearly, the HIRV model has benefited from the exploratory studies discussed in Chapter 6. And it will undoubtedly continue to benefit as more and more communities have the opportunity to apply it on an ongoing basis. As I said in Chapter 1, a definitive evaluation of the HIRV model will not be possible until a number of communities have fully implemented it and have had sufficient time to monitor and assess it. In the second section of Chapter 6 I discussed how the findings from the exploratory studies led me to abandon a focus on model structuring (which was the result of an over-emphasis on methodology) in favour of a focus on process. In this chapter I assess the effectiveness of this amended focus.

The problems of presenting the HIRV model to diverse audiences (i.e., those made up of participants from different communities) are well documented in Chapter 6. The HIRV model is intended to be a community-based, community-participatory approach; thus its effectiveness is best evaluated at the community level. In this chapter I look at how the HIRV model was received by potential members of local HIRV committees in the BC communities of Barriere, Taylor, and Kamloops. In doing this I attempt to answer the fourth research question posed in Chapter 1: "How do I know whether or not the HIRV model can be successfully implemented?"

I divide this chapter into four sections. The first section elaborates upon participatory case studies as a qualitative research method capable of assessing the implementation of HIRV. The second section provides an overview of the participatory case study process. The third section focuses on the three participatory case studies, each of which is divided into three parts: (1) a community profile, (2) a description and analysis of the HIRV workshop, and (3) an analysis of the results of the questionnaire. The fourth section provides a cross-case analysis and concludes with a summary of findings and areas of future research.

7.1. Research Methods

This section elaborates on the methodology used to assess the implementation of the model: (1) research design, (2) sampling, (3) relationship between the researcher and the researched, (4) data collection, (5) data analysis, and (6) validity of findings.

7.1.1. Research Design

Creswell (1998) describes five qualitative research traditions that may be used to determine how one will design one's research: (1) biographical study, (2) phenomenological study, (3) grounded theory, (4) ethnographic study, and (5) case study. The following, which is based on Creswell's work, is an overview of these five traditions, and it provides the rationale for my choosing (5) – the case study tradition.

1. A biographical study involves depicting one person and her/his experiences either as told to the researcher or as found in other material. Clearly, a biographical study is not relevant to evaluating the implementation of the HIRV model.
2. A phenomenological study "describes the meaning of lived experiences" (Creswell 1998, 51). In this kind of study, researchers search for the central theme of an experience and emphasize the "intentionality of consciousness" (52). Typically, individuals experience a particular event and then are asked to describe their everyday lived experiences as they pertain to that event. For example, an investigator may wish to explore what constitutes the essential structure of a "caring interaction" between a nurse and patient (Creswell 1998). While this type of study may be useful in addressing how people experience a disaster, it is not useful in addressing the implementation of the HIRV model.
3. Based on fieldwork, studies in grounded theory generate theories that apply to a particular situation. Grounded theory can be used to indicate a relationship between concepts or sets of concepts (Strauss and Corbin 1994, cited in Creswell 1996, 56), and its method of data analysis is well developed and standardized. Typically, this mode of research is used to enable the researcher to understand how individuals react to a certain situation. The researcher collects field data, analyzes it, returns to the field to collect more data, and so forth. The research continues until categories of information become saturated and the theory is satisfactorily elaborated

upon (Creswell 1992). While this research tradition may be useful for assessing the long-term effectiveness of the HIRV model, it is not suitable for assessing the information gleaned from short-term case studies used for evaluating the implementation of the HIRV model.

4. An ethnographic study describes a culture or system, and it is typically based on prolonged observation. In some cases, the researcher spends months or years with members of the group or culture being studied. This approach, often used by anthropologists, is not applicable to the research conducted for this dissertation.
5. A case study involves exploring a case, or multiple cases, "over time through detailed, in-depth data collection involving multiple sources of information" (Creswell 1992, 61). The case study research tradition is clearly relevant to my work, which involves studying representatives of communities (i.e., HRV committee members) that have been exposed to the HIRV model and that have had an opportunity to apply it. As I am responsible for developing the HIRV model, it is incumbent upon me to be the one to present it to community members. This being so, I utilize a type of case study that is amenable to this -- the participatory case study.

7.1.2. Sampling

Most qualitative research designs involve only three types of sampling: probability, purposeful, and convenience (Light et al. 1990; Weiss 1994; Patton 1990). Given that, currently, there are not many communities that are actively evincing an interest in the HIRV model,[46] probability sampling is not an effective method. Purposeful sampling is also ineffective because there are no special criteria that would warrant including one community rather than another. Although some researchers question the usefulness of convenience sampling, Weiss (1994) argues that, when it is difficult to gain access to certain groups or categories of people, it is the only feasible way to proceed. Given the small number of communities that have indicated an interest in the HIRV model,

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[46] The exploratory studies, with their varied participants, generated interest in the HIRV model. Recognizing the importance of completing an HRV analysis, instructors of the Provincial Emergency Program Academy at the Justice Institute (New Westminster, British Columbia) decided to promote the use of the HIRV model, and they agreed to sponsor workshops to interested communities in the late winter of 2000. Unfortunately, in January 2000, due to fiscal restraints, the workshops were cancelled; however, some communities were still interested in having them.

convenience sampling appears to be the most viable research sampling method for this study.

Two communities self-selected (Barriere and Taylor); that is, they requested the HIRV workshop. With regard to the other community (Kamloops), the provincial emergency manager initiated its participation. Typically, researchers choose no more than four cases (Creswell 1992). This being so, I believe that a well-designed analysis of Barriere, Taylor, and Kamloops provides enough information to enable me to draw some useful conclusions about my research problem.

7.1.3. The Relationship between the Researcher and the Researched

The relationship between the researcher and the researched involves the former establishing rapport with, or gaining access to, the latter. In each of the communities I had preliminary conversations with the emergency planner. Each community was faxed basic information about the HIRV model (see Appendix J). I established rapport with participants during discussions regarding who should be invited to attend the workshop; what maps, tools, and so on would be needed; and the place and timing of the session. It is logical to assume that if, by this time, my relationship with the research participants had not been a positive one, then the community would have chosen not to participate.

7.1.4. Collection

Case studies usually involve multiple sources of information, and the ones I conducted in Barriere, Taylor, and Kamloops are no exception. I utilized three main methods of data collection:

(1) During the workshop not only did I facilitate the introduction and implementation of the HIRV model, but I also documented the events and findings, eventually producing a descriptive narrative pertaining to the implementation of the HIRV model. In order to facilitate this process, if there were no objections, I videotaped, or at least tape-recorded, the sessions.

(2) I asked participants to complete several tasks as they worked through the HIRV model, and I used copies of the

outputs (e.g., delineations of areas for comparative analyses, etc.) to assist in the analysis.

(3) Immediately following the workshop, I gave all of the participants a questionnaire (see Appendix H) to complete. This questionnaire was designed to elicit some basic demographic data concerning the participants (e.g., how long have they lived in the community? are they employed by the municipality? have they participated in any other HRV processes?) and to evaluate how well they believed that the HIRV model met the fourteen objectives set out in Chapter 3.

For the purposes of the questionnaire, I reworded the fourteen objectives of the model so as to facilitate participant understanding. For example, "Disaster management and community planning need to be integrated in order to successfully focus on sustainable hazard mitigation" was reworded as follows: "The HIRV model integrates both disaster management and community planning in order to successfully focus on sustainable hazard mitigation." Participants were asked to use a five-point scale to show whether or not they thought that HIRV met its stated objectives:

1	2	3	4	5
Strongly Disagree		Somewhat Agree Somewhat Disagree		Strongly Agree

I decided to use a five-point scale for two reasons: (1) it is familiar (having been used in many surveys, etc.) and, thus, the case study participants would be used to it; and (2) unlike a simple yes-no scale, it would allow me to judge the degree to which participants believed the fourteen objectives were being met.[47] I encouraged participants to make additional comments after each question and at the end of the questionnaire. I prefaced each questionnaire with an information sheet that had met University of British Columbia standards, as determined by the University of British Columbia Ethics Review Committee (see Appendix H). As per University of British Columbia policy, every questionnaire included specific information on how the research would be conducted, how the results

[47] Unfortunately, when the final version of the questionnaire was produced, the bottom line of each of the rating scales was inadvertently cut off (i.e., "somewhat disagree"); however, as is discussed later, this omission does not seem to detract from the validity of the questionnaire. Participants appear to have used the scale appropriately.

would be used, and who would have access to this information.

7.1.5. Data Analysis

The three participatory case studies resulted in multiple-source, in-depth data collection. The first part of the data analysis provides the reader with a basic community profile: location, geography, and socio-economic data. This information is informed by a literature review as well as by information gleaned from workshop participants.

The second part of the data analysis is based on direct observation (supplemented by a review of the video and voice tapings) of how the workshop progressed. It includes a descriptive narrative that provides detailed data regarding workshop participants, how the workshop was conducted, and how the overall HIRV model was implemented.

As discussed in Chapter 5, some of the organizational behaviour literature helps us to understand the HIRV process. Appendix D provides an overview of the individual demographics that had an impact upon the effectiveness of the HIRV model: gender, age, ethnic background, status, and personality traits (Robbins 1998). Further to this, as is mentioned in Chapter 5, some group dynamics – such as cohesiveness, size, norms, and composition (Robbins 1998) – also had an impact upon the effectiveness of the HIRV model's implementation. Although degree of cohesiveness and development of norms can only be evaluated after a group has been functioning for some time, this is not true of size and composition.

Given the small number of people that were expected to participate in each of the workshops, for the purposes of maintaining confidentiality, I did not ask participants for a great deal of personal information (e.g., age, ethnic background). As well, given the short time frame of the workshop, I did not expect that an analysis of individual demographics would result in any meaningful findings. However, as I discuss later, two factors did appear to have an influence on the HIRV process: status and the personality traits of emergency responders. While it was difficult, within the workshop setting, to evaluate the comparative status of the participants, in the case of the Kamloops case study, the presence of the mayor and local elected officials undoubtedly had an effect on the responses of other municipal staff who were also group participants (see Kamloops case study).

The third part of the data analysis focuses on findings derived from the questionnaire. From these I determine whether or not workshop participants believed that the HIRV model effectively met the key objectives of HRV analysis; an important factor in determining whether or not the HIRV model can be effectively implemented. As I did in Chapter 6, I use quasi-statistics (Becker 1970; Maxwell 1996), or simple numerical results, to arrive at my conclusions.

The fourth part of the data analysis consists of a cross-case and within-case analysis of the similarities and the differences between and amongst the three participatory case studies. I use the findings derived from this as a basis for making recommendations regarding future research on and development or the HIRV model.

7.1.6. Validity

The primary threats to the validity of qualitative research are: (1) the bias of the researcher, and (2) reactivity (Maxwell 1996). In order to guard against (1), I utilized data triangulation,[48] which is an established way of reducing the risk of biases and of ensuring a high degree of validity (Creswell 1992; Maxwell 1996). As for reactivity (the influence of the researcher on the setting), I could not eliminate it, as I directly participated in the case studies. However, I minimized reactivity by carefully preparing the workshops. Each participant was given a structured workbook to follow, thus ensuring that each group received the same material in the same order. As well, each group received the same package of overheads to accompany the workbooks. Of course, as with any workshop, different questions were asked and different issues emerged. This is inevitable, but by presenting my material in a standard format I ensured that the core information was the same and was delivered in the same manner across cases.

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[48] Data triangulation refers to the use of multiple methods of data collection (e.g., video recordings, tape recordings, and field notes).

7.2. Preparatory Work: Introducing HIRV and the Workshop Structure

As discussed at the end of Chapter 6, I needed to incorporate a number of key points into the design of this round of exploratory studies. The findings from the previous exploratory studies make it clear that it is important to: (1) have the emergency manager of each community convene a hazards, risk, and vulnerability committee; (2) present the HIRV model within a workshop setting; and (3) have committee members apply the HIRV model to their respective communities.

In order to attract community participants, I developed a one-page handout and distributed it at numerous conferences and meetings related to disaster management (see Appendix I). I also approached emergency managers in numerous communities, faculty members, and those who had been involved in the previous exploratory studies. Whenever an emergency manager's community indicated an interest in being involved in a case study, I sent the appropriate person(s) an information package relating to the HIRV model (see Appendix J). I then made a follow-up phone call.

Furthermore, as was previously discussed, the Provincial Emergency Program had planned to offer courses in communities throughout British Columbia in order to present the HIRV model; however, these courses were cancelled due to fiscal restraints and new priorities within the new British Columbia Emergency Management System. Indeed, it was now difficult to find communities that were interested in assessing the HIRV model. In many cases, while there was interest in the process itself, emergency managers were under heavy workloads and did not feel that they had the time to organize the requisite introductory workshops. In other cases, as the disaster management process did not have much community support, there was simply no way of incorporating it. For example, in some instances emergency managers were volunteers who worked in relative isolation and did not see the need for developing committees to deal with disaster management. It is important to note that the unwillingness of communities to consider the HIRV model was not based on resistance to the HIRV model per se; rather, it was a reflection of the overall state of disaster management in British Columbia.

Nevertheless, three emergency managers did agree to engage in a participatory case study. In all three cases the process was tape-recorded so that information could be verified; in Taylor and Kamloops the process was also video-taped. Each participant received the HIRV handbook (see Appendix E) and the HIRV workbook (see Appendix F). Based on feedback from the previous exploratory studies, I realized that it was important to simplify access to, and the organization of, the numerous supplementary materials that supplemented the HIRV workbook. Thus I presented the HIRV handbook in a three-ring binder, with coloured tabs to separate each of the six sections: (1) a list of the fourteen objectives; (2) a selected list of readings on risk communication, risk perception, and risk acceptance (including a bibliography); (3) a comprehensive list of potential hazards; (4) a description and discussion of seventeen selected hazards; (5) an itemized list of risk factors relating to the seventeen selected hazards; and (6) an itemized list of vulnerability factors relating to the selected hazards.

I used coloured overheads to reinforce the workbook's key points. Generally, I used the same format as I had used in the exploratory studies: I offered a short introduction to a given topic and followed this with a group exercise. I made a number of changes to the HIRV workbook in order to intensify the focus on the HIRV process and to clearly differentiate between the various points in the analysis (see Appendix F).

Assuming that the membership of the HIRV committee would be capped at fifteen, I organized the workshop around seating the participants in two groups. I presented the first four sections of the workbook, which are general in nature, in a lecture format followed by an informal discussion. Once I had introduced the section on hazards, the participants began to work in groups. The first group task was to identify as many potential hazards as possible (participants were not directed to consider whether or not these hazards could occur in their own community) and then to review the comprehensive list of hazards included in the HIRV model for HRV analysis. I also showed them the video *A Decade of Disasters* (Emergency Preparedness Canada 1997) in order to help them understand the scope and nature of various hazards.

The next step involved each group examining a map of its community and determining how to divide the latter into planning zones that would be appropriate to the implementation of the HIRV model. Once this was done, each group reviewed the definitions and discussion material related to the HIRV handbook's seventeen selected hazards. Upon completing this review, I asked each group to choose two of the selected hazards and at least one of the identified areas in its community. The community risk, vulnerability, impact, and risk management analyses were based on these choices. Using their knowledge of their community, group members applied the risk and vulnerability factors for their chosen hazards and area. They then determined the certainty of their analysis, thereby arriving at a risk and vulnerability rating for their chosen areas. Their findings were compared and discussed on a group-to-group basis.

The groups then completed the impact analysis, discussed their findings on a group-to-group basis, arrived at the impact rating, and completed the risk management phase of the HIRV analysis. To complete the workshop, the group reviewed the implementation of the HIRV model and the structure of the HIRV committee. Thus, at the end of the workshop, participants had:

- gained an understanding of the overall HIRV model and its key objectives;
- established the terms of the HIRV model (e.g., arrived at a common definition of disaster);
- reviewed the comprehensive list of hazards;
- reviewed the selected list of seventeen hazard definitions and discussions;
- chosen how the community was to be divided for the purposes of planning and comparative analysis;
- chosen at least two areas of the community for workshop purposes;
- chosen at least two hazards for workshop purposes;
- applied the risk and vulnerability factors for the chosen hazards and areas;
- completed the impact analysis for the two hazards;
- completed the risk management analysis for the chosen hazards and areas; and
- reviewed the implementation of the HIRV model and the structure of the HIRV committee.

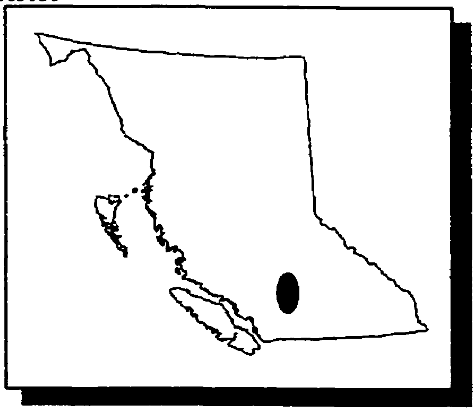
The participants were then ready to embark on an assessment of the implementation of the HIRV model.

7.3. A Participatory Case Study: Barriere and the North Thompson Sub-Regional District

The first participatory case study was held on 28 March 2000 in Barriere, British Columbia.

7.3.1. Community Profile

Figure 14: Map of British Columbia Indicating Approximate Location of Thompson Nicola Regional District



Barriere is a small town, with a population of 1,100, located sixty-six kilometres north of Kamloops (365 kilometres northeast of Vancouver) in south-central British Columbia. It is part of the Thompson Nicola Regional District (TNRD). There are approximately 3,400 residents in the area that includes, and surrounds, Barriere.[49] Because many of the area's residents live in communities outside Barriere, the emergency planner invited residents from the towns of Little Fort, Darfield, Louis Creek, and McLure (see Figure 15).

Barriere, the main town in the area, is situated near the juncture of the Barriere and North Thompson Rivers. It is located in the Central North Thompson Valley and is bordered on the east by the Shuswap Highlands, which rise up to 1,830 metres. The predominant industry of the area is forestry;[50] three major mills – Tolko Fadear Division, Gilbert Smith Forest Products, and Darfield Building Products – are located in the area. There is an emerging tourist industry, with a new motel having been completed within the last six months. The biggest tourist event is the North Thompson Fall Farm, which is held on Labour Day Weekend (TNRD 1997). Barriere is located close to the Canadian National (CN) Rail line and is adjacent to the Yellowhead (No. 5) Highway.

As mentioned, residents from four other towns besides Barriere were invited to the workshop. The

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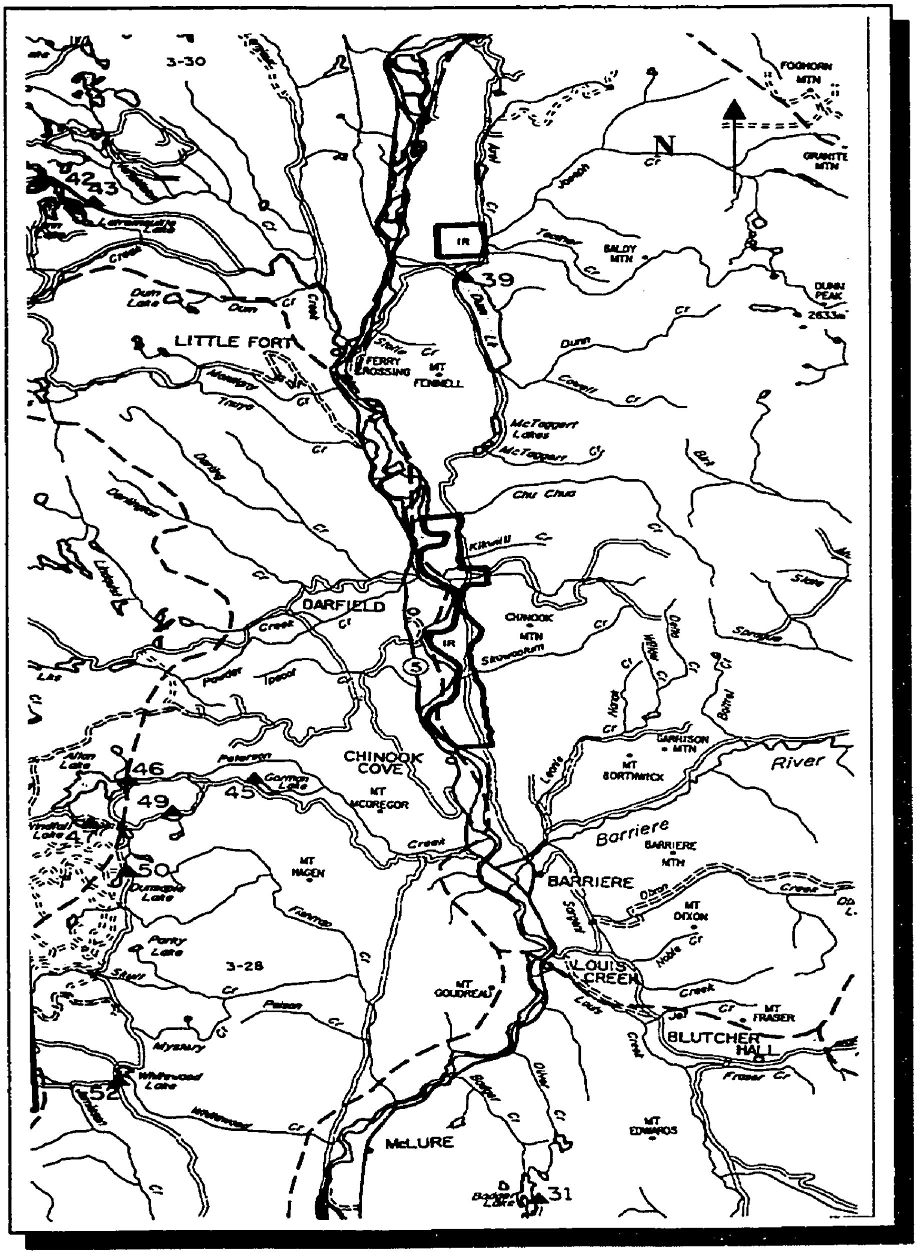
[49] Information provided by a North Thompson regional planner who attended the workshop.

[50] Approximately 75 per cent of the area's labour force is either directly or indirectly dependent upon the forest industry (TNRD 1996).

northernmost community represented is Little Fort, a community of less than 300 residents. It does not have a major employer, and it consists mainly of self-owned farms and a few stores, a restaurant, a hotel, and a pub. It has an elementary school that goes up to Grade 5 (after that students are bused to Barriere).

Darfield, Louis Creek, and McLure are all smaller than Little Fort. Each town has a population of less than 300 residents and boasts a few self-owned businesses. A small ferry service is located in McLure, and it provides people with transportation across the North Thompson River.

Figure 15: Map of Barriere and North Thompson Sub-Region



Source: B.C. Ministry of Forests (1984) Scale 1: 150,000

7.3.2. Analysis of the Implementation of the HIRV Model

The emergency coordinator, agreed to hold the HIRV workshop. Earlier, she had been provided with a sample of the HIRV workbook (see Appendix F) and the information package (see Appendix J). The following people took part in the workshop and constituted the HIRV committee: (1) the emergency coordinator; (2) the ambulance station chief; (3) a TNRD planner; (4) the Provincial Emergency Program (PEP) regional manager; (5) a reporter for, and owner of, the *North Thompson Star Journal*; (6) the local Emergency Social Services (ESS) director; (7) a community resident; (8) a representative from the BC Ministry of Transportation and Highways; (9) a member of the North Thompson Indian Band; (10 and 11) two representatives from Tolko Industries; (12) a member of Barriere Search and Rescue (SAR); (13) a representative from the Little Fort fire department; and (14) a representative from the Barriere Health Clinic. Seven of the participants were women and seven were men.

Of the three case studies, the one in Barriere had the most diverse committee. I spent some time at the beginning of the workshop explaining the roles of the individual participants and their potential contribution to the HIRV process. I did not notice any influences that could be attributed to age or gender. There was only one person from a visible ethnic minority. She was a member of the North Thompson Indian Band, and a number of times participants asked her to provide them with a First Nations perspective. It was difficult to judge how participants evaluated status, as there was no indication that any one person was judged to be of higher status than another.

According to the organizational behaviour literature regarding group dynamics, a large, diverse group would engage in diverse input, a high degree of fact finding, and much discussion. This was certainly the case in Barriere (see below). According to Robbins (1998), as group size increases, opportunity for individual participation decreases. In order to maximize individual participation, and in order to benefit from the diversity of the committee, I divided the participants into two groups. This gave people more opportunity to participate in the discussions. And , as the findings of each group were shared and discussed with the other group, there was also an opportunity for diverse input.

The workshop was held in the Search and Rescue (SAR) Hall, and participants sat around a long narrow table in the SAR conference room: those sitting at one end of the table formed the first group and those sitting at the other end formed the second group. As soon as the introductions were complete, I began the workshop by going through the HIRV workbook (see Appendix F) with the participants. Once we reached the hazard identification phase, I asked each group to identify as many hazards as possible. Neither group was able to identify more than thirty hazards (thus supporting the findings of the previous exploratory studies). Participants were then invited to review the comprehensive list of hazards that was provided in the HIRV handbook (see Appendix E). I stressed the importance of considering all of the potential hazards, and the participants acknowledged that they had experienced a number of hazards that were on the list but that they had not previously paid any heed to them. The results of the workshop supported the importance of providing definitions and discussions regarding potential hazards (see Appendix E), as participants often failed to differentiate between types of hazards (i.e., they identified "flood" as a potential hazard but did not identify the different types of floods [e.g., flash flood, snow melt] that could occur).

I asked the two groups to choose any two of the seventeen hazards that were included in the HIRV handbook, and both groups made the same choice: rail accidents and urban interface wildfires. The latter choice is not surprising, as a number of the participants were volunteer firefighters. Following the HIRV model, both groups were asked to divide the area into logical planning zones. This was the first point in the workshop when group size and composition became factors in the discussion. There was considerable controversy surrounding how the area was to be divided. Some of the SAR members[51] wanted the outer perimeter of the area to be similar to that used by the Barriere SAR team; others wanted to use Electoral Area O. There was some discussion on the part of those from the towns and villages outside of Barriere concerning whether or not they should be included in a regional approach. In the end, the groups decided to use the approximate boundaries of Electoral Area O; namely, all of the area south of, and including, Little Fort (see Figure 15) down to McLure. They also agreed to use a regional approach.

They divided the area into six zones. Using the river and rail line as a median, they established the following zones: Zone 1 was the area around Little Fort; Zone 2 was the area south of Zone 1 and north of Barriere, and it included the North Thompson Native Reserve and Darfield; Zone 3 was the town of Barriere and its

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[51] A number of participants were members of the voluntary SAR team.

immediate area; Zone 4 was the area south of Barriere down to McLure; Zone 5 was the largely uninhabited area to the west of Zones 1, 2, 3, and 4; and Zone 6 was the also largely uninhabited area to the east of Zones 1, 2, 3, and 4.

One group chose to use Zone 2 and the other group chose to use Zone 3 for the purposes of the workshop. The groups reviewed the historical data for the two hazards in their respective areas. There had been numerous rail accidents and wildfires in both zones. Once each group completed its review, I asked it to review its findings with the other group. In both cases, members of the other group added incidents that had not been thought of by the group completing the initial data collection. As is discussed in Chapter 5, it is expected that individuals will not fully recollect historical events. This supports the HIRV model's emphasis on using community residents and newspaper archives as sources of historical information.

Each group then applied the risk factors for the two hazards to their respective zones. While at least some of the risk factors applied to each zone, there were more risk factors for a rail accident in Zone 3 than in Zone 2, mostly because of the shunting areas and the number of rail crossings in the Barriere area. There were also more risk factors for an urban interface wildfire in Zone 3 because its homes were increasingly encroaching upon the forest. While both groups considered the certainty of the information for the urban interface wildfire to be well established (a firefighter was on the committee, as were members of the volunteer fire department), both groups also realized that they lacked some information regarding the risk factors for rail accidents and that they needed to bring in experts from CN Rail.

The groups then applied the vulnerability factors and, again, Zone 3 proved to be the most vulnerable to both hazards. Several questions prompted participants to engage in rather lengthy discussions, primarily regarding the location and existence of historical sites for First Nations people, and whether there were areas of significant ecological importance. The impacts of the rail accidents and urban interface wildfires was highest in the social impact area for Zone 3 and highest in the environmental impact area for Zone 2. The HIRV committee had an interesting time attempting to determine the political impact rating for rail accidents. It quickly became apparent that participants did not trust CN Rail personnel. This lack of trust, which was based primarily on the belief that CN

Rail was dishonest about reporting derailments[52] and that it tended to minimize previous impacts, was instrumental in raising the political impact for rail accidents to a high factor. The overall rating for Zone 3 was a moderate to high degree of risk and vulnerability for both rail and urban interface wildfires, and the rating for Zone 2 was a moderate to low degree of risk and vulnerability for both rail and urban interface wildfires. The two groups were able to complete the tasks within the established time frame.

In order to overcome some of the problems that occurred in the previous set of exploratory studies (see Chapter 6), I proposed that it was important to ensure that all participants actually resided in the same community or region. The benefits of this were apparent. Unlike the workshops in the previous exploratory studies, this one was fast-paced and dynamic. Participants did not have to "look up" basic facts and guess at information. And all of the participants had an investment in the outcome of the HIRV findings, as was evident in the prolonged discussions that took place concerning whether various risk factors did or did not exist. For example, there was a lengthy debate amongst the various fire personnel as to whether or not the buildup of potential forest fuel (e.g., dead pine branches) had increased and whether or not the area was experiencing a drought.

The composition of the HIRV committee was not all that the material in Chapter 5 suggests it should have been. As previously mentioned, the lack of experts was a problem. For example, in order to complete their analysis, participants needed information that only someone from CN Rail could provide. However, the use of the SPR Model (see Chapter 5) provided participants with an opportunity to complete the HIRV model while also making sure that their reservations regarding the validity of some of their decisions were noted. Having someone from the media on the committee was useful, and there was much discussion as to how the *North Thompson Star Journal* would report the findings of the HIRV committee.

While individual demographics were not particularly relevant to this workshop, the size and diversity of

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[52] The reporter recounted an incident in which she had been called by local residents to the site of the derailment of several boxcars. She took photographs of the derailment, and when she subsequently contacted CN Rail its spokesperson denied that it had taken place. Even after she sent them copies of the photographs, they still would not acknowledge that it had happened!

the committee proved to be an asset. The workshop was dynamic, people participated, and the tasks were completed. It is now time to look at how the participants evaluated the HIRV model.

7.3.3. Results of the Questionnaire

Did the participants believe that the HIRV model met the stated objectives? When the workshop was over, I gave them an opportunity to complete a questionnaire (see Appendix H) if they so desired. As soon as the participants departed, I coded the questionnaires: B1 for the first questionnaire handed in, B2 for the second, and so on (see Appendix K, Table 54). All fourteen participants completed a questionnaire. Nine of the participants had resided for ten or more years in the community, only one person was employed by the region, and nine people had been involved in a previous HRV process.

The findings were interesting. Overall, participants agreed that the HIRV model for HRV analysis met the stated objectives: the mean rating per question ranged from a low of 3.79 to a high of 4.50 and, in every case, the median was equal to 4.0. In only four instances was there disagreement as to whether the HIRV model had met a particular objective, and two of these instances concerned Question 6 (which pertained to whether participants had learned something new about their community). This question may have been so rated because most of the respondents had resided in the community for over ten years (and thus already knew a lot about it) and because the hazards chosen were familiar to many of them.

The questions that elicited the strongest agreement were those that asked whether the HIRV model: (1) accurately identified hazards; (2) determined areas at greatest risk; and (3) was affordable and did not require access to sophisticated technology. There was also strong agreement that the HIRV model: (1) led to the integration of disaster management and community planning; (2) dealt with the issues of risk perception; (3) was able to influence decision makers; and (4) allowed participants to record their degree of certainty regarding their decisions. The question that received the lowest rating (3.79) was the one that pertained to community residents having access to existing data.

There were not a lot of comments made by the participants who attended the Barriere workshop (see

Appendix K, Table 55), but those I did receive were positive, thus indicating that the participants believed the HIRV model to be useful. One person noted that the HIRV model did not address how to motivate the general public. However, this same person also noted that it facilitated public participation and influenced decision makers. I have no idea how the respondent would reconcile these seemingly contradictory positions. Another respondent indicated that the lack of experts was a problem.

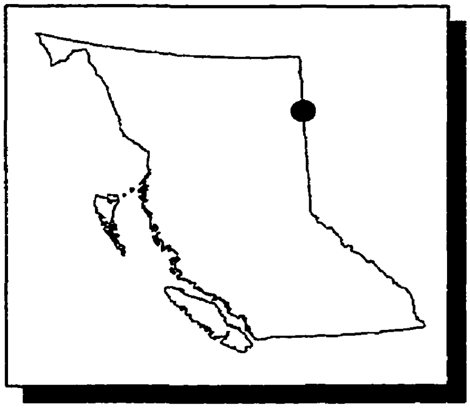
In summary, the participants in the Barriere workshop agreed that the HIRV model for HRV analysis met the stated objectives and that the HRV process was both practical and useful.

7.4. Participatory Case Study: Taylor

The second participatory case study was held in Taylor, British Columbia, on 2 April 2000.

7.4.1. Community Profile

Figure 16: Map of British Columbia Indicating Approximate Location of Taylor



Taylor is a small community of 1,200,[53] and it is located approximately sixteen kilometres south of Fort St. John, which is located in the northeast corner of British Columbia. Fort St. John is the largest community in northeast British Columbia, with a core population of approximately 15,000 (BC Adventure Network 1996) and servicing an area population of over 50,000 (BC Adventure Network 1996). Many of the residents of Taylor work for Westcoast Energy (a large oil refinery), Fibreco and Solex (pulp and paper mills), and/or Canfor (a lumber mill). All of these industries are located on the outskirts of the town (see Figure 17). Other residents work in Fort St. John.

The town has an elementary school, some recreational facilities, a motel, a restaurant, and a few businesses. The rail line parallels the Alaska Highway for awhile, and then branches out to the Canfor mill to the west, the Fibreco and Solex mills to the east, and the Westcoast Energy refinery to the south before crossing the Peace River.

One of the interesting facts about Taylor is that, in early 1999, there was a large fire at Westcoast Energy, followed by a major explosion,[54] which led to the total evacuation of the town. Although eventually contained, the initial explosion nearly led to the complete loss of the refinery (it was a year until the refinery was able to re-open) and the subsequent loss of the entire town. Until that time, residents had felt quite safe; however, following the

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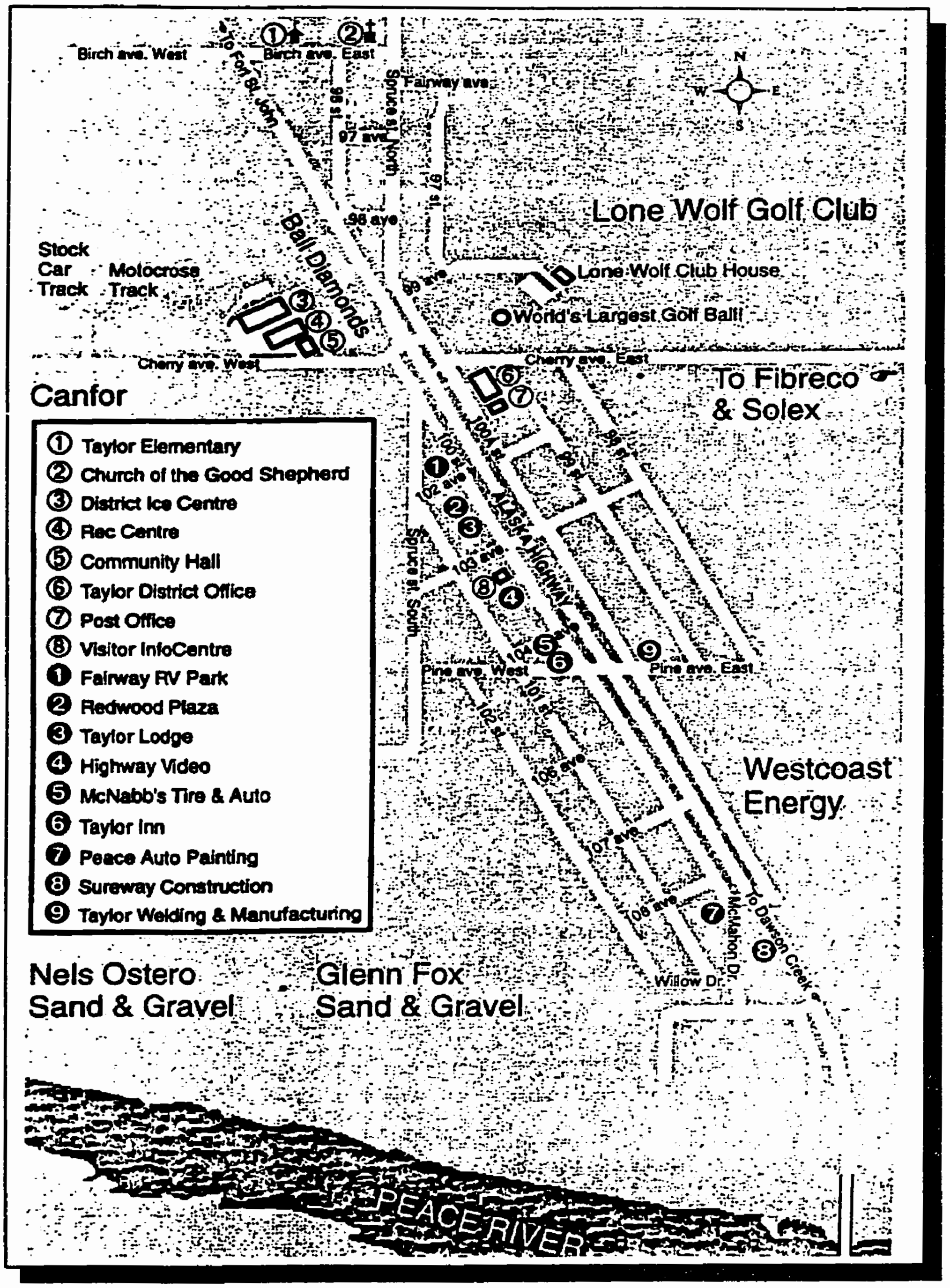
[53] Information provided by workshop participants.

[54] Ibid.

explosion, many residents were very concerned about the potential for a future explosion. Every time Westcoast Energy tests the alarm siren (every Wednesday at noon), many residents worry that it is warning them of another explosion.[55]

Figure 17: Map of Taylor



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[55] Ibid. The initial explosion took place at noon on a Wednesday, and it was only when the siren did not stop within the usual time frame that residents realized there was a problem.

Source: **(Taylor Municipality 1999)**

7.4.2. Analysis of the Implementation of the HIRV Model

The person who initiated the HIRV workshop was the emergency social services (ESS) director. She had heard about the HIRV workshop from ESS volunteers who had attended a 1997 workshop at the Emergency Preparedness Conference, and she believed this one would be of value to the community. Although twelve people confirmed that they would attend the workshop, only four showed up:[56] (1) the emergency manager, (2) the PEP regional manager, (3) the local ESS director, and (4) an ESS volunteer. Two of the participants were women and two were men.

Given the size of the group, it was not possible to determine whether or not individual demographics were relevant. However, this workshop did present me with a good opportunity to consider group dynamics and to measure the effectiveness of a small committee as opposed to a large committee (such as the one in Barriere). Robbins (1998) argues that a small committee tends to allow for greater discussion and participation than does a large one and that it also tends to complete group tasks more quickly. He also says, however, that a small committee tends not to be as effective as a large one with regard to problem solving. There is no question that Robbins's research is borne out by the Taylor case study. The small size of the group provided an opportunity for considerable dialogue between the participants and myself regarding the HIRV process and its objectives. Participants were also able to spend much more time discussing issues amongst themselves (where applicable, these are documented below) than were the participants of the Barriere workshop.

The workshop was held in the Taylor Fire Hall, and participants sat at one table. Given the size of the group, I decided not to divide it. Other than this, however, the workshop followed the same format as did the one given in Barriere. I asked the group to identify as many hazards as possible, and no one was able to identify more

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[56] The executive director from the Emergency Social Services Association of British Columbia (ESSA) attended the workshop for informational purposes only.

than twenty -- fewer than were identified in Barriere.[57] As would be expected, the hazards that they were able to identify were the ones with which they were most familiar: rail derailments, bush and forest fires, floods, and hazardous material spills, and explosions. The participants were surprised at the number of potential hazards that had not occurred to them. A review of the HRV analysis that they had included in their current *Emergency Planning Manual*[58] revealed that it was missing many hazards (e.g., potential airplane crash). And, as was also the case in Barriere, the participants often did not differentiate between types of hazards, again supporting the need for providing a detailed definition and description of hazards.

The group chose two hazards: rail accidents and hazardous material spills in situ. Given the Westcoast Energy explosion, participants were interested in seeing the effect of a future hazardous material spill on their town and in determining their areas of vulnerability. Following the HIRV model, I asked the group to divide the community into logical planning zones. As part of Taylor's disaster management program, the community had already been divided into six evacuation zones. The group eventually decided to use the same areas, although there was considerable discussion regarding whether or not South Taylor, an unincorporated area located south of the Peace River, should become a seventh zone. Group members finally decided that they should not start to plan for this area at this time, as it is under the auspices of the Peace River Regional District. However, they did acknowledge that, should the residents of South Taylor be affected by a disaster, the community of Taylor would have to respond.

Using the Alaska Highway as a median, the group established Zone 1 as the area north of Cherry Avenue and west of the Alaska Highway; Zone 2 as the area north of Cherry Avenue and east of the Alaska Highway; Zone 3 as the area west of the Alaska Highway and between Cherry Avenue and Pine Avenue West; Zone 4 as the area east of the Alaska Highway and between Cherry Avenue and Pine Avenue East; Zone 5 as the area south of Pine Avenue West down to the Peace River; and Zone 6 as the area east of the Alaska Highway and south of Pine Avenue East down to the Peace River. The group chose to work with Zones 4 (mostly residential) and 6 (Westcoast

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[57] Considerable research supports the finding that an increase in the number of active participants will generate an increased number of alternatives (Brookfield 1986).

[58] This manual did not use a standardized approach to HRV analysis.

Energy and the Fibreco and Solex mills).

The group then reviewed the historical data for the two hazards in their area. There had been a number of rail accidents over the years in both zones, and there had been a number of hazardous material spills in Zone 6. During the process, participants kept adding to the list of historical data, again demonstrating the need for including the public and the local media in the HRV process.

The group then applied the risk factors for the two hazards to their identified zones. The risk factors for a rail accident were higher in Zone 4, mostly because of the number of rail crossings in that zone. There are fewer rail crossings in Zone 6, and where they do exist, because of plant safety procedures, the crossings are well controlled. However, while there was very little risk of a hazardous material spill in situ in Zone 4, the risk was very high in Zone 6 due to that area's heavy industrial activity. Participants believed that their information was fairly well established, but they also recognized that it was only rated as probable and that they needed to get representatives from BC Rail, from the mills, and from Westcoast Energy to supplement their information. Again, the need to have experts on the HIRV committee was shown to be essential. Similar to the participants in Barriere, the participants in Taylor found that the SPR model helped them to deal with issues of certainty and permitted them to continue with their assessment.

Next the group applied the vulnerability factors to their data, and Zone 4 proved to be the most vulnerable to both hazards. This was primarily due to two factors: (1) although the employees at the plant were well prepared to deal with either hazard, the residents of Zone 4 were not (little to no training was in place); and (2) the density of the Zone 4 population (compared to the population in other areas of Taylor) led to increased vulnerability. As might be expected, the impacts of a rail accident or a hazardous material spill in situ in Taylor demonstrated a high social impact in Zone 4 and a high economic impact in Zone 6. The overall rating for Zone 4 was a moderate to high degree of risk and vulnerability for rail accidents coupled with a moderate to low degree of risk, and a moderate to high degree of vulnerability for hazardous material spills in situ. The overall rating for Zone 6 was a moderate to low degree of risk and vulnerability for rail accidents and a moderate to high degree of risk and vulnerability for hazardous material spills in situ.

The analysis of the workshop proceedings indicate that the HRV committee should be large, diverse, and community-centred. Whereas the Taylor workshop was completed more quickly than was the one in Barriere, there was not as much direct input and the findings were undoubtedly not as comprehensive (e.g., historical incidents were not recollected). At the end of the workshop, participants were asked to fill out a questionnaire.

7.4.3. Results of the Questionnaire

All of the participants filled out the questionnaire, and as soon as they departed I coded it: T1 for the first questionnaire to be handed in, T2 for the second, and so on. Unlike in Barriere, in Taylor only one participant had resided in the community for more than ten years (see Appendix K, Table 56). Furthermore, only one person worked for the municipality, and only one person had not participated in a previous HRV analysis.

As can be seen in Table 56 (Appendix K), overall, participants strongly agreed (mean ranged from 4.5 to 5.0, as did the median) that the HIRV model for HRV analysis met the stated objectives. They also wrote more comments[59] than did the participants in the Barriere workshop (see Appendix K, Table 57). Their comments were very positive, indicating that the HIRV model is practically based, participatory in nature, and useful as a planning tool and as a tool for dealing with disaster management. One interesting comment related to the potential use of the HIRV model in demonstrating to the public at large that the community had shown "due diligence" and, thus, could not be subject to lawsuits[60]. A number of municipal councils in British Columbia have become increasingly concerned with potential lawsuits, and the implementation of the HIRV model for HRV analysis could demonstrate

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[59] The added comments may be due to the amount of time that was available for discussion.

[60] Interestingly, when the neighbouring community of Fort St. John had been contacted regarding their interest in the HIRV workshop (in February 2000 they were to have received the Justice Institute course based on the HIRV model), they declined to participate because they felt that the workshop I was proposing was not "certified" by the Provincial Emergency Program and, thus, could leave them open to potential lawsuits. (N.B., there is no certification board for any of the Justice Institute's emergency management courses.)

that a community had undertaken a rigorous process in order to identify risks and vulnerabilities – assuming, of course, that the community had taken mitigative steps to deal with identified risks and vulnerabilities!

In summary, the results of the Taylor workshop supported the need for a large, diverse committee, and the participants strongly supported the HIRV model for HRV analysis. They believed that it met the objectives and that it would be of assistance to them in the future.

7.5. A Participatory Case Study: Kamloops

The third participatory case study was held in Kamloops on 20 April 2000.

7.5.1. Community Profile

Kamloops is the largest city in the Thompson Nicola Regional District (TNRD), and it has a population of 81,000 (City of Kamloops 1999). It has experienced rapid growth during the last five years, with approximately 1,800 residents moving there each year. It is an interesting city in that a number of communities have been amalgamated with it, and it is now divided into "neighbourhoods" such as Brocklehurst, Dufferin, Valleyview, and Aberdeen (see Figure 19). The Kamloops economy, which was originally based on agriculture and forestry, is now

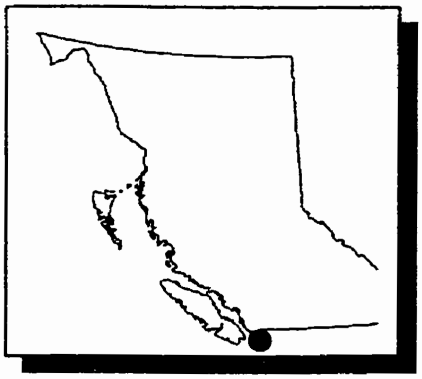
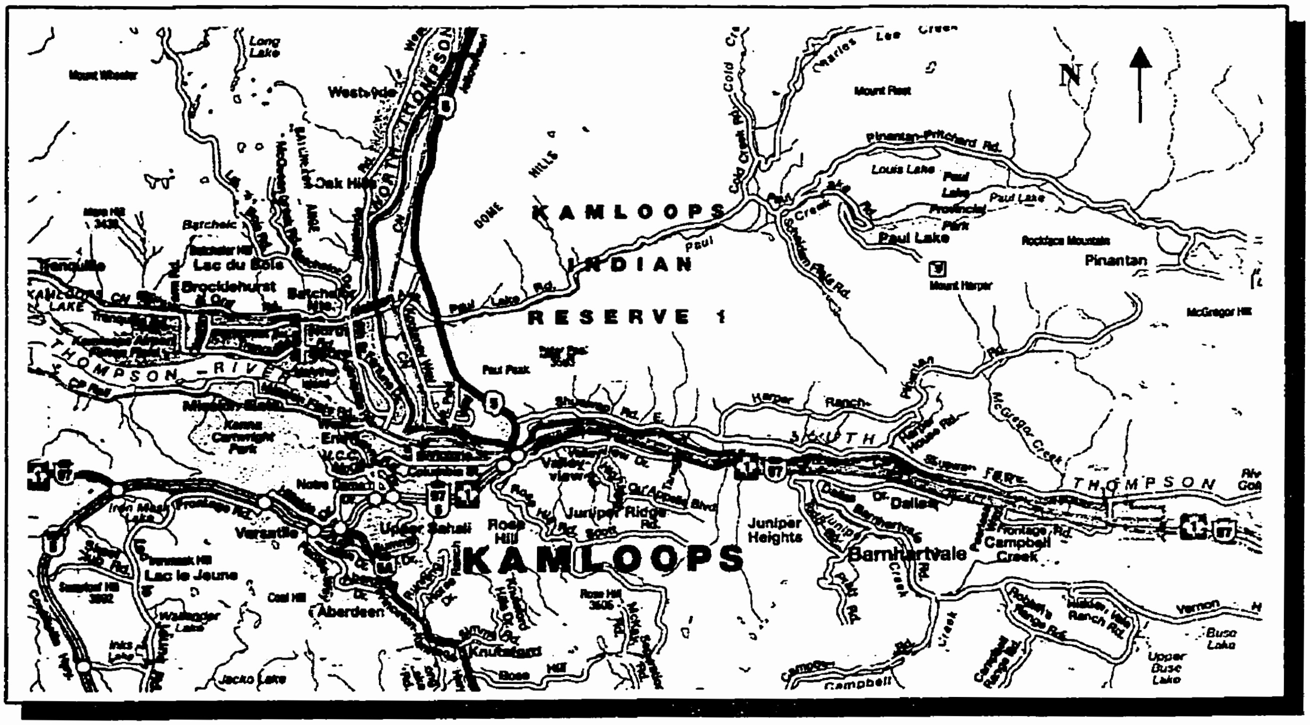


Figure 18: Map of British Columbia Indicating Approximate Location of Kamloops

Figure 19: Map of Kamloops



Source: Map Art Publications (1997) Adapted Scale 1: 200,000 diversified. Kamloops, a Shuswap term meaning "Meeting of the Waters," is situated at the junction of the North and South Thompson Rivers (City of Kamloops 1999).

Kamloops is the transportation hub of the TNRD. It contains a major highway junction, it has the largest airport in the area, and it is the central hub of both CN Rail and BC Rail. Not surprisingly, Kamloops is fast becoming a major recreation and tourism destination (City of Kamloops 1999); a recently licensed casino has apparently increased tourism and attracted residents from local suburbs into downtown core.

7.5.2. Analysis of the Implementation of the HIRV Model

The Kamloops workshop was primarily initiated by the PEP regional manager for the central area. He had attended the Barriere workshop and had thought that it would be a good idea for the City of Kamloops to participate in a similar one. He approached city staff members and the emergency planner, and they agreed to hold the workshop. Thirteen people agreed to attend, and eleven showed up. The workshop was attended by: (1-3) the mayor and two councillors (unlike the workshops in the other communities, the one in Kamloops attracted three politicians); (4) the director of finance; (5) the director of public services and operations; (6) the emergency planner (who was also the fire chief); (7-10) four deputy emergency coordinators; and (11) the ESS director.

Before discussing individual and group dynamics, it is important to put the workshop into context. The HIRV model stresses the need to have a politician on the HIRV committee; however, having politicians attend this workshop led to some confusion and contributed to it not being as well organized as were the other two. The first problem was that the mayor called an emergency in-camera council meeting for April 20 at 0900h (precisely the time the workshop was supposed to start). Consequently, half of the participants ended up waiting almost an hour for the politicians and city staff to arrive. This was the first indication of the importance of status within a group setting. The time and place for the workshop had been agreed to for some time,[61] but clearly the mayor's and council's wishes superseded this commitment. Those in attendance recognized this situation and chose to wait for their arrival rather than to start without them. As becomes clear in the following text, the importance of status as an

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[61] The date was chosen by the City of Kamloops, not the researcher.

individual demographic factor emerged several times over the course of this workshop.

The next problem was that the mayor also called a press conference at 1300h to announce a decision that had been reached earlier in the morning. This meant that he and the councillors had to miss the first portion of the afternoon session. All of this activity also meant that there were numerous interruptions during the workshop, as people came and went. And holding the workshop on the Thursday prior to the four-day Easter weekend probably did not help. Accordingly, only six people stayed until the end of the workshop

The Kamloops workshop presented me with an opportunity to consider another interesting factor. Organizational behaviour refers to the influence of personality traits, and in the HIRV committee that formed the basis of this case study, three of the four deputy coordinators as well as the ESS director were firefighters. As is discussed later, the personality traits of these emergency responders may well have been a factor in how this committee chose to implement the HIRV model. There were no visible minorities in the group, and age and gender (four of the participants were women and seven were men) did not appear to be factors.

The group was sufficiently large to generate discussion and participation; however, the composition of the group was intriguing. The deputy coordinator who arranged the workshop received all of the pre-workshop information (see Appendix J). The decisions about who to invite to sit on the HIRV committee were obviously not hers alone to make. It was interesting to note who was not in attendance: the media, the business community, and experts. The only people in attendance were those who worked for the municipality. This is not so surprising when one considers the history of disaster management in Kamloops. As is the case in a number of communities, in Kamloops the fire chief is also the emergency coordinator. However, in Kamloops, unlike in most communities, the fire chief appointed the ESS director (a job typically held by someone with a social services background) and three of the four deputy coordinators from the fire department. Thus, disaster management has been taking place in some isolation: the only other parties involved were those with a direct municipal role (e.g., the police).[62] Any meetings that were held in the past were focused on fire prevention and did not pay much attention to other hazards. Robbins and Langton's (2000) findings suggest that there would be considerable resistance to introducing the HIRV model

[62] The following anecdotal information was provided at various times and by various workshop participants.

for HRV analysis into such an environment. As is later discussed, the HIRV model did meet with some success in making participants, including the fire chief, aware of a different way of doing things.

Although the city planner was invited, he did not accept the invitation (reasons were not given) nor did he choose to appoint another planner to attend. This was disappointing but not unexpected given that there has typically been little coordination between city planning and disaster management.

The workshop was held in one of the boardrooms at city hall, and participants sat at one large table. Given the size of the original group, it was decided to divide it into two sub-groups; however, as the attendance fluctuated so widely, after lunch we amalgamated both groups. It was interesting that as soon as I mentioned dividing the group into two sections, one of the council members immediately suggested that the elected officials participate in each group (they had all arrived together and all sat next to each other at one end of the table). It seemed apparent that, at least for this councillor, it was important to consider the status of the elected officials and to ensure that they were equally represented in both groups. After this was agreed to, other participants then noticed that all of the emergency responders were seated together, and they recommended that they, too, be divided. Although not questioned on this point, it seems clear from the comments that the participants valued the need for group diversity and recognized that emergency responders shared similar perceptions.

The workshop followed the same outline as did those in Barriere and Taylor. Once I had made the introductions and had reviewed the first section of the HIRV handbook, I asked the group to identify as many hazards as possible. No group was able to identify more than twenty hazards. A review of the HRV analysis included in their current *Emergency Planning Manual*[63] showed that it was missing many hazards. As in Taylor, the hazards that were included were those most commonly known: fire, train derailments, flooding, and so on. Both groups spent a considerable amount of time reviewing and discussing the seventeen selected hazards. Given the shortened time available for the workshop, discussion had to be terminated because many of the emergency responders wanted to read the information on each of the hazards in detail. As was the case in Barriere and Taylor, participants often did not differentiate between types of hazards (e.g., snow-melt floods versus floods caused by

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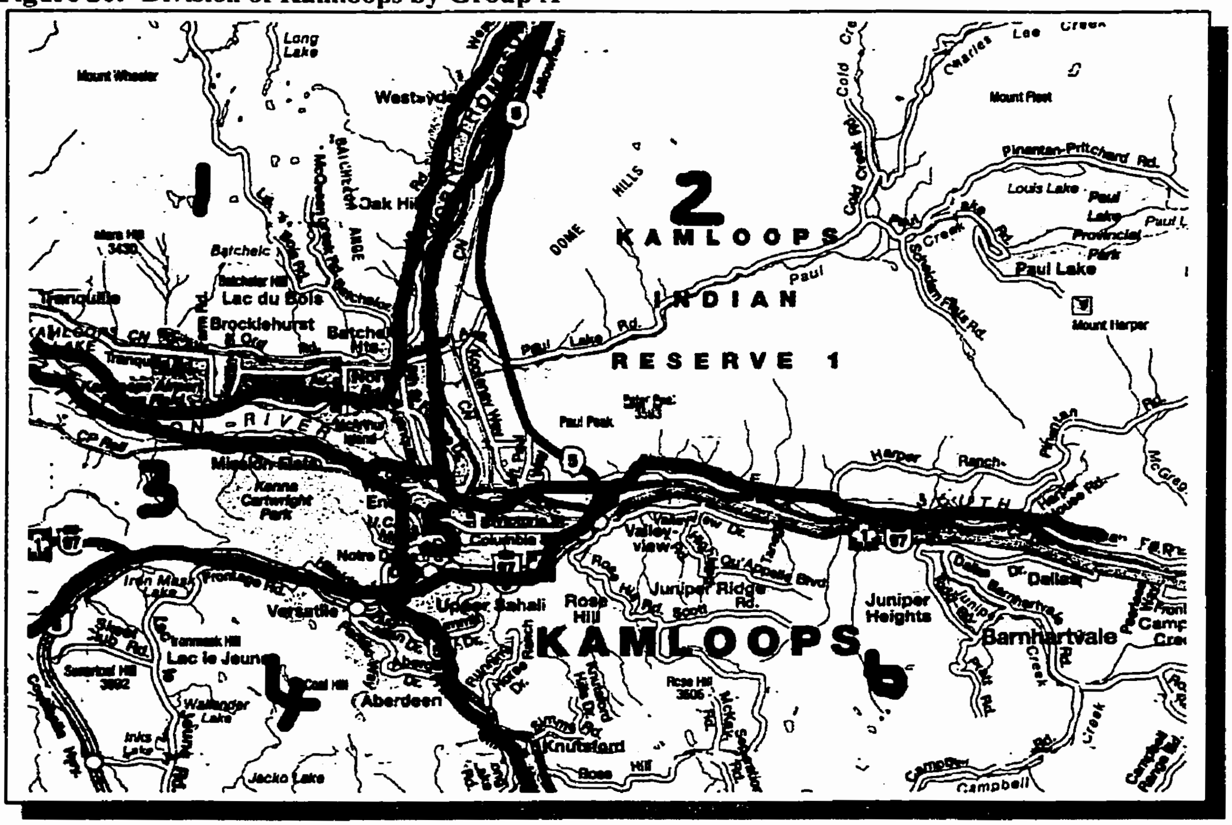
[63] Ibid.

excessive rain).

The first group (Group A) chose aircraft accidents and urban interface wildfires. The second group (Group B) chose rail accidents and urban interface wildfires. Following the HIRV model for HRV analysis, I asked the groups to divide the community into logical planning zones. This proved to be an interesting exercise. Group B (mostly comprised of first responders) wanted to divide the community into six vertical zones. Starting from the west, Zone 1 included the airport and the area known as Tranquille; Zone 2 included Brocklehurst; Zone 3 included the North Shore; Zone 4 included the area along both sides of the North Thompson River as well as the downtown core; Zone 5 included the area of Valleyview; and Zone 6 included the area of Barnhartvale. Group A also divided the community into six zones, but its division was more functional than was Group B's in that it used both rivers as natural medians. Zone 1 was the area around Westsyde; Zone 2 was the area east of the North Thompson River and north of the South Thompson River (mostly a Native reserve); Zone 3 was the area west of the North Thompson River and north of the South Thompson River; Zone 4 was the areas of Sahali and Aberdeen; Zone 5 was the downtown core and the area south of the South Thompson River and north of the Trans-Canada Highway; and Zone 6 was the area south of the South Thompson River and east of the downtown core (see Figure 20).

Figure 20: Division of Kamloops by Group A



There was considerable debate as to the merits of each way of dividing the Kamloops area. The way chosen by Group B did not seem particularly beneficial, as the zones did not seem particularly homogenous. However, the participants in Group B were reluctant to use the way chosen by Group A. From Chapter 6 the reader may recall that, during the Sooke workshop, Group 1 (which was led by a fire chief and which included a number of emergency responders) recommended that the community be divided along five vertical lines. As Sooke was the only exploratory study in which emergency responders participated, the relevance of this strategy was unclear. Nevertheless, it seemed interesting to ask whether there were any personality traits specific to emergency responders that might assist in interpreting their actions. And, indeed, the literature on the personality traits of emergency responders indicates that while data are not conclusive, there might well be a connection between personality traits and actions. Yarmey (1990) and other researchers (Asken 1993; Stevens 1999) acknowledge that many emergency responders appear to have a tendency: (1) to need to be in control; (2) to be more comfortable when experiencing clear, non-contradictory demands and directions; and (3) to be conservative. In recent research, Stevens (1999) uses the Myers-Briggs Type Indicator[64] to assess the personality types of police officers. He argues that use of this test indicates that most police officers

> direct their energy towards people and things but are afterthinkers; they rely on their experiences and practicality to see them through situations, and take situations as they come; their decisions are based on what they perceive as logic and they tend to act impersonally; lastly they are decisive and self-regimented. (61)

Stevens further suggests that police officers are concrete current thinkers as opposed to abstract theoretical thinkers (62).

While Yarmey (1990) and Chui (1998) warn against stereotyping emergency responders, I suggest, given the evidence in both the Sooke and Kamloops workshops, that it does seem that personality traits had an effect on the implementation of the HIRV model. In both workshops the fire responders divided the community into zones, adopting a simple linear approach that failed to take into consideration the differences in neighbourhoods and zoning (i.e., residential versus industrial).

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[64] The Myers-Briggs Type Indicator is one of the most-used personality indicators (Stevens 1999).

To return to the workshop and the problem over which approach to use, it was finally decided that the matter had to be put to a vote. Perhaps consensus could have been reached had more time been available; however, what occurred in Kamloops strongly supports the need for a facilitator and the value of having an odd number of participants on the HIRV committee. Both groups eventually agreed to use Group A's approach to dividing the community. Group A chose Zones 3 and 5, while Group B chose Zones 4 and 6.

The groups then reviewed the historical data for the two hazards in their respective areas. There had been a number of rail accidents over the years in Zones 3 and 5, and both of these zones had had a number of urban interface wildfires. Group B determined that a couple of aircraft crashes had taken place in Zone 6, and both Zones 4 and 6 had also had a number of urban interface wildfires. During the process, participants kept adding to the list of historical data; and, as in Barriere and Taylor, when each group presented its information, participants in the other group were able to add to it. This supported the importance of widespread public participation in developing a historical database.

The groups then applied the risk factors for the two hazards to their respective zones. Group A determined that there were an equal number of risk factors in Zones 3 and 5, as there were major rail lines running through both areas and both had a number of rail crossings. They determined that Zone 3 had a higher risk rating for urban interface wildfires than did Zone 5. Group B found that both Zones 4 and 6 had equal ratings for aircraft accidents and urban interface wildfires. There were a number of firefighters in both groups, thus participants believed that their information was well established for urban interface wildfires; however, they acknowledged that information regarding rail accidents and aircraft accidents would need to be supplemented by representatives from CN Rail, BC Rail, and the airport.

After lunch, the two groups amalgamated and decided to focus on Zones 5 and 6 for the rest of the workshop. The two hazards that it chose were rail accidents and urban interface wildfires. The group then applied the vulnerability factors, and it identified Zone 5 as being more vulnerable to rail accidents than Zone 6. This was primarily due to the size and makeup of the Zone 5 population and the lack of preparedness of the community at large for dealing with this type of hazard. Participants believed that due to major mitigative efforts in dealing with urban interface fires, the vulnerability in Zone 5 was +1 (slight degree of vulnerability) and that the vulnerability in Zone 6 was –1 (slight degree of invulnerability).

Assessing how well Kamloops was prepared to deal with rail derailments proved to be an interesting exercise. There is no doubt that the fire chief was aware of the politicians who were in the room during this discussion (one councillor and the mayor). He was visibly proud of the mitigative efforts that had been put in place to deal with the urban interface wildfires, but he became visibly concerned when participants started to question the planning that was in place for rail derailments. As it became clear to participants that little had been done in this area, it was evident that the other firefighters were uncomfortable about challenging their boss. Whereas the questions dealing with fire prevention had been direct and pointed, the questions dealing with derailments were conciliatory and vague.

The fire chief became visibly angry as others started to question the appropriateness of the existing planning efforts. Eventually he began to realize that those who lived in the two zones were quite vulnerable to rail derailments, yet little to no effort had been made to educate the public and response personnel as to the potential problems should such an event take place. Dealing with the hazard zone by zone also provided an opportunity for participants to assess the differences in what would occur, depending on where the train might derail and, thus, to focus on the implication of having a derailment block access to certain key parts of the city.

As was to be expected, the impacts of either a rail accident or an urban interface wildfire were significantly higher in Zone 5 than they were in Zone 6. The politicians in attendance were particularly interested in the political impact analysis. I was asked many questions in this area, and I offered some examples of the political impacts of previous disasters (see Chapter 3).

The group then completed the overall ratings and established its priorities. The findings surprised a number of the participants, as they contradicted their belief that urban interface wildfires were a priority concern for Kamloops. However, the findings for Zone 5 indicated that the risk of a rail accident was +2 with a vulnerability rating of +3, while the risk of an urban interface wildfire was –1 with a vulnerability rating of +1. As the discussion progressed and the current plan was examined, it became clear that the fire chief's focus on urban interface wildfires had led to having a strong mitigative program to deal with these hazards; however, this was at the expense of having a program to deal with rail accidents.

The ability of the HIRV model to deal with resistance to change was evident. Once the fire chief became aware of the various risk and vulnerability factors, he admitted that it would be difficult to go back to the status quo (see the discussion of the "driving force" at the end of Chapter 5). Indeed, the fire chief (and emergency planner) for Kamloops commented that this workshop had "opened [his] eyes" to a different way of conducting HRV analysis. He said that he was now determined to use the HIRV model and to implement a HIRV committee. It will be interesting to see how far this goes and whether the process becomes open to the public at large. I suggest that the educational aspect of the HIRV model and the participation of workshop members, coupled with the support of a facilitator, aided in overcoming initial resistance to the HIRV model.

Once the overall ratings were completed and any questions answered, I asked participants to fill out the questionnaire.

7.5.3. Results of the Questionnaire

The participants found the workshop valuable and agreed that it met the stated objectives. As previously discussed, only six participants remained at the end of the workshop, and one of these (the mayor) had been absent for a portion of the afternoon session. I gave questionnaires to those who left early, and two were returned by mail. As soon as the participants departed, I coded the questionnaires: K1 for the first questionnaire handed in, K2 for the second, and so on (the two questionnaires that were later received by mail were coded K7 and K8, respectively). The ratings were positive (the mean ranged from 3.38 to 4.25 [ten responses had a mean of 3.75 or higher], the median ranged from 3.50 to 4.00) and indicated that the participants agreed that the HIRV model for HRV analysis met the stated objectives (see Appendix K, Table 58).

Only one of the participants had lived in the community for less than ten years, all worked for the municipality, and only four had taken part in a previous HRV analysis. The strongest responses[65] pertained to: (1) the integration of disaster management with community planning, (2) the degree of public participation, (3) the need to take into account how risk is perceived by residents and responders, and (4) the ability to determine the certainty of one's information. The weakest responses[66] were in regard to (1) making sure that residents have access to data about hazards, and (2) providing a means of determining the accuracy and availability of scientific knowledge. Possible reasons for the lower ratings in the preceding two areas may be: (1) the difficulty of conducting a workshop with a fluctuating audience (especially during the impact phase of the HIRV model), (2) the problem of receiving responses to the questionnaire when the participant had not attended the full workshop, and (3) the fact that the focus was on hazards that were relatively well understood by the participants. In retrospect, I should have stressed the fact that additional resources could be brought in to assist in providing information for less familiar hazards.

Generally, the average scores on the Kamloops questionnaires were lower than were those on the questionnaires from the other two communities; however, the responses from one of the participants (K7) was significantly lower than were the scores of the other participants. K7 did not complete the workshop (she/he did not return after lunch), and all of her/his responses were scored equally (with a rating of 3). Because there were only eight participants in total, the scores of this one participant reduced the mean but did not affect the median scores. If this questionnaire is deleted from the analysis, then ten out of the fourteen questions have a mean score of 4 or higher, indicating substantial support for the HIRV model.

Possibly reflecting the need to leave quickly and prepare for a four-day Easter weekend, respondents' comments were at a minimum. Of those who stayed until the end of the workshop, one person wanted to see more videos and another found the workshop enjoyable (see Appendix K, Table 59). One of the elected officials had previously attended the course for Mayors and Elected Municipal Officials at CEPC in 1996. Unfortunately, she did not return after lunch. However, she did say that she found that the current HIRV model was more refined than the one that had been presented at CEPC.

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[65] Those responses with a mean of 4.0 or higher.

[66] Responses with a mean of less than 3.50.

In summary, the findings were positive. In many cases all participants strongly agreed that the HIRV model met the stated objectives.

7.6. A Participatory Cross-Case Study Analysis

Barriere, Taylor, and Kamloops provided well-balanced case studies, thus enabling me to assess the effectiveness of the implementation of the HIRV model for HRV analysis. The participants in the Barriere workshop took a regional approach to the application of HIRV, incorporating several smaller communities into the study area; the participants in the Taylor workshop took a community-based approach, restricting themselves to the area that fell within municipal boundaries; and the participants in the Kamloops workshop also took a community-based approach. In the Barriere case study, the committee was large and diverse and was more representative of the recommended HIRV model than were the committees in Taylor and Kamloops. In Taylor the committee was small, and in Kamloops, while the committee was large, attendance was restricted to municipal staff. In all cases participants agreed that the HIRV model met the stated objectives, and they found it both useful and practical.

In a one-day workshop it is not always possible to examine the relevance of such individual demographics as age and gender; however, the findings in Kamloops suggested that the status of those involved on the HIRV committee is an important factor and that an experienced facilitator is beneficial in ensuring that all participants have an opportunity to present their opinions and share information. While certainly not conclusive, the approach taken by the emergency responders in Kamloops (and Sooke) suggests that the personality traits of emergency responders may have some influence on the outcome of the HIRV process. This is something that a facilitator must take into account.

The findings show that the size and composition of the HIRV committee is important. The more effective HIRV committee is one that is large and diverse. Although the participants in the small Taylor workshop had more opportunity to participate in discussions, the quality of their discussions could not match the quality of those that took place in Barriere and Kamloops. It was clear that diversity of participants added to quality of outcomes (this was particularly evident in Barriere). It should be noted that in Kamloops the lack of media and outsiders on the HIRV committee restricted the availability of information and indigenous knowledge.

Despite the differences between the three case studies, it is interesting to note that there are also a number of similarities:

- in each workshop participants were unable to identify more than thirty hazards[67];
- in the two communities that had an emergency plan, participants noted that many potential hazards were omitted from the HRV analysis;
- participants were unsure of many of the definitions of hazards and appreciated the opportunity to read about them in the HIRV handbook;
- in each workshop, despite very different community profiles, participants all delineated six separate zones for planning purposes;[68]
- participants quickly chose the hazards with which they were most familiar (e.g., urban interface wildfires);
- in many cases participants were uncertain about their decisions regarding risk, vulnerability, and impact factors, and they identified the need to bring other experts into the HIRV process; and
- participants believed that the HIRV process had provided them with valid information about the risks and vulnerabilities in their community.

When comparing the results of one workshop with those of the others, I found that, while the mean scores ranged from 4.86 for Taylor to 4.08 for Barriere to 3.79 for Kamloops, the median scores were all either 4.00 or 4.50 (see Appendix K, Table 60). The high median scores indicate a strong belief that the HIRV model is able to meet the stated objectives.

There is no question that due to the late starting time and the political activity that interrupted the process, the Kamloops workshop did not run as smoothly as the other two. The fluctuations in attendance and the difficulty of maintaining concentration within this volatile atmosphere probably caused the slightly lower ratings in the Kamloops responses. The higher ratings for Taylor could be a result of the small size of the workshop, which

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[67] In general, communities were able to identify most of the most well known hazards (e.g., earthquake, forest fire, rail derailment), but they failed to consider less common hazards such as debris torrents, plant infestations, and aircraft crashes, and failed to differentiate between snow-melt floods, flash floods, etc..

[68] As did the community of Sooke (see Chapter 6).

resulted in participants having a greater amount of time to discuss the objectives of the HIRV model as well as a greater amount of time to discuss specific issues and to ask questions. Furthermore, since the majority of participants in the Taylor workshop were much newer to the community than were those in the Barriere and Kamloops workshops, it is not surprising that they had more to learn about their community.

Across all responses to the questionnaires, the mean and median scores are very close and reflect the general belief that the HIRV model for HRV analysis can provide communities and regions with a viable process and methodology. Based on the findings of the three participatory case studies, the final section of this chapter focuses on areas for future research.

7.7. Conclusions and Areas for Future Research

The findings of the exploratory studies discussed in Chapter 6 were disappointing, and my focus on model structuring as the basis for the HIRV model proved to be flawed. The findings from this second round of exploratory studies – the three participatory case studies in Barriere, Taylor, and Kamloops – are very different. These workshops were effective in that participants were able to complete the tasks set out in the HIRV workbook. In addition, I received twenty-four responses to my questionnaire and, based on a rating scale from one to five (where five indicates that the respondents strongly agree), the overall median was four or higher and indicated that the participants strongly believed in the ability of the HIRV model to meet the stated objectives.

The findings of the earlier exploratory studies indicated that future applications of the HIRV model needed to take a number of factors into account. One key factor was the need for the HIRV model to be implemented at the community level, and another was to ensure that HIRV committee members had a personal investment in the outcome of their work. The importance of the latter factor became very clear during the community-based participatory case studies, as participants engaged in more discussion and debate and were able to contribute to a historical database pertaining to previous disasters. The earlier exploratory studies also pointed out the importance of giving as much attention to process as to methodology. Restructuring the workshops for the three case studies and focusing on the objectives of HIRV right at the beginning went a long way to meeting this requirement. The responses to the questionnaires indicated that the earlier problem had been successfully addressed. As well, many of the participants in the earlier exploratory studies had commented negatively on the amount of paper that the HIRV model required. The revised HIRV handbook and binder appears to have successfully addressed this, as there were no such complaints in any of the three most recent case studies.

The findings of the participatory case studies support the need for public participation and a large and diverse HIRV committee. The case studies also supported my contention that implementing the HIRV model would not always be easy and that, consequently, it is important to have a facilitator.

It is now time to fully implement the HIRV model for HRV analysis and to evaluate the findings over the long term. Communities must have an opportunity to work with the HIRV model, to complete the assessments for different hazards, to set priorities, and to make their recommendations for the application of mitigation strategies. Just as the earlier exploratory studies suggested valuable changes to the HIRV model, so do the three participatory case studies:

(1) The selection and implementation of the HIRV committee is important. More consideration needs to be given to the selection and appointment of the members of this committee. Providing interested communities with an informational package is apparently not sufficient, as all three communities selected very different members for their HIRV committees. The findings suggest that before establishing the first committee meeting, there should be a meeting (or at least a conference call) between key committee members (e.g., the disaster manager, community planner) in order to stress the importance of selecting appropriate HIRV committee members. Once the committee is selected, the first meeting should focus on the importance of committee members' roles and the expected evolution of the HIRV process.

(2) The diversity and role of HIRV committee members is important. In particular, people need to realize the advantages of having members of the media sit on the committee. While having a reporter at the table may not be an issue in a small community like Barriere, this was not so for Kamloops. As well, it is important that the HIRV committee include a representative from the third sector. This person must adequately represent, and communicate with, vulnerable members of society. The HIRV handbook also needs to include a section on the importance of the roles of various HIRV committee members, and it needs to develop a "job description" for each potential member.

(3) Use of a facilitator is important. Greater focus needs to be given to the appointment of a facilitator. When the committee is selected, the community should engage a facilitator to assist in the implementation of the HIRV model. As I will not always be available to educate committee members as to the objectives and methodology of HIRV, it is important to develop a facilitator's handbook. This handbook would be used in conjunction with the HIRV workbook.

(4) A detailed list of potential experts needs to be developed. All of the case studies needed expert advice on questions regarding potential hazards. In some cases, participants did not see the relationship between bringing in people to help them determine risk and vulnerabilities and trying to provide a "best guess" response. I believe that for each hazard, there should be a list of suggested experts (by function or title [e.g., local meteorologist, risk manager for rail company, forestry consultant]). An expert should be invited to attend meetings as an ad hoc member of the committee whenever it addresses a hazard pertinent to her/his expertise.

Finally, the findings of the participatory studies suggest numerous areas of interest for future research.

(1) Three communities in British Columbia had the opportunity to implement the HIRV model. It is important to continue to monitor them and, in so doing, to evaluate the progress of the HIRV model on a long-term basis. A comparative evaluation between communities that do not use the HIRV model and those that do would be beneficial. It is hoped that the findings derived from such research will demonstrate that the latter are more likely to implement mitigation strategies than are the former.

(2) The recommendations for changes to the implementation of the HIRV model should be acted upon. As new communities become interested in applying the HIRV model, the effectiveness of these changes should be evaluated against the three participatory case studies. Once the facilitator's handbook is complete, the researcher can take a non-participatory approach and carry out further evaluations of the HIRV model.

(3) While the three participatory case studies were specific to British Columbia, there is no reason to believe that the HIRV process would not work elsewhere. Communities in other locales should be encouraged to use the HIRV model, and the implementation process should be evaluated.

(4) Having politicians and a fire chief on the Kamloops HIRV committee influenced how participants reacted to the HIRV process. As the HIRV model is implemented, the membership of the HIRV committee should be monitored with an eye to determining whether or not better choices for membership may be identified.

(5) In two studies, Kamloops and Sooke, emergency responders took a very linear approach to how their communities were to be divided for the purposes of implementing the HIRV model. This may well have reflected how fire prevention and community awareness programs had been conducted in the past. It will be interesting to monitor the future implementation of HIRV and to determine whether or not there is something distinct about how emergency responders conceptualize the ways in which communities are organized. Findings pertaining to this may assist in the development of mitigation programs and emergency response procedures.

(6) In all of the participatory case studies, as well as in the Sooke workshop, participants ultimately decided to divide the community into six zones. Why six? Is this just coincidence or is there something about using six zones that is particularly relevant to the implementation of the HIRV model? As more communities start to implement the HIRV model, the number of zones that are identified should be considered and their significance assessed.

(7) For the purposes of this thesis, I chose, defined, and discussed seventeen hazards, researching and documenting the risk and vulnerability factors for all of them. The accumulated research on the remaining hazards needs to be completed so that communities will have access to all of the base data necessary to carrying out the HIRV model. A CD-ROM or an interactive program that is accessible via the Internet would be useful with regard to organizing all of the data.

(8) Worldwide, there is considerable work being done on HAZUS, NHEMATIS, RADIUS, and other expert initiatives pertaining to HRV analysis. While most of these initiatives now focus on one or two hazards, this focus may well be expanded. Using the HIRV model does not preclude the use of other approaches to HRV analysis, and it will be important to monitor and evaluate the development of all of them. It will be especially interesting to evaluate the findings on the earthquake-based RADIUS project and to assess how its strengths compare to those of the all-hazard HIRV model. What will be particularly interesting will be the way in which the RADIUS project: (1) involves decision makers and local government officials, (2) involves both scientists and laypersons, (3) transfers scientific data so that residents can understand them, and (4) uses the mass media.

The future holds many interesting and exciting possibilities for additional HRV research. The final chapter of this thesis briefly summarizes the content of this dissertation and identifies how the thesis goal and research questions have been addressed.

8. Thesis Summary and Concluding Remarks

This thesis is concerned with HRV analyses as they apply to communities and regional districts that are planning for, and responding to, disasters. Disasters will continue to occur, and their social, economic, and environmental impacts will continue to increase. Unfortunately, to this point, communities and regional districts have had neither effective disaster management programs nor adequate models for HRV analysis, which is the cornerstone of the disaster management process. With adequate HRV analyses, communities can: (1) develop warning systems, (2) focus planning efforts on hazards that are likely to occur and that will have a serious impact, and (3) ensure that planning initiatives and mitigative strategies enhance resilience. When communities do not have access to adequate HRV analyses, the consequences are numerous and serious: people die unnecessarily, people are unnecessarily injured, and valuable resources and property are destroyed. I address this problem through mainly qualitative research methods: extensive and multi-disciplinary literature reviews; a review of extant models for HRV analysis; and extended exploratory studies.

The key definitions used in this dissertation focusing on disasters are:

- a disaster is a non-routine event that exceeds the capacity of the affected area to respond to it in such a way as to save lives; to preserve property; and to maintain the social, ecological, economic, and political stability of the affected region.
- disaster management is the process of forming common objectives and common values in order to encourage participants to plan for and deal with potential and actual disasters;
- risk is the probability, based on available data and scientific knowledge, of a disaster occurring in a particular place;
- impact reflects the social, economic, environmental and political consequences of a disaster; and
- vulnerability is the susceptibility of people, property, industry, resources, ecosystems, or historical buildings and artefacts to the negative impact of a disaster.

The goal of the thesis is to develop and to evaluate an integrated and community-based model for HRV analysis — one that has the potential to successfully mitigate the impacts of a disaster. The importance of HRV analysis has been well documented in the literature, and a number of different models for HRV analysis have been developed over the past decade. A survey of communities across Canada revealed that only a few communities used one of the established models for HRV analysis. This being the case, the first research question was: ***Why are existing models for HRV analysis so seldom used?*** The answer to this question is that extant models to HRV analysis are seldom used because there are so many obstacles to integrating HRV analysis and decision making. Some of these obstacles are due to the following:

1. Historically, disaster management and community planning have been rooted in very different ideologies, despite the fact that they share some common features and objectives; namely, the desire to achieve a sustainable, healthy, and resilient community. There is a need for a planning approach that integrates land-use planning and disaster management, along with a high degree of public participation. The case study relating to the Portola Valley, California, gives credence to the potential success of this type of planning approach.

2. Disaster management is forced to deal with a number of social factors: (1) lack of public awareness, (2) public apathy, (3) risk communication, (4) risk perception, and (5) acceptance of risk. Overcoming denial is one of the key factors in dealing with public apathy; adequately communicating risks is another. Risk communication cannot start without risk awareness and evaluation; consequently, the key points that an adequate model has to take into account are: (1) the need to have a dialogue amongst and between local stakeholders and experts, (2) the need to provide stakeholders with essential and easily understood quantitative and qualitative data, and (3) the need to recognize the importance of assessing and understanding community vulnerabilities. The process of risk assessment is often centred on how people perceive risk, thus an adequate HRV process has to include an educational component pertaining to risk perception and risk assessment. Another key element in dealing with how people perceive and communicate information about hazards and risks pertains to the need to take into consideration the existing vulnerabilities of people and their immediate surroundings.

3. Successful mitigation programs must deal with (1) the unreliability of much of the scientific and technological data that deals with disasters, and (2) the economic barriers to using high-technology tools when conducting HRV analyses. The findings show that planning tools should encompass a wide range of options, including those that are not highly dependent upon technology and that are affordable at the local government level.

4. A review of organizational factors indicates that communities frequently do not have access to sufficient resources to enable them to adequately conduct disaster management business. Without the political will to allocate enough resources, few communities will be sufficiently prepared to deal with disasters. Two key elements of a successful HRV analysis are: (1) the ability to ensure that information is shared with the public, thus facilitating the development of a political constituency, and (2) the ability to ensure that the concerns of competing special interest groups are incorporated into the overall HRV process. Without recognizing the effect of competing interests on the political stage, the adoption of mitigation strategies will be seriously compromised.

The preceding obstacles not only explain why so few HRV analyses were being utilized, they also reveal that an adequate HRV analysis must meet a number of key objectives. By synthesizing an extensive interdisciplinary literature review and Renn's approach, I was able to identify fourteen such objectives. These became the basis for the dissertation.

We know that there are a number of models for HRV analysis and a variety of obstacles that prevent communities from implementing them. Is the problem one of implementation? Or are these models themselves deficient? This led me to the second research question: ***Do any of the extant models for HRV analysis incorporate the key objectives of an adequate HRV analysis?*** The answer to this question is no. Research indicates that there are eight key internationally recognized all-hazard, community-based models for HRV analysis: the model used by Emergency Preparedness Canada, two models used by the Federal Emergency Management Agency in the United States, one model used in Australia, two models developed by the United Nations, one model developed by the Norwegian government, and a model recently released by the National Oceanic and Atmospheric Administration in the United States. When evaluated against the fourteen objectives previously identified, these models were found to be deficient in numerous areas.

Having assessed the deficiencies of the extant models for HRV analysis, I arrived at the third research question: ***Can I develop a new model for HRV analysis that meets the key objectives?*** The answer to this question is yes. I call my new model HIRV – An Integrated Model for Community Hazard, Impact, Risk and Vulnerability Analysis.

I developed the HIRV model for HRV analysis – a model that I designed to take into account the fourteen key objectives of HRV analysis – by conducting an extensive literature review, by utilizing the best aspects of extant models for HRV analysis, and by conducting exploratory studies. The HIRV model is based on the principle of community participation, and it is comprised of five parts: (1) hazard identification, (2) risk analysis, (3) vulnerability analysis, (4) impact analysis, and (5) risk management. It provides the means for communities to identify potential hazards, to assess the relative risks and vulnerabilities of a particular area, to assess the impact of potential hazards, and to prioritize findings with regard to the allocation of time and resources.

Once I developed the essence of the HIRV model, I arrived at the fourth and final research question: ***How do I know whether or not the HIRV model can be successfully implemented?***

In order to address this question, I engaged in an extensive and extended series of exploratory studies. These studies were essential to the development of the HIRV model, as many of the latter's unique qualities came about as a result of their findings. The exploratory studies were particularly relevant in my coming to the realization that I would have to abandon model structuring as a way of focusing my research and concentrate, instead, on the HRV process itself.

A second set of exploratory studies, based on the revised HIRV model, made use of participatory case studies to evaluate the effectiveness of the implementation of the HIRV model. Three communities in British Columbia (Barriere, Taylor, and Kamloops) agreed to participate in a HIRV workshop designed to enable community members to apply the HIRV model to their own communities. When the workshops were complete, the participants filled out a questionnaire that was designed to elicit how well they thought that the HIRV model met the fourteen key objectives. The results of this questionnaire were positive and indicated that it was time to implement and evaluate the HIRV model on a long-term basis.

The HIRV model makes an important contribution to the field of disaster management and community planning and has a number of unique elements. The HIRV process

1. is carried out by a diverse advisory committee; decisions are shared between community officials and public representatives. Experts, the media, industry, residents and others all have a role on the HIRV committee.
2. explicitly states that its goal is to focus on sustainable hazard mitigation and, in order to succeed, the HIRV model involves widespread public participation and recognizes that political legitimation is crucial to ensuring the adoption of mitigative strategies.
3. ensures that there is adequate risk communication. The HIRV model involves stakeholders and makes use of the media, and its findings are presented in a format that can be understood by the general public.
4. is grounded in the belief that it is only when the public understands potential hazards and their consequences that enough public pressure will be put on elected officials to ensure that mitigative steps will be taken.
5. recognizes that disasters do not affect all residents equally. It is the only model whose process is designed to empower those most vulnerable through providing a forum within which it is possible to acknowledge issues of equity. In order to enable residents to evaluate equity issues, the HIRV model uses the concepts of zones, or neighbourhoods, to divide a community for comparative purposes.
6. is not dependent upon expensive tools and technology. All communities can afford to implement it. However, should communities have access to GIS, satellite-based intelligence, and so on, the HIRV model is adaptable and can accommodate sophisticated data.

The HIRV methodology, like the HIRV process, is also strong and contributes a number of unique factors. It

1. provides communities with a comprehensive list of hazards. Only by considering all of these hazards can members of a community feel assured that they have not omitted an important one.

2. makes broad use of risk and vulnerability factors. Not only does use of these factors make the evaluative process seem less burdensome, it also makes the rationale for the ratings more apparent, thus adding to the robustness of the analysis.
3. classifies vulnerability factors as a function of people, place, time, and preparedness.
4. incorporates the need to acknowledge and deal with uncertainty. Adaptation of the SPR model to the HIRV risk, vulnerability, and impact analyses is important, and it assists in pinpointing areas of future research as well as areas of agreement and disagreement.
5. recognizes the importance of completing social, environmental, economic, and political impact analyses.
6. allows the HIRV committee to group together those areas of the community that are high risk/high vulnerability and those areas that are low risk/low vulnerability; the former would be given a high priority for mitigation projects, while the latter would be given a low priority. Those areas that fall in between (i.e., high risk/low vulnerability, low risk/high vulnerability, and those moderately affected) would be carefully evaluated and prioritized according to the best judgment available.

Did I meet the thesis goal? Yes. I have developed an effective, integrated, and community-based model for HRV analysis – one that has the potential to successfully mitigate the impacts of a disaster. I believe that the HIRV model will prove to be most beneficial, as it will enable many communities to implement sustainable mitigative strategies.

> Keep in mind that mitigation and effective hazard reduction are the result of human action – reports written, research conducted, and information transferred do not get the job done alone. One of the basic beliefs of our time is that with sufficient information, we can always deduce the correct answer .... Please remember that communication remains a means not an end, that change occurs because of work done on the ground. Do not underestimate the value of information; the potential for ineffective, if not disastrous, mistakes as a result of lack of knowledge is obvious. But if you are truly interested in mitigating disasters, you must transform knowledge and conviction into efforts that change the world. (Myers 1993, 53)

9. Bibliography

Aguirre, Benigno. (1994). Planning, Warning, Evacuation and Search and Rescue: A Review of the Social Science Research Literature. Texas: Recovery Center, Texas A&M University.

Alderfer, Clayton P. (1987). "An Intergroup Perspective on Group Dynamics." In *Handbook of Organizational Behavior,* ed. Jay W. Lorsch. 190-219. Englewood Cliffs, NJ: Prentice-Hall.

Alesch, Daniel J., and William J. Petak. (1986). *The Politics and Economics of Earthquake Hazard Mitigation.* Boulder, CO: Institute of Behavioral Science, University of Colorado.

Alexander, David. (1991). "Natural Disasters: A Framework for Research and Teaching." *Disasters* 15 (3): 209-226.

American Red Cross. (1993). *Emergency Management Guide for Business and Industry.* Washington, D.C., USA: FEMA.

---. (1992). *Community Disaster Education Guide.* Washington D.C., USA: American Red Cross.

---. (1986). *Disaster Service Regulations and Procedures.* ARC 3002/3050: Washington, DC: American Red Cross.

Anderson, Mary B. (1992). "Metropolitan Areas and Disaster Vulnerability: A Consideration for Developing Countries." In *Environmental Management and Urban Vulnerability*, ed., Alcira Kreimer and Mohan Munasinghe, 77-92. New York: World Bank.

Andrews, Richard N.L., Raymond Burby, Alvis G. Turner. (1985). *Hazardous Materials in North Carolina.* Chapel Hill, NC: Center for Urban and Regional Studies, UNC Chapel Hill.

Arnstein, Sherry R. (1969). "A Ladder of Citizen Participation." *Journal of the American Institute of Planners* 35 (4): n.p.

Asken, Michael J. (1993). *PsycherResponse: Psychological Skills for Optimal Performance by Emergency Responders.* Englewood Cliffs, NJ: Regents/Prentice-Hall.

Aspen Global Change Institute. (1996). "Natural Hazards and Global Change. " In *The Elements of Change 1996.* Susan Joy Hassol and John Katzenberger (eds.), 11-88. Aspen: Aspen Global Change Institute.

Atwater, Brian F. (1996). "Coastal geologic evidence for past great earthquakes at the Cascadia subduction zone." In *Abstracts for the Pan Pacific Hazards '96 Conference and Trade Show, Vancouver, British Columbia, July29 -August 2 1996.* Vancouver, BC: Disaster Preparedness Resources Centre, University of British Columbia.

Auf Der Heide, Erik. (1989). *Disaster Response: Principles of Preparation and Coordination.* St. Louis, Missouri: C.V. Mosby.

Australia and New Zealand Governments. (1995). *The Australia/New Zealand Risk Management Standard.* Australia and New Zealand Government Publication #4360.

Aysan, Y.F. (1993). "Vulnerability Assessment." In *Natural Disasters: Protecting Vulnerable Communities*, ed., P.A. Merriman.. 1-14. London: Telford.

Aysan, Yasemin. (1990). "Social and Cultural Aspects of Community Vulnerability and Risk Communication." In *Hazards and the Communication of Risk*, ed. John Handmer and Edmund Penning-Rowsell. Brookfield, VT: Gower.

Barranquilla APELL Group. (1997). "Proceso APELL Barranquilla, Colomiba." *Industry and Environment* 20 (3): 37-41.

Basabe, P. (1999). "Natural Disaster Prevention in the Paute River Basin, Ecuador." *IDNDR Informs: Newsletter for Latin America and the Caribbean* 15: 26-27.

Basham, P. W., J.J. Clague, S.G. Evans, R.A.F. Grieve, J.A. Heginbottom, C.J. Hickson, and K. Moran. (1995). *Overview of Geological and Geophysical Hazards in Canada.* Canada: Geological Survey of Canada.

Bay Area Regional Earthquake Preparedness Project. (1992). *Proceedings: Joint Symposium on Earthquake Hazard Management in Urban Areas.* California: Bay Area Earthquake Preparedness Project.

---. (1989). *Earthquake Vulnerability Analysis for Local Governments.* California: Bay Area Earthquake Preparedness Project.

Beatley, Timothy, and Philip R. Berke. (1993). "Time to Shake Up Earthquake Planning." College Station: Texas: Hazard Reduction Recovery Center, Texas A&M University.

Becker, H.S. (1970). *Sociological Work: Method and Substance.* New Brunswick, NJ: Transaction.

Berke, Philip R., and Steven P. French. (1994). *The Influence of State Planning Mandates on Local Planning Quality.* Texas: Recovery Center, Texas A&M University.

Berke, Philip R., Jack Kartez, and Dennis Wenger. (1993). "Recovery after Disaster: Achieving Sustainable Development, Mitigation and Equity." *Disasters* 17 (2): 93-109.

Bernstein, Alan B. (1987). *The Emergency Public Relations Manual.* 3rd ed. Canada: Pase Incorporated.

Blake, Paul A. (1989). "Communicable Disease Control." In *The Public Health Consequences of Disasters 1989*, Michael B. Gregg, (ed.). 7-12. Washington, DC: US Department of Health and Human Services.

Bolin, Robert. (1993). *Household and Community Recovery After Earthquakes.* Boulder, CO: Institute of Behavioral Science, University of Colorado.

---. (1982). *Long-Term Family Recovery In Disaster.* Boulder, CO: Institute of Behavioral Sciences, University of Colorado.

---. (1976). "Family Recovery from Natural Disaster: A Preliminary Model." *Mass Emergencies* 1: 267-77.

Bolin, Robert, and Patricia Bolton.(1986). *Race, Religion and Ethnicity in Disaster Recovery.* Boulder, CO: Natural Hazards Research and Applications Information Centre, Institute of Behavioral Sciences.

Bolton, Patricia, and Carlyn E. Orians. (1998). "Local Earthquake Mitigation Programs: Perceptions of Their Effectiveness Following Loma Prieta Earthquake." In *The Loma Prieta, California Earthquake of October 17, 1989: Recovery, Mitigation and Reconstruction*. Joanne Nigg (ed.). 35-52. Washington, DC: US Government Printing Office.

Boothroyd, Peter, and Owen A. Anderson. (1973). *The Difference Between Corporate and Social Planning, and the Implications for Indian Affairs.* Regina, Saskatchewan: Department of Indian and Northern Affairs.

British Columbia Adventure Network. (1996). *Communities of the Peace River and Alaska Highway.* http://www.bcadventure.com/adventure/explore/peace/cities/index.html.

British Columbia Environment. (1992). *Guidelines for Industry Emergency Response Contingency Plans.* Victoria, BC: Ministry of Environment, Lands and Parks.

British Columbia Forest Service. (1984). *Kamloops Region.* Victoria, B.C.: B.C. Forest Service.

Britton, Neal. (1989). "Decision-Making in Emergency Organizations Under Conditions of Crisis and Uncertainty." In *Risk and Perception and Response in Australia: Proceedings of a Workshop at the Australian Counter Disaster College July 1989.* Australia: The Center for Resource and Environmental Studies.

—. (1986). "Developing an Understanding of Disaster." *Australian and New Zealand Journal of Sociology* 22 (2): 254-71.

Britton, Neal, and John Oliver. (1991). "Introduction: The Meanings of Hazard." In *Sterling Offices Seminar Proceedings,* ed., Neil Britton and John Oliver, 1-10. Australia : Sterling Offices (Australia) Ltd.

Brookfield, Stephen D. (1986). *Understanding and Facilitating Adult Learning.* San Francisco, California: Jossey-Bass Publishers.

Bruce, Jim. (1995). "Introduction." In *Improving Responses to Atmospheric Extremes: The Role of Insurance and Compensation,* ed. Jim McCulloch and David Etkin, 1-1 - 1-6. Downsview, ON: Environment Canada.

Buckle, Philip. (1999). "Re-defining Community and Vulnerability in the Context of Emergency Management." *Australian Journal of Emergency Management* (Summer): 21-26.

—. (1995). "A Framework for Assessing Vulnerability." *Australian Journal of Emergency Management* 10 (1): 11-15.

Burby, Raymond J. (1998a). "Policies for Sustainable Land Use." In *Cooperating with Nature: Confronting Natural Hazards with Land-Use Planning for Sustainable Communities,* ed., 263-91. Raymond Burby, Washington, DC: Joseph Henry.

Burby, Raymond J. (1998b). "Natural Hazards and Land Use: An Introduction." In *Cooperating with Nature: Confronting Natural Hazards with Land-Use Planning for Sustainable Communities,* ed., 1-26. Raymond Burby, Washington, DC: Joseph Henry.

Burkhart, Ford N. (1991). *Media, Emergency Warnings, and Citizen Response.* Boulder, Colorado: Westview Press.

Burton, Ian. (1994). "Costs of Atmospheric Hazards." In *Proceedings of a Workshop on Improving Responses to Atmospheric Extremes: The Role of Insurance and Compensation.* David Etkin (ed.). 2-1 – 2-11. Ottawa, Canada: Environment Canada.

Burton, Ian, Robert W. Kates, and Gilbert White. (1978). *The Environment as Hazard.* In *Human System Responses to Disaster: An Inventory of Sociological Findings,* ed. Thomas E. Drabek. New York: Oxford University Press.

Burton, Laird. (1996). "What is Emergency Planning?" *In The Canadian Fire Officer's Guide to Emergency Management.* Ron Kuban (ed.). 125-146. Calgary, Alta.: Pendragon Press.

Bush, David M. (1994). "Coastal Mapping and Risk Assessment." In *Natural Disasters: Local and Global Perspective,* ed. National Committee on Property Insurance Proceedings of the 1993 Annual Forum, 9 December 1993, 19-26. Boston, MA: Insurance Institute for Property Loss Reduction.

Callahan, Robert E., C. Patrick Fleenor, and Harry R. Knudson. (1986). *Understanding Organizational Behavior: A Managerial Viewpoint.* Columbus, OH: Merrill.

Camacho, A. (1982). *Societies and Social Decision Functions: A Model with Focus on the Information Problem.* Dordrecht, Holland: D. Reidel Publishing Company.

Canadian Chemical Producers' Association. (1999). http://www.ccpa.ca/english/index.html

—. (N.d.). *Guide to Marine Emergency Response Planning for Chemicals.* Ottawa: Canadian Chemical Producers' Association.

—. *Risk Assessment Guidelines.* Ottawa: Canadian Chemical Producers' Association.

—. *Risk Management Implementation Aid for Distribution Facilities.* Ottawa: Canadian Chemical Producers' Association.

—. *Transportation Risk Management Implementation Aid.* Ottawa: Canadian Chemical Producers' Association.

Castanos, Heriberta, and Cinna Lomnitz. (1995). "Unplanned and Unforeseen Effects of Instabilities in the Nature-Society System as Possible Causes of Earthquake Disasters." In *Natural Hazards* 11, 45-56. Netherlands: Kluwer Academic Publishers.

Central United States Earthquake Consortium. (1993). *Emergency Response and Recovery: Monograph 4.* Memphis, Tennessee: Central United States Earthquake Consortium.

—. (1993). *Socioeconomic Impacts: Monograph 5.* Memphis, TN: Central United States Earthquake Consortium.

Certo, S.C., and S.H. Applebaum. (1983). *Principles of Modern Management.* Dubuque, IN: Brown.

Changnon, S.A., K.E. Kunkel, and B.C. Reinke. (1996). *Impacts and Responses to the 1995 Heat Wave: A Call to Action.* American Meterological Society Bulletin No.77.

Chui, Wing-Hong. (1998). "The Role of Psychology in Policing: An Overview." *Police Journal* (January): 71-80.

Coburn, A.W., R.J.S. Spence, and A. Pomonis. (1991). *Vulnerability and Risk Assessment: Disaster Management Training Programme -- UNDRO.* Cambridge, United Kingdom: Cambridge Architectural Research Limited.

Cohen, Gary. (1994). *The Bhopal Union Carbide Massacre.* New York: Learning Alliance.

Collier, Elaine. (1994). "Modelling Risk in the Insurance Industry." In *Proceedings of a Workshop on Improving Responses to Atmospheric Extremes: The Role of Insurance and Compensation.* David Etkin (ed.). 3-1 – 3-6. Ottawa, Canada: Environment Canada.

Comerio, Mary C. *(1992). Impacts of the Los Angeles Retrofit Ordinance on Residential Buildings.* Earthquake Spectra 8 (1): 79-94.

Covello, V.T., D. von Winterfeldt, and P. Slovic. (1987). "Communicating Scientific Information about Health and Environmental Risks." In *Risk Communication: Proceedings of the National Conference on Risk Communication*, ed., J.D. Davies, V.T. Covello, and F.W. Allen, 109-34. Washington: The Conservation Foundation.

Creswell, John W. (1998). *Qualitative Inquiry and Research Design Choosing Among Five Traditions.* Thousand Oaks, CA: Sage.

Curran, James. (1996). "Mass Media and Democracy Revisited." In *Mass Media and Society* 2nd ed. James Curran and Michael Gurevitch (eds.). 81-119. New York: St. Martin's Press.

Cutter, Susan L., Deborah S.K. Thomas, Micah E. Cutler, Jerry T. Mitchell, and Michael Scott. (1999). *South Carolina Atlas of Environmental Risks and Hazards.* Columbia, South Carolina: Department of Geography Hazards Research Lab, University of South Carolina.

Daines, Guy E. (1991). "Planning, Training and Exercising." In *Emergency Management: Principles and Practice for Local Government*, ed., Thomas E. Drabek and Gerard J. Hoetmer, 161-93. Washington, DC: International City Management Association.

Department of Regional Development and Environment Executive Secretariat for Economic and Social Affairs, General Secretariat of the Organization of American States. (1991) *Primer on Natural Hazard Management in Integrated Regional Development Planning.* Washington, DC: Organization of American States.

Derby, Stephen L., and Ralph Keeney. (1991). "Risk Analysis: Understanding 'How Safe Is Safe Enough?'" In *Readings in Risk,* ed., Theodore S. Glickman and Michael Gough, 43-49. Washington, DC: Resources for the Future.

Deyle, Robert E., Steven P. French, Robert B. Olshansky, and Robert G. Paterson. (1998). "Hazard Assessment: The Factual Basis for Planning and Mitigation." In *Cooperating with Nature: Confronting Natural Hazards with Land-Use Planning for Sustainable Communities*, ed. Raymond Burby, 119-66. Washington, DC: Joseph Henry.

Disaster Preparedness Resources Centre. (1999). *1998 Disaster Preparedness Symposium: Towards an Earthquake Strategy for B.C. Final Repot.* Vancouver, B.C.: Disaster Preparedness Resources Centre.

— (ed.). (1998). *The Mitigation Symposium: Towards a Canadian Mitigation Strategy Comprehensive Symposium Proceedings January 1998.* Vancouver, British Columbia: The Disaster Preparedness Resources Centre, University of British Columbia.

Dombrowsky, Wolf R. (1995). "Again and Again: Is a Disaster What We Call a 'Disaster?'" *International Journal of Mass Emergencies and Disasters* 13 (3): 241-54.

Dorcey, Anthony H.J., and Timothy McDaniels. (1999). "Great Expectation, Mixed Results: Trends in Citizen Involvement in Canadian Environmental Governance." Paper prepared for SSHRC Environmental Trends Project. 2nd draft. Cited with permission.

Dore, Mohammed, and Dave Etkin. (1999). *A Consistent Methodology for Assessing the Economic Costs of Natural Disasters.* Paper presented at the Natural Hazards Conference Boulder Colorado.

Drabek, Thomas E. (1996). *Disaster Evacuation: Tourists and Other Transients.* Boulder, CO: Institute of Behavioral Science, University of Colorado.

—. (1991). "The Evolution of Emergency Management." In *Emergency Management: Principles and Practice for Local Government*, ed., Thomas E. Drabek and Gerard J. Hoetmer, 3-29. Washington, DC: International City Management Association.

—. (1986). *Human System Responses to Disaster: An Inventory of Sociological Findings.* New York: Springer-Verlag.

Drabek, Thomas E., and William H. Key. (1984). *Conquering Disaster: Family Recovery and Long-Term Consequences.* New York: Irvington.

Drabek, Thomas E., Alvin H. Mushkatel, and Thomas S. Kilijanek. (1983). *Earthquake Mitigation Policy: The Experience of Two States.* Denver: Institute of Behavioral Science, University of Colorado.

Drucker, P.F. Management. (1974). *Tasks, Responsibilities, Practices.* New York: Harper and Row.

Dynes, R.R. (1979). "EMS Delivery in Disasters." In *Collected Papers in Emergency Medical Services and Traumatology*, ed. R. Adams Cowley, 56-58. Baltimore: University of Maryland, School of Medicine.

Easson, Gregory L., and Bruce A. Davis. (1999). "High Resolution Remote Sensing for Risk Assessment and Hazard Mitigation". In *Proceedings for the Conference on the Applications of Remote Sensing and GIS for Disaster Management.* National Aeronautics and Space Administration, Federal Emergency Management Agency, George Washington University. 19-21 January. Washington, DC.

Emergency Preparedness Act, C 11. (1988).

Emergency Program Act. (1993). Bill 38.

Emergency Preparedness Canada and Nobility Inc. (2000). "NHEMATIS for Natural Hazards Planning and Assessment." http://www.nobility.com/applications/Emergency_Preparedness/index_fr.htm

Emergency Preparedness Canada. (1997). *A Decade of Disasters*. (video). Ottawa: Canadian Emergency Preparedness College.

---. (1992). "Evaluation of Peacetime Disaster Hazard." In *Emergency Preparedness Program Course - including Annexes A-D.* Ottawa: Emergency Preparedness Canada.

---. (1991). *Vital Points Program*. Ottawa: Emergency Preparedness Canada.

Environics Research Group Limited. (1995). *Emergency Preparedness: Canadian Attitudes and Behaviour.* Ottawa: Emergency Preparedness Canada.

Faupel, C. (1987). "Human Ecology: Contributions to Research and Policy Formation." In *Sociology of Disasters*, ed., R.R. Dynes, B. De Marchi, C. Pelanda, (n.p.). Milano, Italy: Granco Angeli Libri.

Federal Emergency Management Agency. (2000a). Project Impact: Building a Disaster-Resilient Community. http://www.fema.gov/impact/pi_01.htm

Federal Emergency Management Agency. (2000b). *HAZUS 99*. http://www.fema.gov/hazus/hazus99.htm

---. (1998). *Partnerships in Preparedness: A Compendium of Exemplary Practices in Emergency Management,* vol. 2. Washington, DC: Federal Emergency Management Agency.

---. (1997). *Reports on Costs and Benefits of Natural Hazard Mitigation.* Washington, DC: Federal Emergency Management Agency.

---. (1996). *HAZUS: The FEMA Tool for Estimating Earthquake Losses*. Washington, DC: Federal Emergency Management Agency.

---. (1994). *Capabilities for the Emergency Management Partnership Draft Report of FEMA's Civil Defense Study Team.* Washington, DC: Federal Emergency Management Agency.

---. (1993). *Supporting Documentation for Resources Required for the Emergency Management Partnership A Report to the Office of Management and Budget by FEMA's Civil Defense Study Team.* Washington, DC: Federal Emergency Management Agency.

---. (1987). *Hazard Identification, Capability Assessment and Multi-Year Development Plan for Local Governments.* Washington, D.C.: Federal Emergency Management Agency.

Federal Emergency Management Agency Region VIII and the National Park Service, Rocky Mountain Region. (1994). *A Multi-Objective Planning Process for Mitigating Natural Hazards.* Denver: FEMA VIII and the National Park Service, Rocky Mountain Region.

Fischoff, Baruch. (1984). "Judgmental Aspects of Risk Analysis." In *Handbook of Risk Assessment*. U.S.A: National Science Foundation.

Fischhoff, Baruch, Stephen R. Watson, and Chris Hope. (1991). "Defining Risk." In *Readings in Risk*, ed., Theodore S. Glickman and Michael Gough, 30-41. Washington, DC: Resources for the Future.

Fischhoff, Baruch, Sarah Lichtenstein, Paul Slovic, Stephen L. Derby, and Ralph Keeney. (1983). *Acceptable Risk*. New York: Cambridge University Press.

Fischhoff, Barusch, Christoph Hohenemser, Roger Kaspeson, and Robert Kates. (1978). "Handling Hazards: Can Hazard Management be improved?" *Environment* 20 (7): 16-20; 32-37.

Foster, Harold D. (1988). "Multiple Hazard Mapping: A Technique for Reducing Life Loss and Injury." In *Risk Assessment and Management: Emergency Planning Perspective*. Larry R.G. Martin and Gilbert Lafond (eds.). 3-21. Waterloo, Ontario: University of Waterloo Press.

---. (1980). *Disaster Planning: The Preservation of Life and Property*. New York: Springer-Verlag.

Friedmann, John. (1992). *Empowerment: The Politics of Alternative Development*. Cambridge, Massachusetts: Blackwell.

---. (1987). *Planning in the Public Domain: From Knowledge to Action*. Princeton, NJ: Princeton University Press.

Friedmann, John and Clyde Weaver. (1980). *Territory and Function: The Evolution of Regional Planning*. Los Angeles: University of California Press.

Fritz, Charles E. (1961). "Disasters." In *Contemporary Social Problems*, ed. Robert K. Merton and Robert A. Nisbet, 651-94. New York: Harcourt.

Gagne, Robert M. (1987). *Instructional Technology: Foundations*. Hillsdale, N.J.: Lawrence Erlbaum Associates, Publishers.

Giarini, Orio, and Walter R. Stahel. (1993). *The Limits to Certainty* (2nd edition). The Netherlands: Kluwer Academic.

Gilbert, Claude. (1995a). "Studying Disaster: A Review of the Main Conceptual Tools." *International Journal of Mass Emergencies and Disasters* 13 (3): 231-40.

---. (1995b). "Reply to Hewitt." *International Journal of Mass Emergencies and Disasters* 13 (3): 341-46.

Gillespie, David F., Richard A. Colignon, Mahasweta M. Banerjee, Suanan A. Murty, and Mary Rogge. (1993). *Partnerships for Community Preparedness*. Boulder, CO: Institute of Behavioral Science, University of Colorado.

Godschalk, David R. (1991). "Disaster Mitigation and Hazard Management." In *Emergency Management: Principles and Practice for Local Government*, ed. Thomas E. Drabek and Gerard J. Hoetmer, 131-60. Washington, DC: International City Management Association.

Godschalk, David R., and David J. Brower. (1985). "Mitigation Strategies and Integrated Emergency Management." *Public Administration Review* 45: 64-71.

Godschalk, David R., Edward J. Kaiser, and Philip R. Berke. (1998). "Hazard Assessment: The Factual Basis for Planning and Mitigation." In *Cooperating with Nature: Confronting Natural Hazards with Land-Use Planning for Sustainable Communities*, ed. Raymond Burby, 85-118. Washington, DC: Joseph Henry.

Golding, Dominic, Theodore S. Glickman, and Robert A. Hersh. (1992). *Preliminary Proposal for the Development of Community Risk Profile for Pittsburgh.* Washington, DC: Center for Risk Management.

Grazulis, T.P. (1993). Significant Tornadoes 1680 to 1991: A chronology and analysis of events. St. Johnsbury, Vermont: The Tornado Project of Environmental Films.

Greene, Marjorie, Ronald Perry, and Michael Lindell. (1981). "The March 1980 Eruptions of Mt. St. Helens: Citizen Perceptions of Volcano Threat." *Disasters* 5 (1): 49-66.

Grescoe, Taras. (1997). "After the Deluge." *Canadian Geographic*, (March/April), 29-40.

Guarnizo, Caroline. (1992). "Living with Hazards Communities' Adjustment Mechanisms in Developing Countries." In *Environmental Management and Urban Vulnerability*, Alcira Kreimer and Mohan Munasinghe (eds.), 93-107. U.S.: World Bank.

Hackman, J. Richard. (1987). "The Design of Work Teams." In *Handbook of Organizational Behavior*. ed. Jay W. Lorsch. 315-42. Englewood Cliffs, NJ: Prentice-Hall.

Haimes, Yacov Y. (1992). "Toward a Holistic Approach to Total Risk Management." *Geneva Papers on Risk and Insurance* 17 (64): 314-21.

Hammond, John S. (1978a). "Do's and Don'ts of Computer Models for Planning." In *The Decision Science Process integrating the Quantitative and Behavioral.* Thad B., Sang M. Lee and Walter B. Newsom (eds.), 243-263. New York, NY: Petrocelli Books Inc.

—. (1978b). "The Roles of the Manager and Management Scientist in Successful Implementation." In *The Decision Science Process integrating the Quantitative and Behavioral.* Thad B., Sang M. Lee and Walter B. Newsom (eds.), 304-325. New York, NY: Petrocelli Books Inc.

Hammond, John S, Ralph Keeney, Howard Raiffa. (1999). *Smart Choices: A Practical Guide to Making Better Decisions*. Boston, MA: Harvard Business School Press.

Handmer, John, and Dennis Parker. (1991). "Hazard Management in Britain: Another Disastrous Decade?" *Area* 24 (2): 113-22.

Hardy, Cynthia. (1987). "The Contribution of Political Science to Organizational Behavior." In *Handbook of Organizational Behavior* Jay W. Lorsch (ed.). 96-108. Englewood Cliffs, NJ: Prentice-Hall Inc.

Harris, Kathleen. (1998). "The Anatomy of Ice Storm 1998: Part 3." *Ottawa Sun*, Sunday, 18 January, 1.

Harriss, Robert, Christoph Hohenemser, and Robert Kates. (1978). "Our Hazardous Environment." *Environment* 20 (7): 6-15; 38-41.

Harrower, Mervin. (1999). Untitled paper delivered at the 12th Emergency Preparedness Conference. Vancouver, British Columbia.

Hartman, Chester. (1974). *Yerba Buena: Land Grab and Community Resistance in San Francisco.* San Francisco, California: National Housing and Economic Development Law Project, Earl Warren Legal Institute, University of California, Berkeley.

Hattis, Dale, and Robert L. Goble. (1995). "Current Priority-Setting Methodology: Too Little Rationality or Too Much?" In *The Debate over Risk-Based National Environmental Priorities*. Adam M. Finkel and Dominic Golding (eds.), 107-33. Washington DC: Resources for the Future.

Hayes, Robert H., and Richard L. Nolan. (1974). "What Kind of Corporate Modeling Functions Best?" *Harvard Business Review* 52(3): 102-12.

Hays, Walter W. (1991). "Hazard and Risk Assessments in the United States." *Episodes* 14 (1): 7-12.

Heimlich, Joe E. and Emmalou Norland. (1994). *Developing Teaching Style in Adult Education*. San Francisco, California: Jossey-Bass Publishers.

Hewitt, Kenneth. (1995). "Excluded Perspective in the Social Construction of Disaster." *International Journal of Mass Emergencies and Disasters* 13 (3): 317-40.

—, (ed.). (1983). *Interpretations of Calamity*. London: Allen and Unwin.

Hodge, Gerald. (1991). *Planning Canadian Communities: An Introduction to the Principles, Practice, and Participants* (2nd edition). Toronto: Nelson.

Hoetmer, Gerard. (1991). "Introduction." In *Emergency Management: Principles and Practice for Local Government*. Thomas E. Drabek and Gerard J. Hoetmer (eds.), vii-xxxv). Washington, D.C.: International City Management Association

Hohenemser, C., R.W. Kates, and P. Slovic. (1983). "The Nature of Technological Hazard." *Science* 220: 378-84.

Horlick-Jones, Tom. (1995). "Modern Disasters as Outrage and Betrayal." *International Journal of Mass Emergencies and Disasters* 13 (3): 305-16.

Horlick-Jones, Tom, and D.K.C. Jones. (1993). "Communicating Risk to Reduce Vulnerability." In *Natural Disasters: Protecting Vulnerable Communities*, ed. P.A. Merriman, 25-37. London, UK: Telford.

Howe, Charles W., and Harold C. Cochrane. (1993). *Guidelines for the Uniform Definition, Identification, and Measurement of Economic Damages from Natural Hazard Events*. Colorado: Institute of Behavioural Science, University of Colorado.

Institute for Environmental Studies. (1997). *Coping with Natural Hazards in Canada: Scientific, government and Insurance Industry Perspectives. A Study written for the Round Table on Environmental Risk, Natural Hazards and the Insurance Industry*. Toronto, Ontario: Institute for Environmental Studies, University of Toronto.

Insurance Bureau of Canada. (1994). *Canadian Earthquake Exposure (And the Insurance Industry): A Proposal for Action*. Ottawa, Canada: Insurance Bureau of Canada.

Integrated Resource Planning Committee. (1993). Public Participation Guidelines for Land and Resource Management Planning. Victoria, B.C.: The Land Use Coordination Office, Province of British Columbia.

International Decade for Natural Disaster Reduction Secretariat Office for the Coordination of Humanitarian Affairs, United Nations. (1999). RADIUS: an Initiative for IDNDR. http://www.idndr.org/radius/leaflet.htm

International Federation of Red Cross and Red Crescent Societies. (1995). *World Disasters Report 1994*. Switzerland: International Federation of Red Cross and Red Crescent Societies.

Ivancevich, John M. and Michael T. Matteson. (1987). *Organizational Behavior and Management*. Piano, Texas: Business Publications Inc.

Jessen, Knud. (1985). "Aircraft Disaster Readiness." *Journal of World Association for Emergency and Disaster Medicine*. 203-206.

Jovanovic, Petar. (1988). "Modeling of Relationship between Natural and Man-Made Hazards." In *Natural and Man-Made Hazards*, ed., M.I. El-Sabh and T.S. Murty, 9-17. Vancouver: Reidel.

Justice Institute of British Columbia. (1998). *Women in Disasters: Exploring the Issues Seminar: Conference Proceedings*. New Westminster, BC: Justice Institute of British Columbia.

Kamloops, City of. (1999). KAMPLAN – A Community Plan for Kamloops. http://www.city.kamloops.bc.ca/kamplan/indexhtml.

Kaner, Sam, Lenny Lind, Catherine Toldi, sarah Fisk and Duane Berger. (1998). *Facilitator's Guide to Participatory Decision-Making*. Gabriola Island, B.C: New Society Publishers.

Kasperson, Roger E. (1992). "The Social Amplification of Risk." In *Social Theories of Risk*, ed., Sheldon Krimsky and Dominic Golding, 154-178. Westport, CT: Praeger.

Kasperson, Roger E., and K. David Pikawka. (1985). "Societal Response to Hazards and Major Hazard Events: Comparing Natural and Technological Hazards." *Public Administration Review* 45: 7-18.

Kates, Robert W. (ed). (1977). *Managing Technological Hazard: Research Needs and Opportunities*. Denver, CO: Institute of Behavioural Science, University of Colorado.

Keeney, Ralph L., Detlof Von Winterfeldt, and Thomas Eppel. (1990). "Eliciting Public Values for Complex Policy Decisions." *Management Science* 36 (9): 1,011-030.

Kilbourne, Edwin M. (1989) "Heat Waves." In *The Public Health Consequences of Disasters 1989*, ed. Michael B. Gregg, 51-62. Washington, DC: US Department of Health and Human Services.

Koppel, Tom. (1989). "Earthquake! Major Quake Overdue on the West Coast." Ottawa, Canada: Geological Survey of Canada, reprinted from *Canadian Geographic*, August/September, 1-8.

Korver, Adrian. (1985). "What Is a Disaster?" In *International Congress on Disaster Medicine*. 152-53. Netherlands: Netherlands Red Cross Society National Headquarters:

Kreps, Gary A. (1995). "Disaster as Systemic Event and Social Catalyst: A Clarification of Subject Matter." *International Journal of Mass Emergencies and Disasters* 13 (3): 255-84.

—. (1991). "Organizing for Emergency Management." In *Emergency Management: Principles and Practice for Local Government*, ed. Thomas E. Drabek and Gerard J. Hoetmer, 30-54. Washington, DC: International City Management Association.

Kreps, Gary A., Susan Lovegren Bosworth, Jennifer Mooney, Stephen T. Russell, and Kristen A. Myers. (1984). *Organizing, Role Enactment, and Disaster: A Structural Theory*. Newark, Delaware: University of Delaware Press.

Krimsky, Sheldon. (1992). "The Role of Theory in Risk Studies." In *Social Theories of Risk*, ed. Sheldon Krimsky and Dominic Golding, 1-22. Westport, CT: Praeger.

Krimsky, Sheldon, and Dominic Golding, (eds.). (1992). Social Theories of Risk. Westport, CT: Praeger.

Kuban, Ron. (1993). *The Emergency Site Management System: An Extension of the Incident Command System*. Edmonton, AB: Alberta Public Safety Services.

Lash, Jonathan. (1995). "Integrating Science, Values, and Democracy through Comparative Risk Assessment." In *The Debate over Risk-Based National Environmental Priorities*, ed. Adam M. Finkel and Dominic Golding, 69-86. Washington, DC: Resources for the Future.

Laughy, Laurie. (1991). *A Planner's Handbook for Emergency Preparedness*. Vancouver: Centre for Human Settlements, University of British Columbia.

Lave, Charles A. and James G. March. (1975). *An introduction to models in the social sciences*. New York, New York: Harper & Row Publishers.

Lave, Lester B. (1986). "Approaches to Risk Management: A Critique." In *Risk Evaluation and Management*, ed. V. Corello, J. Manker, and J. Mumpane, 461-86. New York: Plenum.

Lavoie, Judith. (1997). "Mayors Defend Storm Response." *Times Colonist* (Victoria), 4 January, A3.

Lawrence, J. (1981). *Approaches to Natural Hazard Planning in Urban Areas*. In *Proceedings of the 11th New Zealand Geographers Conference*. 109-12. New Zealand: New Zealand Geographical Society.

Lewin, K. (1951). *Field Theory in Social Science*. New York: Harper & Row.

Leytens, Anthony. (1993). "Determining Acceptable Risk Levels." *U.S.A Risk Management*, (October), 69-72.

Lindsay, John Roderick. (1993). *Exploring the Interface of Urban Planning and Disaster Management*. Winnipeg: University of Manitoba Press.

Light, R.J., J. Singer, and J. Willett. (1990). *By Design: Conducting Research on Higher Education*. Cambridge, MA: Harvard University Press.

Little, John D.C. (1978). "Models and Managers: The Concept of a Decision Calculus." In *The Decision Science Process integrating the Quantitative and Behavioral*. Thad B., Sang M. Lee and Walter B. Newsom (eds.), 218-242. New York, New York: Petrocelli Books Inc.

Lopes, Rocky. (1992). *Public Perception of Disaster Preparedness Presentations Using Disaster Damage Images*. Boulder, CO: Natural Hazards Research and Applications Information Center, University of Colorado.

Lorimer, Rowland. (1994). *Mass Communications: A Comparative Introduction*. New York: Manchester University Press.

Lowman, Joseph. (1995). *Mastering the Techniques of Teaching* 2nd ed. San Francisco, California: Jossey-Bass Publishers.

Luhmann, Niklas. (1993). *Risk: A Sociological Theory*. New York: de Gruyter.

MacCrimmon, Kenneth R., and Donald Wehrung. (1986). *Taking Risks: The Management of Uncertainty*. New York: Free Press.

Mader, George G. (1994). "Recovery, Mitigation, and Planing." In *Practical Lessons from the Loma Prieta Earthquake*. Washington, DC: National Academy Press.

Mader, George G., with Thomas C. Vlasix and Penelope A. Gregory. (1988). *Geology and Planning: The Portola Valley Experience*. Portola Valley, California: Consolidated Publications.

Mairson, Alan. (1994). "The Great Flood of '93." *National Geographic*, January, 42-86.

Map Art Publicatons. (1997). *Kamloops*. Oshawa, Ontario: Map Art Publications

Maskrey, Andrew. (1989). *Disaster Mitigation: A Community Based Approach*. Oxford: Oxfam.

Maxwell, Joseph A. (1996). *Qualitative Research Design: An Interactive Approach*. Thousand Oaks, CA: Sage.

May, Peter J. (1997). *Addressing Natural Hazards: Challenges and Lessons for Public Policy*. 30-37. Australian Journal of emergency Management.

May, Peter J., and Raymond J. Burby. (1996). "Coercive Versus Cooperative Policies: Comparing Intergovernmental Mandate Performance." *Journal of Policy Analysis and Management* 15 (2): 171-201.

May, Peter J., and Robert E. Deyle. (1998). "Governing Land Use in Hazardous Areas with a Patchwork System." In *Cooperating with Nature: Confronting Natural Hazards with Land-Use Planning for Sustainable Communities*, ed. Raymond Burby, 57-82. Washington, DC: Joseph Henry.

McQuail, Denis. (1996). "Mass media in the Public Interest: Towards a Framework of Norms for Media Performance." In *Mass Media and Society* 2nd ed. James Curran and Michael Gurevitch (eds.). 66-80. New York: St. Martin's Press.

Miles, M.B., and A.M. Huberman. (1994). *Qualitative Data Analysis: An Expanded Sourcebook.* 2nd ed. Thousand Oaks, CA: Sage.

Mileti, Dennis S. (1999). *Disaster by Design.* Washington, DC: Joseph Henry Press.

Mileti, Dennis, Janice R. Hutton, John H. Sorensen. (1981). *Earthquake Prediction Response and Options for Public Policy.* Denver, CO: Institute of Behavioural Science, University of Colorado.

Montz, Burrell E., and Graham A. Tobin. (1997). *The Environmental Impacts of Flooding in St. Maries, Idaho.* Boulder, CO: Natural Hazards Center, University of Colorado.

Morgan, Graham C. (1991). "Quantification of Risks from Slope Hazards." In *Geologic Hazards Workshop Proceedings*, 57-70. Vancouver: Geologic Hazards '91.

Morgan, M. Granger. (1985). "The Importance of Risk Perception." In *Proceedings from Avoiding and Managing Environmental Damage from Major Industrial Accidents*, 321-26. Vancouver, BC: International Conference Presented by the Air Pollution Control Assoc.

Morrow, Betty. (1997). *Diversity and Equity in Disaster Management: Best Practice Models and Strategies for Change.* Paper presented at the Natural Hazards Conference in Boulder, Colorado.

Moss, Richard, and Stephen Schneider. (1997). "Characterizing and Communicating Scientific Uncertainty: Building on the IPCC Second Assessment." In *The Elements of Change 1996.* Susan Joy Hassol and John Katzenberger (eds.), 90-136. Aspen: Aspen Global Change Institute.

Myers, Mary Fran. (1997). *Insights Emerging from the 'Assessment of Research and Applications for Natural Hazards' in the United States.* Vancouver, British Columbia: Disaster Preparedness Resources Centre, University of British Columbia.

---. (1993). "Bridging the Gap between Research and Practice: The Natural Hazards Research and Applications Information Center." *International Journal of Mass Emergencies and Disasters* 11 (1): 41-54.

Myers, Mary Fran, and Denis Mileti. (1995). "Assessing Hazards Research and Applications in the United States." In *Proceedings for the Tri-Lateral Natural Hazards Risk Assessment Conference*, ed. David Etkin, 1-203 - 1-208. Merrickville, ON: Environment Canada.

National Academy of Public Administration. (1993). *Coping with Catastrophe.* Washington, DC: National Academy of Public Administration.

Natural Disasters Organisation. (1991). *Community Emergency Planning Guide.* Australia: Natural Disasters Organisation.

National Oceanic and Atmospheric Administration. (1999). *Community Vulnerability Assessment Tool: New Hanover County, North Carolina.* Charleston, SC: National Oceanic and Atmospheric Administration Coastal Services Center.

National Research Council, Committee on Risk Characterization, Commission on Behavioral and Social Sciences and Education. (1996). *Understanding Risk: Informating Decisions in a Democratic Society.* Washigton, DC: National Academy Press.

National Research Council (1991). *A Safe Future: Reducing the Impacts of Natural Disasters.* Washington, DC: National Academy Press.

---. (1989). *Improving Risk Communication.* Washington, DC.: National Academy Press.

National Wildlife Federation. (1998). *Higher Ground: A Report on Voluntary Property Buyouts in the Nation's Floodplains: A Common Ground Solution Serving People at Risk, Taxpayers and the Environmen.* Washington, DC: National Wildlife Federation.

Norwegian Directorate for Civil Defence and Emergency Planning. (1995). Guidelines for Municipal Risk and Vulnerability Analysis. Oslo, Norway: Norwegian Directorate for Civil Defence and Emergency Planning

Oliver-Smith, A. (ed.). (1986). *Natural Disasters and Cultural Responses: Studies in Third World Societies 36.* Williamsburg, VA: Department of Anthropology, College of William and Mary.

Olshansky, Robert B., and Jack D. Kartez. (1998). "Managing Land Use to Build Resilience." In *Cooperating with Nature: Confronting Natural Hazards with Land-Use Planning for Sustainable Communities*, ed. Raymond Burby, 167-202. Washington, DC: Joseph Henry.

Organization of American States. (1990). *"Disasters, Planning, and Development": Managing Natural Hazards to Reduce Losses.* Washington, DC: Organization of American States.

O'Riordan, Tim. (1990). "Hazard and Risk in the Modern World: Political Models for Programme Design." In *Hazards and the Communication of Risk*, ed., John Handmer and Edmund Penning-Rowsell. 293-301. Brookfield, VT: Gower.

Palacios, Alberto Maturana. (1997). "APELL in Chile: Towards a Port-Oriented Strategy." *Industry and Environment* 20 (3): 19-21.

Palecek, Milos. (1997). "The APELL Programme in the Czech Republic." *Industry and Environment* 20 (3): 42-43.

Paoli, Greg. (1995a). "Turning Natural Hazard Risk Assessments into Decisions." In the *Proceedings for the Tri-Lateral Natural Hazards Risk Assessment Conference,* ed., David Etkin, 1-209 - 1-214). Merrickville, Canada: Environment Canada.

Parker, Ronald Steven. (1992a). "Vulnerability and Resiliency: Environmental Degradation in Major Metropolitan Areas in Developing Countries." In *Environmental Management and Urban Vulnerability*, ed. Alcira Kreimer and Mohan Munasinghe, 108-52. New York: World Bank.

---. (1992b). "Issues and Trends in Emergency Preparedness for Technological Disasters: Moving beyond the 'Natural' and 'Technological' Labels." In *Environmental Management and Urban Vulnerability*, ed. Alcira Kreimer and Mohan Munasinghe, 237-59. USA: World Bank.

Paterson, Robert G. (1998). "The Third Sector: Evolving Partnerships in Hazard Mitigation." In *Cooperating with Nature: Confronting Natural Hazards with Land-Use Planning for Sustainable Communities*, ed. Raymond Burby, 203-230. Washington, DC: Joseph Henry.

Patton, M.W. (1990). *Qualitative Evaluation and Research Methods.* 2nd ed. Newbury Park, CA: Sage.

Payne, B.A., and R.G. Williams. (1985). *Conflict, Public Communication, and Radioactive Waste Management.* Tucson, U.S.: Waste Management '85 Symposium.

Pearce, Larry, and Laurie Pearce. (1994). *The Northridge Earthquake, January 17th, 1994: Disaster Reconnaissance.* Vancouver, BC: Disaster Preparedness Resources Centre, University of British Columbia.

Pearce, Laurie. (1994). *Emergency Preparedness and Emergency Response: A Course Manual.* Revised. Vancouver: British Columbia Institute of Technology.

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1997). *British Columbia Hazard, Risk and Vulnerability Analysis.* Revised Edition. Vancouver: DPRC, University of British Columbia.

---. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis.* Vancouver: DPRC, University of British Columbia.

Penning-Rowsell, Edmund, and John Handmer. (1990). "The Changing Context of Risk Communication." In *Hazards and the Communication of Risk*, ed., John Handmer and Edmund Penning-Rowsell, 3-15. Vermont: Gower.

Perez-Calderon, Luis Jorge. (1998) *The Public Health Impact of Hurricane Mitch in Central America.* Paper presented at the UCLA conference on public health and disasters. Redondo Beach, California, 11-14 April 1999.

Perry, Ronald. (1987). "Disaster Preparedness and Response Among Minority Citizens." In *Sociology of Disasters*, ed. R. Dynes, de Marchi, and Pelanda, n.p. Milan: Franco Angeli.

Perry, Ronald W., and Alvin H. Mushkatel. (1996). *Minority Citizens in Disasters.* Athens, GA: University of Georgia Press.

Petak, W.J. (1985). "Emergency Management: A Challenge for Public Administration." *Public Administration Review* 45 (1): 3-7.

Phillips, David. (1993). *The Day Niagara Falls Ran Dry!* Canada: Key Porter.

---. (1990). *Climates of Canada.* Ottawa: Supply and Services.

Pickett, John H., and Barbara A. Block. (1991). "Day-to-Day Management." In *Emergency Management: Principles and Practice for Local Government*, ed., Thomas E. Drabek and Gerard J. Hoetmer, 263-88. Washington, DC: International City Management Association.

Porfiriev, Boris N. (1995). "Disaster and Disaster Areas: Methodological Issues of Definition and Delineation." *International Journal of Mass Emergencies and Disasters* 13 (3): 285-304.

Provincial Emergency Program. (1997). *Overview of Greater Victoria's Emergency Response to the Blizzard of '96.* Victoria, BC: Provincial Emergency Headquarters.

Public Works Canada. (1991). *The Brandon Plan: A model for Comprehensive Emergency Management.* Ottawa: Emergency Preparedness: Public Works Canada.

---. (1987). *Hazards Analysis: Halifax, Dartmouth, Bedford Area.* Ottawa, ON: Emergency Preparedness, Public Works Canada.

Quarantelli, E.L. (1993). "Converting Disaster Scholarship into Effective Disaster Planning and Managing: Possibilities and Limitations." *International Journal of Mass Emergencies and Disasters* 11 (1): 15-40

---. (1991). *Different Types of Disasters and Planning Implications.* Delaware: Disaster Research Center, University of Delaware.

---. (1987). "What should we Study? Questions and Suggestions for Researchers about the Concepts of Disasters. " *International Journal of Mass Emergencies and Disasters* 5(1): 7-32.

---. (1986). *Planning and Management for the Prevention and Mitigation of Natural Disasters, Especially in a Metropolitan Context.* Delaware: Disaster Research Center, University of Delaware.

---. (1981). "Sociology and Social Psychology of Disaster." In *Complete Record of the Proceedings 9th World Civil Defense Conference, Part 2.* #147. (n.p.) Delaware, USA: Disaster Research Center (Reprinted

Quarantelli, E.L., and Louis Walter. (1997). "Natural Hazards and Global Change." In *The Elements of Change 1996.* Susan Joy Hassol and John Katzenberger (eds.). 1-80. Aspen: Aspen Global Change Institute.

Raynor, Steve. (1992). "Cultural Theory and Risk Analysis." In *Social Theories of Risk*, ed. Sheldon Krimsky and Dominic Golding, 83-115. Westport, CT: Praeger.

Reason, p. (1988). "Introduction." In *Human Inquiry in Action: Developments in New Paradigm Research.* ed. P. Reason, n.p. Newbury Park, CA: Sage.

Renn, Ortwin. (1992). "Concepts of Risk: A Classification." In *Social Theories of Risk*, ed. Sheldon Krimsky and Dominic Golding, 53-79. Westport, CT: Praeger.

Renteria, Henry. (1992). Untitled paper delivered at Hazards Research and Applications Workshop. Natural Hazards Workshop. Boulder, Colorado, July.

Richie, G.N. (1983). "Atlantis, a Disaster Simulation Exercise for Training Purposes." *Emergency Planning Digest,* January/March, 1-5.

Rivett, Patrick. (1980). *Model Building for Decision Analysis.* England: John Wiley & Sons.

Rivlin, Alice M. (1995). "Rationalism and Redemocratization: Time for a Truce." In *The Debate over Risk-Based National Environmental Priorities.* Adam M. Finkel and Dominic Golding (eds.), 21-29. Washington DC: Resources for the Future.

Robbins, Stephen P. (1997). *Organizational Behavior: Concepts, Controversies, and Applications* 8th ed. Englewood Cliffs, NJ: Prentice-Hall.

---. (1993). *Organizational Behavior: Concepts, Controversies, and Applications* 6th ed. Englewood Cliffs, NJ: Prentice-Hall.

---. (1986). *Organizational Behavior: Concepts, Controversies, and Applications* 2nd ed. Englewood Cliffs, NJ: Prentice-Hall.

Robbins, Stephen P. and Nancy Langton. (2000). *Organizational Behavior: Concepts, Controversies, and Applications* 2nd ed. Editor's proof.

Robinson, Andrew. (1993). *Earthshock: Hurricanes, Volcanoes, Earthquakes, Tornadoes and Other Forces of Nature.* London, UK: Thames and Hudson.

Rosenthal, Uriel, M.T. Charles, and P. Hart. (1989). "The World of Crises and Crisis Management." In *Coping with Crises: The Management of Disasters, Riots and Terrorism,* ed., Uriel Rosenthal, M.T. Charles, and P. Hart, 3-33. Springfield, IL: Thomas.

Rowe, W.D. (1991). "The Social Genesis of Risks and Hazards." In *Risk and Society: The Interaction of Science, Technology and Public Policy*, ed., M. Waterstone, 17-31. Netherlands: Kluwer Academic Publishers.

Rubin, Claire. (1991). "Recovery from Disaster." In *Emergency Management: Principles and Practice for Local Government,* ed. Thomas E. Drabek and Gerard J. Hoetmer, 224-61. Washington, DC: International City Management Association.

Rubin, Claire B. and Daniel G. Barbee. (1985). "Disaster Recovery and Hazard Mitigation: Bridging the Intergovernmental Gap." *Public Administration Review* 45 (1): 57-63.

Rubin, Claire B., Martin D. Saperstein, and Daniel G. Barbee. (1985). *Community Recovery from a Major Natural Disaster.* Denver, Colorado. Institute of Behavioural Science, University of Colorado.

Sale, Ian, and Peter Hessman. (1998). "Port Arthur : Lessons for Early Disaster Management." *Australian Journal of Emergency Management* (Winter): 39-41.

Sandman, Peter M. (1991a). *A Formula for Effective Risk Communication.* Video.

Scanlon, T. Joseph. (1991). "Reaching Out: Getting the Community Involved in Preparedness." In *Emergency Management: Principles and Practice for Local Government,* ed., Thomas E. Drabek and Gerard J. Hoetmer, 79-100.

---. (1982). "the Roller Coaster Story of Civil Defence Planning in Canada." *Emergency Planning Digest,* (April-June), 7-14.

Scanlon, Joseph, Suzane Alldred, Al Farrell, Angela Prawzick. (1985). "Coping with the Media in Disasters: Some Predictable Problems. *Public Administration Review* 45 (1): 123-33.

Sen, Yang. (1997). "The Development of UNEP's APELL Programme in Shanghai." *Industry and Environment* 20 (3): 36-37.

Senge, P. (1990). *The Fifth Discipline: The Art and Practice of the Learning Organization.* New York: Doubleday.

Showalter, Pamela Sands, and Mary Fran Myers. (1992). *Natural Disasters as the Cause of Technological Emergencies: A Review of the Decade 1980-1989.* Colorado: Natural Hazards Research and Applications Information Centre, Institute of Behavioral Sciences.

Siegel, Gilbert B. (1985). "Human Resource Development for Emergency Management." *Public Administration Review* 45: 107-17.

Simon, Herbert A. (1976). *Administrative Behaviour.* New York: Free Press.

Slaymaker, Olav. (1995). "A Comprehensive Framework for the Analysis of Risks due to Geomorphic Hazards." In *the Proceedings for the Tri-Lateral Natural Hazards Risk Assessment Conference,* ed. David Etkin, 1-215 - 1-222. Merrickville, Canada: Environment Canada.

Slovic, Paul, Baruch Fischhoff, and Sarah Lichtenstein. (1991). "Rating the Risks." In *Readings in Risk,* ed. Theodore S. Glickman and Michael Gough, 61-74. Washington, DC: Resources for the Future.

---. (1982. *Regulation of Risk: A Psychological Perspective.* Paper. Washington DC: National Science Foundation.

Sorensen, John, and Dennis Mileti. (1991). "Risk Communication in Emergencies." In *Communicating Risk to the Public,* ed., Roger E. Kasperson and Pieter Jan M. Stallen, 367-392. The Netherlands: Kluwer Academic Publishers.

Spicer, Christopher. (1997). *Organizational Public Relations: A Political Perspective.* Mahwah, N.J.:Lawrence Erlbaum Associates.

Stallings, Robert A. (1995). *Promoting Risk: Constructing the Earthquake Threat.* New York: de Gruyter.

Stoner, James A. F., A. Edward Freeman and Daniel A. Gilbert Jr. (1995). *Management* 6th ed. Englewood Cliffs, NJ: Prentice-Hall.

Stevens, Dennis J. (1999). "Research Note: Myers-Briggs Type Indicator – Cops, Convicts, and College Students." *Police Journal* (January): 59-64.

Svenson, Ola. (1988). "Mental Models of Risk, Communication, and Action: Reflections on Social Amplification of Risk." *Risk Analysis* 8 (2): 199-200.

Swanson, Dan. (2000). "Assessing the Effectiveness of a Contingency Plan for an Individual Business Unit." *Disaster Recovery* (Winter): 78-80.

Taylor Municipality. (1999). Emergency Planning Manual for Taylor. Taylor, BC: Taylor Municipality.

Thomas, John Clayton. (1995). *Public Participation in Public Decisions.* San Fransisco, CA: Jossey-Bass Publishers.

Thompson Nicola Regional District. (1997). *Community Profile: North Thompson Subregion.* http//www.tnrd.bc.ca/econ_dev/nthomweb.asp.

Tierney, K.J. (1985). "Emergency Medical Preparedness and Response in Disasters: The Need for Interorganizational Coordination." *Public Administration Review* 45 (77): 77-84.

Tourism Kamloops. (1998). Map of Kamloops. http://www.city.kamloops.bc.ca/maps/city.html

Umakanthan, R.R. (1997). "The Manali-Enmore Industrial Area near Madras: Implementation of the APELL/LAMP Programme." *Industry and Environment* 20 (3): 43-44.

Umstot, Denis D. (1984). *Understanding Organizational Behavior: Concepts and Applications.* St. Paul, Minneapolis: West Publishing Company.

United Nations Centre for Regional Development. (1990). *The Socioeconomic Impacts of Disasters: Report and Summary of Proceedings of the Fourth International Research and Training Seminar on Regional Development Planning for Disaster Prevention.* Washington, DC: World Bank.

United Nations Disaster Relief Organization. (1991). *Mitigating Natural Disasters: Phenomena, Effects and Options: A Manual for Policy makers and Planners.* New York: United Nations.

United Nations Environment Programme Industry and Environment Program Activity Centre. (1991). *Hazard Identification and Evaluation in a Local Community: Technical Report No. 12.* France: United Nations.

United Nations Office for the Coordination of Humanitarian Affairs. (1998). *Central America: Hurricane/Tropical Storm Mitch OCHA Situation Report No. 11.* Geneva: UN Office for the Coordination of Humanitarian Affairs.

United States Department of Health and Human Services. (1989). *The Public Health Consequences of Disasters,* ed. Michael B. Gregg. Washington, DC: US Department of Health and Human Services.

Varnes, D.J. (1978). "Slope Movement Types and Processes." In *Landslides Analysis and Control. Special Report 176.* ed., R.L. Schuster and RIJ. Krizek. Washington, DC: National Academy of Science.

Wallace, William A. and Frank De Balogh. (1985). "Decision Support Systems for Disaster Management." *Public Administration Review.* 45: 134-46.

Ward, Kaari (ed). (1989). *Great Disasters.* Montreal, Canada: Readers Digest.

Weiss, R.S. (1994). *Learning from Strangers: The Art and Method of Qualitative Interviewing.* New York: Free Press.

Wenger, Dennis E. (1980). "A Few Empirical observations Concerning the Relationship between the Mass Media and Disaster Knowledge: A Research Report." In *Disasters and the Mass Media: Proceedings of the Committee on Disasters and the Mass Media Workshop, February 1979.* Washington, DC: National Academy of Sciences.

Wenger, Dennis E., Thomas F. James, and Charles F. Faupel. (1980). *Disaster Beliefs and Emergency Planning.* Newark, Delaware: Disaster Research Project, University of Delaware.

White, Gilbert. (1988). "Paths to Risk Analysis." *Risk Analysis* 8 (2): 171-75.

---. (1979). "Natural Hazards Policy and Research Issues." In *Natural Hazards in Australia*, ed. R.L. Heathcote and B.G. Thom, 15-22. Sydney, Australia: Australian Academy of Science.

---. (1974). *Natural Hazards: Local, National, Global.* New York: Oxford.

Whitman, Robert V. and Henry J. Lagorio. (1999). *The FEMA-NIBS Methodology for Earthquake Loss Estimation.* http://www.fema.gov/hazus/hazus4a.htm

Whyte, Anne V., and Ian Burton (eds). (1980) *Environmental Risk Assessment.* New York: John Wiley and Sons.

Williams, Elizabeth. (1996). *So...You Want to Teach Adults?* Scarborough, Ontario: Pippin Publishing Company.

Williams, Gary, and Dennis S. Mileti. (1986). "Inclusion of Social Variables in Models of Risk Assessment." In *Geotechnical and Geohydrological Aspects of Waste Management*, 375-79. Fort Collins: Hazards Assessment Laboratory, Colorado State University.

---. (1981). "Inclusion of Social Variables in Models of Risk Assessment." In *Geotechnical and Geohydrological Aspects of Waste Management.* 375-79. Rotterdam; Boston : A.A. Balkema.

Wilson, Bruce. (1988). "City of Edmonton: An Emergency Plan that Works." *Emergency Preparedness Digest*, April-June, 17-23.

Wilson, Richard, and E.A.C. Crouch. (1987). "Risk Assessment and Comparisons: An Introduction." *Science*, April, 267-70.

Winchester, Peter. (1992). *Power, Choice and Vulnerability: A Case Study in Disaster Mismanagement in South India, 1977-1988.* London, UK: James and Science Publications.

Wolf, C.P.. (1974). "Social Impact Assessment: The State of the Art." In *Social Impact Assessment.* C.P.Wolf (ed.), 1-35. U.S.: EDRO

Wyner, Alan J., and Dean E. Mann (1983). *Seismic Safety Policy in California: Local Governments and Earthquakes.* Santa Barbara, CA: Department of Political Science, University of California, Santa Barbara.

Wynne, Brian. (1992). "Risk and Social Learning: Reification to Engagement." In *Social Theories of Risk.* Sheldon Krimsky and Dominic Golding (ed)., 275-97. Westport: Praeger.

Yamamoto, Yasumasa, and E. L. Quarantelli. (1982). *Inventory of the Japanese Disaster Research Literature in the Social and Behavioral Sciences.* Columbus, OH: Disaster Research Center, Ohio State University.

Yarmey, A. Daniel. (1990). *Understanding Police and Police Work: Psychosocial Issues.* New York: New York University Press.

Appendix A The Portola Valley Experience

On 20 July 1964 residents voted to incorporate Portola Valley, a town of approximately nine square miles located south of San Francisco, so that they could control its development and so better preserve and protect its natural and diverse environment. The public was very much concerned with maintaining the character of the community and of the open spaces, which included brush, trees, hills, and steep mountains (Mader et al. 1988).

Passing through the valley's floor is the San Andreas Fault. Landslides are common west of the fault, where steep slopes rise to 1,600 feet, while east of the fault, where rolling hills top 400 feet, land movement is negligible. Although most of the Portola Valley's human population lives in the east, development pressures and growth have caused developers to stake out projects in the less geologically stable lands west of the fault. For this town of approximately 4,300 residents, the expenses incurred in such development come to a total of $1.1 million and are not nearly enough to cover the costs of repairing the potential damage caused by an earthquake or a heavy landslide.

Immediately after incorporation, the town established a conservation committee whose mandate was to develop recommendations that would help conserve the natural setting and character of the valley. Dwight Crowder, a geologist and resident of Portola Valley, was appointed to the committee and was the first to recommend that geological conditions be taken into account when considering zoning, subdivision, and site development regulations. By familiarizing himself with the planning process and town regulations, Crowder was able to develop specific and feasible recommendations for considering geological conditions within the context of community planning. He suggested that:

> a town engineering geologist be retained,
> development of steep slopes be restricted,
> geological hazards be mapped,
> development be set back from faults,
> subdivisions and site development be reviewed with respect to geological hazards, and
> lot sizes be allowed to fit the terrain. (Mader et al. 1988, 8)

Although he translated difficult geological data into practical terms and educated the town council as to the importance of considering geological conditions when making its regulations, the council did not incorporate his recommendations into its 1965 general plan. However, in May 1967 a new residential subdivision development, along with a large portion of a public road, was destroyed by a large landslide. At around the same time, a recently approved subdivision was damaged by another landslide, which destroyed a home. Although county funds were used to repair most of the damage, the costs were well above what the newly incorporated town could afford.

Following the 1967 slide, the town council returned to Crowder and asked him to form a geologic hazards committee. He decided that the committee would be comprised of one attorney; one geologist; one local consulting engineering geologist; one local research geologist; and one soils, or foundation, engineer. The committee's mandate was to assist in minimizing geological hazards-related losses to developers, homeowners, and the town (Mader et al. 1988). Shortly after the committee was formed the town planner joined it as an advisor in the hope of translating the effects of geological concerns into feasible proposals for town expansion. Since 1965 Crowder had been discussing with the town planner his geological concerns regarding land development. In August 1967, the committee made three significant recommendations to the town:

> retain an engineering geologist to advise on matters relating to geological hazards;
> ensure that all ordinances and regulations that could be affected by geological hazards have in place procedures to mitigate potential losses; and
> compile a geologic "hazards map" of the town. (Mader et al. 1988, 9)

The interpretive hazards map, indicating the locations of all possible geological hazards, was of special significance to the town, as it was to be designed so that it could be understood by non-geologists. In February 1968, the council approved the implementation of all three recommendations forwarded by the Geologic Hazards Committee. Immediately, the building inspector was to re-evaluate certain existing lots for potential geologic hazards, and the town planner insisted that all development applications contain a soil report or, if necessary, a geological report. All permits for buildings used for public assembly were henceforth required to submit a geologic report along with their building application. The position of town geologist was created not only to ascertain the possible geologic hazards close to town development, but also to oversee and review all subdivision maps and all soil reports submitted by developers. As well, the town geologist was to manage the preparation of a geological hazards map that would guide all future town developments.

Using aerial photographs, field examinations, and other pertinent sources, the town council, guided by the town geologist, drew up a preliminary map of Portola Valley and the portion of the San Andreas Fault that passes through the town at a scale of 1:1,000 (Mader et al. 1988, 13). Due to fault movement in the past, the town geologist recommended that "a belt 100 feet wide [should] be respected in considering development" (Mader et al. 1988, 16) and that properties that traverse the fault should require developers to present more detailed information. He also requested that, with the help of the town council, he form an ad hoc committee that would outline specific criteria needed to guide any development close to the fault. In 1971, the ad hoc committee included the town planner, the town geologist, the town building inspector, the town engineer, two engineering geologists, and a civil engineer. The recommendations proposed by the ad hoc committee included improving the scale of the hazards map to 1:500, ensuring that houses currently on the fault would not be removed but would be reviewed, and resolving that setback requirements for developments along the fault would be applied uniformly to all properties. In 1972, the committee set forth standards to guide all types of development along or near the fault:

- Within a 100-foot-wide band along the entire length of the fault, no buildings for human occupancy should be permitted.
- Within a 250-foot-wide band along the entire length of the fault, only single-family residences limited to single-story, wood-frame construction should be permitted.
- Beyond a 250-foot-wide band along the entire length of the fault, no specific setbacks are necessary. (Mader et al. 1988, 18)

In mid-1972 the town planner incorporated these recommendations into a draft of the proposed permanent zoning regulations. This draft was reviewed by the ad hoc review committee and was discussed at public hearings with property owners within the fault zone. The regulations prevented or restricted only new development within the fault zone; existing buildings did not require removal and their rebuilding would not be prevented. Since the new regulations allowed existing houses to be left untouched, the property owners agreed to the implementation of the proposed regulations. In February 1973 the town council adopted these permanent zoning regulations.

In 1974, the more precise geological map of Portola Valley and its surrounding area was completed. Although the map was prepared and used by geologists, local residents also referred to it in order to understand how it might affect them. The geological map was entitled "Movement Potential of Undisturbed Ground," and its legend contained and explained the four basic categories of land stability, ranging from "relatively stable ground" to "unstable ground characterized by seasonally active down slope movement." However, since the establishing of a property's potential land movement was integral to its development potential, the town council wanted to investigate how to measure that movement and to create guidelines that would apply consistently to all development applications. In essence, it "did not want to give property owners false hope" regarding the future development of their properties (Mader et al. 1988, 25).

To establish precise guidelines, the ad hoc geological committee was formed and, in March 1974, issued its report. Among its recommendations was reducing the permitted density of development according to the extent of the property's geologic hazard (as measured by the land movement potential map). Also, owners whose properties fell within both stable and unstable land categories were to be allowed a higher density of development on the former in order to encourage them to leave the latter as open space. Since much of the land west of the fault is steep, there was also a need to incorporate slope-density regulations. Portola Valley was one of the first communities to pioneer the establishment of slope-density regulations in its zoning regulations. The idea for these new regulations "emerged from the work of the town's planning consultant and a citizens' committee formed to advise" on the Geologic Hazards Committee's general plan (Mader et al. 1988, 27). The main support for the slope-density regulations came from the public's desire to encourage low-density development in certain areas in order to preserve the natural environment and the character of the town. The combination of a reduced yield for unstable land and slope regulations (including provisions for cluster development) not only created safer land developments, but also encouraged development "that is compatible with the natural environment of the community" (Mader et al. 1988, 30).

In much the same way as the 1967 landslides led the Portola Valley to adopt strong geologic regulations, the 1971 San Fernando earthquake forced the State of California to adopt regulations that would require local governments to include seismic safety elements as part of its local planning. Since the Portola Valley had already set the ground rules for measuring the geologic hazards of the underlying fault-line, the integration of seismic safety elements was simple. Due to an increase in both administrative and public awareness vis-à-vis geologic hazards, the initial 1965 general plan was fundamentally changed in 1977. A proposed elementary school and community centre site astride a trace of the fault was changed to open space; and the development potential of the unstable western hillsides, previously slated to undergo a relatively dense residential development, was reduced by about 60 per cent.

Analysis of the Portola Valley experience suggests that the town's success lies in its ability to fully integrate emergency/community planning with a high degree of community participation. The public's primary objective in voting to incorporate the town was to preserve its scenic setting. It was this interest in preserving the town's natural setting, not a concern with geologic conditions, that influenced town planning heavily enough for Portola Valley to form a conservation committee. The reluctance to consider geologic concerns is not unusual: such concerns only become high priority after a geologic catastrophe (Alesch and Petak 1986, 142).

Often many residents do not want to think about the possibility of a disaster. For example, even though the southwest coast of British Columbia has been known as a high-risk area for earthquakes for many years, prior to 1989 residents showed little interest in actively preparing for them. The October 1989 Loma Prieta earthquake was a wake-up call for the citizens of southwest British Columbia. Seeing the images of the earthquake on television seemed to bring home to people the fact that what was happening in California could also happen in British Columbia. Residents asked government officials what activities had been undertaken to deal with the eventuality of an earthquake, and when the answer was "None," political pressure was such that Angus Ree, the Social Credit minister in charge of the emergency program, was removed from his portfolio (Larry Pearce, personal communication).

Similarly, it was only after the major landslides of 1967 that the Portola Valley incorporated geology into its planning. Yet the public's drive for scenic preservation did not change. The popular desire to preserve the town's character worked in tandem with the Geologic Hazards Committee's desire to limit development in certain areas and to encourage open space; thus, there was no public outcry when the town council set regulations that limited development in the outlying areas west of the fault. Although geological and safety concerns, not public opinion, were the main criteria for establishing development regulations, the end result was the same: a 60 per cent reduction in the initially proposed amount of land to be developed west of the fault. In other words, the wishes of the general population were both directly and indirectly satisfied by the Geologic Hazards Committee's proposed development regulations. Let us now take a closer look at the demands and concerns of the residents whose lands were to be directly affected by the development regulations.

There are two reasons why land owners offered no opposition to the new development regulations adopted by the town: (1) the location of Portola Valley and (2) the way in which the Geologic Hazards Committee proposed concerns regarding enforcement. Most of Portola Valley's development lay to the east of the fault where, among small, rolling hills, geologic hazards are low. The proposed 1965 subdivision and development plans covered the land to the west of the fault, where, due to steep mountains and cliffs, there were few residences. Although relatively few owners would be affected by the new regulations, the Geologic Hazards Committee foresaw the need for the latter to ensure the safety of both present and future residents.

The drawing up of a geologic map detailing the nature and the relative seriousness of geologic hazard potential in the Portola Valley area created a base of information for both the council and property owners. Because this map was used to serve the town geologist, the town planner, the developer, and the land owners, it was revised to enable non-geologists to accurately read and understand it. Also, the Geologic Hazards Committee worked towards standardizing the criteria for evaluating the potential hazard of a property (by encouraging clustering and establishing slope-density formulae), thus making the assessment of development applications more equitable. As long as the property owners understood the potential geologic hazards and what they were able to do, and as long as they felt that they were being treated fairly, they were unlikely to balk at the new regulations. Also, property owners were assured that previously existing structures would not have to be torn down or removed, nor would there be any restrictions placed upon attempts to rebuild or modify them. This concession was crucial; as long as the property owners did not have to modify their present situation, they were generally willing to comply with the new regulations.

This concern for addressing the needs of property owners and involving them in the process of implementing new regulations ensured that events ran smoothly. Portola Valley's method of dealing amicably with property owners stands in stark contrast to how the 1966 council of Long Beach dealt with a similar problem. Long Beach's director of building and safety summarily condemned 116 buildings and imposed a sixty-day notice period in which the property owners had to complete the necessary repairs (Alesch and Petak 1986). In response, the owners formed the United Property Owners Association and fought to revise the city ordinance. Although the director had the best intentions, and the potential geologic hazards were substantial (the buildings were made mostly from unreinforced masonry, making the structures extremely unstable in an earthquake), his methods did not involve property owners and, as a consequence, the ensuing court battle proved long and complicated (Alesch and Petak 1986). At the end of 1976, revisions to the Long Beach ordinance were finally approved.

Portola Valley's citizenry were interested both in maintaining the beautiful scenery of their town and in maintaining future development. This interest was one standard by which regulations and restrictions would be measured. The other standard was the little-understood science of geology. As long as the public's concerns were listened to and considered, new regulations (which may, at first, have seemed foreign and intrusive) were seen as necessary and helpful. In the case of Portola Valley, many steps were taken to ensure that both public and geological needs were met. Indeed, the Portola Valley experience provides a clear demonstration of how public participation benefits the community when combined with the participation of both disaster management planners and community planners.

Appendix B Renn's Framework

In order to develop an adequate HRV analysis, it is critical to identify an appropriate framework within which to situate it. Appendix B begins with a review of various frameworks and analyzes their appropriateness to this task. The second section of Appendix B focuses upon what I determined to be a suitable framework Ortwin Renn's (1992, 57) *Systematic Classification of Risk Perspective.*

B.1 The Search for a Framework

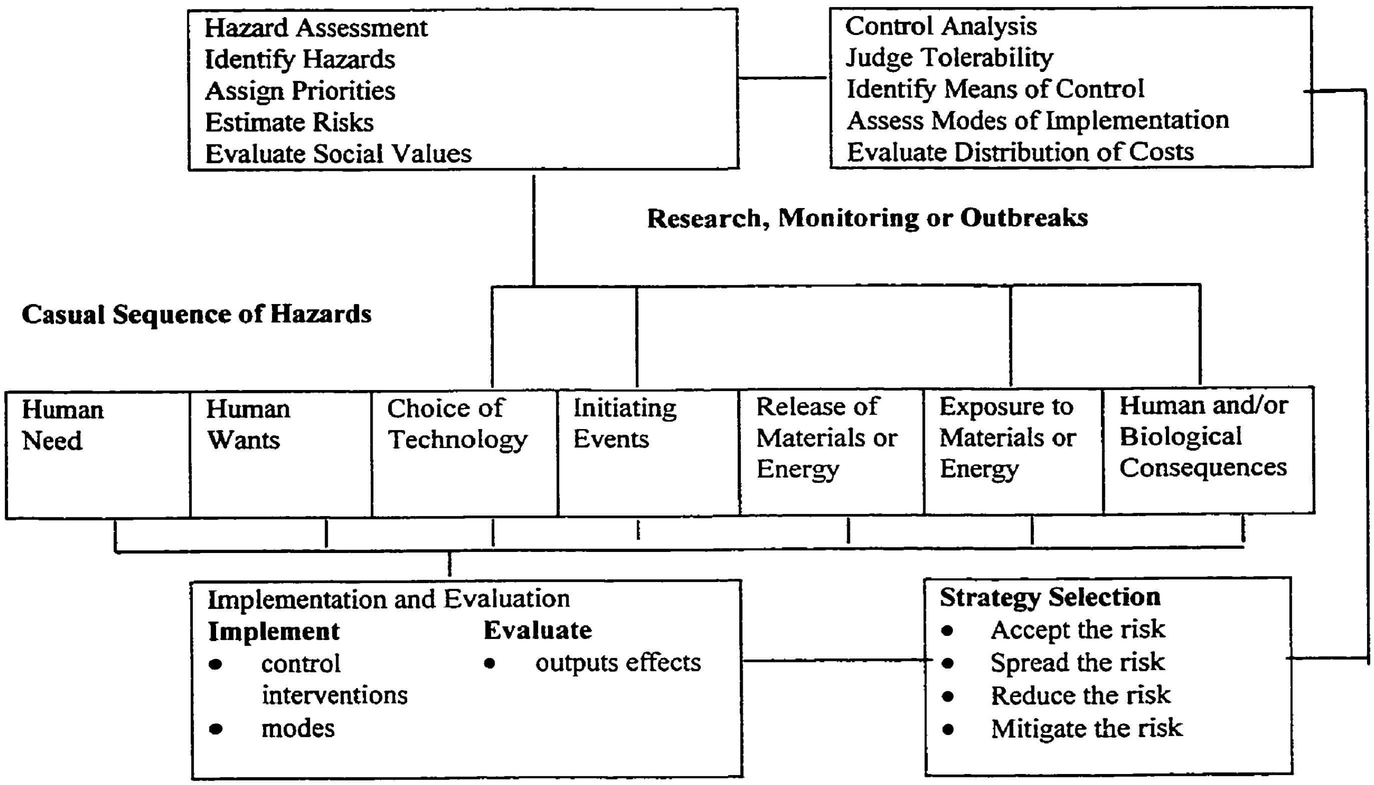
One of the problems of searching through the disaster management planning and mitigation literature for a suitable approach or framework is that, while authors often refer to approaches that are conducive to mitigation, they are seldom comprehensive. For example, Alexander's (1991) pedagogical framework is based on a number of social "laws" derived from case studies (e.g., people tend to overestimate sensational hazardous events) and a series of tables (e.g., structural and non-structural methods of disaster mitigation, classifications of disasters by duration of warning and impact). Upon review, this "framework" is really just a series of related but separate lists of information, and it is utterly lacking in sound theoretical foundation. This was not uncommon, as many proposed frameworks consisted merely of checklists outlining key points derived from case studies (Alesch and Petak 1986, 223-34; Maskrey 1989, 91-99; Andrews et al. 1985, 138-42).

Other problems with purported frameworks were that they: (1) were seldom all-hazard in approach (Mileti et al. 1981; Hunt et al. 1985; Kates 1977); (2) dealt with only one phase of a disaster (Kreps et al. 1984; Rubin et al. 1985, 15; Berke et al. 1993); (3) dealt with only one aspect of the HRV process (e.g., vulnerability) (Winchester 1992); and (4) were directed towards the state, province, or nation (Drabek et al. 1983; Organization of American States 1990) (or towards organizational activities per se [Gillespie et al. 1993]) rather than towards the community. Nevertheless, the literature review identified several frameworks that were worthy of mention, if not for their inherent value as frameworks, then at least for their insights into hazard mitigation.

I review the following frameworks: Siegel (1985), Kasperson and Pijawka (1985), and Godschalk et al. (1998). Siegel's (1985) version of Foster's (1980) framework has four main sections: (1) preparedness and planning (13 elements), (2) mitigation (9 elements), (3) disaster response (9 elements), and (4) disaster recovery (5 elements). He presents this framework as a series of steps, each one leading to the next. Disaster planning is at its least successful when it is conducted in a linear fashion, while it is at its most successful when conducted in a circular fashion. Siegel's only reference to the public and political processes occurs when he deals with regulatory and legal system changes (e.g., communicating a new land-use regulation to the public). Although he acknowledges the need to consider disparate values and levels of risk acceptance, he considers only public officials and disaster managers: public participation is not an issue for him. Siegel's work is, essentially, a list of steps rather than a framework. And it is for this reason that I reject what he offers.

Kasperson and Pijawka's (1985) framework has as its goal the selection of mitigative strategies (see Figure 21), although they use the term "mitigate" with specific reference to disaster response and recovery planning. For them, hazard management has two essential functions: (1) intelligence (the provision of information essential to determining if a problem exists and its possible solutions) and (2) control (the design and implementation of mitigation measures). The hazard management process is defined as a loop of activity encompassing hazard assessment, control analysis, control strategy, and implementation and evaluation.

Figure 21: Flow Chart of Hazard Management



Source: Kasperson and Pijawka (1985, 10)

This framework acknowledges a number of the factors that were addressed in Chapter 3; namely, (1) the problems inherent in attempting to establish priorities, including the consideration of individual and group values; and (2) risk perception and acceptance. The main drawback to this framework is that it does not consider the effect of community and local political processes on the adoption of mitigative measures. Kasperson and Pijawka (1985,

9) themselves acknowledge that their framework can "overwhelm the more limited societal capacity to act." Furthermore, it fails to present any methods for dealing with potential conflicts between different values and competing interests. And, finally, it assumes that technological data are accurate and available, whereas, as has been shown in Chapter 3, this is not the case. Thus I reject what Kasperson and Pijawka have to offer.

Although based solely on land-use mitigation, the approach developed by Godschalk et al. (1998, 115-17) consists of a list of principles and criteria for preparing and evaluating mitigation plans that deal with all potential hazards. This list is composed of twelve key principles and is followed by a number of questions (e.g., "What organizations and individuals were involved in the preparation of the mitigation plan?" [115]). These principles are not derived from a framework per se but from: (1) research on the influence of state mandates on comprehensive plans and their effectiveness vis-à-vis the adoption of mitigative actions; (2) research from New Zealand and the United States on how well disaster management plans have integrated the concept of sustainability; and (3) evaluations of the effects of these principles on mitigation measures adopted by the various states under the Stafford Disaster Relief Act (Godschalk et al. 1998, 114). These twelve principles are: (1) clarity of purpose, (2) citizen participation, (3) issue identification, (4) policy specification, (5) fact base, (6) policy integration, (7) linkages with community development, (8) multiple hazard scope, (9) organization and presentation, (10) internal consistency, (11) performance monitoring, and (12) implementation. As the reader will recognize, these principles have much in common with the factors identified at the end of Chapter 3. Godschalk et al. acknowledge the need for the integration of land-use mitigation and community development, and they focus heavily on citizen participation, asking questions related to the number of stakeholders involved and ensuring an educational approach. They also identify the importance of risk communication and of ensuring that hazardous situations are understood by the population at large.

Godschalk et al.'s twelve principles are important and represent a number of key issues; however, as the authors themselves point out: (1) they are exclusive to land-use mitigation actions; (2) they are not conclusive; and (3) they are only a starting point (114). In reality, these principles and criteria constitute a reflection on basic planning concepts rather than a framework.

Turning now to the literature on corporate management perspective, Wallace and De Balogh (1985) and Leytens (1993) both presented frameworks that were all-hazard in approach. Wallace and De Balogh have identified a Decision Support System (DSS) for disaster management, and this leads to what they describe as a "Framework for Analysis of Disaster Management Activities." DSS is based on four essential components: (1) a data bank, (2) data analysis capability, (3) normative models, and (4) technology for the display and use of (1) and (2) (134). The DSS interacts with two external elements: the disaster manager and the disaster response environment. It is technologically based and assumes that adequate data are available, and it excludes the community at large from the planning process. This framework consists of a matrix listing a number of tasks according to the time frames within which they are to be carried out (e.g., immediately, within a year, over the next twenty-four months). There is no real discussion of the conceptual basis for this framework.

Although Leytens's (1993) framework is based on a corporate perspective, it is worthy of note because it revolves around the concept of risk management and focuses on risk reduction. Upon identifying an actual or perceived risk, the latter is examined in light of the company's objectives and/or values. A decision is made as to whether or not the risk is acceptable, and, in either case, risk reduction strategies are considered. This is somewhat different from what occurs with other frameworks, which only examine risk reduction strategies in light of whether or not they are acceptable. This framework acknowledges that even if the risk is acceptable, mitigative actions may be necessary. It also identifies an "adaptation" phase that sets the stage for the activities that need to occur in order for the mitigative strategies to be effective both inside and outside the organization. However, this framework has two main weaknesses: (1) it assumes a single objective (i.e., that of the company's) and thus does not address competing interests and the needs of a variety of stakeholders; and (2) it fails to identify the scope of a variety of hazards and their differing impact (depending on differing vulnerabilities). And so I reject this framework.

A literature review of what could be loosely categorized as risk proved more fruitful and, ultimately, led to an acceptable framework. Lave's (1986) approach to risk management is interesting in that, although it recognizes the political challenges inherent in a community-based process, it fails to take into account community stakeholders. Although Lave (484-85) acknowledges that his approach contains numerous uncertainties, he believes that the solution lies in "giving the area [of analysis] greater resources and making more of an attempt to use the resulting conclusions." Lave also acknowledges that there are difficult economic and social factors involved in risk management decision making, but his approach leaves us uncertain as to how differences of opinion and vulnerability would be handled. The main reason I did not choose this approach is that it does not consider cultural diversity or direct community involvement.

The area of risk communication has some examples of frameworks regarding hazards, but many are too simplistic to be used in a risk management context. For example, O'Riordan's (1990) framework is based on only two elements: (1) the probability of the hazard (with acknowledgment that the perception of the hazard may be distorted by a number of factors) and (2) actions to be taken once the hazard occurs (namely, to adjust, await for public relief, or move away). Similarly, Sorenson and Mileti's (1991) framework is based on taking five steps once a hazard alert is sounded: hear, understand, believe, personalize, and respond. Penning-Rowsell and Handmer's (1990) framework has some interesting implications concerning the socio-political and cultural context of risk communication; however, it omits the hazard identification and vulnerability assessment phases of risk management. Penning-Rowsell and Handmer clearly see the need for a dialogue between the "experts" and the community, but they only address risks that have been identified and defined as being in the forefront. Furthermore, within this framework community participation has more to do with providing feedback concerning issues that were not well communicated than it does with any real involvement in decision making. Nevertheless, the area of risk communication led me to the literature on overall risk reduction and, thus, to Renn's (1992) framework.

B.2. Renn's Framework

Renn's extensive literature review identified seven approaches to classifying risk perspectives:

- the actuarial approach (using statistical predictions);
- the toxicological and epidemiological approach (including ecotoxicology);
- the engineering approach (including probabilistic risk assessment [PRA]);
- the economic approach (including risk-benefit comparisons);
- the psychological approach (including psychometric analysis);
- social theories of risk; and
- cultural theory of risk (using grid-group analysis[69]). (56)

Renn identifies the basic problems for each of these approaches to risk classification (see Figure 22). Given that disasters apply to more than toxicological and epidemiological situations, Renn's framework has been adapted to show a broader scope in the second column, encompassing all of the necessary technical data (e.g., geological, meteorological, epidemiological, etc.) required for a hazard analysis. Each of these approaches has some direct relevance to disaster management in that they address the distinction between reality and possibility – the one element common to all approaches to risk (Markowitz 1991; Evers and Nowotny 1987 as cited in Renn 1992, 56). Renn's position is: if the future is either predetermined or independent of human activities, then the concept of risk is nonsensical. If the distinction between reality and possibility is accepted, then it is also accepted that humans can make causal connections between actions and so modify outcomes.

What can we extrapolate from Renn's framework? Figure 22 identifies those areas of his framework that are applicable to the HRV process and includes, in summary, the key factors that emerged from my review. As can be seen, the need for adequate risk communication is a major factor in each of the four approaches to risk.

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[69] "The group variable represents the degree of social incorporation of the individual in a social unit ... Grid is defined as a measure of the constraining classifications that bear upon members of any social grouping. Such classifications may be functions of hierarchy, kinship, race, gender, age, and so forth" (Rayner 1992, 87).

Figure 22: A Systematic Classification of Risk Perspective as They Apply to HRV Analysis

	INTEGRATED APPROACHES (e.g., Social Amplification of Risk)						
	Actuarial Approach	**All Hazards Approach**	**Probabilistic Risk Analysis**	**Economics of Risk**	**Psychology of Risk**	**Social Theories of Risk**	**Cultural Theory of Risk**
Base Unit	Expected Value	Modelled Value	Synthesized Expected Value	Expected Utility	Subjectively Expected Value	Perceived Fairness and Competence	Shared Value
Predominant Method	Extrapoliation	Experiments Survey	Event & Fault Tree Analysis	Risk Benefit Analysis	Psychometrics	Surveys Structural Analysis	Grid-Group Analysis
Scope of Risk Concept	Universal One Dimensional	Universal One Dimensional	Safety One Dimensional	Universal One Dimensional	Individual Perceptions Multi-Dimensional	Social Interests Multi-Dimensional	Cultural Clusters Multi-Dimensional
Basic Problem Area	Averaging over space, time, context			Preference Aggregation		Social Relativism	
	Predictive Power	Transfer to Humans Intervening Variables	Common Mode Failure	Common Denominator	Social Relevance	Complexity	Empirical Validity
Major Application	Insurance	Life and Safety Protection of Property	Safety Engineering	Decision Making	Policy Making and Regulations Conflict Resolution (Mediation) Risk Communication		
Instrumental Function	Risk Sharing	Early Warning		Resource Allocation	Individual Assessment	Equity Fairness Political Acceptance	Cultural Identity
		Standard Setting	Improving Systems				
Social Function	Assessment	Risk Reduction and Policy Selection (Coping with Uncertainty)				Political Legitimation	

Source: **Renn (1992, 57) adapted**

To begin with, Kasperson (1992, 157) states that the "social amplification of risk" is based "on the thesis that events pertaining to hazards interact with psychological, social, institutional, and cultural processes in ways that can heighten or attenuate perceptions of risk and shape risk behavior." In other words, when a disaster takes place information from it, along with the potential for further such incidents, will influence how people behave. These behaviours, in turn, generate secondary consequences, thus influencing the degree of a disaster's impact (e.g., loss of life and property, etc.).

Kasperson (159) refers to the individuals and/or groups who collect the information regarding risks and then actively communicate it to others as "amplification stations": the impact of their collected information ripples through the community, amplifying itself as it does so. This amplification process is dynamic, is based on hazards and risks, and promotes continued learning and social interaction (160). To paraphrase Kasperson, the disaster managers and community planners act cooperatively as amplification stations, working with community stakeholders and experts in the process of disseminating information regarding hazards and risks. This process is directly linked to the goal of disaster management; that is, to changing behaviour so that it results in the implementation of sustainable hazard mitigation strategies. By using Renn's framework, one can identify and address the factors that lead to the successful implementation of sustainable hazard mitigation.

(1) So, how do the columns in Renn's framwork (see Figure 22) relate to the process of disaster management? The first three columns (actuarial, all-hazard, and probabilistic) I discuss under technical risk analyses; the fourth and fifth columns (economics and psychology) I discuss under economic perspectives and psychological perspectives, respectively; and the latter two columns (social and cultural) I discuss under sociological perspectives. Each of these four classifications addresses three key questions (albeit from differing conceptual viewpoints): (1) How can we specify or measure uncertainties? (2) What are undesirable outcomes? and (3) What is the underlying concept of reality?

B.2.1. Technical Risk Analyses

The technical perspectives on risk include those approaches to risk analysis that anticipate the negative impacts of a disaster by averaging these events over time and by using relative frequencies (observed or modelled) to arrive at probabilities (Renn 1992, 59). These perspectives can be used to reveal, avoid, and/or modify the impacts of disasters. The major application of the actuarial approach to risk analysis relates primarily to insurance (58). The base unit -- the expected value -- is the relative frequency of a hazardous event over time: "the resulting risk assessment is reduced to a single dimension representing an average over space, time and context" (58). Thus, for example, by using the actuarial approach to risk analysis one is able to predict the number of fatalities from air crashes in the next year. There are two key conditions for the success of such predictions: (1) there must be sufficient statistical data; and (2) causal agents (e.g., the number of air crashes) must remain stable (Häfele, Renn, and Erdmann 1990, cited in Renn 1992, 58).

The instrumental function of the actuarial approach to risk analysis (Renn's first column) is risk sharing -- one of the four risk reduction strategies previously discussed. There are some problems with this approach. First of all, there is not a lot of statistically accurate data for many disasters (e.g., past major earthquakes in the Pacific Northwest), and, second, global warming and other factors have led to problems in predicting weather patterns. Accordingly, some insurers will not provide insurance for certain hazards (e.g., Canadian insurers do not provide insurance for residential flooding) or in certain areas (e.g., earthquake insurance is not sold by all insurance companies in the community of Richmond, British Columbia, as it is below sea level). In the United States, a number of researchers believe that participation in the National Flood Insurance Program has, in fact, contributed to people building in flood plains (May and Deyle 1998). Nevertheless, insurance remains an important mitigative tool.

The assessment of the all-hazards approach to risk analysis (Renn's second column) is clearly in the domain of HRV analysis. Surveys (e.g., soil mapping) and experiments (e.g., testing of chemicals) provide the predominant methods of obtaining data. Once hazards have been identified, the basic problems concern determining the risk to humans and protecting the latter as well as property. As discussed in Chapter 1, when this information is not available and adequately communicated, warnings systems are inadequate and the result is unnecessary loss of life and property. Information on risk directly affects the adoption of overall mitigative strategies and the ability to cope with uncertainty. As with all technological approaches to risk analysis, there needs to be some way of acknowledging the degree of uncertainty in the area as well as documenting the various factors that lead to the estimation of risk for a particular hazard.

The information gathered under probabilistic risk analysis (Renn's third column) is used to predict the failure of complex technological systems (e.g., nuclear power plants) (Renn 1992, 59). It is used primarily to identify and develop mitigative strategies for overcoming potential system failures. This information is very technical in nature and is often very poorly communicated to the population at large (National Research Council 1989, 70). Probabilistic risk analysis also has direct links to HRV processes (albeit in more limited situations).

As summarized by Renn, there have been numerous criticisms (mostly from social scientists) of the technological approaches to risk analysis. This is because: (1) the importance of a particular risk often depends on people's individual values; (2) activities and consequences are often too complex to be meaningfully represented by technological approaches; (3) the organizational processes that are in place to manage and control risks are often flawed; (4) the numerical combination of magnitude and probabilities assumes equal weight for both components; and (5) the technological nature of the process puts inordinate power in the hands of scientists who are neither qualified nor legally entitled to carry out risk management processes. While these criticisms often apply to technologically based analyses, it would be foolish to ignore technological approaches to risk analysis. As Renn (61) contends, these criticisms can be tempered by the inclusion of sociological approaches to risk analysis.

In summary, we have three technological approaches to risk analysis: (1) actuarial, (2) all-hazard, and (3) probabilistic. While all apply to the process of disaster management, it is only the latter two that apply to the HRV process.

B.2.2. An Economic Perspective

The fourth column in Renn's framework represents a shift away from the technological approach to risk analysis in that the negative impacts of a disaster are transformed into subjective utilities; that is, what is assessed is the satisfaction (or dissatisfaction) with the potential consequences of a disaster (62). Now the level of stakeholder satisfaction can be measured, and this common denominator allows for the comparison of benefits and risks

(Merkhofer 1987, cited in Renn 1992, 62). "Economic theory perceives risk analysis as part of a larger cost-benefit consideration in which risks are the expected utility losses resulting from an event or an activity."

There are numerous pros and cons to the cost-benefit method of decision making. On the positive side, it can assist in determining how resources are allocated in terms of mitigative strategies. For example, what is the cost of relocating homes already located in the flood plain versus paying for the damage following the next flood? On the negative side, benefits/costs are usually measured in dollars and cents, and the impacts of disasters are not so easily measured. This is why cost-benefit methods of decision making are not more widely used.

The economic approach to risk analysis certainly has a relationship to disaster management; however, it applies to the mitigative process rather than to the HRV process.

B.2.3. A Psychological Perspective

The fourth column in Renn's (64) framework focuses on three main factors:

(1) personal preferences for probabilities and attempts to explain why individuals do not base their risk judgments on expected values;

(2) identification of personal biases in people's ability to draw inferences from probabilistic information; and

(3) the contextual variables for shaping individual risk estimations.

Contextual variables include such factors as the expected number of deaths; low probability/high consequence events; and how people perceive risks. As discussed at length in Chapter 3, how people perceive risk is directly correlated to how they deal with it. The psychological approach to risk analysis assists us in understanding public values, gaining access to the necessary data (when available), and developing risk communication strategies. It also underscores the importance of personal experiences.

The psychological approach to risk analysis, according to Renn's framework, can best be applied to: (1) policy making and mitigative actions, (2) conflict resolution, and (3) risk communication strategies. All of the foregoing lead to the adoption of risk reduction strategies. One of the weaknesses of the psychological approach to risk analysis is that it is individually based and, thus, is dependent upon an aggregation of preferences. However, the sociological approaches to risk analysis help to keep the psychological approach in perspective. Clearly, the psychological approach is directly relevant to HRV analysis.

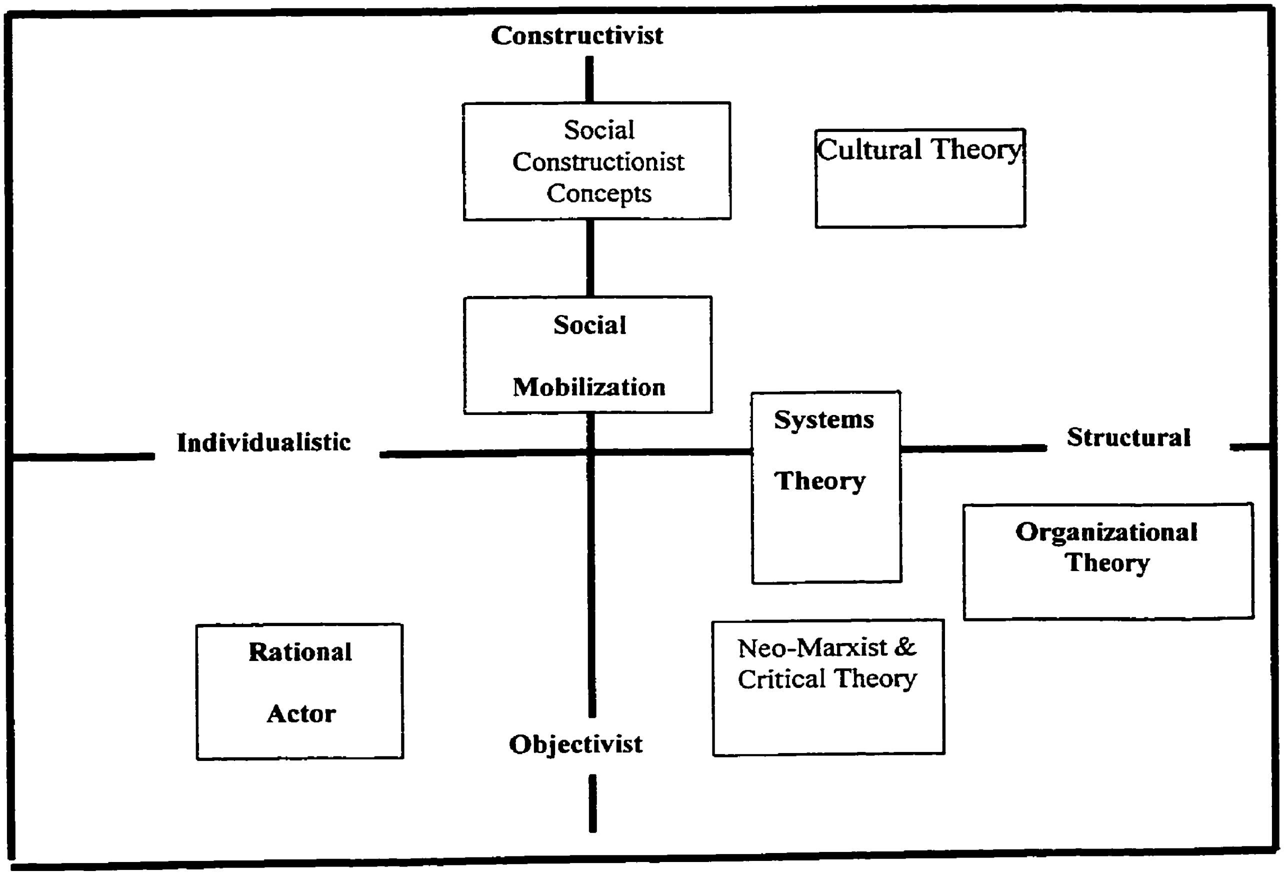
B.2.4. Sociological Perspectives

Renn has difficulty when he attempts to classify the sociological perspectives on risk analysis. His taxonomy of sociological theories measures them from two perspectives: (1) individualistic versus structural and (2) objective versus constructivist (see Figure 23). The individualistic and structural dimensions measure the degree of individual as opposed to aggregate involvement. The objective and constructivist dimensions measure the degree to which the risk is real and observable (objective) as opposed to the degree to which it is a fabrication (constructivist). These various concepts provide us with insights regarding the disaster management process.

Before discussing each of these constructs individually, it is important to note that they are linked by a "common interest in explaining or predicting the experience of social injustice and unfairness in relation to distributional inequities" (71). Renn acknowledges that this common interest is probably least apparent in organizational theory, but even there it exists to some degree.

Moving in a clockwise fashion, beginning with the rational actor concept, let us examine the relevance of these social theories to disaster management. Dawes (cited in Renn 1992, 69) concludes that the rational actor concept is widely used in economic and social science analyses of social behaviour. Social actions are seen as a result of individuals intentionally promoting their interests (e.g., the developer wishing to promote development on hazardous land sites). If one actor (who may represent a group) perceives risks as threats to his or her interest, then he or she will mobilize political action in order to reduce or mitigate that risk (69). This will often not be in the best interests of other stakeholders. Thus, with regard to the HRV process, understanding the rational actor concept is key to dealing with competing stakeholder interests when identifying hazards and risks.

Figure 23: Major Sociological Perspectives on Risk



Source: Renn (1992, 68)

Renn posits that social mobilization theory[70] focuses on two questions: (1) under what circumstances are individuals motivated to take action? and (2) what conditions are necessary for social groups to succeed? One could paraphrase the above with regard to disaster management: (1) under what circumstances will individuals take mitigative actions? and (2) what conditions are necessary for this to succeed? The links to disaster management are evident. Given that the HRV process is the cornerstone of disaster management, it is crucial that it have access to such relevant information.

Social constructivists treat risks as if they were not objectively based but were constructed from the beliefs of various actors (71). Social constructivism is perhaps best illustrated by those environmentalists who believe that

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[70] Renn would classify social mobilization planning theories, such as those described by Friedmann (1987), under neo-Marxist and critical theory.

certain chemicals, no matter what the dilution and no matter what the data indicate, are inherently toxic to humans and animals. "The need to compromise between self-interest, that is, constructing one's own group-specific reality, and the necessity to communicate, that is, constructing a socially meaningful reality, determines the range and limitations of possible constructs of reality" (71). It is in this area that the conflict resolution process will be especially important.

Leaving the cultural theory of risk until the next section, I now look at those approaches that Renn categorizes under policy analysis and/or systems theory. The planning tradition behind policy analysis is grounded in the behaviour of large organizations and their ability to make rational decisions without espousing a particular philosophical position. Policy analysis resulted from the confluence of three streams of intellectual discourse: systems engineering, political and administrative sciences, and management science (Friedmann 1987). Renn states that systems theory spans both real and constructed realities and that risk issues evolved within a process that involved groups sharing their knowledge of the environment with others.

It was recognized that planners did not always have the necessary data to choose the best alternatives and that, therefore, their choice was perforce based on the best information available. For this reason, their decisions could never be considered to be totally rational. Simon (1976) states that, since people's knowledge is fragmentary and their alternatives limited, the best choice is one that satisfies the organization's values. The test was one of common sense based on available evidence.

While systems theory is grounded in organizations as opposed to communities, its link with the HRV process lies in the difficulties inherent in trying to assess risk with inadequate data. While it is important to take a technological approach to risk analysis as far as is reasonably possible, it is also important to recognize a lack of accurate information and to make decisions based on common sense and available evidence. Furthermore, systems theory contends that an educational approach to risk analysis is beneficial.

Organizational theory, a behaviourist approach to risk analysis, began with the study of groups and group dynamics. A search for appropriate methodology led scientists to try to change the behaviour of groups, and this, in turn, led to the attempt to link small group research with change in formal organizations (Friedmann 1987). Organizational theorists contributed to risk analysis in cases that involved complex technological processes (e.g., nuclear power stations) -- situations in which the routinization of tasks and the diffusion of responsibility can lead to high estimates of risk because of the potential for operational errors and loss of control. Although not particularly relevant at the community planning level, organizational theory does indicate the need for community stakeholders to understand corporate risk assessments.

Under the neo-Marxist and critical theory category, Renn slots theories that focus on enabling groups and communities to determine their own acceptable level of risk (71). Renn's taxonomy would include Friedmann's classification of social mobilization theory, which is founded on the principle of political social action and asserts the primacy of direct collective action from below (Friedmann 1987). According to Friedmann, social mobilization planning falls under the category of radical planning in that it specifically addresses the powerless and disinherited. Because it challenges the existing structures of dominance and dependence it is classified as radical. This is of relevance to disaster management theory because it stresses the importance of conducting a vulnerability assessment. As mentioned, the poor, the elderly, and so on are usually those most affected by disasters, and, in the interest of equity, the vulnerable will have to become active participants in the HRV process and, ultimately, in the disaster management process.

Thus, according to the social theories of risk, the successful HRV process will need to identify several factors, the five most relevant being: (1) the need to take into account competing individual interests, (2) the need to consider that some beliefs and values may not be dependent upon facts, (3) the need to accept that when accurate data are not available decisions will have to made according to common sense and the data that are available, (4) the need to promote an educational process while conducting risk assessment, and (5) the need to take into consideration the vulnerable and least resilient of our communities by empowering them and giving them access to the political arena.

The last column in Renn's framework applies to the last perspective in Figure 24: cultural theory. Renn states that, recently, "anthropologists and cultural sociologists have suggested that social responses to risk are determined by prototypes of cultural belief patterns; that is, clusters of related convictions and perceptions of reality" (72). He concludes that most concede that, even though cultural theory applies to large groups rather than to individuals, it can be used to predict individual responses. Renn identifies five prototypes:

- entrepreneurial -- those who perceive risk taking to be an opportunity to succeed;
- egalitarian -- those who emphasize cooperation and equality rather than competition and freedom;
- bureaucrats -- those who rely on rules and procedures to cope with uncertainty;
- atomized -- those who believe in hierarchy but do not identify with the hierarchy in which they believe (they trust only themselves and oppose any risks that might be thrust upon them); and
- autonomous -- those who accept risks as long as they do not involve the coercion of others.

Renn believes that these prototypes offer "an interpretation of the social experience of risk [and] can offer additional evidence for the importance of cultural factors in risk perception and risk policies" (76). Although cultural considerations are of interest to the HRV process, it would seem that cultural theory would be more applicable to the overall disaster management process. This is because it could aid in finding ways (1) to reach out to individuals belonging to various cultural prototypes and (2) to ensure that disaster response and recovery planning take them into consideration.

B.3. A Summary of Renn's Framework and Its Application to the HRV Process

What can we extrapolate from Renn's framework and apply to HRV analysis? Figure 24 identifies those areas of Renn's framework that apply to the HRV process. It includes, in summary, the elements that emerged from my review of Renn. As can be seen, the need for adequate risk communication is a major factor in each of the four approaches to risk.

Other factors that arise are:

- the importance of the identification of hazards;
- the need to be able to identify the various risk factors that lead to the estimation of risk;
- the need to assess the accuracy of qualitative and quantitative data;
- the need to acknowledge and deal with uncertainty;
- the need to have widespread public participation on the part of the various stakeholders, including: experts, high technology/high risk industry, special interest groups, and vulnerable members of the community;
- the need to affirm varying perceptions of risk;
- the need to have an evolving educational process;
- the need to have access to information;
- the need to empower the vulnerable members of society through the HRV process;
- the need to provide an adequate forum by which to acknowledge and address issues of equity and fairness; and
- political legitimation is essential to ensuring the adoption of mitigative strategies.

As will be seen, these twelve factors compare positively with those factors that arose from the literature review (although they are not parallel).

Figure 24: A Systematic Classification of Risk Perspective as It Applies to HRV Analysis

	INTEGRATED APPROACHES (e.g., Social Amplification of Risk)			
	All Hazard Data	**Probabilistic Risk Analysis**	**Psychology of Risk**	**Social Theories of Risk**
Base Unit	Modelled Value	Synthesized Expected Value	Subjectively Expected Value	Perceived Fairness and Competence
Predominant Method	Experiments	Event & Fault Tree Analysis	Psycho-metrics	Surveys
	Survey			Structural Analysis
Scope of Risk Concept	Universal	Safety	Individual Perceptions	Social Interests
	One Dimensional	One Dimensional	Multi-Dimensional	Multi-Dimensional
Basic Problem Area	Averaging over space, time, context		Preference Aggregation	Social Relativism
	Transfer to Humans; Intervening Variables	Common Mode Failure	Social Relevance	Complexity
Major Appli-cation	Life & Safety	Safety Engineering	Policy Making and Regulations	
	Protection of Property		Conflict Resolution (Mediation)	
			Risk Communication	
Instru-mental Function	Early Warning		Individual Assessment	Equity Fairness
	Standard Setting	Improving Systems		Political Acceptance
Social Function	Assessment	Risk Reduction and Policy Selection (Coping with Uncertainty)		Political Legitimation
Factors	• Identification of Hazards • Identification of Risk factors • Accuracy of Data • Dealing with Uncertainty • Adequate Risk Communication	• Participation of Experts • Participation of High Technology/High Risk Industry • Adequate Risk Communication	• Affirmation of Varying Risk Perceptions • Community Participation • Adequate Risk Communication	• Acknowledgement of Special Interest Groups • Adequate Risk Communication • Educative Process • Access to Information • Empowerment of the Vulnerable • Issues of Equity

Appendix C. A Discussion of Models for HRV Analysis Excluded from the Review and Evaluation

In searching for models for HRV analysis that met the criteria set down in the first section of Chapter 4, I came across many models that met some, but not all, of them. Most of the models failed to meet the criteria because they considered only one particular hazard (e.g., earthquakes). Thus, while they do not appear in my evaluation, I include them in an appendix in order to provide the reader with a sense of the number and scope of the various models for HRV analysis.

Discussions with emergency planners across Canada and at the Canadian Emergency Preparedness College (CEPC) in Arnprior, Ontario, identified many and various models for HRV analysis (often variations of standard operating procedures). Many of these have been developed to deal with specific chemical and hazardous material spills. For example, the Canadian Chemical Producers' Association publishes a number of planning guides, such as the *Risk Assessment Guidelines* and the *Guide to Marine Emergency Response Planning for Chemicals*, to deal with potential chemically induced disasters. In keeping with the criteria relevant to this thesis, I exclude those models for HRV analysis that are hazard-specific. However, much of the work in Canada and around the world (United Nations Environment Programme 1993) that deals with hazardous materials and their potential impact on the environment does have a lot to say about the value of public participation. Some of this is discussed in Chapter 6.

As mentioned in Chapter 3, EPC, in conjunction with Nobility Inc., is working on NHEMATIS; however, this four-year project got under way in 1998 and is, at this point, only in the prototype stage[71] (EPC and Nobility Inc. 2000). At this point, it is intended to support modelling capabilities for four natural hazards: earthquakes, tornadoes, landslides, and floods. Given that NHEMATIS is still in the development stage, it is simply too early to evaluate it.

Public Works Canada (1991) helped the City of Brandon to complete an HRV analysis prior to the development of comprehensive emergency management plans. Although this analysis pertains to disasters, it

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[71] Prototype study areas are: Vancouver, British Columbia; Ottawa-Carleton, Ontario; Edmonton, Alberta; Montreal, Quebec; and Fredericton, New Brunswick.

includes planning for only four hazards: (1) dangerous goods accidents, (2) floods, (3) severe weather, and (4) radiation incidents. The need to enhance the scope of this approach is recognized, for completing a further HRV analysis is one of the items included in Brandon's multi-year plan. However, it is not clear how this will be carried out.

A number of models for HRV analysis are developed for internal disaster management operations pertaining to single sites (e.g., the *Risk Management Implementation Aid for Distribution Facilities* [Canadian Chemical Producers' Association n.d.]) or to a specific economic sector (e.g., the British Columbia Ministry of the Environment's [1992] *Guidelines for Industry Emergency Response Contingency Plans*). Furthermore, the Major Industrial Accident Council of Canada (MIACC), prior to its demise in 1999, published guidelines and standards for industry-based disasters. However, because these models for HRV analysis are not community-based, I exclude them from my critical review.

I also exclude models for HRV analysis that were developed for specific transportation sectors, such as the *Transportation Risk Management Implementation Aid Facilities* (Canadian Chemical Producers' Association n.d.), as well as approaches that concern themselves with incidents in which the impact of the hazardous event does not require a community response (e.g., an air crash in the isolated northern Rocky Mountains).

The United States has been doing a great deal of work in the area of loss estimation modelling. HAZUS, for example, is intended to be an essential element of FEMA's Project Impact.[72] The latest HAZUS99 release only provides loss estimation modelling for earthquakes, while the preview wind and flood estimation models are being developed for release in 2002 (FEMA 2000). Furthermore, HAZUS is still very much in the developmental stages; FEMA warns potential users that, "although considerable effort has been expended to create HAZUS, it should still be considered an ongoing work. For example various components of HAZUS require further calibration based on data from other earthquakes besides Northridge and Loma Prieta ... [C]ertain results generated by HAZUS are not yet completely acceptable because aspects of loss estimation are not resolved" (FEMA 2000). As with the NHEMATIS approach that EPC is developing, HAZUS deals with only one hazard – earthquakes – and it is too

[72] see Chapter 3 for more information regarding Project Impact, a community-based mitigation program.

early to effectively critique it.

Although excluded from detailed critical review because it is only focused on earthquakes, the Bay Area Earthquake Preparedness Project's (BEPP) (1991) *Earthquake Vulnerability Analysis for Local Governments* is worthy of mention because it is one of the few models for HRV analysis that explicitly addresses vulnerability factors. It includes four factors: (1) seismic data, (2) an inventory of building stock, (3) an inventory of lifelines and critical facilities, and (4) figures for population density for daytime and evening (see Chapter 5 for references to differing population densities). The BEPP handbook also mentions that information on populations with special needs, such as the elderly or non-English-speaking people, might also be a key factor in ensuring a successful HRV process.

The American Red Cross's (1993) *Emergency Management Guide for Business and Industry* includes a brief section on HRV analysis. However, its model for HRV analysis is so briefly described that it does not provide enough material to warrant a serious review. It suggests beginning the process by completing an inventory of the respective capacities of various businesses to respond. The second step is to identify potential hazards, and it lists a number of them. It calculates probability using a simple scale of 1 to 5, with 1 as the lowest probability and 5 as the highest. The impact of any given hazard on people (deaths and injuries) and potential economic loss are assessed using this same scale. Next, the capacity to respond and gain access to internal and external resources is rated using a scale on which 5 represents weak resources and 1 represents strong resources. The numbers are then added together, and the comparative totals are used to set priorities for planning. The Red Cross gives no guidelines for evaluating risk factors, and it estimates probability without referring to available historical data, thus giving the reader no guidance on how to estimate probability.

The American Red Cross (1992) also widely distributes the *Community Disaster Education Guide.* Its approach to HRV analysis identifies seventeen hazards. It then suggests developing a community profile that includes population characteristics, building types and locations, and the location and nature of businesses and media outlets. The final step is to identify vulnerable populations, buildings, and infrastructures. The purpose of this assessment is to target audiences for disaster education. Unfortunately, risk factors, historical data, probabilities, and other criteria essential to HRV analysis are missing. This increases the risk of controversy both regarding this approach's findings and the way in which it conducts its assessment.

Cutter et al. (1999) released a CD-ROM, entitled *South Carolina Atlas of Environmental Risks and Hazards*, which is worthy of mention because it offers a model for HRV analysis that is all-hazard in scope and includes hazards such as hurricanes, earthquakes, toxic spills, and pollution. It also focuses on events that are disaster-related, although it does include a section on "everyday," or "personal," disasters, including household and motor vehicle accidents. For each hazard (e.g., flood) the CD-ROM displays four categories of information: (1) general information about the hazard; (2) what people can do to prepare for the hazard; (3) information regarding historical events in South Carolina; and (4) maps and charts of South Carolina indicating the location of historical events, seasonality of hazards, number of deaths and injuries, and damage estimates from previous events. The *South Carolina Atlas of Environmental Risks and Hazards* model for HRV analysis is state- rather than community-based, and it does not derive from a planning approach but, rather, outlines steps for personal preparedness (e.g., ensure that windows have shutters in order to reduce losses in strong winds). Although the information included in this CD-ROM would be very useful in implementing an HRV process, it stops short of constituting one.

RADIUS[73] is a 1998 initiative under the auspices of the Office for the Coordination of Humanitarian Affairs, United Nations, and is in recognition of the International Decade for Natural Disaster Reduction(IDNDR Secretariat 1999). The outcomes of the RADIUS project are expected to be published in 2000 and will provide a comparative analysis of earthquake risk and risk management practices in nine cities as well as a compilation of risk management practices in another eighteen cities. Although it is only concerned with a single hazard (earthquakes) and the final report is not complete, there are a couple of points worthy of mention. Although it can be adapted to GIS systems, unlike HAZUS and NHEMATIS, it is not dependent upon them. The RADIUS project begins with an earthquake scenario and then, as participants discuss the impact of this potential earthquake on their community, they develop an action plan. The RADIUS process explicitly recognizes: (1) the importance of involving local politicians in the HRV process, (2) the need for mass media to involve the public, and (3) the importance of risk communication. These three points are identical to three of the objectives of an adequate HRV analysis. It will be

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[73] Risk Assessment Tools for Diagnosis of Urban Areas against Seismic Disasters.

interesting to assess the findings of the RADIUS and project and to see how well it incorporates these three objectives into its process and methodology. (See Chapter 5 for additional references to RADIUS.)

Appendix D. Composition of the HIRV Committee

The HIRV committee needs to include interested parties, experts, and decision makers. Given the focus on sustainable hazard mitigation, and the objective of integrating disaster management and community planning, two key committee members would be the disaster manager and the community planner. The disaster manager brings expertise vis-à-vis disasters, and the community planner, who benefits by gaining an awareness of where hazards, risks, and vulnerabilities are located, brings the ability to make informed decisions regarding future land use.

Potentially, all of a community's residents have an interest in the findings of a comprehensive HRV analysis, yet clearly everyone cannot participate on an advisory committee and not every interested group can sit at the table. Thomas (1995, 122) suggests that, while some managers attempt to deal with this problem by appointing an "average citizen" with no particular bias or interest, the evidence indicates that the leaders of established organizations make the best committee members. Not only are these leaders more likely to be accepted as legitimate representatives, but they are also "most likely to display the type of broad orientation conducive to effective decision making" (Cole, cited in Thomas 1995, 122). Nevertheless, in the area of disaster management, appointing an "average citizen," especially a long-time resident, is important. Wynne (1992) argues that, in many cases, it is local residents rather than scientists and experts who are truly knowledgeable about the local environment. This was recognized in the EPC model for HRV analysis and was identified in a number of situations that have been summarized by Kasperson (1992). Furthermore, the National Research Council (1996) points out that indigenous-risk knowledge is a very important factor in assessing hazards and risks.

Who are the key stakeholders? The HIRV committee's findings will potentially affect decisions regarding land-use policies; thus it can be expected that the business community and developers would be interested parties. A number of researchers (Kaufman and Jacobs 1996; Aspen Global Institute 1996) emphasize a strong need for the private business community to participate in developing strategic planning proponents. Burby (1998) advocates for the participation of representatives from businesses, land development agencies, and real estate agencies. A leader from the general business community (e.g., a president of the local chamber of commerce) and one from a private land developers organization could make valuable contributions to the HIRV committee. However, it is important to choose these two representatives carefully and to ensure that they do not "fall into [the] narrow pursuit of self-interest" (Cole, cited in Thomas 1995, 122).

Given the high concern with the environment and with potential chemical hazards, it is not surprising that several researchers suggest that representatives of industry should participate on committees concerned with potentially hazardous materials (United Nations Environment Programme Industry and Environment Program Activity Centre 1992; Thomas 1995; Burton 1996). The NOAA approach to HRV analysis also recognized the importance of involving industry. Several recent initiatives in Canada, such as the CAP programs,[74] have encouraged members of the Canadian Chemical Producers Association and members of the Responsible Care Program to initiate contact with local residents and disaster managers. Following this, if a community supports heavy industry, then one of its representatives should be invited to sit on the HIRV committee.

Almost at the other end of the spectrum are representatives from environmentalist organizations. Developing policies that deal with hazards involves "creat[ing] constituencies that advocate attention to issues of sustainability and hazard mitigation" (May 1997 36). Policy makers and planners have found that agencies that advocate environmental sustainability support hazard reduction (Paterson 1998). Indeed, hazard reduction and environmental protection are mutually reinforcing activities that, taken together, tend to promote sustainable communities (Berke and Beatley, Hamilton, cited in Paterson 1998). While environmentalists are not newcomers to the field of disaster management, in the past their roles have been limited (Paterson 1998). These people would add to the effectiveness and credibility of the HIRV committee. Parker (1992a) argues that, if one is to prevail upon local politicians to assist in mobilizing public opinion, then political considerations must be taken into account. Obviously, most politicians are hesitant to make decisions that may be unpopular and hence threaten their survival. Certainly, in North America most communities have active members of recognized environmental organizations, and a representative of one of these should be on the HIRV committee.

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[74] Community Advisory Panels (CAP) are a Canadian initiative, developed under the Responsible Care Program of the Canadian Chemical Producers Association. These panels provide a forum for dealing with issues that may arise when a community is located in close proximity to large chemical manufacturing and oil refining industries (Canadian Chemical Producers Association 1999).

Paterson (1998) argues that a representative from scientific, technical, and professional associations should be involved in implementing mitigation strategies – a view supported by numerous researchers (Alesch and Petak, Berke and Beatley, Dynes, and May, cited in Paterson 1998, 220). A member of the Professional Engineers Association might well fill this role on the HIRV committee.

Faced with rising costs following a disaster, insurers have devoted considerable resources that are conducive to mitigation, and their role in hazard mitigation, specifically, has been recognized for some time (Burton 1994; Disaster Preparedness Resources Centre 1999). In many cases, insurance and re-insurance agencies have completed extensive work on the community impact of various hazards (e.g., Insurance Bureau of Canada 1994). Consequently, a representative from one of these agencies would make a valuable contribution to the HIRV committee.

Another group of stakeholders that has often been involved in calculating the community impact of disasters is made up of utility organizations. Electric power, water, sewerage, natural gas, telecommunication lines, and so on are all critical community lifelines. As have insurers, utility companies have long been recognized as essential partners in disaster preparedness and response (Disaster Preparedness Centre 1999; Institute for Environmental Studies 1997). A representative willing to represent local utility companies could also contribute to the HIRV committee by sharing not only her/his research data, but also information regarding the vulnerability of lifelines. Given the importance of community lifelines, it is interesting that the SMUG approach to HRV analysis was the only one that specifically singled out the need to involve utility companies in the HRV process.

It is just as important to have an industrial-sector expert on the HIRV committee as it is to have a scientist or a natural hazards expert. This person can assist in evaluating data and ensuring that scientific data are adequately "translated" for the layperson. It would be impossible to have all of the relevant experts sitting around the committee table, so it is suggested that experts be invited, as ad hoc members, to contribute information whenever appropriate. A side benefit of having a number of outside experts join the committee on an ad hoc basis is that this is one way of revitalizing an organization that may have become stagnant (Ivancevich and Matteson 1987). Given that the HIRV process is ongoing, it is clearly important to maintain the vitality of the HIRV committee.

There are numerous new tools that have been, and are being, developed to assist in determining the potential risks of, and vulnerabilities to, specific hazards.[75] Experts are strongly encouraged to use these tools where sufficient community data and resources exist. In many cases, communities will find that, while national data exists, local data does not. Most of the extant models for HRV analysis include experts but fail to acknowledge the need for others to take part in the process.

One of the stated objectives of a successful HRV process is to empower vulnerable populations. One way to represent these interests is to include a member of the third sector[76] on the HIRV committee. In the long run, social planners will benefit by gaining new perspectives on how, in times of disaster, social inequities result in increased vulnerability. Paterson (1998, 205) sees the role of the third sector as : (1) building local commitment to change by acting as policy advocates and collaborative problem solvers; (2) coordinating the activities of citizens and government; and (3) building local capacity for change by acting as delivering services, offering educational resources, and functioning as financial supporters of local efforts. The community benefits by having a mechanism to bring risks and vulnerabilities to a public forum, thus enabling people to work together to build a healthier and safer community.

Still, even with a representative from the third sector, the HIRV committee has not yet ensured that it will involve and communicate with the community-at-large. "The foundation of any program to prevent and resolve public controversy must be an informed public" (Connor, cited in Thomas 1995, 141). In all phases of a disaster, the success of a disaster management program will depend upon getting specific information to citizens (Kasperson, cited in Burkhart 1991; Scanlon 1993). Burkhart (1991) stresses that it is as important to provide accurate information before a disaster as it is to do so during and after a disaster. The media are essential to any warning

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[75] HAZUS – Earthquake Loss Estimation Model (FEMA 2000), RADIUS (IDNDR 1999), NHEMATIS (Nobility EM 2000)

[76] Paterson (1998, 204) defines the third sector as the nonprofit, nongovernmental, independent, or voluntary sector.

system (Scanlon 1993; Burkhart 1991; Drabek 1986), and one of the best ways of ensuring that the media will be able to fill their role during the alert and warning phases of a disaster is to make sure that they are well-informed as to potential hazards and that they develop effective warning messages (Scanlon 1993).

The media are clearly important to the disaster management system (Burkhart 1991): the difficulty is in getting them to take an active role.[77] Part of the problem is the reluctance of local governments to directly involve the media in public processes. Paradoxically, the media are perceived as being both friend and foe (Auf der Heide 1989). However, they are expected to serve the "public interest," which means, in practice, "that mass media are the same as any other business or service industry, but carry out some essential tasks for the wider benefit of society, especially in cultural and political life" (McQuail 1996, 68). In addition to the media playing a watchdog role, they also "facilitat[e] self-expression, promot[e] public rationality and enabl[e] collective self-determination" (Curran 1996, 97).

The local media are also repositories of large collections of historical data relating to hazards and disasters. Thus, they can play a true participant role in terms of contributing to the information being collected through the HIRV approach. There are five basic forms of mass communication: oral, literate, electronic oral, electronic audio-visual, and electronic textural-numeric[78] (Lorimer 1994). While oral communication involves face-to-face interaction, literate communication is only indirectly social and leads to "the development of general and specific explanatory concepts that form into a system or general theory" (Lorimer 1994, 13).

Burkhart's (1991) research indicates that newspapers and television are the leading channels for passing on disaster preparedness literature and that they are the media of choice for the general public. Thus it would be a good idea to include a newspaper reporter on the HIRV committee. However, use of local newspapers results in "the practice and product of providing information and leisure entertainment to large, often unknown, and increasingly

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[77] Despite a federal mandate in the United States to include media members on all local emergency planning committees dealing with chemical hazards, few of the committees have had any active media participation (Hadden, cited in Burkhart 1991).

[78] This refers to the processing of information by computers and telecommunications.

fragmenting audiences....from all social strata and demographic groups but who are homogeneous in their behaviour of choosing to attend to an information source" (Lorimer 1994, 25).

But how do we communicate, and involve, those who do not have access to local newspapers? One of the difficulties in any public participation process is that

> no matter what the circumstances, many who are eligible to participate do not, and those who do participate are seldom a cross section of all who were eligible. In particular, participants usually have higher socio-economic status — better education and higher incomes – than non-participants. (Thomas 1995, 25)

Thus, the need to involve a public relations officer. Spicer (1997,22) argues that "the 'best' public relations encourage and enhance consensus and community." He believes that the foremost function of public relations is to build and maintain healthy relationships by maintaining a dialogue between people and organizations, by encouraging discussion of all views, and by helping to communicate opinions. Public relations officers are all too often viewed as "product publicists" rather than as people who can provide a technical support function; that is, as people who can effectively reach target audiences (Spicer 1997). One of the challenges for the public relations officer is to bring the findings of the HIRV committee to the most vulnerable populations. This may be done through neighbourhood displays in malls, community recreation centres, grocery stores, information booths at local community events, local newsletters, and so on. Although public officials may believe that the public cannot understand technicalities, the evidence is otherwise (Scanlon 1993, 91). However, information must be presented in a form that the public can understand.

> Government projects that disseminate historical accounts of community disasters, case studies of near misses that could have been disastrous, or even well-targeted community hazard mapping programs disseminated to the most at-risk local groups help create the prerequisite awareness needed for group mobilization. (Paterson 1998, 210)

Benefit is derived not just from disseminating information to the general public, but also from receiving the public's feedback. The initiation of two-way communication will help to legitimize the HIRV committee. As Dowling and Pfeffer (cited in Hardy 1987, 103) point out: "To be able to operate without risk of intervention an organization must establish its legitimacy in the eyes of the external institutions that affect it, as well as its own members."

Finally we come to the last member of the HIRV committee: the elected official. It is important for an elected official – an experienced decision maker – to be on this committee. Although many researchers have discussed the need for elected officials to be involved in pre-disaster activities, Petak (1985, 5) states it most forcibly:

> It is important to note that current decision-making approaches tend to put a great deal of power in the hands of technical experts and professional administrators who are not directly accountable to the public. Elected officials must, therefore, assert their responsibility as representatives of the public and actively engage in the process of exercising value judgments which will lead to agenda setting, resource allocations, staffing, training, and, ultimately the effective implementation of a program designed to mitigate against, prepare for, respond to, and recover from disasters when and if they should occur.

Given the importance of involving local politicians in pre-disaster activities, it is interesting that only one of the extant approaches to HRV analysis, the OSLO approach, does so.

Organizational behaviour literature, which has many contributing disciplines (e.g., psychology, sociology, social psychology, anthropology, and political science), offers some suggestions as to what qualities the "ideal" committee or work-group member should embody (Robbins 1998). Individual demographics suggest that there are a number of factors that bear some relationship to task performance. These are: (1) age, (2) status, (3) gender, (4) ethnicity, and (5) personality traits. Although it is extremely unlikely that any community-based HIRV committee would be able to recruit members by pre-testing suitable candidates for personality traits, recruiting with an eye to factors 1 through 4 may well ensure an effective working group.

1. *Age*: Although there is a widespread belief that job performance declines with increasing age, most of the evidence contradicts this (Robbins 1998, 43); however, since people of a certain age share the same general major life experiences (e.g., the Second World War, the Vietnam War), they tend to share some of the same values (133). In the interests of diversity, it would be beneficial to ensure that participants come from different age cohorts.
2. *Status:* This is a socially defined rank given to group members by other group members (Robbins 1998). Formal status includes such things as titles, pay and benefits, and relationships. "However great their actual

power, higher-ranking people tend to be seen by lower-ranking members as possessing more power than they experience themselves as being able to use effectively" (Alderfer 1987, 207). The difficulty with status is that, in many cases, it exists because of the power of the individual. There are five basic sources of power: (1) the ability to confer reward upon the influencee, (2) the ability to mete out punishment, (3) legitimate power by virtue of position, (4) power based on expertise, and (5) power based on the influencee's desire to identify with or imitate the influencer (Stoner et al. 1995). When there is an imbalance of power, subordinates may feel inhibited and unable to express their opinions. Thus, in choosing members of the HIRV committee, one must address the status and power of the individuals being considered.

3. *Gender*: Differences between men and women in organizations reflect the effects of unequal influence, stereotypical perceptions, and sexuality (Alderfer 1987). "Evidence suggests that there are few, if any, important differences between men and women that will affect their job performance" (Robbins 1998, 44). However, there *is* evidence that women are more comfortable with a democratic leadership style, while men are more comfortable with a directive style. Women tend to

> encourage participation, share power and information, and attempt to enhance followers' self-worth ... Men, on the other hand, are more likely to use a directive command-control-style. They rely on the formal authority of their position for their influence base. (Robbins 1998, 378)

While this must be considered a very broad generalization, it does suggest that gender should be taken into account and that some balance between male and female committee members would be of benefit.

4. *Ethnic differences*: Ethnic and cultural differences have been found to be closely tied to historical relationships between the ethnic groups in any given region (Alderfer 1987). Cultural diversity, as a consequence of local historical relationships, should be taken in account when considering appointments to the HIRV committee.

5. *Personality Traits*: Although not particularly useful with regard to choosing members of the HIRV committee, these are worthy of mention, if only to assist in assessing the character of individuals once the committee is in operation. According to Robbins (1998, 1993), there are a number of personality traits that can influence organizational behaviour:

- *Locus of Control*: people who believe they are masters of their destiny tend to be more dissatisfied with their work than do others;

- *Achievement Orientation*: people with a high need to achieve need tasks that carry an intermediate amount of difficulty;
- *Authoritariansm*: high-authoritarianism personalities are successful in highly structured tasks but not in tasks that require sensitivity to the feelings of others;
- *Machiavellianism*: Machiavellian personalities do well when jobs require bargaining and offer substantial rewards for winning;
- Self-Esteem: there is evidence that persons with high self-esteem believe that they possess the ability they need in order to succeed and are satisfied with their jobs;
- *Self-Monitoring*: early research suggests that high self-monitors pay close attention to the behaviour of others and are more capable of conforming than are low self-monitors; and
- *Risk Taking*: high risk-takers do well when jobs require that decisions be made quickly; they do less well when discussion and deliberation is part of the process.

Once the members of the HIRV committee have been selected, the remaining issue concerns who should chair the committee. Personalities, management styles, organizational structures, and so on all play a role in determining who would be the best chair for the HIRV committee. There may be a tendency to appoint the elected official as the chair; however, given some of the factors raised in the previous discussion regarding the role of status and power, it is likely more preferable, and definitely more equitable, to have a rotating chair.

Appendix E. Handbook

Handbook for

HIRV:
A COMMUNITY BASED HAZARD, IMPACT, RISK AND VULNERABILITY ANALYSIS:

Laurie Pearce

E.1. Fourteen Key Objectives for a Successful Hazard, Risk and Vulnerability (HRV) Analysis

1. Disaster management and community planning need to be integrated in order to successfully focus on sustainable hazard mitigation.
2. The HRV process needs to have widespread public participation on the part of the various stakeholders including: experts, high technology/high risk industry, special interest groups, the media, and vulnerable members of the community
3. Adequate risk communication is an essential element and dialogue among and between the local stakeholders (i.e., the community residents) and the experts (i.e., community planners and hazards experts) needs to occur so that research data are easily understood
4. Community stakeholders need access to adequate quantitative and qualitative data.
5. An analysis of risk needs to take into account how it is perceived by the people directly affected by it as well as by the individuals and organizations involved in responding to it.
6. The HRV process needs to have an evolving educational process.
7. The HRV process needs to provide an adequate forum within which to acknowledge and address issues of equity and fairness.
8. The HRV process should empower vulnerable members of society.
9. The state of scientific and technological knowledge needs to be determined.
10. Accurate identification of hazards is important.
11. The various risk factors that lead to the estimation of risk need to be identified.
12. The HRV process needs to acknowledge and deal with uncertainty and the inability of the scientific and expert community to accurately predict potential hazardous events.
13. Tools for HRV analysis should encompass a wide range of options that are not highly dependent upon technology and that are affordable for local governments.
14. The HRV process needs to have political legitimation as an instrumental function of ensuring the adoption of mitigative strategies. This will involve affirming the diversity of social interests and recognizing the various competing interests that exist within the community.

E.2. Readings on Risk Communication, Risk Perception and Risk Acceptance as They Relate to Hazard, Risk And Vulnerability (HRV) Analysis

E.2.1. Risk Communication

Risk communication assesses (1) how participants receive and understand information regarding local hazards and risks, and (2) how the results of the HRV analysis are communicated to the policy makers and decision makers. The resultant information could be construed as a warning, even though it does not occur in an atmosphere within which one has to take immediate action in order to preserve one's life. As Penning-Rowsell and Handmer (1990, 11) put it: "Risk communication is the passing of risk information from those who have that information to those who are presumed to be without it ... Risk communication cannot start without risk awareness and evaluation."

Communication implies dialogue and, thus, the active participation of both experts and laypersons. The NRC (1989, 149) concludes that four objectives are key to improving risk communications: (1) goal setting, (2) openness, (3) balance, and (4) competence. As a means of achieving these objectives, it is important, at the start of any given project, to determine:

- what the public know, believe, and do not believe about the subject risk and ways to control it;
- what quantitative and qualitative information participants need to know to make critical decisions;
- and how they think about and conceptualize the risk. (NRC 1989, 153)

Certainly, the HRV process should include both scientific and two-way exchanges. Ideally, as communities engage in the HRV analysis they should be sharing and exchanging information on issues of joint concern. It is important for those involved in the HRV process to be aware of cultural and ethnic contexts. For example, after the Whittier Narrows earthquake in 1987, emergency managers were initially surprised by the large numbers of Hispanic people who refused to return to their homes after they had been assessed as safe by local engineers. In many cases Hispanic residents, unused to the superior building standards in the United States, thought a large crack in the plaster indicated the likelihood of building collapse. Often residents left the parks and returned to their homes only after "reassurance teams" – comprised of translators, social workers, engineers, and community leaders – met with each family at its home (Bolin 1993).

In their third point, Pidgeon et al. (cited in Horlick-Jones and Jones (1993,1) state that risk communication can be part of a wider political process. In many cases it is the poorer socio-economic sector that faces the greatest exposure to hazards. For example, wealthy neighbourhoods are not usually located next to industrial properties or along railroad tracks or major transportation corridors. In many cases residents living in areas that are vulnerable to hazards are there because of financial constraints: they cannot afford to live in "safer" neighbourhoods.

One should not ignore the media, as heightened media interest seems to influence emergency preparedness at the community level. This is in agreement with the 1979 findings of Okabe et al. (cited in Yamamoto and Quarantelli 1982, 165-66): "The more often people obtain information: (1) the more they trust an earthquake prediction; (2) the more they prepare against an earthquake; (3) the stronger their anxieties are; (4) the stronger their desires to move are; and (5) the more severe damages they predict." For example, in the Lower Mainland of British Columbia, an area that has not experienced a major earthquake for decades, earthquake preparedness has a high degree of public interest and appears to be well supported in a number of communities. Media coverage of the risk of potential earthquakes has been high relative to coverage of other hazards, and numerous articles have been written concerning earthquakes experienced by other cities around the world (e.g., Los Angeles, Kobe).

In a number of studies (Wenger 1980; Greene et al. 1981) mass media were found to be the most salient sources of information. Most community residents (60 per cent to 70 per cent) reported that television and radio were crucial sources of disaster information. The role of the media is especially important during the warning phase, when residents need to take precautionary measures (e.g., sandbagging) or make plans for evacuation (Scanlon et al. 1985, 123). Clearly, an HRV process needs to take into account the significance of outside agencies, such as the media, in order to ensure that it is amenable to the sharing of information.

As I will now go on to show, even once risks are adequately communicated, people will tend to perceive them in different ways.

E.2.2. Actual and Perceived Risk

In any process that involves the determination of risk, it is important for the players to understand the concept of risk perception. Slovic (cited in Slaymaker 1995, 3) defines risk perception as "the 'common sense' understanding of hazards, exposure and risk, arrived at by a community through intuitive reasoning ... usually expressed ... as 'safe' or 'unsafe.'" He goes on to mention that "policy decisions are almost always driven by perceived risk among the population affected and among decision makers [and that] these perceptions are commonly at variance with 'technical' risk assessments."

People need to have the most accurate information available when assessing the probability of a hazardous event, and researchers have found that there is often little correlation between perceived risk and actual risk (Auf der Heide 1989; Covello et al. 1987; Derby and Keeney 1991; Fischhoff 1984; Fischhoff et al. 1991, 1983). When people realize exactly how a hazardous event will affect them they are much more likely to put pressure on the local government to reduce their vulnerability. One need only look at how quickly community lobby groups form once people are aware of the possibility of having a hazardous waste facility in, or high-powered electric transmission lines running through, their neighbourhood.

Many researchers (Drabek 1986, 323-24) have found that the more experience one has with specific hazards, especially if one has a direct economic relationship to them, the greater the accuracy of risk perception. However, this experience is not universal, as some people still believe that "lightning never strikes twice in the same place." Others believe that if their properties were damaged in the last disaster, then they won't be damaged in the next one. In some cases, people who have "lived through" a disaster minimize future risk. For example, it became rapidly apparent to researchers that many people who stated that they had previously survived a hurricane ("it wasn't so bad") had, in fact, only been directly affected by its periphery and, thus, were unrealistic in their assessment of their ability to survive another one (324).

Slovic et al. (1982, 263) define the characteristics of risk (all of which, it would seem, may be readily applied to the field of disaster management) as follows: (1) voluntariness, (2) dread, (3) knowledge, (4) controllability, (5) benefits to society, and (6) number of deaths. Voluntary hazards (e.g., mountain climbing, use of X-rays, driving motorcycles) tend to be controllable and well known, while hazards that threaten future generations tend to be seen as catastrophic. Risks that are not clearly understood, that evoke a feeling of dread, and that affect a large number of people are considered more dangerous than others (Slovic et al. 1982, 263). And there are other factors that can affect the way in which risks are considered.

It is, therefore, important to determine what factors people take into consideration when determining whether or not a potential event is risky. Hohenemser et al. (1983, 382) state "The most striking aspect of these results is that perceived risk shows no significant correlation with the factor of mortality. Thus, the variable most frequently chosen by scientists to represent risk appears not to be a strong factor in the judgment of our subjects." It has been shown that awareness of previous disasters is directly related to age, length of residence, and proximity to the damaged area (pp. 325-26). The individual perception of some risks is intrinsically linked to periods of life (Giarini 1993, 246). For example, a twenty-year-old may find the idea of car racing exciting, while a fifty-year-old may simply find it dangerous. It also appears that long intervals between disasters can lull people into a false sense of security.

Morgan (1985, 323) agrees, and he mentions that the public does indeed concern itself with factors other than mortality rates.

> Other things besides the number of people killed or injured count to most people ... things like equity, things like whether the benefits and the risk are imposed on the same or different people, and things like whether the risk is voluntary or involuntary. There is nothing irrational about such views. Indeed they are highly rational views. They reflect concerns about things like freedom, justice and democracy that we hold to be important in our society.

Several decades of study on droughts, earthquakes, and floods show that any analysis of risk needs to take into account how it is perceived by the people directly affected as well as by the individuals and organizations involved in responding to it, relying solely on the perceptions of scientific and technical analysts may give one a false impression of the actual situation (White 1988, 173). Therefore, we need to ensure that the public is an active participant in the HRV process.

Given that the process of risk assessment is often grounded in how people perceive risk, and given that most researchers agree that the general public is not very adept at estimating risk, it is critical that any such process include an educational component with regard to risk perception and risk assessment. Participants will need to have guidelines to help them assess whatever data is available. And, finally, understanding the social vulnerabilities of people and where they live and work continue to be key elements in dealing with how people perceive and communicate information about hazards and risks.

E.2.3. Risk Acceptance

Upon hearing about the risk posed by a particular hazard, one person moves away and another pays it little or no heed. What is not acceptable to one is perfectly acceptable to another. However, in many situations, while some people might find the risk acceptable, others might simply be unable to avoid it due to financial or other considerations. For example, while families might not find living next to an industrial site acceptable, they may well be unable to afford to move to a safer location. Similarly, in the case of earthquakes, families may not be able to leave a high-risk seismic area, as it would mean unemployment and the loss of relatives and friends.

Even after a major disaster, for a variety of reasons residents are often reluctant to leave the affected area. Consider the situation in Skopje, where, following the 1976 earthquake, it is estimated that 150,000 people left the city within the first three weeks. "However, families did not like being split up, children could not speak the language of different Yugoslav republics and the net result was that within 2 1/2 months they had virtually all returned" (Davis, cited in Drabek 1986, 241).

What is acceptable risk? How safe is safe enough? As William W. Lowrance asks, "Who should decide on the acceptability of what risk, for whom, in what terms, and why?" (cited in Haimes 1992, 314). Consider the following anecdote:

> A real estate developer standing on the ground floor of a new apartment building on the floodplain of a creek in a Missouri valley town was asked whether he thought he was taking any risk in locating a structure there. He replied to the contrary and, when pressed, observed further that he knew that the stream had many years earlier reached a stage at the point as high as his shoulders. How then could he say there was no risk? His answer was, "There isn't any risk; I expect to sell this building before the next flood season." (Burton et al. 1978, 96)

The self-interest of the real estate developer aside, some people are greater risk takers than are others; some would be willing to buy those apartment units and others would not. As Luhmann (1993, 112) says,

> Empirical research shows above all that the willingness to take "risks" depends on how firmly we believe ourselves capable of keeping precarious situations under control, of checking a tendency towards causing loss, or maintaining our coverage by means of help, insurances, and the like in the event of losses occurring. It is not infrequent to overestimate our own competence while underestimating that of others.

According to Svenson (1988, 199): "One important aspect of the mental representation of a risk is whether it is considered acceptable or nonacceptable. If the risk is regarded as acceptable, no further action is taken. But if it is seen as unacceptable this builds up a potential for action." If the public deems a risk to be unacceptable, and if the community does nothing to rectify it, then people may simply leave. The solution is to engage in proactive mitigation measures. As Giarini (1993, 246) says, "Uncertainty may be described as the sum of all potential hazards around us, perceived or not. Each individual can ignore some of these potential hazards, take preventive action against others through physical or financial protection, or fall into a state of anxiety that ends him up in hospital."

It is important for the public to understand what others (e.g., regulators, scientists, and politicians) deem to be acceptable risk. While those completing the risk assessment do not necessarily have to accept the conclusions of experts and politicians, they should at least understand their reasoning. For example, the government of British Columbia has stated that, if the flood has an annual return frequency of 1 in 500 years, then it is acceptable to rezone the land in the flood plain for residential dwellings. Since there is no flood insurance for private dwellings in Canada, the government believes that having to pay out compensation for flood damage on a 1-per-500-year basis is quite acceptable. That floods could occur within two years back-to-back (as was the case in the Mississippi Valley) is, apparently, also acceptable. As stated by Burby (1998 264), government programs such as the National Flood

Insurance Program in the United States have actually increased the willingness of people to build in flood plains because it has made the risk acceptable.

In every case, an individual's perception of risk is based on her or his background; thus, those engaged in the HRV assessment process need to be aware of their own biases. Williams and Mileti (1986) state that much of what can be considered under acceptability of risk is related to the quality of life (e.g., income, health, safety, community integration, education, individual expression, etc.) of the individuals involved. For example, "most people would experience some difficulty relating to an event that had a return period of greater that 100 years, but this does not prevent them from having perceptions on acceptability" (Morgan 1991, 61).

E.2.4. Bibliography

Bolin, Robert. (1993). *Household and Community Recovery After Earthquakes.* Boulder, CO: Institute of Behavioral Science, University of Colorado.

Burby, Raymond J. (1998). "Policies for Sustainable Land Use." In *Cooperating with Nature: Confronting Natural Hazards with Land-Use Planning for Sustainable Communities*, ed., 263-91. Raymond Burby, Washington, DC: Joseph Henry.

Burton, Ian, Robert W. Kates, and Gilbert White. (1978). *The Environment as Hazard.* In *Human System Responses to Disaster: An Inventory of Sociological Findings*, ed. Thomas E. Drabek. New York: Oxford University Press.

Drabek, Thomas E. (1986). *Human System Responses to Disaster: An Inventory of Sociological Findings.* New York: Springer-Verlag.

Giarini, Orio, and Walter R. Stahel. (1993). *The Limits to Certainty* (2nd edition). The Netherlands: Kluwer Academic.

Greene, Marjorie, Ronald Perry, and Michael Lindell. (1981). "The March 1980 Eruptions of Mt. St. Helens: Citizen Perceptions of Volcano Threat." *Disasters* 5 (1): 49-66.

Haimes, Yacov Y. (1992). "Toward a Holistic Approach to Total Risk Management." *Geneva Papers on Risk and Insurance* 17 (64): 314-21.

Hohenemser, C., R.W. Kates, and P. Slovic. (1983). "The Nature of Technological Hazard." *Science* 220: 378-84.

Horlick-Jones, Tom, and D.K.C. Jones. (1993). "Communicating Risk to Reduce Vulnerability." In *Natural Disasters: Protecting Vulnerable Communities*, ed. P.A. Merriman, 25-37. London, UK: Telford.

Luhmann, Niklas. (1993). *Risk: A Sociological Theory.* New York: de Gruyter.

Morgan, Graham C. (1991). "Quantification of Risks from Slope Hazards." In *Geologic Hazards Workshop Proceedings*, 57-70. Vancouver: Geologic Hazards '91.

Morgan, M. Granger. (1985). "The Importance of Risk Perception." In *Proceedings from Avoiding and Managing Environmental Damage from Major Industrial Accidents*, 321-26. Vancouver, BC: International Conference Presented by the Air Pollution Control Assoc.

National Research Council. (1989). *Improving Risk Communication*. Washington, DC.: National Academy Press.

Penning-Rowsell, Edmund, and John Handmer. (1990). "The Changing Context of Risk Communication." In *Hazards and the Communication of Risk*, ed., John Handmer and Edmund Penning-Rowsell, 3-15.

Scanlon, Joseph, Suzane Alldred, Al Farrell, Angela Prawzick. (1985). "Coping with the Media in Disasters: Some Predictable Problems. *Public Administration Review* 45 (1): 123-33.Vermont: Gower.

Slaymaker, Olav. (1995). "A Comprehensive Framework for the Analysis of Risks due to Geomorphic Hazards." In *the Proceedings for the Tri-Lateral Natural Hazards Risk Assessment Conference*, ed. David Etkin, 1-215 - 1-222. Merrickville, Canada: Environment Canada.

Slovic, Paul, Baruch Fischhoff, and Sarah Lichtenstein. (1991). "Rating the Risks." In *Readings in Risk*, ed. Theodore S. Glickman and Michael Gough, 61-74. Washington, DC: Resources for the Future.

Svenson, Ola. (1988). "Mental Models of Risk, Communication, and Action: Reflections on Social Amplification of Risk." *Risk Analysis* 8 (2): 199-200.

Wenger, Dennis E. (1980). "A Few Empirical observations Concerning the Relationship between the Mass Media and Disaster Knowledge: A Research Report." In *Disasters and the Mass Media: Proceedings of the Committee on Disasters and the Mass Media Workshop, February 1979*. Washington, DC: National Academy of Sciences.

White, Gilbert. (1988). "Paths to Risk Analysis." *Risk Analysis* 8 (2): 171-75.

Williams, Gary, and Dennis S. Mileti. (1986). "Inclusion of Social Variables in Models of Risk Assessment." In *Geotechnical and Geohydrological Aspects of Waste Management*, 375-79. Fort Collins: Hazards Assessment Laboratory, Colorado State University.

Yamamoto, Yasumasa, and E. L. Quarantelli. (1982). *Inventory of the Japanese Disaster Research Literature in the Social and Behavioral Sciences*. Columbus, OH: Disaster Research Center, Ohio State University.

E.3. Hazard Identification

The Committee should review all the potential hazards listed. Hazards are listed by cause:
Natural hazards,

- Diseases, epidemics and infestations,
- Person induced hazards.

E.3.1. Natural Hazards

Classification	Hazard	Historical Data
Astronomical	1. Asteroid Crashes 2. Comet Crashes 3. Geo-magnetic Storms 4. Meteor Showers	
Atmospheric	1. Blizzards 2. Extreme Cold 3. Fog 4. Freezing Rain or Drizzle 5. Frost 6. Hailstorms 7. Heat Waves 8. Hurricanes 9. Ice Fogs and Ice Storms 10. Lake-effect Storms 11. Lightning 12. Snow Storms 13. Thunderstorms 14. Tornadoes 15. Wind Storms	
Fires	1. Forest Fires 2. Grass, bush and brush Fires 3. Urban Wildland Interface Fire	

Classification	**Hazard**	**Historical Data**
Geological	1. Avalanches 2. Debris Avalanches, Debris Flows and Torrents 3. Expansive Soils 4. Landslides 5. Land Subsidence and Sinkholes 6. Sand and Dust Storms 7. Submarine Slides	
Hydrological	1. Drought 2. Erosion, Accretion and Desertification 3. Floods - Flash Urban 4. Floods - Flash 5. Floods - Local 6. Floods - River Ice Jam 7. Floods - Snow Melt 8. Glaciers 9. Icebergs, Ice Islands and Sea Ice 10. Rain Storms 11. Sea Storms 12. Seiche 13. Storm Surges	
Seismic	1. Ground Failure 2. Liquefaction 3. Surface Faulting 4. Tectonic Deformation 5. Tsunamis	
Volcanic	Appendix A. Ash Falls 2. Lava Flows 3. Mudflows 4. Projectiles and Lateral Blasts 5. Pyroclastic Flows	

Table 34: Natural Hazards

E.3.2. Diseases, Epidemics and Infestations

Classification	Hazard	Historical Data
Diseases Affecting People	• virally and bacterially human transmitted epidemics • virally and bacterially insect-borne epidemics • virally and bacterially animal-borne epidemics • water- and air-borne epidemics • parasites	
Diseases Affecting Animals	• virally and bacterially human transmitted epidemics • virally and bacterially insect-borne epidemics • virally and bacterially animal-borne epidemics • water- and air-borne epidemics • parasites	
Diseases and Infestations Affecting Plants	• virally and bacterially human transmitted epidemics • virally and bacterially insect-borne epidemics and infestations • virally and bacterially animal-borne epidemics and infestations • water- and air-borne fungus and mould diseases • parasites	

Table 35: Diseases, Epidemics and Infestations

As guideline to the committee the following diseases, epidemics and pest infestations are provided. However, the committee should consult with local sources to expand on the list, keeping in mind local conditions.

Human	**Animal**	**Plant**
Acute encephalitis	Anthrax	Asian Gypsy Moth
Acute meningitis	Brucellosis	European Gypsy Moth
AIDS	Foot and Mouth	PYK
Cholera	Gastroenteritis	Spruce Budworm
Cryptosporidium	Lumpjaw	
Diphtheria	Rabies	
Ebola Fever	Swine Fever	
Flu	Tuberculosis	
Hepatitis		
Malaria		
Measles		
Scarlet Fever		
Tuberculosis		
Typhoid		
Yellow Fever		

Table 36: Guide to Potential Diseases, Epidemics and Infestations

E.3.3. Person Induced Hazards

A number of the hazards included on the person induced hazards list also appear in the natural hazards list.

Classification	Hazard	Historical Data
Accidents	1. Air Crashes 2. Marine Accidents 3. Motor Vehicle Crashes 4. Rail Accidents 5. Subway Accidents	
Dam Failure		
Earthquakes		
Ecological Destruction		
Explosions and Leaks	1. Gas Explosions and Gas Leaks 2. Mine 3. Other Explosions	
Famine		
Fire	1. Forest Fires 2. Urban Fires 3. Urban Wildland Interface 4. Grass, Bush and Brush Fires	
Geological	1. Avalanches 2. Debris Avalanches, Debris Flows and Torrents 3. Landslides 4. Sand and Dust Storms 5. Submarine Slides 6. Land Subsidence	
Global Warming		
Hazardous Material Accidents - In Situ		
Hazardous Material Spills - Transport	1. Air 2. Marine 3. Land 4. Rail	

Classification	Hazard	Historical Data
Hydrological	1. Drought 2. Erosion and Accretion 3. Local Flooding 4. Seiche 5. Desertification	
Nuclear Accidents		
Pollution		
Power Outages		
Riots		
Space Object Crashes		
Structural Collapse	1. Buildings 2. Structures	
Terrorism	1. Bombs 2. Hostage	
Y2K		
War		

Table 37: Person Induced Hazards

E.3.4. Multi Hazards

Since research in the area of multi-hazards is still in its infancy, multi-hazards are beyond the scope in terms of risk analysis. However, in many cases where relationships between hazards are known, they can be addressed in the vulnerability assessment. For example, it is known that earthquakes can cause landslides. Therefore, proximity to an area subject to landslides can be recorded as an added vulnerability to earthquakes.
As a guideline, and for educative purposes, some of the relationships between natural and person induced hazards are presented in *Table 5*.

Table 38: Natural Hazards Causing Technological Hazards

Natural Hazard	Person Induced Hazards
Earthquake	• Hazardous material spills: petroleum, air fuel, formaldehyde • Gas Leaks: ammonia, hydrogen cyanide gas, chlorine • Asbestos Release (from damaged buildings)
Rock Slide	• Derailed a freight train, which in turn spilled fuel into a creek and started a fire that burned for an entire day
Volcanic Eruption	• Clogging air intake valves • Airplane crashes • Floods caused by melting summits almost broke through an oil pipeline
Hurricane	• Hazardous material spills: petroleum, diesel fuel • Gas Leaks: propane • Asbestos Release (from damaged buildings) • Destruction of septic tanks and water contamination
Flooding	• Hazardous material spills: petroleum, diesel fuel, pesticides, kerosene, farm chemicals • Gas Leaks: propane
Lightning	• Hit a major transformer, closing the power plant

adapted from Showalter and Myers (1992:12-22)

E.4. Definitions and Discussions of Hazards

<table>
<tr><th>Air Crashes</th><th>Historical Data</th></tr>
<tr><td>Definition

An air crash is considered to be an accident involving one or more airplanes. While most airplane crashes occur on or near an airport, airplane crashes can occur anywhere.
Discussion

The causes of air crashes can be summarized as:

• the physical flying stressors (e.g. the noise, glare and pressure changes),

• the anxiety stress factors (e.g. level of training, night flying and unfamiliar airports),

• personal stress factors (e.g. hunger, fatigue and worry), and

• emergency stressors (e.g. control malfunction, metal fatigue and engine fire.</td><td></td></tr>
</table>

References

Jessen, Knud. (1985). "Aircraft Disaster Readiness." *Journal of World Association for Emergency and Disaster Medicine*. 203-206.

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis*. Vancouver, B.C.: DPRC, University of British Columbia.

Blizzards	**Historical Data**
Definition Blizzards combine high winds (typically in the 90 to 130 kilometres per hour range), blowing snow and low temperatures. The effects of the storm are always intensified by the wind chill factor associated with the high winds. Blizzard conditions occur most often in unforested areas where there are no trees present to break the effects of the wind. **Discussion** Blizzards are considered by climatologists, farmers and transportation engineers to be the most dangerous of winter storms Combining strong winds, low temperatures and poor visibility, blizzards wreak havoc on traffic, buildings, and livestock. A significant effect associated with blizzards is the disruption of power and communication lines. Blizzard conditions are often accompanied by freezing rain or sleet and the combination of wind and blowing, freezing rain causes large buildups of ice on transmission lines, which quickly break. In some areas, such as the leeward shores and coves along large bodies of water, bursts of wind can greatly intensify the blizzard conditions, resulting in a number of serious impacts upon living conditions in rural and urban areas.	

References

Phillips, David. (1990). *Climates of Canada.* 59-62. Ottawa, Canada: Canadian Government Publishing Centre, Supply and Services Canada.

Phillips, David. (1993). The Day Niagara Falls Ran Dry! 72-77. Canada: Key Porter Books.

Dam Failure	**Historical Data**
Definition A dam breach is defined as a breach in the dam itself, its foundation, abutments, or spillway, which results in large or rapidly increasing, uncontrolled releases of water from the reservoir. **Discussion** A dam breach threatens life and property downstream of the event. In many locations, roads, railways, bridges and ferry networks would also be at risk. Major dams are defined as those over 9 metres in height and which meet the criteria in terms of their foundations and their water storage capacity. They may present a significant hazard, such as the domino effect. Mine tailing dams, chemical and sewage lagoons and dump leaching lakes are also potential hazards. Sewage lagoons can have 35 foot walls and hold 700 acre feet of sewage.	

References

B.C. Hydro, B.C. Ministry of Energy, Mines and Petroleum Resources, BC Gas and Canadian Cartographics Ltd. (1991). *Energy Resources of British Columbia.* Burnaby: Canadian Cartographics Ltd.

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis.* Vancouver, B.C.: DPRC, University of British Columbia.

Drought	Historical Data
Definition Drought results from an abnormal water deficiency. While drought is often measured in terms of water deficiency, it manifests itself in crop failures, dust storms, deficient and polluted water supplies and distressed economic and ecological systems. There are many definitions: some conceptual and some operational. Conceptual definitions such as "statistical chance combination of persistent and persistently recurrent meteorological events" and operational definitions such as "a period of more than fourteen days in the United Kingdom without measurable rain" say little about the societal impact, which is of primary concern. **Discussion** Droughts are usually due to natural causes, but are exacerbated by growing demands, urbanization and other human conditions. While usually considered in the context of agriculture, many other resources and commercial activities are affected. Forest fires are largely the product of drought. Decreased water levels in lakes and streams can greatly penalize inland navigation, fish production, recreation and hydropower generation. Each drought is different, although many droughts appear cyclic in nature, and there may be many years between droughts. In arid regions of the world, which occupy over one-third of the world's land, droughts may appear to be endless. But drought occurs in every type of climate; the intensity, duration and area of impact greatly fluctuating from locality to locality. While the primary cause of drought is variations in the climate which produce less precipitation than expected, there are many other underlying factors which need to be considered. The main causal factors to be considered are degradation of the land and increased water usage. Vulnerability to drought continues as the climate varies, people have poor memories regarding the past and fail to plan adequately, and society itself is rapidly changing. Within developed countries, buffering against drought has often been achieved through produce diversification, risk spreading, crop insurance, and improved technology	

References

McKay, G.A. (1988). "Drought: A Global Perspective." In *Natural and Man-Made Hazards*. M.I. El-Sabh and T.S. Murty. (eds.), 319-336. Dordrecht, Holland: D. Reidel Publishing Company.

Phillips, David. (1990). *Climates of Canada*. 50-52. Ottawa, Canada: Canadian Government Publishing Centre, Supply and Services Canada.

Earthquakes	Historical Data
Definition Earthquakes are considered to be a special type of geological hazard. An earthquake is a series of elastic waves propagated in the earth, initiated where stress along a fault exceeds the elastic limit of the rock so that sudden movement occurs along the fault. The ground motion provokes secondary hazards, namely surface faulting, tectonic deformation, ground failure, liquefaction and tsunamis. Ground failure consists of violent shaking of the ground which accompanies movement along a fault rupture. Surface faulting is the tearing of the earth's surface by differential movement across a fault. Liquefaction is the phenomena in which a loose deposit of sand existing below the water table loses its internal strength when subjected to severe earthquake ground motion. Tectonic deformation occurs when there is horizontal or vertical distortion of the Earth's surface that usually accompanies surface faulting. **Discussion** The primary effect of earthquakes is the violent ground motion accompanying movement along a fault. Seismic energy is emitted from fault ruptures as seismic waves which may cause damage to buildings, bridges and other structures near or on the earth's surface. Three major types of seismic waves are generated by an earthquake shock.. Each type of wave travels through the earth at a different speed depending on the properties of the wave, and the material through which it travels. • The fastest are the *Primary* (P waves) or compression waves. These are a kind of longitudinal wave, similar in character to sound waves passing through a liquid or gas. They travel in average crustal rocks at about five kilometres per second. • Next in speed, are *Secondary* waves (S waves). In these, particles oscillate back and forth at right angles to the direction of wave travel. S waves travel through the earth's crust at about three kilometres per second. This side to side motion is usually the most destructive because unreinforced buildings are less able to withstand side to side motion than vertical displacement. • *Surface waves* (also called Rayleigh and Love waves) are the slowest moving, and travel near the surface of the earth with a speed of less than three kilometres per second Particles in surface waves move in an orbit similar to that of particles in water waves.	

Earthquakes cont'd......	Historical Data
• High-frequency waves (P and S waves) are more efficient at vibrating low buildings than are low-frequency waves (Rayleigh and Love waves). Low-frequency waves are more likely to vibrate tall buildings and can cause damage at great distances from the fault rupture. Magnitude is a measure of physical energy released, or strength of an earthquake. It is most commonly expressed as a relative magnitude on the Richter Scale (a logarithmic scale, to the base 10, of wave amplitude. It is unusual for shocks smaller than magnitude 2 to be felt anywhere. Earthquakes with magnitude of 3 can be felt by humans when near the epicentre of the quake. Damage begins to occur to buildings at about a magnitude of 6. Any earthquake above magnitude 7 can be a major disaster if it occurs near a densely populated area. Lack of sophisticated measuring equipment in the past has made it difficult to accurately determine the magnitude of earlier earthquakes. Generally, most seismologists feel that historical earthquakes have not exceeded a magnitude of 9 to 9.2. Seismic activity is also expressed in terms of felt intensities on the Modified Mercalli Scale. This scale is an evaluation of the severity of ground motion at a given location as measured in relation to the effects of the earthquake on human life. The MMS ranges from barely perceptible earthquakes at MMI to near total destruction at MMXII. It provides a convenient way for an observer to summarize what happened so that it can be compared with the happenings in other places. Liquefaction occurs when saturated sand is shaken to the point that it behaves like a liquid, and soil loses its strength or stiffness. Although liquefaction by itself is not ground failure, the liquefaction process results in almost total reduction of shear strength. This reduction of strength can result in ground failure of several types, the most common being : • Lateral spreads which involve lateral displacement of large surficial blocks of soil as a result of liquefaction in subsurface layers. They generally develop on very gentle slopes (most commonly between 0.3 and 3 degrees) and move toward a free face, such as an incised stream channel. Lateral displacements range up to several feet, and, in particularly susceptible conditions, to several tens of feet, accompanied by ground cracking and differential vertical displacement. Lateral spreads often disrupt the foundations of buildings or other structures, rupture pipelines and other utilities in the failure mass.	

Earthquakes cont'd......	Historical Data
Flow failures occur with liquefaction-caused landslides that develop in loose saturated sands or silts on natural or human-made slopes greater than 3 degrees. Flows may consist of completely liquefied soils, or of blocks of intact material riding on layers of liquefied soil. They often displace large masses of material for many tens of feet at velocities ranging up to tens of miles per hour. • Densification and ground settlement are commonly associated with and enhanced by liquefaction. Several classic examples of ground settlement caused by seismic shaking occurred in saturated sediments along the coast of Alaska due to the 1964 earthquake; at Portage, Alaska, settlement lowered the ground surface sufficiently so that houses and highway and railroad grades were inundated at high tide. The 1949 Olympia earthquake caused structural damage to buildings on the Duwamish Flat in south Seattle due to settlement of saturated sediments. • Sand boils often form at the surface during ground settlement. Although sand boils are not strictly a form of ground failure because alone they do not cause ground deformation, they provide diagnostic evidence of elevated pore-water pressure at depth and indication that liquefaction has occurred. Loss of bearing capacity occurs when the soil supporting a building or other structure liquefies and loses strength. This process results in large soil deformations under load, allowing the structures to settle and tip.	

References

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis*. Vancouver, B.C.: DPRC, University of British Columbia.

United Nations. (1991). *Mitigating Natural Disasters: Phenomena, Effects and Options A Manual for Policy Makers and Planners*. New York, N.Y.: UNDRO.

Geo-Magnetic Storms	**Historical Data**
Definition A stream of electrically charged particles is constantly being emitted from the sun. When these particles reach earth, they form a teardrop-shaped magnetic field - the magnetosphere - around the earth. The bombardment of the magnetosphere by high-energy solar particles is called a geo-magnetic storm. **Discussion** Forecasts of geomagnetic storms and auroral activity have been sent to power companies, communication facilities, defence officials and individuals for decades. In Canada these forecasts are comprised of three types: medium term (27 day multi-zone forecasts); short term (72 hour forecasts) and magnetic alert messages. These storms cause problems for communications companies and utilities. The electrical energy flowing to earth from the sun is powerful enough to alter radio transmissions, distort television receptions, cross telephone conversations, etc.. They can also overload utility circuits and cause widespread blackouts	

References
Phillips, David. (1993). *The Day Niagara Falls Ran Dry*! 31-35. Canada: Key Porter Books.

<table>
<tr><th>Hailstorms</th><th>Historical Data</th></tr>
<tr><td>

Definition

Hail is precipitation in the form of balls or irregular lumps of ice. By convention, hail has a diameter of 5 millimetres or more, while smaller particles may be classified as either ice pellets or snow pellets.

Hailstones are created by the gradual accretion of layers of frozen cloud droplets around an initial ice crystal or a frozen water droplet. The main cause of hail is atmospheric instability, which often produces up-drafts strong enough to carry the weight of hailstones as they grow.

Discussion

The impact and hazard of hailstorms is, in many respects similar to that of blizzard conditions, as agriculture and property are both often seriously damaged by hail. However, the damage caused by hail is most often in the form of crop destruction, with some damage to buildings and automobiles, broken glass and the like. Hailstorms rarely, if ever, cause fatalities but can cause great economic losses.

Hailstorms are particularly damaging as they tend to coincide with the time period at which agricultural crops are at their most vulnerable. The crops most susceptible to hail damage are tall stemmed plants such as wheat, barley, oats, rye and corn, with a late maturing date.

</td><td></td></tr>
</table>

References
Canadian National Committee for IDNDR. (1994). *Canadian National Report*. Canada: Canadian National Committee for IDNDR.
Phillips, David. (1990). *Climates of Canada*. 52-53. Ottawa, Canada: Canadian Government Publishing Centre, Supply and Services Canada.

Hazardous Material Accidents - In Situ	Historical Data
Definition The United States Environmental Protection Agency (EPA) defines risk from a fixed facility as any uncontrolled release of material posing a risk to health, safety, and property. **Discussion** Materials considered hazardous are explosives and blasting agents, flammable and inflammable gases, flammable liquids and solids, poisons, biological wastes, etiological agents, corrosive substances, and hazardous wastes. Facilities which should be deemed vulnerable to hazardous waste spills or accidents include locations where such materials are manufactured, processed, stored, treated, and disposed of. Under the British Columbia Ministry of Environmental Emergency Program, spills of hazardous materials are classified as Urgent (Code II) or Non-Urgent (Code I) (BC Ministry of Environment 1992). Spills of hazardous materials are Code II incidents, as they pose threat to human, fish or wildlife populations, often requiring evacuation of humans. Spills of all of the substances listed above would be considered Code II.	

References

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis*. Vancouver, B.C.: DPRC, University of British Columbia.

Heat Waves	**Historical Data**
Definition A heat wave can take a number of forms. Such events can be characterised by temperatures significantly above the mean for an extended period; or by a combination of high temperatures with high humidity and a lack of air motion. **Discussion** Key factors are: air temperature, humidity, air motion, and radiant heat. Of these factors, temperature is the most important. Existence of a high temperature over a number of days is especially relevant when over 7 days. Often there is little night time cooling. Humidex is a measure of what hot weather "feels like" to the average person. At a Humidex level of 4-45 degrees C everyone is uncomfortable and at 46+ active physical exertion must be avoided. The climate severity index measures discomfort, psychological state, safety, and outdoor mobility. Summer discomfort is defined by the Humidex, length and warmth of summer and dampness. The effects of heat waves on physical health include heatstroke, heat exhaustion, heat syncope, and heat cramps. Heat stroke occurs when the internal temperature of the body reaches to more than 105 degrees Fahrenheit. Those affected by heatstroke are typically delirious, or comatose, and it can lead to sustained neurological damage or even death. Heat exhaustion is a less severe condition, with those affected experiencing dizziness, nausea, disorientation, and excessive fatigue. Research indicates that these symptoms may result more from an electrolyte imbalance than the impact of high temperatures. Heat exhaustion is rarely fatal, and is easily redressed through rehydration and electrolyte balancing. Heat syncope is a sudden loss of consciousness, thought to arise from circulatory difficulties associated with high temperatures. Those affected seem to recover quickly, once they are returned to a vertical position. Non-health related impacts of heat waves include a rise in crime, violent behaviour, and social unrest which are typically centred in urban areas.	

References

Kilbourne, Edwin M. (1989) "Heat Waves." In *The Public Health Consequences of Disasters 1989*. Michael B. Gregg MD (ed.), 51-61. USA: US Department of Health and Human Services.

Phillips, David. (1993). *The Day Niagara Falls Ran Dry*! 65-71. Canada: Key Porter Books.

Phillips, David. (1990). *Climates of Canada*. 22-29. Ottawa, Canada: Canadian Government Publishing Centre, Supply and Services Canada.

Human Diseases - Human Transmitted	Historical Data
Definition Included are human diseases and epidemics which affect people, cause death, have serious economic implications and form the basis for a mass casualty emergency response. **Discussion** Infectious diseases which affect humans are often of great concern, evidenced by the often rapid and intensive response to a disease outbreak. There are so many diseases, each with their own characteristics, incubation times, etc. that it is important to consult with public health officials and the medical community when attempting to determine diseases likely to occur in one's community.	

References

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis*. Vancouver, B.C.: DPRC, University of British Columbia.

Ice Storms and Ice Fogs	Historical Data
Definition An ice storm combines high wind, freezing temperature and freezing rain or drizzle. An ice fog occurs when the temperature drops below -30C so that water vapour condenses directly into tiny ice crystals and there is a source of warm moisture. **Discussion** It is the combination of high wind and freezing precipitation which causes damage during an ice storm, as the amount of precipitation is frequently low enough that damage from it alone would be minimal. High winds cause freezing precipitation to form a glaze of ice on structures, leading to eventual failure. Severe damage to hydro lines cause a loss of power for heat and light, along with a disruption of telephone systems, can have very serious and potentially fatal consequences. The disruption of transportation systems, communications, and hydro service can affect literally thousands of people. Schools close, businesses are unable to operate, highways and local roads become treacherous, and police and emergency services have difficulty performing their day-to-day tasks. As well, in some towns in the recent past, ice fog has wreaked havoc on local transportation and infrastructure. Freezing precipitation can have severe economic impacts, particularly on agricultural production.	

References

Chaine, P.M., R.W. Verge, G. Castonguay, and J. Gariepy. (1974). *Wind and Ice Loading in Canada*. Ottawa: Environment Canada.

Phillips, David. (1993). *The Day Niagara Falls Ran Dry*! 78-85. Canada: Key Porter Books.

Phillips, David. (1990). *Climates of Canada*. 40-44. Ottawa, Canada: Canadian Government Publishing Centre, Supply and Services Canada.

Landslides	Historical Data
Definition Landslides occur when slope materials (e.g. natural rocks, soils and combinations of rocks and soils) respond to the forces of gravity. Rock falls, topples, slumps, and lateral spreads are all types of landslides **Discussion** Landslides are triggered by: (1) vibrations from earthquakes, blasting, machinery or traffic; (2) removal of lateral support due to erosion by streams and rivers or waves, previous slope failures, construction, or created lakes and reservoirs; (3) loading as a result of rain, hail, snow, accumulation of soil material, waste piles or buildings and structures; (4) changes in direct water content; and (5) weathering and other physical actions.	

References

Nuhfer, Edward B., Richard J. Proctor and Paul H. Moser. (1993). *The Citizens' Guide to Geologic Hazards*. 15-17. Arvada, Colorado: The American Institute of Professional Geologists.

United Nations. (1991). *Mitigating Natural Disasters: Phenomena, Effects and Options A Manual for Policy Makers and Planners*. New York, N.Y.: UNDRO.

Van Dine, D.F. (1991). "Low Magnitude/High Frequency Mass Movements." In Geologic Hazards in British Columbia: Proceedings of the Geologic Hazards '91 Workshop: February 20-21, 1991. Victoria, B.C.: University of Victoria.

Rail Accidents	Historical Data
Definition Rail accidents occur when a train derails or collides with another train, motor vehicle or obstruction on the rail tracks. A rail accident can also take place on a rapid transit system, such as the ALRT in the Lower Mainland. **Discussion** Certainly train accidents around the world have occurred for a number of reasons. Many accidents are as the result of colliding with another train already on the tracks Train accidents can be caused by rocks or other debris on the tracks as a result of a landslide or, in some cases, vandalism. Driver error, sometimes exacerbated by excess alcohol levels or drugs, can also be responsible for rail accidents. Motor vehicles often are involved in collisions with trains,	

References

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis*. Vancouver, B.C.: DPRC, University of British Columbia.

Riots	Historical Data
Definition A riot is a violent public disorder, specifically a disturbance of the public peace by a group of persons with either a common or random intent to destroy property, assault persons or otherwise disturb the peace. **Discussion** When riots and looting occur, there is often a significant loss of property to businesses, especially small businesses. The publicity that riots generate also serves to scare many people away from the area, for fear of a repeat event. This adds to the economic losses of the impacted area. Often of equal or greater concern are the social and political impacts. When riots develop, there is a feeling that things are generally out of control; and this feeling of vulnerability and sense of helplessness adds to impact of the riot itself. Not only do media tend to give a high priority to such events, but the public also demands for control and order to be brought to the site and retribution to the offenders. Politicians quickly become accountable for the actions that were or were not taken to control the riot and the subsequent aftermath.	

References

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis*. Vancouver, B.C.: DPRC, University of British Columbia.

Snow Storms	Historical Data
Definition Snow storms vary from light sprinkles of snow to accumulations of several metres. Similar to the effects of blizzards, snowstorms are, however, not often associated with high winds. **Discussion** Snow storms can have serious impacts on highways, local roads, and on infrastructure such as hydro-electric transmission lines and communications networks. The failure, or collapse of towers and lines, is caused by the rapid accumulation of snow. The combination of poor traction and inexperienced drivers on highways and local roads can also lead to extensive problems. Heavy snowstorms can also have impacts on agricultural activities, most often the raising of cattle. Heavy accumulations of snow prevent ranchers from gaining access to their stock to feed and protect them. For example, a heavy snowfall in Nebraska and Montana, in 1975, killed 56,000 calves, an economic loss of over $4 million. In addition, the economic costs to ranchers and cattlemen are not limited to the loss of stock but often includes the costs of reaching animals by helicopter or plane. Agricultural losses can also include serious damage to fruit trees and fruit crops if snow arrives late in the spring.	

References

Steppuhn, H. (1981). "Snow in Agriculture." In *The Handbook of Snow*. D.M. Gray and D.H Male (eds.). Oxford: Pergamon Press. 1981.

Urban Wildfire Interface	Historical Data
Definition A wildfire exists when there is uncontrolled burning in grasslands, brush or woodlands. Wildfires may impact adjacent property and infrastructure and threaten human lives. **Discussion** Of increasing concern are wildland-urban interface fires. These fires occur when residential areas include considerable numbers of trees and wildlands, and wind and weather conditions spread an existing fire into a fast moving major fire which often engulfs homes and businesses along with forest stands and parks.	

References

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis*. Vancouver, B.C.: DPRC, University of British Columbia.

E.5. Risk Analysis

Hazard	Risk Factors
Air Crashes	☐ A study completed by the International Civil Aviation Organization in 1981, found that the larger the aircraft, the less likely it is to crash so places in the flight path of large aircraft are less likely to be impacted by a crash. ☐ Since most air accidents occur on or near airports, at either landing or take-off, airports and areas with large numbers of flights are clearly more at risk. ☐ Since most air accidents occur on or near airports, airports and areas with large numbers of flights are clearly more at risk. ☐ Areas near flight paths which are near mountains are more at risk. ☐ Areas near flight paths which are near areas of poor weather visibility are more at risk. ☐ Areas near air craft training stations. ☐ Areas near military missile and artillery training areas. ☐ Areas near air shows.

Jessen, Knud. (1985). "Aircraft Disaster Readiness." *Journal of World Association for Emergency and Disaster Medicine.* 203-206.

Hazard	Risk Factors
Blizzards	☐ Arctic and inland prairie regions in Canada are most at risk. ☐ Major transportation corridors across flat windy areas. ☐ Altitude: temperature decreases 6.5 degrees C for every 1000 m. rise in altitude. ☐ Monthly temperatures vary fairly directly with latitude. The further north (in the Northern hemisphere) the colder. ☐ Ratings on climate severity index. The closer the rating to 100 points, the higher the uncomfortableness and hazardous rating (e.g., St. John's has a rating of 56 versus Victoria with a rating of 13). ☐ Previous blizzards in the area.

References

Phillips, David. (1990). *Climates of Canada*. 59-62. Ottawa, Canada: Canadian Government Publishing Centre, Supply and Services Canada.
Phillips, David. (1993). The Day Niagara Falls Ran Dry! 72-77. Canada: Key Porter Books.

Hazard	Risk Factors
Dam Failure	☐ Areas below the floodpath of abandoned and neglected dams. ☐ Areas below the floodpath of a dam which has not received regular inspections which take into account the construction of the dam, the structure of the dam, the overall maintenance of the dam and state of preparedness. ☐ Typically, older dams are not seismically safe, were built of varied materials and with less stringent engineering codes. ☐ All dams, may fail at some point. Clearly many of the older dams, built on and around old mining sites are the most at risk, but engineering errors and human error can lead to dam failure in any dam, including the more recently built ones. ☐. Semi-arid areas where there has been heavy water usage for irrigation and farming, has led to the development of many dams which may be at risk. ☐. Dams in steep mountainous areas may be susceptible to avalanches and landslides.

Hazard	Risk Factors
Drought	☐ Inland areas are at more risk of drought. ☐ Previous droughts in the area. ☐ Degradation of land. ☐ Increased water usage.

Hazard	Risk Factors
Earthquakes **Natural Hazards**	☐ The most fundamental information for a hazard assessment is the record of past earthquakes in a region. Where earthquake occurred in the past, they will happen again. ☐ The intensity of ground shaking during an earthquake depends on local ground conditions. For example, when all other factors are equal, soft soils shake more than do stiff soils ☐ Areas of alluvial soil, modern day muds, fill, river channel sediments and beach sand: Ground shaking is strongly increased, and is most prone to ground failure and liquefaction. ☐ Areas nearest to fault segments that are likely to move. However, in some cases it is difficult to determine how recently a fault moved and it is not unusual to recognize that a fault exists until after a strong earthquake. ☐ Unconsolidated Sediments: where moderate or poorly consolidated youthful marine and river deposits exist shaking is increased, especially if sediments are thick and water saturated. ☐ Unstable Bedrock: Ground shaking may be slightly increased and there is susceptibility to landsliding, especially if on steep slopes or water saturated ☐ Susceptible areas include those adjacent to places prone to land slides, mudslides, avalanches and rock falls. Unstable areas generally on steep slopes which have failed in the past and may fall again during strong ground shaking.

Hazard	*Risk Factors*
Earthquakes **Person Induced**	☐ Previous earthquakes have occurred in the past. ☐ Areas near major projects which are involved in filling large water impoundments. ☐ Areas in the same geological area as where projects involving deep well injections are being undertaken. ☐ Areas in the vicinity of underground explosions of nuclear devices.

Hazard	Risk Factors
Geo-Magnetic Storms	□ In the north these are more frequent around the northern auroral oval which encircles the north magnetic pole.

Hazard	Risk Factors
Hailstorms	□ Continental interior of North America. □ May to July is the when the maximum size hailstorms occur in Canada. □ Previously known hailstorms.

Hazard	Risk Factors
Hazardous Material Accidents - In Situ	☐ Many industrial sites contain large amounts of toxic hazardous materials. Areas close to sites where dangerous substances are being handled in a quantity that could cause a serious accident. ☐ Generally speaking chemicals stored under pressure (greater than amient pressure) pose a greater threat to employees, the community, and the environment than those not under pressure ☐ Although disagreement prevails concerning what constitutes a safe distance from a chemical plant, a distance of 2,000 feet has been considered as fatality free from flying fragments in 99% of plant explosions. The same source indicates that a distance of 4,900 feet or over is 100% safe, although the implementation of such a standard would probably not be economically feasible ☐ Areas near sites where hazardous materials have been stored for long periods of time. ☐ Areas in proximity to deteriorating hazardous material storage containers or buildings. ☐ Areas in proximity to large-scale chemical plants; especially if the area has large fluctuations in temperature and weather conditions. ☐ In the recent past, a material of increasing concern has been polychlorinated biphenyls (PCBs). Areas around PCB storage sites are at risk. ☐ Previous hazardous materials spills have occurred in the area. ☐ Areas in proximity of fixed sources of hazardous wastes and waste disposal sites. ☐ Areas near forest mills which have large quantities of anti-sapstains, a group of chemicals similar in chemical composition to PCBs which are applied to wood to prevent staining of timber in storage or transport. ☐ Areas in the proximity of active pulp and paper mills which contain a number of serious pollutants which may contaminate the ocean and the air. ☐ Once valuable ores are extracted from the earth during mining processes, the remaining ore is discarded as waste rock or tailings. Areas near these sites can be at risk. ☐ Increased patients care produces a growing amount of biomedical or infectious wastes. For a number of years, these wastes were dumped in municipal landfills. Wastes are often stockpiled for several days between collections, a concentration of wastes which presents a threat to regional health, in the case of earthquake, flood, or other disaster. ☐ Areas in proximity to local municipal or regional garbage dumps. ☐ Areas in proximity to nuclear power plants. ☐ Areas in proximity to run-down areas susceptible to large urban fires.. ☐ Lack of inspection of sites and willingness to enforce regulations for the storage of and training in the use of hazardous materials. ☐ Storage of radioactive and toxic materials (e.g. plutonium).

References

United Nations Environment Programme Industry and Environment Program Activity Centre. (1991). *Hazard Identification and Evaluation in a Local Community*. Technical Report No. 2. France: United Nations.

Hazard	Risk Factors
Heat Waves	☐ Previous heat waves. ☐ Below 60°N Latitude and above 40°S Latitude. No known models or risk factors which have demonstrated any usefulness in the prospective prediction of heat waves.

References

Kilbourne, Edwin M.. (1989) "Heat Waves." In *The Public Health Consequences of Disasters 1989*. 51-62. Michael B. Gregg MD (ed). USA: US Department of Health and Human Services.

Hazard	Risk Factors
Human Diseases - Human Transmitted	☐ All urban areas with relatively high population densities are at greater risk. ☐ Decreased numbers of public health inspections and inability to adequate inspect and enforce public health safety regulations. ☐ Deteriorating sewage systems. ☐ Decreased use of vaccinations. ☐ Increases in new diseases or strains of diseases which are resistant to medication. ☐ Many of those affected by communicable diseases are children, who in turn can infect parents or other adults. Therefore, those areas with high numbers of school age children are also more at risk of spreading infectious. ☐ Many infection are beginning to be spread through economically disadvantaged groups and cultural minorities.

References

Blake, Paul A.. (1989) "Communicable Disease Control" In *The Public Health Consequences of Disasters 1989*. 7-11. Michael B. Gregg MD (ed). USA: US Department of Health and Human Services.

Hazard	Risk Factors
Ice Fogs and Ice Storms	☐ In the Northern hemisphere, the riskiest months for freezing precipitation are November and December in the west, November through February in the central regions and December to March in the east. ☐ Previous ice fogs and ice storms. ☐ High northern latitudes and coastal areas. ☐ In many urban and rural places in the province, wood burning emits high levels of particulate pollution and moisture to the atmosphere which increases the likelihood of ice fogs.

Hazard	*Risk Factors*
Landslides	☐ The most important risk factor is the presence of previous landslides as landslides are rarely occurring events and standard statistical methods do not apply to their prediction. ☐ Fine-grained soils that lie on slopes and that are rich in swelling clays are particularly susceptible to creeping and slumping. Quick clays can flow quickly and with devastating consequences. ☐ Road construction, logging, reservoir creation, irrigation and urban development along slopes. ☐ Known faults, folds and layering of soils which affect the stability of soil and rocks. ☐ Areas of deforestation and poor drainage increase the likelihood of landslides.

Hazard	Risk Factors
Rail Accidents	☐ The most fundamental information for a hazard assessment is the record of past earthquakes in a region. Where earthquake occurred in the past, they will happen again. ☐ Certainly any traffic crossings add to the risk. ☐ Rail lines through avalanche areas are always at risk, and the potential for derailment would seem to be higher in the steep mountainous areas of the province. ☐ Shunting yards. ☐ Lack of adequate inspections, enforcement of regulations and proper training for railroad staff. ☐ Areas of high rail volume are more at risk. ☐ Rail lines which cross earthquake fault lines, are located on liquefiable soil or are otherwise at risk from earthquakes or volcanic activity.

Hazard	Risk Factors
Riots	☐ Areas most at risk would seem to be the large urban centres. ☐ Smaller municipalities which hold festivals which attract large numbers of outsiders to the community. ☐ Communities where riots have previously occurred and which attract outsiders "looking for trouble." ☐ Of additional concern would seem to be heavy-metal and other types of concerts which attract certain young people. ☐ Major events which allow consumption of alcohol or where adequate enforcement of drinking is not maintained. ☐ Large sports stadiums or areas where sport celebrations are being held (e.g. parade routes).

Hazard	Risk Factors
Snow Storms	☐ Previous major snowstorms in the area. ☐ Generally the higher latitudes have less snow. ☐ Inland areas have less snow than coastal areas. ☐ The higher the elevation the higher the snowfalls.

Hazard	Risk Factors
Urban Wildfire Interface	☐ Areas undergoing rapid urban growth, where pockets of suburban development infringe on wildlands, or undeveloped areas, are potentially high risk areas of wildland-urban interface fires. ☐ Fine Fuel Moisture - when the moisture content of forest litter and other fine fuels drops to a low level. ☐ Duff Moisture - when the moisture content of organic surface soils is at a low level. ☐ Drought - when the moisture content of deep organic soils is low (an indication of long term weather conditions). ☐ Initial Spread - fire fuel availability and the potential for high winds. ☐ Buildup - when there is a sufficient amount of fuel available for combustion. ☐ Fire Weather - weather conditions likely to precipitate a major fire. ☐ Certain fuel or forest types such as dry conifer and grasses are more combustible than deciduous forests. ☐ Lack of the existence or enforcement of bylaws regulating the building of homes and businesses in wildland areas. Some of these regulations would include restricting roofing materials such as shakes; allowing vegetation to physically touch the building, stockpiling of wood against the building, etc.. ☐ Lack of fire fighting capacity in areas or urban and wildland interface (e.g. lack of fire hydrants, roads inaccessible by fire trucks, etc.).

E.6. Vulnerability Assessment

Air Crashes

People	Place	Preparedness	Time
☐ **Age** • For the elderly and the very young, lack of mobility to flee, inability to withstand trauma and exacerbation of underlying disease increase vulnerability. ☐ **Density** • Generally speaking, the higher the population density, the higher the likelihood of injuries and deaths. ☐ **Gender** ☐ **Ethnicity** • Generally speaking areas with a high ethnic and cultural composition are more vulnerable due to communication issues (e.g. inability to understand warnings, read educative and training information, etc.). ☐ **Socio-economic Status** • Generally speaking those poor sectors of the population are more vulnerable to any kind of disaster - factors include poorer health, less adequate shelter, less education and lack of funds to assist in their recovery.	☐ **Buildings** • Tall buildings near or on airport take-off and landing paths. ☐ **Critical Facilities** ☐ **Ecological Sites** ☐ **Economic Sectors** • Air travel may decrease as a result of a major crash. • Tourism. ☐ **Historical and Cultural Sites** ☐ **Lifelines and Infrastructure** • Lifeline facilities near or on airport take-off and landing paths. ☐ **Non-structural property** ☐ **Recreational Land** ☐ **Structures** • Tall structures near or on airport take-off and landing paths.	☐ **Capability to respond** • Inadequate emergency response plans for both off and on airport incidents. • Lack of tested emergency response plans. ☐ **Community Education and Training** • Inadequate community emergency preparedness education and training programs, including neighbourhood preparedness training. ☐ **Mitigation Program** ☐ **Warning Systems** • Lack of adequate weather forecasting programs. • Lack of prepared warning messages advising people of the need to evacuate areas at risk.	☐ **Time of Day** • Fewer planes are traveling between 2000h and 0600h. ☐ **Day of Week** ☐ **Time of Year** • Summer is the busiest time for air travel. • End of school and school start-up are very busy times. ☐ **Holidays** Major holidays are very busy times for air travel - especially Christmas time.

References

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis.* Vancouver, B.C.: DPRC, University of British Columbia.

Blizzards

People	**Place**	**Preparedness**	**Time**
☐ **Age** • For the elderly and the very young, lack of mobility to flee, inability to withstand trauma and exacerbation of underlying disease increase vulnerability. • The elderly have difficulty because of a lack of vasoconstriction and the basic metabolic rate decreases with age. • The elderly appear to perceive cold less well than younger persons and may voluntarily set thermostats lower. • The relatively young can be more vulnerable because of skiing and other winter sports. • Those under <1 year of age, neonates, and premature babies have a large ratio of heat losing surface to heat-generating volume, a thin layer of insulating subcutaneous fat and an inability to control their environment. • Many elderly are often dependent upon prescription drugs and they may not have access to these drugs during a prolonged blizzard. ☐ **Density**	☐ **Buildings** • Old buildings not built to current building codes. ☐ **Critical Facilities** ☐ **Ecological Sites** • Sites of a delicate nature, located in unforested areas and not usually subject to blizzards. ☐ **Economic Sectors** • Sectors which are dependent upon urgent mail or cargo shipments (as transportation is generally severely affected by blizzards). • Greenhouses and dairy farms may be affected by ongoing blizzards. ☐ **Historical and Cultural Sites** • Old buildings not built to current building codes. ☐ **Lifelines and Infrastructure** • Unreinforced lifelines subject to damage by high winds. ☐ **Non-structural property** ☐ **Recreational Land** ☐ **Structures** • Unreinforced structures subject to damage by high winds.	☐ **Capability to respond** • Inadequate emergency response plans for blizzards. • Lack of tested emergency response plans. • Ensuring the population has access to sufficient and dry clothing. • Ensuring that there are properly heated buildings available as shelters.	☐ **Time of Day** ☐ **Day of Week** ☐ **Time of Year** • Winter. ☐ **Holidays** • Low staffing levels during holidays in communication and power facilities.

Blizzards cont'd...

People	Place	Preparedness	Time
☐ **Gender** ☐ **Ethnicity** • Generally speaking areas with a high ethnic and cultural composition are more vulnerable due to communication issues (e.g. inability to understand warnings, read educative and training information, etc.). ☐ **Socio-economic Status** • The poor are vulnerable since they may not be able to afford extra heat. • Generally speaking those poor sectors of the population are more vulnerable to any kind of disaster - factors include poorer health, less adequate shelter, less education and lack of funds to assist in their recovery. ☐ **Miscellaneous** • Ethanol ingestion by middle aged alcoholics predisposes them to hypothermia, but ironically appears to improve survival. • Those persons with a protein -calorie malfunction. • Those with hypothyroidism.		☐ **Community Education and Training** • Community education and training programs, especially for new parents. • Education and training programs for recreationalists. • Inadequate community emergency preparedness education and training programs, including neighbourhood preparedness training ☐ **Mitigation Program** • Enforcement of housing maintenance and occupancy ordinances. • Adequate thermal standards in nursing homes, hospitals, etc.. ☐ **Warning Systems** • Lack of adequate weather forecasting programs. • Lack of prepared warning messages advising people with vulnerabilities of symptoms of exposure to cold and the need seek warm shelter • Warnings to those on neuroleptic drugs.	

References

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis.* Vancouver, B.C.: DPRC, University of British Columbia.

Phillips, David. (1993). *The Day Niagara Falls Ran Dry*! Canada: Key Porter Books.

Phillips, David. (1990). *Climates of Canada.* 50-52. Ottawa, Canada: Canadian Government Publishing Centre, Supply and Services Canada.

Dam Failures

People	Place	Preparedness	Time
☐ **Age** • For the elderly and the very young, lack of mobility to flee, inability to withstand trauma and exacerbation of underlying disease increase vulnerability. ☐ **Density** • Generally speaking, the higher the population density, the higher the likelihood of injuries and deaths. ☐ **Gender** ☐ **Ethnicity** • Generally speaking areas with a high ethnic and cultural composition are more vulnerable due to communication issues (e.g. inability to understand warnings, read educative and training information, etc.). ☐ **Socio-economic Status** • Generally speaking those poor sectors of the population are more vulnerable to any kind of disaster - factors include poorer health, less adequate shelter, less education and lack of funds to assist in their recovery.	☐ **Buildings** ☐ **Critical Facilities** ☐ **Ecological Sites** • Many ecological sites are severely affected by rapid increases or decreases in water supply. ☐ **Economic Sectors** • Industries with high water use and high power use. • Businesses with high water use and high power use. • Agricultural sectors which use irrigation. ☐ **Historical and Cultural Sites** ☐ **Lifelines and Infrastructure** • Power lines. • Water lines. • Gas Pipelines. • Telephone lines. ☐ **Non-structural property** ☐ **Recreational Land** • Recreational land in dam floodway. ☐ **Structures**	☐ **Capability to respond** • Inadequate emergency response plans for dam failures. • Lack of tested emergency response plans. • lack of evacuation plans for dam floodway areas. ☐ **Community Education and Training** • Inadequate community emergency preparedness education and training programs, including neighbourhood preparedness training. ☐ **Mitigation Program** • Lack of ongoing-monitoring of dam maintenance. ☐ **Warning Systems** • Lack of adequate weather forecasting programs. • Lack of prepared warning messages advising people to evacuate.	☐ **Time of Day** ☐ **Day of Week** ☐ **Time of Year** ☐ **Holidays**

References

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis.* Vancouver, B.C.: DPRC, University of British Columbia.

Drought

People	Place	Preparedness	Time
☐ **Age** • For the elderly and the very young inability to withstand trauma and exacerbation of underlying disease increase vulnerability. ☐ **Density** ☐ **Gender** ☐ **Ethnicity** • Generally speaking areas with a high ethnic and cultural composition are more vulnerable due to communication issues (e.g. inability to understand warnings, read educative and training information, etc.). ☐ **Socio-economic Status** • Poverty - drought often leads to higher prices of food goods. • Generally speaking those poor sectors of the population are more vulnerable to any kind of disaster - factors include poorer health, less adequate shelter, less education and lack of funds to assist in their recovery.	☐ **Buildings** ☐ **Critical Facilities** • Hydro-electric power dams are vulnerable to drought situations. • Hospitals are extremely vulnerable to a lack of water. • Fire suppression services are vulnerable to a lack of water. ☐ **Ecological Sites** • Many fragile ecological sites are very vulnerable to drought conditions. ☐ **Economic Sectors** • Farms and areas of agricultural products are especially vulnerable to droughts. • Animal herds in areas such as cattle ranges are very vulnerable to droughts. • Forested areas. • Wildlife. • Areas which are dependent upon a single produce focus. • Tourism. ☐ **Historical and Cultural Sites** ☐ **Lifelines and Infrastructure** • Water pipelines. • Sewerage and sewage treatment plants. ☐ **Non-structural property** ☐ **Recreational Land** • Recreational land which depends upon an adequate water supply in order to be attractive (e.g. forest trails for hiking). • Lack of water increases the vulnerability of forests to forest fires. ☐ **Structures**	☐ **Capability to respond** • Inadequate emergency response plans. • Lack of tested emergency response plans. ☐ **Community Education and Training** • Inadequate community emergency preparedness education and training programs, including neighbourhood preparedness training. ☐ **Mitigation Program** ☐ **Warning Systems** • Lack of adequate weather forecasting programs. • Lack of prepared warning messages advising people to reduce water usage	☐ **Time of Day** ☐ **Day of Week** ☐ **Time of Year** • Summer months ☐ **Holidays**

References

McKay, G.A. (1988). "Drought: A Global Perspective." In *Natural and Man-Made Hazards*. M.I. El-Sabh and T.S. Murty. (eds.), 319-336. Dordrecht, Holland: D. Reidel Publishing Company.

Phillips, David. (1993). *The Day Niagara Falls Ran Dry*! Canada: Key Porter Books.

Phillips, David. (1990). *Climates of Canada*. 50-52. Ottawa, Canada: Canadian Government Publishing Centre, Supply and Services Canada.

Earthquakes

People	Place	Preparedness	Time
☐ **Age** • For the elderly and the very young, lack of mobility to flee collapsing structures, inability to withstand trauma and exacerbation of underlying disease increase vulnerability. ☐ **Density** • Death tolls can be very high when earthquake occurs in an urban area. • Those living alone are most often the last to be rescued - areas with a high singles population are more vulnerable. ☐ **Gender** • Women of all ages have a higher rate of serious injury.	☐ **Buildings** • Unreinforced masonry buildings are especially vulnerable. • Adobe buildings are very vulnerable. • "Modern" medium rise, concrete slab buildings are likely to collapse due to lack of supports. • Self-built buildings are more vulnerable • Brick chimneys may collapse. • Asbestos used in building increases the likelihood that the building may be inhabitable for some time following the quake. • Studies of the damage patterns in the 1971 San Fernando earthquake showed building professionals that nonductile concrete structures are prone to damage in strong earthquakes. • Lack of adequate space between buildings increases the likelihood that they will pound together. • Lack of quality construction and building inspections increases their vulnerability.	☐ **Capability to Respond** • Inadequate emergency response plans for both earthquakes. • Lack of tested emergency response plans. ☐ **Community Education and Training** • Lack of earthquake drills practiced in schools and in the community. • Inadequate community emergency preparedness education and training programs, including neighbourhood preparedness training.	☐ **Time of Day** • Crowded bars and dancing places at night have typically been sites of many injuries following a quake. • Commuter rush hours when bridges, tunnels and transportation systems are in maximum use. ☐ **Day of Week**

Earthquakes cont'd…

People	Place	Preparedness	Time
☐ **Ethnicity** • The inability of minorities to get aid means that there is a longer period before economic recovery and thus it can mean a long term decline in the quality of life and standard of living. • Areas with a high ethnic and cultural composition are more vulnerable due to communication issues (e.g. inability to understand warnings, read educative and training information, etc.). ☐ **Socio-economic Status** • It is common that most vulnerable sites and buildings of the worst quality are occupied by the poorest of the community. • Generally speaking those poor sectors of the population are more vulnerable to any kind of disaster - factors include poorer health, less adequate shelter, less education and lack of funds to assist in their recovery. ☐ **Miscellaneous**	☐ **Critical Facilities** • Schools built prior to existing building codes and not seismically retrofitted. • Hospitals built prior to existing building codes and not seismically retrofitted. • Emergency Response Centres built prior to existing building codes and not seismically retrofitted. ☐ **Ecological Sites** ☐ **Economic Sector** • Existence of chemical and petroleum hazards which would contribute to fire and toxic combustion. • Hazardous waste sites. • Nuclear power plants. • Oil Refineries. • Tourism • Port Facilities and Docking Facilities. ☐ **Historical and Cultural Sites** • Unretrofitted buildings • Museum collections. ☐ **Lifelines and Infrastructure** • Unretrofitted rail lines may be damaged. • Failure of unretrofitted dams upstream may resulting in flooding. • Unretrofitted underground pipelines for natural gas. • Unretrofitted telephone networks. • Unretrofitted Hydro substations. • Unretrofitted Micro-towers. • Unretrofitted water systems. • Unretrofitted sewerage. • Unretrofitted bridges. Unretrofitted airports.	☐ **Mitigation Program** • Retrofitting of older buildings. ☐ **Warning Systems**	☐ **Time of Year** • May cause flooding if quake occurs when rivers are at their peak. ☐ **Holidays**

Earthquakes cont'd...

	☐ **Non-structural property** • Unsecured furniture, ceiling tiles, bookcases, • Unsecured computer equipment. • Libraries. • Unsecured art collections. • Medical facilities. • Laboratories. ☐ **Recreational Land** • Recreational land with slopes and mountain which may be subject to landslides in an earthquake. ☐ **Structures** • Unreinforced structures.		

References

Aysan, Yasemin. (1990). "Social and Cultural Aspects of Community Vulnerability and Risk Communication.." *In Hazards and the Communication of Risk.* John Handmer and Edmund Penning-Rowsell (eds), 319-336. Vermont, U.S.A.: Gower Publishing Co.

Bolin, Robert and Patricia Bolton. (1986). *Race, Religion and Ethnicity in Disaster Recovery.* Colorado, USA: Natural Hazards Research and Applications Information Centre, Institute of Behavioral Sciences.

Gates, William E. (1991). *Structural Seismic Risk Assessment and Structural Mitigation.* BICEPP News. 4-7.

Geohazards International. (1994). *The Quito Earthquake Risk Management Project.* California, USA: Stanford University, California.

Office of Emergency Services California. (1994). *Unacceptable Risk: Earthquake Hazard Mitigation in One California School District.* California, USA: Office of Emergency Services California.

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis.* Vancouver, B.C.: DPRC, University of British Columbia.

Stratton, James W.. "Earthquakes." (1989). In *The Public Health Consequences of Disasters 1989.* Michael B. Gregg MD (ed). 13-28. USA: US Department of Health and Human Services..

Geo-Magnetic Storms

People	Place	Preparedness	Time
☐ **Age** • For the elderly and the very young, lack of mobility to flee, inability to withstand trauma and exacerbation of underlying disease increase vulnerability - in this case more as a result of power outages caused by the storms. ☐ **Density** ☐ **Gender** ☐ **Ethnicity** • Generally speaking areas with a high ethnic and cultural composition are more vulnerable due to communication issues (e.g. inability to understand warnings, read educative and training information, etc.). ☐ **Socio-economic Status** • Generally speaking those poor sectors of the population are more vulnerable to any kind of disaster - factors include poorer health, less adequate shelter, less education and lack of funds to assist in their recovery.	☐ **Buildings** ☐ **Critical Facilities** • Because of computer and power outages, emergency response dispatch systems and major hospitals and other sites without backup power systems are vulnerable. • Power generating facilities. ☐ **Ecological Sites** ☐ **Economic Sectors** • Because of computer and power outages, businesses, banks, and other sites without backup power systems are vulnerable. • Television and other broadcasting sites. • Prolonged power outages affect greenhouses and dairy farms. • ☐ **Historical and Cultural Sites** ☐ **Lifelines and Infrastructure** • Power substations. ☐ **Non-structural property** ☐ **Recreational Land** ☐ **Structures**	☐ **Capability to respond** • Inadequate emergency response plans for geo-magnetic storms. • Lack of tested emergency response plans. ☐ **Community Education and Training** • Inadequate community emergency preparedness education and training programs, including neighbourhood preparedness training. ☐ **Mitigation Program** ☐ **Warning Systems** • Lack of adequate weather forecasting programs. • Lack of prepared warning messages.	☐ **Time of Day** ☐ **Day of Week** ☐ **Time of Year** • Because of their ability to cause power blackouts, cold winters are a vulnerable time of the year. • Because of their ability to cause power blackouts, hot summers, when people are dependent upon air conditioners, are a vulnerable time of the year. ☐ **Holidays** • Low staffing levels during holidays in communication and power facilities.

References

Phillips, David. (1993). *The Day Niagara Falls Ran Dry*! Canada: Key Porter Books.

Hailstorms

People	Place	Preparedness	Time
☐ **Age** • For the elderly and the very young, lack of mobility to flee, inability to withstand trauma and exacerbation of underlying disease increase vulnerability. ☐ **Density** ☐ **Gender** ☐ **Ethnicity** • Generally speaking areas with a high ethnic and cultural composition are more vulnerable due to communication issues (e.g. inability to understand warnings, read educative and training information, etc.). ☐ **Socio-economic Status** • Generally speaking those poor sectors of the population are more vulnerable to any kind of disaster - factors include poorer health, less adequate shelter, less education and lack of funds to assist in	☐ **Buildings** • Damage to buildings (broken windows, paint removed, etc.). ☐ **Critical Facilities** ☐ **Ecological Sites** • Fragile ecological sites with many small plants. ☐ **Economic Sectors** • Crop destruction: wheat, barley, oats, rye and corn. • Greenhouses. • Airport hangers, small airports. • Car dealers and sites of stored new vehicles. ☐ **Historical and Cultural Sites** ☐ **Lifelines and Infrastructure** • Micro-wave towers. • Satellite dishes. • Transportation routes. ☐ **Non-structural property** ☐ **Recreational Land** ☐ **Structures**	☐ **Capability to respond** • Inadequate emergency response plans for hailstorms. • Lack of tested emergency response plans. ☐ **Community Education and Training** • Education and training programs for recreationalists. • Inadequate community emergency preparedness education and training programs, including neighbourhood preparedness training ☐ **Mitigation Program** ☐ **Warning Systems** • Lack of adequate weather forecasting programs. • Lack of prepared warning messages advising people to take necessary precautions.	☐ **Time of Day** • 75% of all hail storms occur between 1200h and 1700h. ☐ **Day of Week** ☐ **Time of Year** • Hailstorms tend to occur in July in the corn growing areas of the midwest and August in the Prairie wheat growing areas. ☐ **Holidays**

References

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis*. Vancouver, B.C.: DPRC, University of British Columbia.

Phillips, David. (1993). *The Day Niagara Falls Ran Dry*! 88-91. Canada: Key Porter Books.

Phillips, David. (1990). *Climates of Canada*. 52-53. Ottawa, Canada: Canadian Government Publishing Centre, Supply and Services Canada.

Hazardous Material Accidents - In Situ

People	Place	Preparedness	Time
☐ **Age** • For the elderly and the very young, lack of mobility to flee, inability to withstand trauma and exacerbation of underlying disease increase vulnerability. ☐ **Density** • Generally speaking, the higher the population density, the higher the likelihood of injuries and deaths. ☐ **Gender** ☐ **Ethnicity** • Generally speaking areas with a high ethnic and cultural composition are more vulnerable due to communication issues (e.g. inability to understand warnings, read educative and training information, etc.). ☐ **Socio-economic Status** • Generally speaking those poor sectors of the population are more vulnerable to any kind of disaster - factors include poorer health, less adequate shelter, less education and lack of funds to assist in their recovery.	☐ **Buildings** ☐ **Critical Facilities** ☐ **Ecological Sites** ☐ **Economic Sectors** ☐ **Historical and Cultural Sites** ☐ **Lifelines and Infrastructure** ☐ **Non-structural property** ☐ **Recreational Land** ☐ **Structures**	☐ **Capability to respond** • Inadequate emergency response plans for hazardous material accidents in-situ. • Lack of tested emergency response plans. ☐ **Community Education and Training** • Inadequate community emergency preparedness education and training programs, including neighbourhood preparedness training. ☐ **Mitigation Program** ☐ **Warning Systems** • Lack of adequate monitoring and forecasting programs. • Lack of prepared warning messages advising people of the incident, actions to be taken and of evacuation routes.	☐ **Time of Day** ☐ **Day of Week** ☐ **Time of Year** ☐ **Holidays**

References

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis*. Vancouver, B.C.: DPRC, University of British Columbia.

Heat Waves

People	Place	Preparedness	Time
☐ **Age** • Those over the age of 65 are less likely to have the necessary cardiac output and have a decreased systemic vascular resistance. • Those over 65 have an increased body temperature at which sweating begins. • Those over 65 are less able to perceive differences in temperature and thus are less able to effectively regulate their thermal environments. • Those over 85 years of age are at increased risk. • Babies and those under 5 years of age are more at risk. • Children with congenital abnormalities of the central nervous system and diarrhea illnesses are more at risk. ☐ **Density** ☐ **Gender** • Males are more vulnerable in their teenage years perhaps of greater heat exposure and exertion exercise. • In all other cases, females are greater at risk. ☐ **Ethnicity** • Generally speaking areas with a high ethnic and cultural composition are more vulnerable due to communication issues (e.g. inability to understand warnings, read educative and training information, etc.). ☐ **General** • Use of electric fans not much use and may exacerbate heat stress. • Prior history of heatstroke and obesity increase vulnerability.	☐ **Buildings** • Increased risk in urban areas suggesting a sort of "dose response" effect of urbanization which results in higher temperatures • Tall buildings may reduce wind velocity, decreasing the contribution of moving air to evaporative and convective cooling. • Masses of brick, stone and concrete asphalt and cement absorb radiant heat from the sun and radiate it at night. ☐ **Critical Facilities** ☐ **Ecological Sites** ☐ **Economic Sector** • Agricultural crops are vulnerable to heat waves. ☐ **Historical and Cultural Sites** ☐ **Lifelines and Infrastructure** • Rail lines may be damaged. ☐ **Non-structural property** ☐ **Recreational Land** • Forest fires increase in heat waves. ☐ **Structures**	☐ **Capability to respond** • Inadequate emergency response plans for heat waves. • Lack of tested emergency response plans. • Emergency plan with ability to access shelter with air conditioning. ☐ **Community Education and Training** • Education and training programs for recreationalists. • Inadequate community emergency preparedness education and training programs, including neighbourhood preparedness training. ☐ **Mitigation Program** ☐ **Warning Systems** • Lack of adequate weather forecasting programs. • Lack of prepared warning messages advising people with vulnerabilities to seek air-conditioned facilities.	☐ **Time of Day** • Mid-day. ☐ **Day of Week** ☐ **Time of Year** • Summer time, particularly if the heat wave is the early part of the summer before people body's have had time to adapt to warmer weather. ☐ **Holidays**

References

Kilbourne, Edwin M.. (1989). "Heat Waves." In *The Public Health Consequences of Disasters 1989.* Michael B. Gregg MD (ed). 51-62. US Department of Health and Human Services. USA.

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis.* Vancouver, B.C.: DPRC, University of British Columbia.

Phillips, David. (1993). *The Day Niagara Falls Ran Dry*! 88-91. Canada: Key Porter Books.

Phillips, David. (1990). *Climates of Canada.* 52-53. Ottawa, Canada: Canadian Government Publishing Centre, Supply and Services Canada.

Human Diseases - Human Transmitted

People	Place	Preparedness	Time
☐ **Age** • For the elderly and the very young, inability to withstand trauma and exacerbation of underlying disease increase vulnerability. ☐ **Density** • Generally speaking, the higher the population density, the higher the likelihood of injuries and deaths. ☐ **Gender** ☐ **Ethnicity** • Generally speaking areas with a high ethnic and cultural composition are more vulnerable due to communication issues (e.g. inability to understand warnings, read educative and training information, etc.). ☐ **Socio-economic Status** • Generally speaking those poor sectors of the population are more vulnerable to any kind of disaster - factors include poorer health, less adequate shelter, less education and lack of funds to assist in their recovery.	☐ **Buildings** ☐ **Critical Facilities** • Facilities with highly specialized jobs and little cross-training. • Hospitals and medical facilities. ☐ **Ecological Sites** ☐ **Economic Sectors** • Business and industries with a large labour pool running on minimum staffing. • Business and industries with highly specialized jobs and little cross-training. • Tourism. ☐ **Historical and Cultural Sites** ☐ **Lifelines and Infrastructure** ☐ **Non-structural property** ☐ **Recreational Land** ☐ **Structures**	☐ **Capability to respond** • Inadequate emergency response plans for human-transmitted diseases. • Lack of tested emergency response plans. ☐ **Community Education and Training** • Inadequate community emergency preparedness education and training programs, including neighbourhood preparedness training. ☐ **Mitigation Program** • Vaccination programs. ☐ **Warning Systems** • Lack of adequate disease forecasting programs. • Lack of prepared warning messages advising people with vulnerabilities of symptoms and medical advice.	☐ **Time of Day** ☐ **Day of Week** ☐ **Time of Year** ☐ **Holidays**

References

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis*. Vancouver, B.C.: DPRC, University of British Columbia.

Ice Fogs and Ice Storms

People	Place	Preparedness	Time
☐ **Age** • For the elderly and the very young, lack of mobility to flee, inability to withstand trauma and exacerbation of underlying disease increase vulnerability. ☐ **Density** • Generally speaking, the higher the population density, the higher the likelihood of injuries and deaths. ☐ **Gender** ☐ **Ethnicity** • Generally speaking areas with a high ethnic and cultural composition are more vulnerable due to communication issues (e.g. inability to understand warnings, read educative and training information, etc.). ☐ **Socio-economic Status** • Generally speaking those poor sectors of the population are more vulnerable to any kind of disaster - factors include poorer health, less adequate shelter, less education and lack of funds to assist in their recovery.	☐ **Buildings** • Buildings built to previous building colds as roofs can be rendered unsafe by heavy ice loading. ☐ **Critical Facilities** • Because of resulting power black-outs and disrupted telephone services, dispatch systems and critical facilities without back-up power are vulnerable. ☐ **Ecological Sites** • Areas with young or very old trees can be severely damaged by heavy ice loading. ☐ **Economic Sectors** • Agricultural products can be killed. ☐ **Historical and Cultural Sites** • Buildings built to previous building colds as roofs can be rendered unsafe by heavy ice loading. ☐ **Lifelines and Infrastructure** • Transportation systems can be disrupted as highways and local roads become treacherous. ☐ **Non-structural property** ☐ **Recreational Land** ☐ **Structures** Structures built to previous building colds as roofs can be rendered unsafe by heavy ice loading.	☐ **Capability to respond** • Inadequate emergency response plans for both ice fogs and ice storms. • Lack of tested emergency response plans. • Ensuring the population has access to sufficient and dry clothing. • Ensuring that there are properly heated buildings available as shelters ☐ **Community Education and Training** • Education and training programs for recreationalists. • Inadequate community emergency preparedness education and training programs, including neighbourhood preparedness training. ☐ **Mitigation Program** ☐ **Warning Systems** • Lack of adequate weather forecasting programs. • Lack of prepared warning messages advising people with vulnerabilities to seek warm facilities.	☐ **Time of Day** ☐ **Day of Week** ☐ **Time of Year** • Fall and winter. ☐ **Holidays**

References

Chaine, P.M., R.W. Verge, G. Castonguay, and J. Gariepy. (1974). *Wind and Ice Loading in Canada.* Ottawa: Environment Canada.

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis.* Vancouver, B.C.: DPRC, University of British Columbia.

Phillips, David. (1993). *The Day Niagara Falls Ran Dry*! 78-85. Canada: Key Porter Books.

Landslides

People	Place	Preparedness	Time
☐ **Age** • For the elderly and the very young, lack of mobility to flee, inability to withstand trauma and exacerbation of underlying disease increase vulnerability. ☐ **Density** • Generally speaking, the higher the population density, the higher the likelihood of injuries and deaths. ☐ **Gender** ☐ **Ethnicity** • Generally speaking areas with a high ethnic and cultural composition are more vulnerable due to communication issues (e.g. inability to understand warnings, read educative and training information, etc.). ☐ **Socio-economic Status** • Generally speaking those poor sectors of the population are more vulnerable to any kind of disaster - factors include poorer health, less adequate shelter, less education and lack of funds to assist in their recovery.	☐ **Buildings** ☐ **Critical Facilities** ☐ **Ecological Sites** • River systems, spawning grounds, etc. can be severely damaged by landslides. ☐ **Economic Sectors** • Mining Industry. ☐ **Historical and Cultural Sites** ☐ **Lifelines and Infrastructure** • Unreinforced natural gas pipelines. • Unreinforced water and sewerage pipelines. • Transmission lines. • Unprotected main highways and arterial roads. • Unprotected bridges. ☐ **Non-structural property** ☐ **Recreational Land** • Can be severely affected by landslides. ☐ **Structures**	☐ **Capability to respond** • Inadequate emergency response plans for dealing with landslides. • Lack of tested emergency response plans. ☐ **Community Education and Training** • Education and training programs for recreationalists. • Inadequate community emergency preparedness education and training programs, including neighbourhood preparedness training. ☐ **Mitigation Program** ☐ **Warning Systems** • Lack of adequate soil monitoring programs in areas of instability programs. • Lack of prepared warning messages advising people of evacuation procedures.	☐ **Time of Day** ☐ **Day of Week** ☐ **Time of Year** ☐ **Holidays**

References

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis.* Vancouver, B.C.: DPRC, University of British Columbia.

Rail Accidents

People	Place	Preparedness	Time
☐ **Age** • For the elderly and the very young, lack of mobility to flee, inability to withstand trauma and exacerbation of underlying disease increase vulnerability. ☐ **Density** • Generally speaking, the higher the population density, the higher the likelihood of injuries and deaths. ☐ **Gender** ☐ **Ethnicity** • Generally speaking areas with a high ethnic and cultural composition are more vulnerable due to communication issues (e.g. inability to understand warnings, read educative and training information, etc.). ☐ **Socio-economic Status** • Generally speaking those poor sectors of the population are more vulnerable to any kind of disaster - factors include poorer health, less adequate shelter, less education and lack of funds to assist in their recovery.	☐ **Buildings** ☐ **Critical Facilities** ☐ **Ecological Sites** ☐ **Economic Sectors** ☐ **Historical and Cultural Sites** ☐ **Lifelines and Infrastructure** ☐ **Non-structural property** ☐ **Recreational Land** ☐ **Structures**	☐ **Capability to respond** • Inadequate emergency response plans for both off and on rail track incidents (e.g. train falling into river). • Lack of tested emergency response plans. ☐ **Community Education and Training** • Inadequate community emergency preparedness education and training programs, including neighbourhood preparedness training. ☐ **Mitigation Program** ☐ **Warning Systems** • Lack of adequate weather forecasting programs.	☐ **Time of Day** ☐ **Day of Week** ☐ **Time of Year** ☐ **Holidays**

References

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis.* Vancouver, B.C.: DPRC, University of British Columbia.

Riots

People	Place	Preparedness	Time
☐ **Age** • For the elderly and the very young, lack of mobility to flee, inability to withstand trauma and exacerbation of underlying disease increase vulnerability. ☐ **Density** • Generally speaking, the higher the population density, the higher the likelihood of injuries and deaths. ☐ **Gender** ☐ **Ethnicity** • Generally speaking areas with a high ethnic and cultural composition are more vulnerable due to communication issues (e.g. inability to understand warnings, read educative and training information, etc.). ☐ **Socio-economic Status** • Generally speaking those poor sectors of the population are more vulnerable to any kind of disaster - factors include poorer health, less adequate shelter, less education and lack of funds to assist in their recovery.	☐ **Buildings** ☐ **Critical Facilities** • Critical facilities such as police stations may become the target of riots. ☐ **Ecological Sites** ☐ **Economic Sectors** • Businesses, especially those along main streets near meeting places or spectator sports sites. ☐ **Historical and Cultural Sites** ☐ **Lifelines and Infrastructure** ☐ **Non-structural property** • Store front windows. • Goods on display along store fronts. • Cars parked on streets along congregation points. ☐ **Recreational Land** ☐ **Structures**	☐ **Capability to respond** • Inadequate emergency response plans for riots. • Lack of tested emergency response plans. ☐ **Community Education and Training** • Inadequate community emergency preparedness education and training programs, including neighbourhood preparedness training. ☐ **Mitigation Program** ☐ **Warning Systems** • Lack of prepared warning messages advising people of actions they should be taking.	☐ **Time of Day** ☐ **Day of Week** ☐ **Time of Year** ☐ **Holidays**

References

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis.* Vancouver, B.C.: DPRC, University of British Columbia.

Snow Storms

People	Place	Preparedness	Time
☐ **Age** • For the elderly and the very young, lack of mobility to flee, inability to withstand trauma and exacerbation of underlying disease increase vulnerability. • The elderly have difficulty because of a lack of vasoconstriction and the basic metabolic rate decreases with age. • The elderly appear to perceive cold less well than younger persons and may voluntarily set thermostats lower. • The relatively young can be more vulnerable because of skiing and other winter sports. • Those under <1 year of age, neonates, and premature babies have a large ratio of heat losing surface to heat-generating volume, a thin layer of insulating subcutaneous fat and an inability to control their environment. • Many elderly are often dependent upon prescription drugs and they may not have access to these drugs during a prolonged snowstorm. ☐ **Density** ☐ **Gender**	☐ **Buildings** • Buildings built to previous building colds as roofs can be rendered unsafe by heavy snow loading. ☐ **Critical Facilities** ☐ **Ecological Sites** • Areas with young or very old trees can be severely damaged by heavy snow loading. ☐ **Economic Sectors** • Crops can be killed. ☐ **Historical and Cultural Sites** • Buildings built to previous building colds as roofs can be rendered unsafe by heavy snow loading. ☐ **Lifelines and Infrastructure** ☐ **Non-structural property** ☐ **Recreational Land** ☐ **Structures**	☐ **Capability to respond** • Inadequate emergency response plans for snow storms. • Lack of tested emergency response plans. • Ensuring the population has access to sufficient and dry clothing. • Ensuring that there are properly heated buildings available as shelters ☐ **Community Education and Training** • Education and training programs for recreationalists. • Inadequate community emergency preparedness education and training programs, including neighbourhood preparedness training.	☐ **Time of Day** ☐ **Day of Week** ☐ **Time of Year** ☐ **Holidays**

Snow Storms cont'd...

People	Place	Preparedness	Time
☐ **Ethnicity** • Generally speaking areas with a high ethnic and cultural composition are more vulnerable due to communication issues (e.g. inability to understand warnings, read educative and training information, etc.). ☐ **Socio-economic Status** • Generally speaking those poor sectors of the population are more vulnerable to any kind of disaster - factors include poorer health, less adequate shelter, less education and lack of funds to assist in their recovery.		☐ **Mitigation Program** • Enforcement of housing maintenance and occupancy ordinances. • Adequate thermal standards in nursing homes, hospitals, etc.. ☐ **Warning Systems** • Lack of adequate weather forecasting programs.	

References

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis*. Vancouver, B.C.: DPRC, University of British Columbia.

Phillips, David. (1993). *The Day Niagara Falls Ran Dry*! Canada: Key Porter Books.

Phillips, David. (1990). *Climates of Canada*. Ottawa, Canada: Canadian Government Publishing Centre, Supply and Services Canada.

Urban Wildfire Interface

People	Place	Preparedness	Time
☐ **Age** • For the elderly and the very young, lack of mobility to flee, inability to withstand trauma and exacerbation of underlying disease increase vulnerability. ☐ **Density** • Generally speaking, the higher the population density, the higher the likelihood of injuries and deaths. ☐ **Gender** ☐ **Ethnicity** • Generally speaking areas with a high ethnic and cultural composition are more vulnerable due to communication issues (e.g. inability to understand warnings, read educative and training information, etc.). ☐ **Socio-economic Status** • Generally speaking those poor sectors of the population are more vulnerable to any kind of disaster - factors include poorer health, less adequate shelter, less education and lack of funds to assist in their recovery.	☐ **Buildings** • Wooden buildings. • Buildings which are highly combustible. • Buildings with wooden shingles. ☐ **Critical Facilities** • Wooden buildings. • Buildings which are highly combustible. • Buildings with wooden shingles. ☐ **Ecological Sites** ☐ **Economic Sectors** ☐ **Historical and Cultural Sites** • Wooden buildings. • Buildings which are highly combustible. • Buildings with wooden shingles. ☐ **Lifelines and Infrastructure** ☐ **Non-structural property** ☐ **Recreational Land** • Forested areas. • Treed areas with deep, long roots. ☐ **Structures**	☐ **Capability to respond** • Inadequate emergency response plans for both urban wildfire interfaces. • Lack of tested emergency response plans. ☐ **Community Education and Training** • Education and training programs for recreationalists. • Training programs for homeowners so as to ensure that vegetation is kept away from one's home, etc.. Inadequate community emergency preparedness education and training programs, including neighbourhood preparedness training. ☐ **Mitigation Program** • Lack of regular home inspections to ensure that homeowners are not increasing the likelihood of wildfires spreading rapidly.	☐ **Time of Day** ☐ **Day of Week** ☐ **Time of Year** • Summer. • Periods of high winds. ☐ **Holidays** • People away for long weekends and holidays and thus lack of monitoring of potential fires.

Urban Wildfire Interface cont'd...

People	Place	Preparedness	Time
		• Lack of programs to decrease the likelihood of home fires (e.g. by-laws for asphalt roofs instead of shingles). • Inadequate fire protection services in outlying areas. • Lack of fire-breaks. ☐ **Warning Systems** • Lack of adequate weather forecasting programs. • Lack of prepared warning messages advising people of evacuation routes, etc..	

References

Pearce, Laurie, Henry Hightower, Barry Konkin, Sophie Megalos, and James Pernu. (1993). *British Columbia Hazard, Risk and Vulnerability Analysis*. Vancouver, B.C.: DPRC, University of British Columbia.

Appendix F. Workbook

Workbook

for

A COMMUNITY BASED HAZARD, IMPACT, RISK AND VULNERABILITY ANALYSIS: HIRV

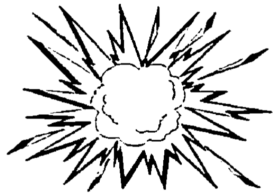
Part One

Laurie Pearce

HIRV: A COMMUNITY BASED HAZARD, IMPACT, RISK AND VULNERABILITY ANALYSIS

F.1. Definitions

The following definitions, taken from *Webster's New International Dictionary*, are used with reference to abnormal or critical situations:



- ***accident***: an unfortunate event resulting from carelessness, unawareness, ignorance or a combination of causes.
- ***incident***: a subordinate or accessory event; event, occurrence; hostile clash of e.g., troops of countries at war; public event causing trouble.
- ***crisis***: turning point, esp. of disease; time of danger or suspense in politics, commerce, etc.
- ***emergency***: a sudden state of danger, etc., condition needing immediate treatment; condition approximating to that of war.
- ***disaster***: sudden moment of great misfortune; calamity, complete failure.
- ***calamity***: an extraordinarily grave event marked by great loss and lasting distress and affliction.
- ***catastrophe***: sudden or widespread or noteworthy disaster; event subverting system of things; disastrous end; ruin.

Notes:

F.2. Disaster

A disaster is a non-routine event which exceeds the capacity of the affected area to respond to it in such a way as to save lives, to preserve property, and to maintain the social, ecological, economic, and political stability of the impacted region.

This definition of disaster eliminates from consideration routine emergencies such as house or apartment fires, motor vehicle accidents, and so on.

F.2.1. Disaster management

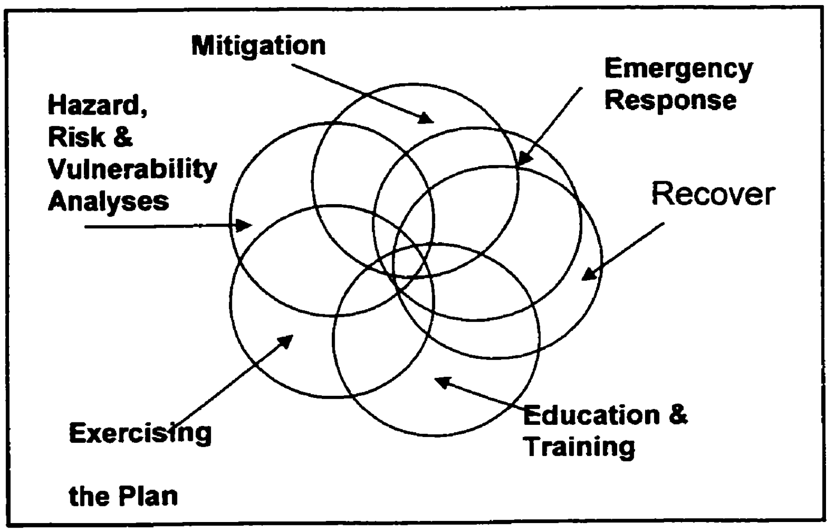
Disaster management:

is the process of forming common objectives and common values in order to encourage participants to deal with potential and actual disasters.

The goal of **disaster management** is:

to assist communities to respond before, during, and after a disaster in order to save lives, to preserve property, and to maintain the social, ecological, economic, and political stability of the impacted region.

The purpose of each one of the five steps of disaster management (i.e., HRV analyses, mitigation, emergency response, training and education, and exercising) is to assist in attaining this goal.



- the disaster management process is never complete
- various activities may occur simultaneously

- the cornerstone is the HRV analysis. The findings of this analysis lead to the development of mitigation strategies, improved emergency response plans, and community and responder education and training programs.

F.3. Other Models for HRV Analyses

A number of other models for HRV analysis exist. In the development of the HIRV approach, the following were examined:

1. The (APELL) model, known as the Awareness and Preparedness for Emergencies at Local Level by the United Nations Environment Programme Industry and Environment/Programme Activity.

2. The Emergency Preparedness Canada (EPC) model.

3. The Federal Emergency Management Agency (FEMA) Hazards Identification, Capability Assessment and Multi-Year Development Plan for Local Governments.

4. The FEMA History, Vulnerability, Maximum Threat, and Probability Approachl

4. The National Oceanic and Atmospheric Administration (NOAA) Approach: a Community Vulnerability Assessment Tool

5. The Norwegian Directorate for Civil Defence and Emergency Planning (OSLO) Guidelines for Municipal Risk and Vulnerability Analysis

6. SMUG (Seriousness, Manageability, Urgency, and Growth Hazard Priority System) Model by Australia's Natural Disasters Organization.

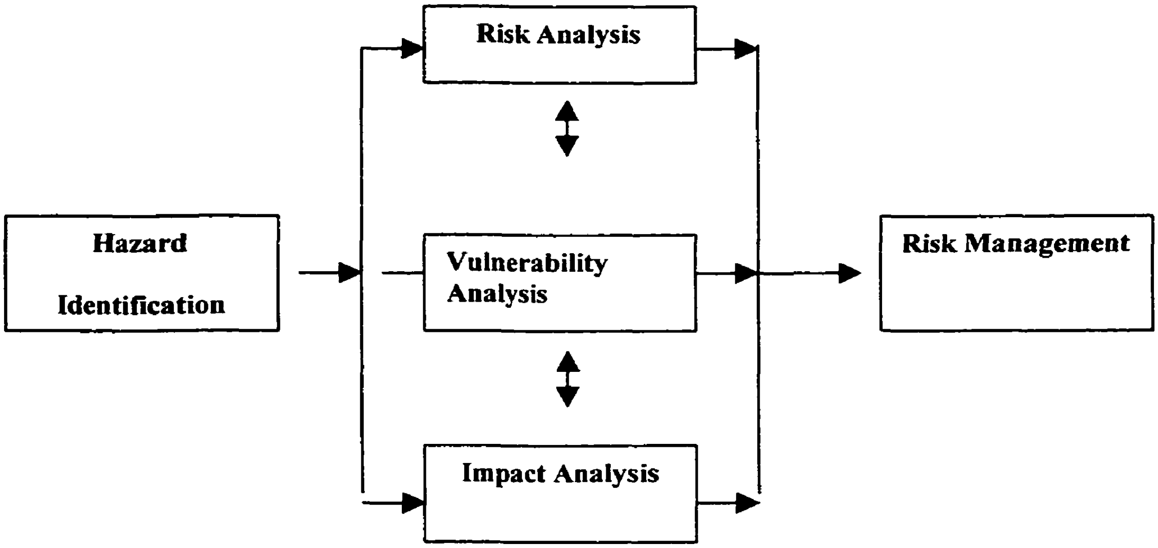
8. The United Nations Disaster Relief Organization (UNDRO) Approach

There are more weaknesses than strengths in the foregoing eight models for HRV analysis. They are particularly weak in terms of providing: (1) a focus on sustainable hazard mitigation through integration with community planning; (2) widespread public participation; (3) adequate risk communication between local stakeholders and experts; (4) an adequate forum within which to acknowledge and address issues of equity and fairness; (5) an ability to empower vulnerable members of society; and (6) an affirmation of the diversity of social and competing interests within any given community through political legitimation.

With the exception of that of the NOAA and UNDRO models, methodology is weak and does not stand up to scrutiny. There tended to be more strengths in the hazard identification phase, which was the easiest phase to address with regard to complexity. The risk assessment phase was slightly better handled than was the vulnerability assessment phase -- probably a reflection of the greater awareness of the issues around risk assessment. However, some approaches did not fully incorporate even the basics of risk analysis (such as including risk factors) into their processes.

The vulnerability assessment is poorly dealt with by all of the HRV models (other than that of NOAA). A general lack of robustness ensures that the risk management phase of HRV analysis reflects the truth of the principle that when the inputs are not adequate and easily communicable, the outputs will not be supported and will not be valid.

F.4. The HIRV Process



- it is community and regionally based;
- it is first and foremost a tool for local communities and regional governments;
- the goal of the HIRV model is to assist the community to develop mitigative strategies vis-à-vis hazards.
- incorporates information from local planning departments and can provide valuable information for community development planning.

Notes:

F.5. The Committee

A committee, composed of both laypersons and experts, will lay the groundwork for the implementation of the HIRV model. They will work from an HIRV Handbook.

- enables experts to gain an understanding of community concerns
- and to benefits from local knowledge
- enables community representatives to gain information that can only be supplied by local experts.

The HIRV working committee can include participants from the areas and offices represented in the following list (additional experts can and should be invited to attend when appropriate):

- *Local elected official*
- *Community resident*
- *Social planning*
- *Scientist or expert in potential natural hazards*
- Representative from the insurance industry
- Principal from a development company
- *Disaster management planning*
- *Member from local media*
- *Representative from any major local industry*
- Representatives from major resource sectors (e.g. forestry, fisheries)
- Engineering (i.e., particularly structural engineering, others would also be useful)
- Utilities
- *Community planning*
- *Public relations*
- *Environmentalist*
- *Public health inspector or medical health officer*
- Representative from the local business association
- Local firefighter familiar with hazardous materials

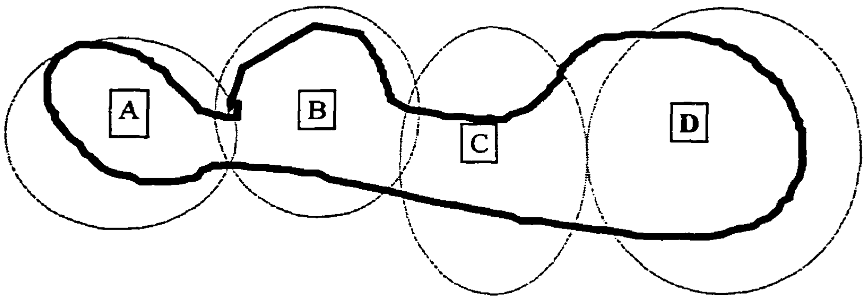
F.6. Overview of the HIRV Model

1. Hazard Identification

Review of Hazards

2. Divide the Community or Region into Separate Areas for Analysis

For example:



3. Risk Factors

- For each location and for each hazard

As an example, a summary of the factors has been chosen to highlight the process:

Name of Hazard	Historical Data	Risk Factors	Certainty of Data	Risk Rating
Air Crashes	*Listing of previous events*	*4/8*	*Well established*	*+2*

Scale for Determining the Likelihood of a Disaster Occurring due to a Specific Hazard

+3	Hazard is very likely to occur.	-1	Hazard is not very likely to occur.
+2	Hazard is likely to occur	-2	Hazard is unlikely to occur.
+1	Hazard has a slight chance of occurring	-3	Hazard is very unlikely to occur.

4. Vulnerability Factors

- For each location and for each hazard

As an example, a few of the factors have been chosen to highlight the process:

People	Place	Preparedness	Time
☑ **Age** ☐ **Density**	☐ **Buildings** ☑ **Critical Facilities**	☐ **Capability to respond** ☑ **Community Education and Training**	☐ **Time of Day** ☐ **Day of Week**

Example of the Vulnerability Assessment Sheet:

Name of Hazard	Social	Place	Preparedness	Time	Certainty of Data	Vulnerability Rating
Air Crashes	2/5	*5/11*	*3/4*	*Summer & Christmas* *During the day*	*Well established*	*+2*

Scale for Determining the Vulnerability to a Disaster Occurring from a Specific Hazard

+3	High degree of vulnerability.	-1	Slight degree of Invulnerability
+2	Moderate degree of vulnerability.	-2	Moderate degree of invulnerability.
+1	Slight degree of vulnerability	-3	High degree of invulnerability.

5. **Impacts**

- For each location and for each hazard

As an example, a few of the factors have been chosen to highlight the process:

Social	**Environmental**	**Economic**	**Political**
[3] Number of deaths. [3] Number of injuries. [1] Loss of housing. •	[1] Quality of air. [1] Quality and quantity of water. [1] Quality and quantify of soil.	[1] Structural damage. [1] Non-structural damage. [1] Loss of jobs.	[1] Coerced risks [3] Government control. [1] Unfair risks.

Scale for Determining the Degree of Impact to a Disaster Occurring from a Specific Hazard

+3	Moderate to high degree of impact.
+2	Low to moderate degree of impact.
+1	Little or no degree of impact.

Name of Hazard	**Social**	**Environmental**	**Economic**	**Political**	**Certainty**	**Impact Rating**
Air Crash	+2	+1	+1	+2	Well established	+2

6. **Risk Management Analysis**

- For each location and for each hazard

Hazard	**Risk Rating**	**Certainty**	**Vulnerability Rating**	**Certainty**	**Impact Analysis**	**Certainty**	**Risk & Vulnerability Analysis**
Air Crashes	+2	Well Established	+2	Speculative	En=1 S=2 Ec=1 P=2	Well Established	R=Moderate V=Moderate

F.7. Hazard Identification

A hazard:

is a threat to humans and what they value: life, well-being, material goods, and environment.

Hazards are classified as:

- **Natural hazards** - those that are normally thought of as "Acts of God" (e.g., earthquakes and hurricanes).
- **Diseases**, epidemics and pest infestations - self-explanatory and may apply to people, animals, or plants.
- **Person-induced hazards** - those that are caused either by acts of commission (e.g., the building of bombs) or acts of omission (e.g. failure to build a dam able to withstand an earthquake).

Given that the goal of the disaster management process is to develop mitigative strategies, it is important to look at causes. Strategies will differ depending upon the cause of the event in question. For example, if the effects of a flood are being exacerbated by poor logging practices upstream, then those involved in the logging operations need to address their practice.

Notes:

F.7.1. Group Exercise

In your groups list as many hazards as you can think of:

F.7.2. Definitions and Descriptions

It is not enough that the HIRV handbook provide a list of hazards. As part of the educational process, each hazard must be briefly defined and described.

- the purpose is not to provide an exhaustive account of all hazards but to provide enough information so that laypersons on the HIRV committee can understand the cause and scope of each.
- should provide sources for those who wish to seek additional information.

F.7.3. Group Exercise

Review the handout listing all of the hazards. How many did your group leave out? Why do you think some were left out?

Notes:

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F.7.4. Multi-Hazards

Although the HIRV model is not designed to accommodate chain events and multi-hazard situations, it can certainly assist communities in coping with these situations during the risk-assessment phase.

F.8. Step Two - Organizing the Community

If a community is small, and if, after plotting the hazards and areas of impact, it appears that the entire community is equally impacted, then it should be assessed as one entity. However, if the location of a potential hazard indicates that some parts of the community, or region, will be more affected than others, then, for the purpose of analysis, the community or region should be divided into significant areas.

F.8.1. Group Exercise - Dividing the Community

Examine the community maps which have been provided. Note what are the key elements of the map. How would your group divide the community? Keep in mind the hazards you have discussed.

Notes:

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F.9. Risk Analysis

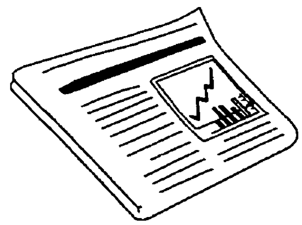
Risk is defined as:

the probability or chance of an event occurring in a particular area, based on historical data and predictions for future events.

F.9.1. Step One - Historical Data

- The first step is to review each hazard and then collect the historical data for each hazard.

F.9.2. Group Exercise - Historical Data



Choose one hazard from the list with which you are familiar. Using knowledge from the communities represented at the table complete the historical analysis for that hazard with the group.

Notes:

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Summarize and transfer this information to the **Risk Analysis Sheet** (in ***Workbook 2*** p.1).

F.9.3. Step Two Examining the Factors

- must determine the scope of the potential disaster which might result from each hazard by examining the risk factors associated with each hazard
- risk factors that the HIRV model provides only serve as a guideline
- experts should be invited to partake in the process of determining whether or not risk factors exist

F.9.4. Group Exercise - Examining the Risk Factors

Choose the hazards for which you have completed a historical analysis. Examine the risk factors for these hazards for each area in the community. Complete the Risk Factor sheets that apply. Think about those hazards for which you know little information.

Notes:

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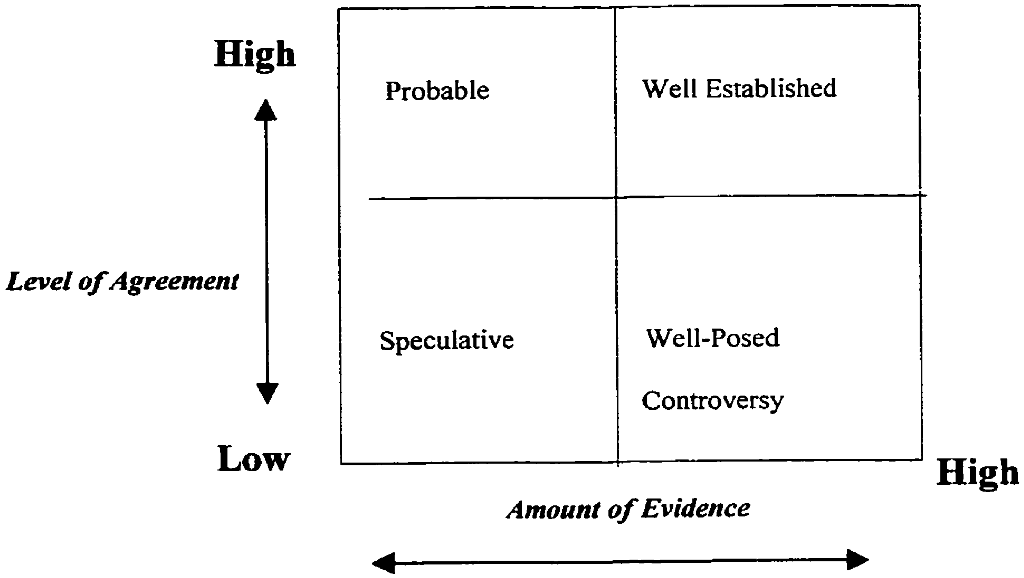
F.9.5. Step Three Determining the Likelihood of a Disaster Occurring

Transfer the number of risk factors (e.g. 4/6 Factors apply) that exist to the **Risk Analysis Sheet** (in ***Workbook 2*** p.1).

F.9.6. Step Four - Assessing Certainty

Evaluate the historical data and the risk factors. In some cases you may be unsure of the probabilities. The following model may help in determining the certainty of the information you have received from experts and members of the committee.



Transfer your assessment to the **Risk Analysis Sheet** (in ***Workbook 2*** p.1).

F.9.7. Step Five - Rating Risk

Use the following scale to rate the likelihood of a disaster occurring for each section of the community.

Scale for Determining the Likelihood of a Disaster Occurring due to a Specific Hazard

+3	Hazard is very likely to occur.	-1	Hazard is not very likely to occur.
+2	Hazard is likely to occur	-2	Hazard is unlikely to occur.
+1	Hazard has a slight chance of occurring	-3	Hazard is very unlikely to occur.

Transfer your assessment to the **Risk Analysis Sheet** (in ***Workbook 2*** p.1).

F.10. Vulnerability Assessment

> Risk, however, should not be confused with vulnerability, which refers to the resources and coping abilities of a specific community to a specific hazard ... Vulnerability is a reflection of the community's coping resources and may vary within the smaller social and economic groups which form a large community. (Lindsay 1993, 68)

Vulnerability is defined:

as the susceptibility of people, property, industry, resources, and areas of environmental and historic concern to the negative impact of an event.

Vulnerabilities are represented as a function of:

- people,
- place,
- preparedness, and
- time

F.10.1. Step One- Examining the Vulnerability Factors

Factors

People	Place	Preparedness	Time
1. age	1. buildings	1. capability to respond	1. population density re: time of day
2. density	2. critical facilities	2. community education and training	2. population density re: day of the week
3. gender	3. ecological sites	3. mitigation program	3. population density re: time of year
4. ethnicity	4. economic sectors	4. warning systems	4. population density re: holidays
5. socio-economic status	5. historical and cultural sites		
	6. lifelines and infrastructure		
	7. non-structural property		
	8. recreational land		
	9. structures		

F.10.2. Group Exercise - Examining the Vulnerability Factors

Choose the hazard for which you have completed risk analysis. Examine the vulnerability factors for this hazard for each area in the community. Complete the Vulnerability Factors that apply. Think about those hazards for which you know little information.

Notes:

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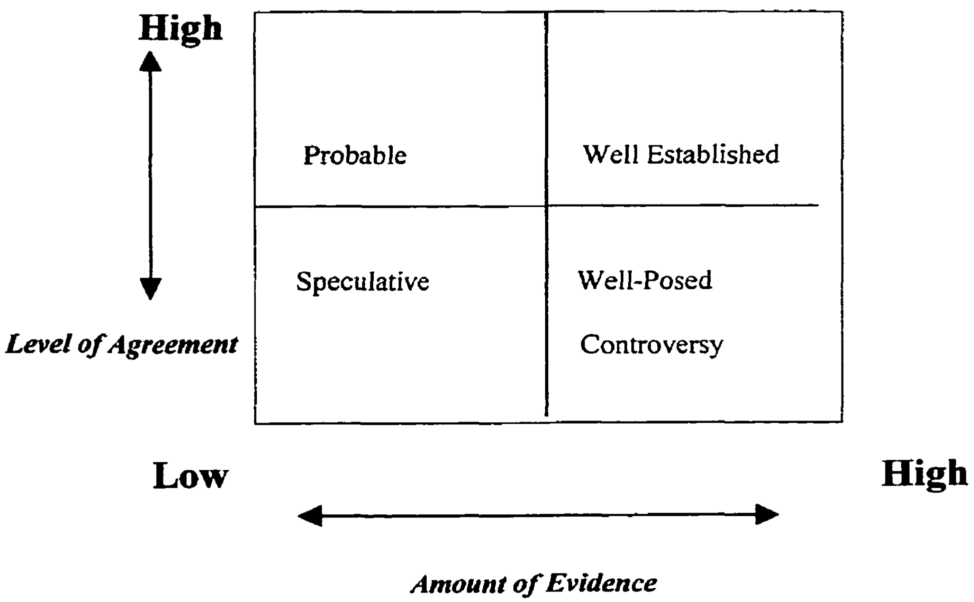
Transfer your findings to the **Vulnerability Factor Analysis Sheet** (in ***Workbook 2*** p.2).

F.10.3. Step Two Determining the Degree of Vulnerability

Transfer the number of vulnerability factors (e.g. 4/6 Factors apply) that exist to the **Vulnerability Assessment Sheet** (in ***Workbook 2*** p.3).

F.10.4. Assessing Certainty

Evaluate the historical data and the risk factors. In some cases you may be unsure of the probabilities. The following model may help in determining the certainty of the information you have received from experts and members of the committee.



Transfer your assessment to the **Vulnerability Assessment Sheet** (in ***Workbook 2*** p.3).

F.10.5. Rating Vulnerability

Use the following scale to rate the vulnerability for each section of the community.

Scale for Determining the Vulnerability to a Disaster Occurring from a Specific Hazard

+3	High degree of vulnerability.	-1	Slight degree of invulnerability.
+2	Moderate degree of vulnerability.	-2	Moderate degree of invulnerability.
+1	Slight degree of vulnerability	-3	High degree of invulnerability.

Transfer your assessment to the **Vulnerability Assessment Sheet** (in ***Workbook 2*** p.3).

F.11. Impact Analysis

F.11.1. Step One- Examining the Impact Factors

Impacts can be viewed as being:

- social,
- environmental,
- economic, or
- political.

Notes:

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Vulnerabilities and Social Impacts

Vulnerabilities	Social Impacts
• age • gender • ethnic and cultural background • population density • time of day, week, year	• number of deaths • number of injuries
• buildings	• loss of housing • disruption of family life • loss of schools or educational opportunity • loss of a historical site • loss of a cultural site • loss of health services • loss of critical facilities
• recreational land	• loss of recreational opportunities

Notes:

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Vulnerabilities and Environmental Impacts

Vulnerabilities	Environmental Impacts
• industrial sector • lifelines and infrastructure • ecological sites • natural resources sector • agricultural sector • historical buildings and artifacts	• quality of air • quality and quantity of water • quality and quantity of soil • destruction to plant life • deaths and injuries to wildlife • destruction of natural resources • destruction of eco-systems

Vulnerabilities and Economic Impacts

Vulnerabilities	Economic Impacts
• buildings • structures • critical facilities • historical and cultural sites • lifelines and infrastructure • non-structural property	• structural damage • non-structural damage
• economic sectors • recreational land • lifelines and infrastructure	• loss of jobs • loss of revenue • loss of service • deaths and injuries to livestock and domestic animals • destruction of crops

Notes:

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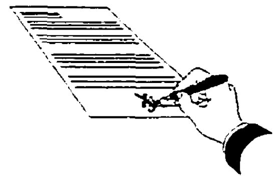
Vulnerabilities and Political Impacts

Vulnerabilities	Political Impacts
• capability to respond • community education and training • warning system • number of potential technological hazards	• public perception of blame

Political Impacts

There are a number of different factors which may help to determine what the degree of community outrage might be for particular risks:



1. **Voluntary risks are accepted more readily than are those that are imposed (voluntary vs coerced).**
2. **Risks under individual control are accepted more readily than are those under government control.**
3. **Risks that seem fair are more acceptable than are those that seem unfair.**
4. **Risk information that comes from trustworthy sources is more readily believed than is risk information that comes from untrustworthy sources.**
5. **Risks that seem ethically objectionable will seem more risky than will those that do not.**
6. **Natural risks seem more acceptable than do industrial risks.**
7. **Exotic risks seem more risky than do familiar risks.**
8. **Risks that are associated with memorable events are considered more risky than are risks which are not so associated.**
9. **Risks that are "dreaded" seem less acceptable than do those that are not.**
10. **Risks that are undetectable create more fear than do those that are detectable.**
11. **Risks that are well understood by science are more acceptable than are those that are not.**
12. **Risks that are chronic are better accepted than those that are catastrophic.**
13. **Risks that occur within the context of a responsive process are better accepted than those that are part of an unresponsive process.** (Bernstein 1987 and Sandman 1991)

The greater the number and seriousness of these factors, the greater the likelihood of public concern.

F.11.2. Group Exercise - Examining the Impact Factors

Choose the hazard for which you have completed the vulnerability analysis. Examine the impact factors for this hazard for each area in the community. Complete the Impact Factors that apply. Think about those hazards for which you know little information.

Notes:

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____

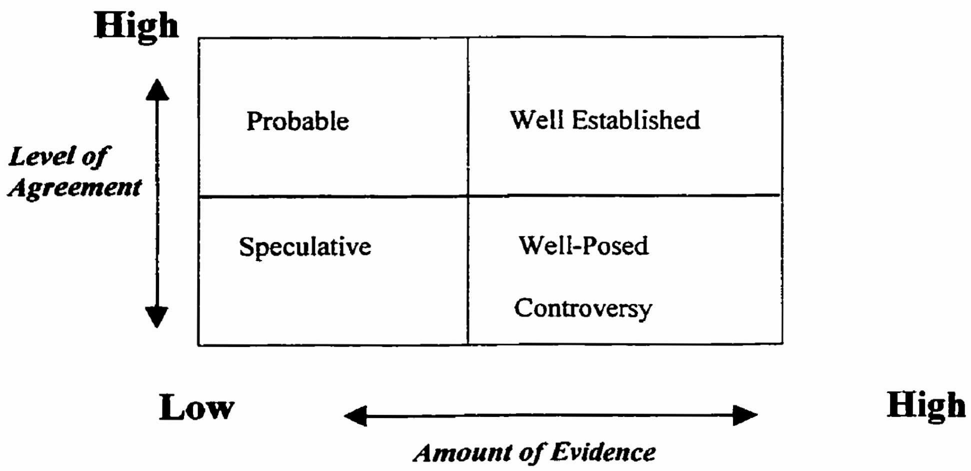
Transfer your findings to the **Impact Factor Analysis Sheet** (in ***Workbook 2*** p.4).

F.11.3. Step Two Determining the Degree of Impact

Transfer the ratings of the impact factors to the **Impact Assessment** (in ***Workbook 2*** p.5).

F.11.4. Assessing Certainty

Evaluate the historical data and the risk factors. In some cases you may be unsure of the probabilities. The following model may help in determining the certainty of the information you have received from experts and members of the committee.



Transfer your assessment to the **Impact Assessment Sheet** (in ***Workbook 2*** p.5).

F.11.5. Rating Impact

Use the following scale to rate the impacts for each section of the community.

Scale for Determining the Impact of a Disaster Occurring from a Specific Hazard

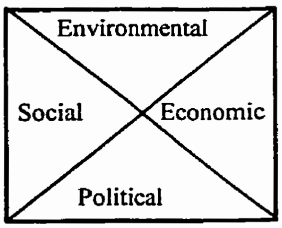
+3	Moderate to high degree of impact.
+2	Low to moderate degree of impact.
+1	Little or no degree of impact.

Illustration of the Recording of the Impact Analysis

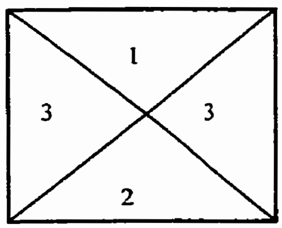
Hazard	**Area 1 Impact Analysis**	**Area 2 Impact Analysis**
Flood		
Hazardous Material Spill		

Transfer your assessment to the **Impact Assessment Sheet** (in ***Workbook 2*** p.5).

where:



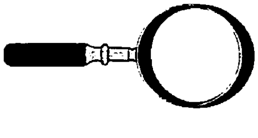
and the impacts could be recorded as:



F.12. Risk Management

> To be effective and meaningful, risk management must be an integral part of the overall management of a system. (Haimes 1995, 4)

This model uses the **risk management process** identified by the National Research Council (1991: Appendix), which indicates communities concerned with hazard reduction should take the following steps:



1. ***Identify natural hazards (location, intensity, frequency).***
2. ***Map hazard-prone areas and environmentally sensitive areas.***
3. ***Inventory structures and areas vulnerable to hazards (e.g., unreinforced masonry, mobile homes).***
4. ***Inventory critical facilities and resources (e.g., hospitals, schools, utilities, and endangered species).***
5. ***Inventory sites containing hazardous and toxic materials, determine vulnerability.***
6. ***Inventory special-needs groups (e.g., elderly, people with handicaps).***
7. ***Conduct hazard and risk assessments (vulnerability of population and natural resources to specific hazards).***
8. ***Prepare hazard overlay maps in order to depict vulnerable areas and populations.***
9. ***Digitize hazard and risk assessments (e.g., geographic information systems).***
10. ***Develop procedures and schedule for updating hazard and risk assessments.***
11. ***Translate hazard and risk assessments into recommendations for action (e.g., community public awareness, mitigation, preparedness programs).***

This process allows the committee to identify:

- those hazards which are likely to occur and will have a high impact upon the community;
- those hazards which are unlikely to occur and will have a low impact upon the community;
- those areas in the community which are at greatest risk; and
- those areas in the community which are at least risk.

> According to Hattis and Goble (1995, 108), for example, "no priority system should be applied too strictly in the allocation of resources; a 'portfolio approach' is desirable that spreads some efforts to lower-priority candidates."

F.12.1. Group Exercise - Completing Risk Management

For the hazards, risks and vulnerabilities you have identified, complete the risk management process.

Step One

Transfer your findings from the **Risk Analysis Sheet**, the **Vulnerability Assessment Sheet** and the **Impact Assessment Sheet** to the **Risk Management Sheet** (in ***Workbook 2*** p.6)..

Step Two

Discuss your priorities

Notes:

F.13. The Implementation Guide

It is the disaster manager's responsibility to determine the leadership for the HIRV committee and to ensure that it is as effective as possible. The following implementation guide for the HIRV committee, at the community or regional level, has been adapted from the Federal Emergency Management Agency's (Region 8) and the National Park Service's (Rocky Mountain Region) (1994, 8-11) *A Multi-Objective Planning Process for Mitigating Natural Hazards*. Its outline is designed to maximize the efficiency and effectiveness of group participation in multi-objective planning sessions.

Time-Frame	Tasks:
Before the first planning session	• Identify the area for which planning is to be done. • Find and meet with potential project partners • Set a date and location. • Begin notifying potentially interested groups and individuals about the planning session. • Start identifying planning issues by meeting or speaking informally with local groups and individuals. • Draft a planning session agenda. • Find and invite committee members. • Find and invite recorders. • Finalize the agenda. • Maximize public involvement. • Make sure public affairs work is under way. • Ensure local publicity is arranged for the first committee meetin
The day before the planning session:	• Do a last-minute check. • Meet with facilitator.
First day of the planning session:	• Prepare the meeting place. • Follow the agenda. • Convene the introductory session. • Get committee ready to begin identifying issues. • Continue media coverage. • Become familiar with the educational material provided.
Hazard Identification:	• Become familiar with the educational material provided. • Identify all potential hazards. • Attempt to identify potential multi-hazard events. • Obtain historical data on potential hazards. • Conduct field reconnaissance. • Publish and provide access to information for the community at large.

Phases	Tasks
Risk Analysis:	• Become familiar with the educational material provided. • Eliminate all hazards for which there exists no possibility of occurrence. • Conduct field reconnaissance. • Establish the location of the potential hazard and the area of impact. • Determine whether the community is equally affected by most hazards or whether it should be divided into significant areas for comparative purposes and ease of analysis. • Review the risk factors for each hazard, using experts to justify the evaluation of risk whenever possible. • Determine the likelihood of a specific hazard occurring. • Complete the Risk Analysis recording sheet with all ratings. • Publish and provide access to information for the community at large.
Vulnerability Analysis:	• Become familiar with the educational material provided. • Review the vulnerability factors for each hazard and rate each factor in terms of whether or not the area is highly vulnerable. • Complete the Vulnerability Assessment recording sheet with all ratings. • Publish and provide access to information for the community at large.
Impact Analysis	• Become familiar with the educational material provided. • Review the ratings for vulnerability and determine and rate the social, environmental, economic, and political impacts for each hazard and area. • Complete the Impact Assessment recording sheet with all ratings • Publish and provide access to information for the community at large.
Risk Management:	• Become familiar with the educational material provided. • Compare the risks and impacts for all hazards and study areas. • Using the Risk Management Recording Forms determine the high and low priorities for application of mitigation strategies. • Group remaining hazards and study areas into areas of secondary priority (if desired, additional levels may be used). • Get committee ready to formulate specific aspects of its recommendations. • Publish and provide access to information for the community at large.
Prior to Initial Presentation:	• Have the committee revise and update its suggested solutions. • Combine the committee's written materials into a draft plan. • Make copies of the finished draft plan.
Presentation to Elected Officials and Policy Makers:	• Distribute copies of the draft plan. • Have experts stand by to answer questions on recommendations. • Present the draft plan to local officials. • Have a meeting of project partners. • Obtain public input through public meeting and broadcast. • Encourage public involvement. • Publish and provide access to information for the community at large.
Ongoing Sessions:	• Establish a monitoring system to evaluate how the recommendations are being acted upon. • Continue to update the analysis.

Source: Adapted from Federal Emergency Management Agency (Region 8) and the

Bibliography

Bernstein, Alan B. (1987). *The Emergency Public Relations Manual*: Third Edition. Canada: Pase Incorporated.

Federal Emergency Management Agency Region VIII and the National Park Service, Rocky Mountain Region. (1994). *A Multi-Objective Planning Process for Mitigating Natural Hazards.* Federal Emergency Management Agency Region VIII and the National Park Service, Rocky Mountain Region. Denver, Colorado.

Haimes, Yacov Y. (1992). "Toward a Holistic Approach to Total Risk Management." *Geneva Papers on Risk and Insurance* 17 (64): 314-321.

Hattis, Dale and Robert L. Goble. (1995). "Current Priority-Setting Methodology: Too Little Rationality or Too Much?" In *The Debate over Risk-Based National Environmental Priorities.* Adam M. Finkel and Dominic Golding (eds.), 107-133. Washington DC: Resources for the Future.

Lindsay, John Roderick. (1993). *Exploring the Interface of Urban Planning and Disaster Management.* Manitoba, Canada: University of Manitoba.

Moss, Richard and Stephen Schneider. (1997). "Characterizing and Communicating Scientific Uncertainty: Building on the IPCC Second Assessment." In the *Elements of Change 1996.* Susan Joy Hassol and John Katzenberger (eds.). 90-136. Aspen, Colorado: Aspen Global Change Institute.

National Research Council. (1991). *A Safe Future: Reducing the Impacts of Natural Disasters.* Washington, DC.: National Academy Press.

Sandman, Peter. (1991). A Formula for Effective Risk Communication. Video.

Workbook

for

A COMMUNITY OR REGIONAL HAZARD, IMPACT, RISK AND VULNERABILITY ANALYSIS: HIRV

Part Two - Forms

Laurie Pearce

Table of Contents

F.14. Risk Analysis Sheet

Area: ______________________ **Area:** ______________________

Name of Hazard	Historical Data	Risk Factors	Certainty of Data	Risk Rating	Historical Data	Risk Factors	Certainty of Data	Risk Rating

F.15. Vulnerability Factor Analysis

Hazard: ______________________

Area: ____________________ **Area:** ____________________

People	Place	Preparedness	Time	People	Place	Preparedness	Time
☐ Age ☐ Density ☐ Gender ☐ Ethnicity ☐ Socio-economic Status	☐ Buildings ☐ Critical Facilities ☐ Ecological Sites ☐ Economic Sectors ☐ Historical and Cultural Sites ☐ Lifelines and Infrastructure ☐ Property ☐ Recreational Land ☐ Structures	☐ Capability to respond ☐ Community Education and Training ☐ Mitigation Program ☐ Warning Systems	☐ Time of Day ☐ Day of Week ☐ Time of Year ☐ Holidays	☐ Age ☐ Density ☐ Gender ☐ Ethnicity ☐ Socio-economic Status	☐ Buildings ☐ Critical Facilities ☐ Ecological Sites ☐ Economic Sectors ☐ Historical and Cultural Sites ☐ Lifelines and Infrastructure ☐ Property ☐ Recreational Land ☐ Structures	☐ Capability to respond ☐ Community Education and Training ☐ Mitigation Program ☐ Warning Systems	☐ Time of Day ☐ Day of Week ☐ Time of Year ☐ Holidays

F.16. Vulnerability Assessment Sheet

Area: ______________________

Name of Hazard	People	Place	Preparedness	Time	Certainty	Vulnerability Rating

Area: ______________________

Name of Hazard	People	Place	Preparedness	Time	Certainty	Vulnerability Rating

F.17. Impact Factor Analysis

Hazard: ____________________ **Area:** ____________________

Social	Environmental	Economic	Political
☐ Number of deaths.	☐ Quality of air.	☐ Structural damage.	1. ☐ Coerced risks
☐ Number of injuries.	☐ Quality and quantity of water.	☐ Non-structural damage.	2. ☐ Government control.
☐ Loss of housing.	☐ Quality and quantify of soil.	☐ Loss of jobs.	3. ☐ Unfair risks.
☐ Disruption of family life.	☐ Death and injuries to wildlife.	☐ Loss of service.	4. ☐ Untrustworthy sources.
☐ Loss of schools or educational opportunity.	☐ Destruction of natural resources.	☐ Loss of revenue.	5. ☐ Ethically objectionable
☐ Loss of historical sites.		☐ Deaths and injuries to livestock and domestic animals.	6. ☐ Industrial risks.
☐ Loss of cultural site.		☐ Destruction of crops.	7. ☐ Exotic risks
☐ Loss of health services.			8. ☐ Memorable events.
☐ Loss of critical facilities.			9. ☐ Dreaded risks.
☐ Loss of recreational space.			10. ☐ Undetectable risks.
			11. ☐ Not understood by science.
			12. ☐ Catastrophic risks.
			13. ☐ Unresponsive process.

F.18. Impact Assessment Sheet

Area: ______________________________

Name of Hazard	Social	Environmental	Economic	Political	Certainty	Impact Rating

Area: ______________________________

Name of Hazard	Social	Environmental	Economic	Political	Certainty	Impact Rating

F.19. Risk Management Analysis Sheet

Area: ____________________

Hazard	Risk Rating	Vulnerability Rating	Impact Analysis	Certainty	Risk & Vulnerability Analysis

Area: ____________________

Hazard	Risk Rating	Vulnerability Rating	Impact Analysis	Certainty	Risk & Vulnerability Analysis

Appendix G Tables and Responses to Exploratory Studies

The following table outlines the CEPC Mayors and Elected Municipal Officials courses in which I presented an overview of the HIRV approach to HRV analysis.

Table 39: Courses for Mayors and Elected Municipal Officials, 1991-1996

Date	Course Number	Number of Students	Instructor
15-18 April 1991	1235	26	Pearce
06-09 May 1991	1247	21	Pearce
17-20 June 1991	1261	21	Pearce
9-12 September 1991	1266	18	Pearce
28-31 October 1991	1285	19	Pearce
25-28 November 1991	1295	19	Namur
27-30 January 1992	1312	16	Pearce
17-20 February 1992	1322	19	Pearce
25-28 May 1992	1357	23	Pearce
8-11 June 1992	1363	17	Pearce
22-25 June 1992	1369	21	Namur
14-17 September 1992	1372	22	Pearce
2-5 November 1992	1391	25	Namur
8-11 February 1993	1416	28	Namur
8-11 March 1993	1428	25	Pearce
05-08 May 1993	1437	25	Namur
17-20 May 1993	1452	27	Pearce
24-27 January 1994	1508	23	Pearce
07-10 March 1994	1522	21	Pearce
9-12 May 1994	1538	20	Pearce
30 May-02 June 1994	1543	16	Pearce
12-15 September 1994	1556	17	Pearce
31 September-03 October 1994	1575	20	Pearce
27 February-02 March 1995	1606	25	Pearce
14-15 March 1995	Newfoundland	36	George
24-27 April 1995	1618	20	Pearce
11-14 September 1995	1639	20	Pearce
19-22 February 1996	1686	23	Pearce
Totals	**28**	**613**	

Table 40 includes a complete list of the comments on the CEPC general evaluations for the Mayor and Elected Municipal Officials courses over a four-year period. There were three places on the general course evaluation where participants could be reasonably expected to make comments about the HIRV module: (1) What subject interested you the most?; (2) What subject interested you the least?; and (3) General Comments. It should be noted that, according to the CEPC curriculum, the section that included the HIRV module was entitled "Phases and Characteristics of Disasters and Planning Priorities."

Table 40: A Comprehensive List of Comments Relevant to the HIRV Approach: Taken from Evaluations for the Mayors and Elected Municipal Officials Courses at CEPC from June 1991 to September 1995

Question 1: What subject area interested you the most?
Awareness of the types of emergencies that can happen in and around your community
Making you realize hazards in your town that you never thought about
The structure and implementation of a Disaster Plan
Hazard analysis
Hazard analysis and transportation of dangerous goods
Hazard analysis
The method of building and composing a good emergency plan - step-by-step
The preparation and evaluation of potential disaster areas
Development of a comprehensive plan designed for a specific site
Community planning process
Disaster planning in totality
Community planning process
Planning, priorities and characteristics of disaster
Hazard analysis
The planning process
Hazards/risk assessment
The community planning process
The way to set up an overall plan for emergency and/or disaster
Phases and characteristics of disaster planning and priorities
The subject matter that Laurie presented
Community planning
Hazard analysis
Phases and characteristics of disasters and planning priorities
Phases and characteristics of disasters and planning priorities
Phases and characteristics of disasters and planning priorities
Hazard analysis
Hazard analysis
Information relating to the preparation of an Emergency Planning Process and Hazard Analysis

Question 2: Which subject area was of least interest to you?
Risk analysis and hazard assessment
Hazard analysis due to the realization that I have little exposure to these scenarios at present, but should become familiar with potential danger

General Comments
More time on some issues: Hazard Analysis
Politics of emergency planning - I still have a problem with weighting "political" reasons as an equal to social, environmental and economic impacts

Table 41 is a sample of the questionnaire that was distributed at the final Mayors and Elected Officials course, held on 19 February 1996.

Table 41: Questionnaire Distributed at Mayors and Elected Municipal Officials Course

These questions are based on the hazard, risk and vulnerability assessment presentation that you received on Monday, February 19th, 1996. Please take a few minutes to complete the following questions and circle the appropriate value which best represents your answer.

1. The first step in the process was the hazard identification process and a list of common hazards was provided by participants. Do you feel that the circulated list of hazards would be useful to you and your community as part of your emergency preparedness program?

1	2	3	4	5	6	7	8	9	10

Not Useful — Moderately useful — Very Useful

2. The next step was to complete a risk analysis which included determining the historical information and examining the risk factors. Was this process easy to understand and apply?

1	2	3	4	5	6	7	8	9	10

Not Useful — Moderately useful — Very Useful

3. The third step was to consider vulnerabilities in terms of people, place, time and the degree of preparedness of a community. Did you find this concept easy to understand and apply?

1	2	3	4	5	6	7	8	9	10

Not Useful — Moderately useful — Very Useful

4. The fourth step was to translate these vulnerabilities into impacts: social, economic, environmental and political. Did this process make sense and was it easy to apply?

1	2	3	4	5	6	7	8	9	10

Not Useful — Moderately useful — Very Useful

5. Finally the last step was to prioritize the various hazards, risks and vulnerabilities for mitigative actions. This was accomplished by rating the risks and vulnerabilities and classifying them into either high, moderate or low categories.

a. Did dividing the community into various sectors or neighbourhoods (e.g. port, park) for the purposes of prioritization seem a useful method for your emergency preparedness program?

1	2	3	4	5	6	7	8	9	10

Not Useful — Moderately useful — Very Useful

If not useful, why not? ☐ My community is too small

Other: ____

b. Did you feel that the prioritization of hazards, risks and vulnerabilities was a useful way of identifying the hazards most likely to occur in your community and the neighbourhoods or sectors that are the most vulnerable?

1	2	3	4	5	6	7	8	9	10

Not Useful — Moderately useful — Very Useful

If not useful, why not? ____

c. Do you feel that using this method of prioritizing the hazards, risk and vulnerabilities would lead to the development of a effective and efficient mitigation program for your community?

1	2	3	4	5	6	7	8	9	10

Not effective — Moderately effective — Very effective

If not useful, why not? ____

The following two tables state the results of the Questionnaires.

Table 42: Results of Questionnaires Distributed at Mayors and Elected Municipal Officials Course

Respondent #	1 Haz. ID	2 Risk	# 3 Vulnerabilities	# 4 Impacts	#5a Sectors	Too Small	# 5b Priorities	# 5c Mitigation
1	8	8	8	8	8		8	8
2	8	8	7	8	8		8	8
3	10	10	10	10	10		10	10
4	6	6	6	6	6		6	6
5	8	8	8	8	8		8	7
6	9	6	8	8	1	Yes	8	6
7	7	6	8	8	8		7	7
8	10	8	9	9	10		10	10
9	9	6	8	6	10		10	9
10	8	7	7	8	3	Yes	4	4
11	6	7	7	8	8		8	9
12	9	8	8	8	8		8	8
13	10	6	8	9	8		8	9
14	9	7	8	6	8		8	8
15	9	7	8	8	9		9	9
16	8	7	8	8	9		9	8
17	7	8	8	8	9		8	8
18	9	8	6	7	8		8	8
19	9	8	8	8	9		8	9
20	8	5	7	6	7		7	7
21	9	8	9	9	6		8	7
Mean	8.38	7.24	7.81	7.81	8.26		8.00	7.86
Median	8.5	7	8	8	8		8	8

Table 43: Results of Questionnaire Distributed at Mayors and Elected Municipal Officials course 19 February 1996.

Comments

#6: 5c - It is not necessarily easy to make the jump from hazard and risk to mitigation but this process helps us to decide what should be worked on.
#8: 5a - Even "if too small" useful to divide into type of sectors.
#10: 2 - Difficult to understand at first.
#17: 5a - My town is small but the exercise did stretch my mind, and so is very useful.
#18: 5a - Ownership and community involvement.
#19: 5a - The practical application helped in the understanding.
#21: 5a - If each group could have done 2-3 areas it would have made your point more thorough.

The following table provides all of the responses that were entered on the course evaluation that CEPC distributed at the end of the Post-Secondary Institutions course.

Table 44: Comments Based on Post-Secondary Institutions Course Evaluations from November 1995

Question Please provide us with your comments on the module on Hazard Analysis and Risk Assessment?
Good
Very Useful
Important topics
Good
Very good
Fine
Good - would like more
As above - excellent tools
Would like to spend more time on this topic Believe it to be very important. "Risk = Hazard + outrage" Dr. Peter Sandman, Rutgers University
Don't remember
Good tools to start with
Critical starting point but I'm not sure how many will actually follow the procedure
Excellent - good tool to use in the analysis
Very good
Very good - very relevant
General comment provided good guidelines to start and the "health & safety" of persons is number 1
Very relevant
Very good
Good workable model presented Would like to see lists perhaps of natural and man made situations to select relevant list for our campus
Good
Could be a little longer
Again, it is important that this topic is covered in the first half day of the course
Relevant
Good
Very well done
Interesting and relevant
Nice short session
Most delegates from universities and colleges that come to this course deal with this subject every day in their jobs Not much time is required here
Okay

Table 45 lists the criteria that were established for determining the adequacy of an HRV model and that were used in the exploratory studies.

Table 45: List of Criteria for Determining the Adequacy of HRV Models

The Overall HRV Process

1. maintains a community and regional focus and is flexible enough to adapt to local conditions.
2. is part of a disaster management process, the goal of which is to assist communities and regions to develop mitigative strategies.
3. is part of the community planning process.
4. includes public participation.
5. provides for the education of participants and points them to various sources of information.
6. is simple and easily communicable.
7. enables users to consider, but not be constrained, by expert advice.
8. is robust and is easy to control.
9. is considerate of the working environment and does not have a rigid structure that forces participants to complete processes in a specific order.

The Hazard Identification Process

1. includes only hazards that are likely to lead to a disaster.
2. contains a complete list of hazards and is all hazard in scope (includes:
   a. natural hazards,
   b. diseases and epidemics, and
   c. person-induced hazards).
1. includes public participation.
2. provides for the education of participants and points them to various sources of information.
3. is simple and easily communicable.
4. enables users to consider, but not be constrained, by expert advice.
5. is robust and is easy to control.
6. is considerate of the working environment and does not have a rigid structure that forces participants to complete processes in a specific order.

The Risk Assessment Process

1. includes historical data.
2. includes guidelines for the identification of risk factors for each hazard:
   a. natural hazards,
   b. diseases and epidemics, and
   c. person-induced hazards).
1. identifies the possible locations of each of the potential hazards.
2. assesses the probability of each hazard, grouping risks according to the best data available.
3. allows for the most likely disaster scenarios - maximum credible incidents.
4. includes public participation during this process.
5. provides for the education of participants and points them to various sources of information. Part of this entails ensuring that an educational component of risk perception and guidelines to risk assessment be included with the model.
6. is simple and easily communicable.
7. enables users to consider, but not be constrained, by expert advice.
8. is robust and is easy to control.
9. is considerate of the working environment and does not have a rigid structure that forces participants to complete processes in a specific order.

The Vulnerability and Impact Assessment

1. includes the age, gender, socio-economic status, and ethnic and cultural background of community residents and visitors.
2. includes the assessment of structures and buildings, including schools and other critical facilities. Also include lifelines (e.g., water mains, power lines, etc.) and infrastructure (e.g., bridges, overpasses).

Table 45 List of Criteria for HRV Models cont'd...

1. includes the capacity of the community to respond to a disaster, or the degree of disaster preparedness of the community.
2. includes economic factors (e.g., industry, value of structures, etc.).
3. ensures that the necessary environmental assessments are conducted.
4. takes into consideration that the vulnerability of a community can be influenced by the time of incident.
5. considers
a. social (e.g., number of potential deaths, loss of housing) impacts,
b. political (i.e., the likelihood of blame) impacts,
c. environmental (e.g., the quality of air, the quality of water) impacts, and
d. economic impacts (e.g., loss of businesses, loss of jobs).
1. includes public participation during this process.
2. provides for the education of participants and points them to various sources of information.
3. is simple and easily communicable.
4. enables users to consider, but not be constrained, by expert advice.
5. is robust and is easy to control.
6. is considerate of the working environment and does not have a rigid structure that forces participants to complete processes in a specific order.
The Risk Management Process
1. includes as an output a ranking of hazards, risk, and vulnerabilities with recommendations for mitigative actions.
2. ensures that a monitoring system be in place.
3. includes public participation during this process.
4. provides for the education of participants and points them to various sources of information.
5. is simple and easily communicable.
6. enables users to consider, but not be constrained, by expert advice.
7. is robust and is easy to control.
8. is considerate of the working environment and does not have a rigid structure that forces participants to complete processes in a specific order.

Table 46 provides a tabulated list of the responses to the questionnaires that were given to the participants of the Emergency Preparedness Conference. Each question relates to a specific criterion that appears on the list in the preceding table. For example,

The HIRV Model as Presented:		
includes only hazards that are likely to lead to a disaster	Yes	No

The criteria in Table 46 are numbered as they are in Table 45. Although the questionnaire provided only for "Yes" or "No" answers, in a few cases respondents wrote "?" or circled both the "Yes" and the "No"; these are tabulated as "Unsure."

Table 46: Responses to Questionnaire: Emergency Preparedness Conference Workshop

Criteria	Yes	%	Unsure	%	No	%	Total
HIRV Process							
Question 1	9	100.00	0	0.00	0	0.00	100.00
Question 2	9	100.00	0	0.00	0	0.00	100.00
Question 3	9	100.00	0	0.00	0	0.00	100.00
Question 4	6	66.67	2	22.22	1	11.11	100.00
Question 5	8	88.89	0	0.00	1	11.11	100.00
Question 6	6	66.67	0	0.00	3	33.33	100.00
Question 7	8	88.89	0	0.00	1	11.11	100.00
Question 8	3	33.33	1	11.11	5	55.56	100.00
Question 9	7	77.78	0	0.00	2	22.22	100.00
Hazard Identification							
Question 1	5	55.56	1	11.11	3	33.33	100.00
Question 2a	9	100.00	0	0.00	0	0.00	100.00
Question 2b	9	100.00	0	0.00	0	0.00	100.00
Question 2c	9	100.00	0	0.00	0	0.00	100.00
Question 3	7	77.78	1	11.11	1	11.11	100.00
Question 4	9	100.00	0	0.00	0	0.00	100.00
Question 5	6	66.67	1	11.11	2	22.22	100.00
Question 6	9	100.00	0	0.00	0	0.00	100.00
Question 7	7	77.78	2	22.22	0	0.00	100.00
Question 8	8	88.89	0	0.00	1	11.11	100.00
Risk Analysis							
Question 1	9	100.00	0	0.00	0	0.00	100.00
Question 2a	9	100.00	0	0.00	0	0.00	100.00
Question 2b	9	100.00	0	0.00	0	0.00	100.00
Question 2c	9	100.00	0	0.00	0	0.00	100.00
Question 3	9	100.00	0	0.00	0	0.00	100.00
Question 4	8	88.89	0	0.00	1	11.11	100.00
Question 5	8	88.89	0	0.00	1	11.11	100.00
Question 6	6	66.67	2	22.22	1	11.11	100.00
Question 7	9	100.00	0	0.00	0	0.00	100.00
Question 8	8	88.89	1	11.11	0	0.00	100.00
Question 9	8	88.89	0	0.00	1	11.11	100.00
Question 10	7	77.78	1	11.11	1	11.11	100.00
Question 11	8	88.89	0	0.00	1	11.11	100.00
Vulnerability Analysis							
Question 1	9	100.00	0	0.00	0	0.00	100.00
Question 2	8	88.89	0	0.00	1	11.11	100.00
Question 3	9	100.00	0	0.00	0	0.00	100.00
Question 4	8	88.89	1	11.11	0	0.00	100.00
Question 5	7	77.78	2	22.22	0	0.00	100.00
Question 6	9	100.00	0	0.00	0	0.00	100.00
Vulnerability Analysis							
Question 7a	9	100.00	0	0.00	0	0.00	100.00
Question 7b	9	100.00	0	0.00	0	0.00	100.00
Question 7c	9	100.00	0	0.00	0	0.00	100.00
Question 7d	9	100.00	0	0.00	0	0.00	100.00
Question 8	7	77.78	2	22.22	0	0.00	100.00
Question 9	9	100.00	0	0.00	0	0.00	100.00
Question 10	5	55.56	0	0.00	4	44.44	100.00
Question 11	7	77.78	1	11.11	1	11.11	100.00
Question 12	6	66.67	0	0.00	3	33.33	100.00
Question 13	8	88.89	0	0.00	1	11.11	100.00

Table 46 Responses to Questionnaire: Emergency Preparedness Conference Workshop cont'd...

Criteria	Yes	%	Unsure	%	No	%	Total %
Risk Management							
Question 1	9	100.00	0	0.00	0	0.00	100.00
Question 2	7	77.78	1	11.11	1	11.11	100.00
Question 3	8	88.89	1	11.11	0	0.00	100.00
Question 4	8	88.89	1	11.11	0	0.00	100.00
Question 5	7	77.78	1	11.11	1	11.11	100.00
Question 6	7	77.78	1	11.11	1	11.11	100.00
Question 7	4	44.44	3	33.33	2	22.22	100.00
Question 8	7	77.78	1	11.11	1	11.11	100.00

The following two tables list the participants who attended the two invitational workshops that were held in December 1997.

Table 47: List of Participants for the Invitational Workshop held in Burnaby, 1 December 1997

1. Baderush, Tony	Emergency Planning Consultant, Port Coquitlam, BC
2. Bolton, Patricia	Senior Research Scientist, Batelle Research Institute
3. Caldwell, Gaeron	ESS Coordinator, North and West Vancouver
4. Gagnon, Pierre	Emergency Management Coordinator, Fraser Valley Regional District
5. Gajb, Mark	Manager of Risk, Safety and Emergency Planning, City of New Westminster
6. Harding, Ruth	Regional Emergency Planning Coordinator, Greater Vancouver Regional District
7. Harkness, Pat	Regional Manager, South-West Region, Provincial Emergency Program
8. Helmer, Mike	Fire Prevention Officer, Abbotsford
9. Lee, Robert	Assistant City Engineer, Coquitlam
10. Lyle, Heather	Emergency Planning Officer, City of Vancouver
11. Moore, Bob	Administrator, Fraser Valley Regional District Chilliwack
12. Oakley, John	Emergency Coordinator, Justice Institute
13. Palmer, Richard	Risk and Emergency Management Analyst, City of Vancouver
14. Pollock, Sally	ESS Program Coordinator, Justice Institute of British Columbia

Table 48: List of Participants for the Invitational Workshop held in Victoria, 9 December 1997

1. Duckworth, Neil	Director Purchasing Services, District of Saanich
2. Emery, Bill	Emergency Program Coordinator, Esquimalt
3. Gray, Sandy	Municipal Administrator, Esquimalt
4. Henderson, Doug	Muncipal Emergency Coordinator, Oak Bay
5. Johnson, Ron	Manager, Provincial Emergency Program
6. Jonientz-Trisler, Chris	Regional Earthquake Program Manager, FEMA Region 10
7. Koch, Doug	Deputy Emergency Coordinator, Victoria
8. Marcinkiewicz, Tom	Administrator, CFB Esquimalt
9. Neilson, Ken	Manager, Civic Facilities, City of Victoria
10. Sikstrom, Brian	Senior Planner, City of Victoria
11. Thoms, Robin	Earthquake Project Officer, Emergency Preparedness Canada
12. Timms, Clive	Manager, Streets Division, City of Victoria

The questionnaires appeared in the same format as they did in the Vancouver workshop. Since the numbers were small, and there appeared to be no statistical difference between the findings of the Victoria and Burnaby workshops, for analytical purposes the responses to the questionnaire were combined.

Table 49: Responses to Questionnaire: Pilot Workshops in Burnaby and Victoria

Criteria	Yes	%	Unsure	%	No	%	Total %
HIRV Process							
Question 1	26	100.00	0	0.00	0	0.00	100.00
Question 2	26	100.00	0	0.00	0	0.00	100.00
Question 3	22	84.62	0	0.00	4	15.38	100.00
Question 4	26	100.00	0	0.00	0	0.00	100.00
Question 5	23	88.46	3	11.54	0	0.00	100.00
Question 6	10	38.46	4	15.38	12	46.15	100.00
Question 7	25	96.15	0	0.00	1	3.85	100.00
Question 8	14	53.85	6	23.08	6	23.08	100.00
Question 9	19	73.08	5	19.23	2	7.69	100.00
Hazard Identification							
Question 1	15	57.69	1	3.85	10	38.46	100.00
Question 2	26	100.00	0	0.00	0	0.00	100.00
Question 3	25	96.15	1	3.85	0	0.00	100.00
Question 4	25	96.15	0	0.00	1	3.85	100.00
Question 5	14	53.85	5	19.23	7	26.92	100.00
Question 6	24	92.31	2	7.69	0	0.00	100.00
Question 7	21	80.77	2	7.69	3	11.54	100.00
Question 8	23	88.46	2	7.69	1	3.85	100.00

Table 49 Responses to Questionnaire: Pilot Workshops in Burnaby and Victoria cont'd...

Criteria	Yes	%	Unsure	%	No	%	Total %
Risk Analysis							
Question 1	26	100.00	0	0.00	0	0.00	100.00
Question 2	26	100.00	0	0.00	0	0.00	100.00
Question 3	23	88.46	1	3.85	2	7.69	100.00
Question 4	24	92.31	0	0.00	2	7.69	100.00
Question 5	22	84.62	1	3.85	3	11.54	100.00
Question 6	25	96.15	1	3.85	0	0.00	100.00
Question 7	24	92.31	0	0.00	2	7.69	100.00
Question 8	14	53.85	4	15.38	8	30.77	100.00
Question 9	26	100.00	0	0.00	0	0.00	100.00
Question 10	23	88.46	1	3.85	2	7.69	100.00
Question 11	20	76.92	5	19.23	1	3.85	100.00
Vulnerability Analysis							
Question 1	26	100.00	0	0.00	0	0.00	100.00
Question 2	26	100.00	0	0.00	0	0.00	100.00
Question 3	26	100.00	0	0.00	0	0.00	100.00
Question 4	26	100.00	0	0.00	0	0.00	100.00
Question 5	23	88.46	2	7.69	1	3.85	100.00
Question 6	24	92.31	1	3.85	1	3.85	100.00
Question 7	26	100.00	0	0.00	0	0.00	100.00
Question 8	26	100.00	0	0.00	0	0.00	100.00
Question 9	24	92.31	1	3.85	1	3.85	100.00
Question 10	14	53.85	5	19.23	7	26.92	100.00
Question 11	25	96.15	1	3.85	0	0.00	100.00
Question 12	20	76.92	4	15.38	2	7.69	100.00
Question 13	22	84.62	3	11.54	1	3.85	100.00
Risk Management							
Question 1	26	100.00	0	0.00	0	0.00	100.00
Question 2	17	65.38	6	23.08	3	11.54	100.00
Question 3	26	100.00	0	0.00	0	0.00	100.00
Question 4	23	88.46	2	7.69	1	3.85	100.00
Question 5	12	46.15	8	30.77	6	23.08	100.00
Question 6	25	96.15	1	3.85	0	0.00	100.00
Question 7	19	73.08	5	19.23	2	7.69	100.00
Question 8	22	84.62	3	11.54	1	3.85	100.00

Table 50 provides a list of those participants who attended the workshop in Sooke.

Table 50: List of Participants for the Workshop Held in Sooke, 25 March 1998

1. Victoria Weber	Search and Rescue Team, Sooke Electoral District
2. R.E. Moffet	Fire Chief, East Sooke Electoral District
3. W.F. Meikle	Deputy Fire Chief, Sooke Electoral District
4. Brenda Young	Emergency Social Services Alternate Director, Sooke Electoral District
5. Beverley Wilson	Emergency Social Services Director, Langford
6. H. Zech	RCMP corporal, Sooke Electoral District

Table 50 List of Participants for the Workshop held in Sooke, 25 March 1998 cont'd...

1. Bob Vanderzwaag	Emergency Coordinator, Sooke Electoral District
2. Ken Greenwood	Emergency Social Services Director, Sooke Electoral District
3. Joseph Arden	Deputy Fire Chief, Langford
4. Jack Poulter	Emergency Social Services Alternate Director, Langford
5. Kerry Zado	Fire Prevention Officer, Sooke Electoral District
6. Calvin Beaton	Emergency Program Coordinator, Metchosin
7. Laurie Spears	Fire Chief, Metchosin
8. Charles Schmidt	Building Inspector, Metchosin
9. Anonymous	newly arrived resident to the Sooke Electoral District

Table 51 presents the findings from the workshop that was held in the Sooke Electoral District. Because of the number of responses that were commented upon and/or that were marked unsure at the Burnaby/Victoria workshops, I decided that the questionnaire for the Sooke workshop should be rated differently. I used a five-point scale, along with an "unsure" category, and asked participants to circle their choice. For example,

The HIRV Model:					
includes only hazards that are likely to lead to a disaster					
1	2	3	4	5	Unsure
Not at all		Somewhat		Very Well	

Table 51: Questionnaires from the Electoral District of Sooke

Criteria	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	Unsure	Mean	Median
HIRV Process																	
Question 1	5	4	4	4	5	4	5	5	4	4	4	4	4	5	0	4.36	4.00
Question 2	4	4	4	4	5	4	5	4	5	4	4	4	5	4	0	4.29	4.00
Question 3	4	4	4	4	5	4	2	4	5	3	3	4	3	5	0	3.86	4.00
Question 4	5	3	3	3	5	3	3	4	5	3	2	3	3	4	0	3.50	3.00
Question 5	5	4	3	3	5	4	4	3	3	5	4	4	4	3	0	3.86	4.00
Question 6	4	5	2	3	4	3	3	4	3	4	4	4	2	4	0	3.50	4.00
Question 7	3	5	4	4	5	3	4	4	4	5	5	4	3	4	1	4.38	4.00
Question 8	3	4	3	3	4	3		4	3	4	4	4	3	4	0	3.29	4.00
Question 9	4	4	4	4	5	3	4	4	4	4	5	4	4	5	0	4.14	4.00
Hazard Identification																	
Question 1	5	4	4		5	1	4	1	2	3	1	3	3	5	1	3.15	3.50
Question 2a	4	4	4	4	5	4	4		5	5	4	4	4	5	1	4.31	4.00
Question 2b	4	4	4	4	5	3	4		4	4	4	4		5	2	4.08	4.00
Question 2c	4	5	4	4	5	3	4		4	4	4	4		5	2	4.17	4.00
Question 3	4	5	4	3	5	2	3	4	4	2	4	3	4	3	0	3.57	4.00
Question 4	5	4	3	3	5	4	4	3	3	4	4	4	4	4	0	3.86	4.00
Question 5	5	4	2	3	4	3	3	4	4	3	4	3	4	4	0	3.57	4.00
Question 6	3	5	4	4	5	4	4	4	4	5	5	4	4	4	0	4.21	4.00
Question 7	4	4	4	3	4	3		3	3	5	4	3	4	4	1	3.69	4.00
Question 8	4	4	4	4	5	3	5	4	4	4	4	4	4	5	0	4.14	4.00
Risk Analysis																	
Question 1	2	5	3	2	5	3	4	5	2	5	4	4	3	5	0	3.71	4.00
Question 2a	3	4	4	4	5	4	4	4	3	4	4	4	4	5	0	4.00	4.00
Question 2b	3	4	4	4	5	3	4	4	2	4	4	4	4	5	0	3.86	4.00
Question 2c	3	4	4	4	5	3	4	4	2	4	4	4	4	5	0	3.86	4.00
Question 3	4	4	4	2	5	3	5	4	5	3	4	4	2		1	3.77	4.00
Question 4	2	5	4	3	5	3	4	4	5	4	5	4	3	4	0	3.93	4.00
Question 5	4	4	4	3	5	3	4	4	4	5	5	4	4	4	0	4.07	4.00
Question 6	5	4	4	3	5	3	3	4	4	3	4	3	3	5	0	3.79	4.00
Question 7	4	4	4	4	5	2	4	4	4	4	5	4	3	4	0	3.93	4.00
Question 8	5	5	2	3	4	3	3	4	4	4	4	3	4	4	0	3.71	4.00
Question 9	5	5	3	4	5	3	4	4	3	4	5	4	4	4	0	4.07	4.00
Question 10	5	5	2	3	4	3		4		4	4	3	4	4	2	3.75	4.00
Question 11	4	4	4	4	5	3	5	4	4	4	4	4	4	5	0	4.14	4.00

Table 51 Questionnaires from the Electoral District of Sooke cont'd…

Criteria	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	Unsure	Mean	Median
Vulnerability Analysis																	
Question 1	3	4	4	3	5	4	5	5	4	4	4	4	4	4	0	4.07	4.00
Question 2	4	5	4	3	5	4	4	4	4	4	4	4	4	4	0	4.07	4.00
Question 3	3	5	4	4	5	4	4	4	4	4	4	4	3	4	0	4.00	4.00
Question 4	4	4	4	4	5	3	4	4	4	4	4	4	3	5	0	4.00	4.00
Question 5	4	5	4	3	5	3	3	3		4	4	4	3	3	1	3.69	3.50
Question 6	4	5	4	4	5	4	4	4	5	5	4		4	5	1	4.38	4.00
Question 7a	5	4	4	4	5	4	4	4	4	4	4	3	2	5	0	4.00	4.00
Question 7b	5	4	4	3	5	4	4	4	4	3	4	3	2	5	0	3.86	4.00
Question 7c	5	4	4	4	5	4	4	4	4	4	4	3	3	5	0	4.07	4.00
Question 7d	5	4	4	4	5	4	4	4	4	4	4	3	3	5	0	4.07	4.00
Question 8	5	4	3	3	5	3	3	3	3	3	4	3	3	4	0	3.50	3.00
Question 9	4	4	3	4	5	3	4	4	3	4	4	4	4	4	0	3.86	4.00
Question 10	4	4	2	3	4	2	3	4	3	4	4	3	3	4	0	3.36	3.50
Question 11	5	4	3	4	5	3	4	4	4	4	4	4	3	4	0	3.93	4.00
Question 12	4	4	2	4	4	3		4	4	4	4	3	3	4	0	3.36	4.00
Question 13	5	4	3	3	5	3	5	4	4	4	4	4	2	5	0	3.93	4.00
Risk Management																	
Question 1	5	4	4	4	5	4	3	4	4	3	4	3	3	5	0	3.93	4.00
Question 2	3	5	3	4	5	3	5	3	3	3	4	4	2		1	3.62	3.00
Question 3	4	4	4	4	5	2	3	4	3	3	4	3	3		1	3.54	3.50
Question 4	4	5	3	3	5	3	4	4	3	4	4	4	4	4	0	3.86	4.00
Question 5	5	4	2	3	4	3	3	4	3	4	4	3	4	4	0	3.57	4.00
Question 6	5	3	3	4	5	3	4	4	4	4	4	4	4	4	0	3.93	4.00
Question 7	5	4	2	3	4	2		4	4	4	4	3	3	4	0	3.29	4.00
Question 8	4	4	3	4	5	3	5	4	4	4	4	4	3	5	0	4.00	4.00
Mean	4.14	4.25	3.46	3.45	4.82	3.18	3.55	3.68	3.59	3.91	4.02	3.59	3.27	4.14		3.86	4.00

Table 52 lists those participants who attended the CEPC workshop.

Table 52: List of Participants at the CEPC Workshop, 16-17 September 1998

1. Colin King	Federal/provincial Liaison Officer, Saskatchewan
2. Shelley James Huebert	Coordinator for Preparedness and Response, Manitoba EMO
3. Suzanne Bernier	EMO Officer – Northeastern Ontario, Ontario
4. Mary Purcell	Consultant, Kingston Ontario
5. Jacques Gregoire	Communication, Centre de securities Civile, Montreal, Quebec
6. Ginette Joly	Coordonnateur du soutine logistique, Centre de securities Civile, Montreal, Quebec
7. Denis, Duquet	Coordonnateur, Gendarmerie royale du Canada, Montreal, Quebec
8. Marc La Fontaine	Coordonnateur federal reg des operations d'urgence, EPC/PCC Quebec
9. Wayne Carnell	Disaster Coordinator, Oromocto, New Brunswick
10. Laurie Young	Training Coordinator, Fredericton, New Brunswick
11. Blaine Rapp	EOC Coordinator, City of Whitehorse, Yukon

The following table provides the responses to the questionnaire used at the CEPC workshop. Here I returned to the original yes-no format, asking participants if they believed that HIRV met the stated criteria; however, I did provide the "unsure" option. I returned to this format because of some of the problems I had with regard to interpreting the data from the Sooke workshop: (1) it seemed that there was no significant difference between a rating of "4" and a rating of "5" (i.e., an answer of 4 or 5 seemed to indicate that the participants agreed that the criterion had been met); and (2) it seemed that there was no significant difference between a rating of "1" and a rating of "2" (i.e., an answer of 1 or 2 seemed to indicate that the participants agreed that the criterion had not been met). In other words, at both the high and low ends of the scale, differentiation seemed unnecessary.

Table 53: Responses to Questionnaires: CEPC Workshop

Criteria	Yes	%	Unsure	%	No	%	Total
HIRV Process							
Question 1	9	81.82	1	9.09	1	9.09	100.00
Question 2	9	81.82	1	9.09	1	9.09	100.00
Question 3	10	90.91	0	0.00	1	9.09	100.00
Question 4	9	81.82	2	18.18		0.00	100.00
Question 5	7	63.64	4	36.36		0.00	100.00
Question 6	1	9.09	7	63.64	3	27.27	100.00
Question 7	7	63.64	3	27.27	1	9.09	100.00
Question 8	3	27.27	6	54.55	2	18.18	100.00
Question 9	6	54.55	4	36.36	1	9.09	100.00

Table 53 Responses to Questionnaires: CEPC Workshop cont'd...

Criteria	Yes	%	Unsure	%	No	%	Total
Hazard Identification							
Question 1	7	63.64	2	18.18	2	18.18	100.00
Question 2a	11	100.00	0	0.00		0.00	100.00
Question 2b	11	100.00	0	0.00		0.00	100.00
Question 2c	11	100.00	0	0.00		0.00	100.00
Question 3	9	81.82	2	18.18		0.00	100.00
Question 4	8	72.73	3	27.27		0.00	100.00
Question 5	6	54.55	3	27.27	2	18.18	100.00
Question 6	7	63.64	4	36.36		0.00	100.00
Question 7	3	27.27	8	72.73		0.00	100.00
Question 8	6	54.55	4	36.36	1	9.09	100.00
Risk Analysis							
Question 1	10	90.91	1	9.09		0.00	100.00
Question 2a	10	90.91	1	9.09		0.00	100.00
Question 2b	10	90.91	1	9.09		0.00	100.00
Question 2c	10	90.91	1	9.09		0.00	100.00
Question 3	10	90.91	1	9.09		0.00	100.00
Question 4	10	90.91	1	9.09		0.00	100.00
Question 5	10	90.91	1	9.09		0.00	100.00
Question 6	9	81.82	2	18.18		0.00	100.00
Question 7	9	81.82	1	9.09	1	9.09	100.00
Question 8	5	45.45	4	36.36	2	18.18	100.00
Question 9	8	72.73	2	18.18	1	9.09	100.00
Question 10	6	54.55	4	36.36	1	9.09	100.00
Question 11	9	81.82	2	18.18		0.00	100.00
Vulnerability Analysis							
Question 1	10	90.91		0.00		0.00	90.91
Question 2	9	81.82	1	9.09		0.00	90.91
Question 3	9	81.82	1	9.09	0	0.00	90.91
Question 4	9	81.82	1	9.09	0	0.00	90.91
Question 5	9	81.82	1	9.09	0	0.00	90.91
Question 6	10	90.91	0	0.00	0	0.00	90.91
Question 7a	8	72.73	2	18.18	0	0.00	90.91
Question 7b	10	90.91	0	0.00	0	0.00	90.91
Question 7c	10	90.91	0	0.00	0	0.00	90.91
Question 7d	9	81.82	1	9.09	0	0.00	90.91
Question 8	8	72.73	2	18.18	0	0.00	90.91
Question 9	7	63.64	3	27.27	0	0.00	90.91
Question 10	4	36.36	5	45.45	1	9.09	90.91
Question 11	8	72.73	2	18.18	0	0.00	90.91
Question 12	4	36.36	5	45.45	1	9.09	90.91
Question 13	7	63.64	1	9.09	2	18.18	90.91
Risk Management							
Question 1	9	81.82	1	9.09	0	0.00	90.91
Question 2	9	81.82	1	9.09	0	0.00	90.91
Question 3	9	81.82	1	9.09	0	0.00	90.91
Question 4	- 7	63.64	3	27.27	0	0.00	90.91
Question 5	5	45.45	3	27.27	2	18.18	90.91
Question 6	8	72.73	2	18.18	0	0.00	90.91
Question 7	6	54.55	2	18.18	2	18.18	90.91
Question 8	7	63.64	3	27.27	0	0.00	90.91

Appendix H Questionnaire

The University of British Columbia
Office of Research Service
Behavioural Research Ethics Board
Room 323 - 2194 Health Sciences Mall, Vancouver, BC V6T 1Z3
Phone: (604) 822-8584 Fax: (604) 822-5093

AN INTEGRATED APPROACH FOR COMMUNITY HAZARD, IMPACT, RISK AND VULNERABILITY ANALYSIS: HIRV

Thank you for taking part on a workshop on the HIRV approach to hazard, impact, risk and vulnerability analyses for communities.

Disasters will continue to occur, and their social, economic, and environmental impacts will continue to increase. Communities are working to develop disaster management programs to prepare for, respond to, and recover from disasters. Before communities can develop and implement mitigative strategies in order to reduce the impact of disasters, it is essential to be knowledgeable regarding the potential hazards, risks and vulnerabilities. Hazard, risk, and vulnerability (HRV) analyses form the cornerstone of disaster management processes; and in the past, communities have not had access to an effective approach to completing HRV analyses. Access to such an approach would enable communities to reduce the number of deaths and injuries, and mitigate against the loss of valuable property and resources.

In order to determine whether or not the HIRV approach meets a number of key objectives, you are requested to complete the following questionnaire, which should take approximately 20 minutes of your time. Your answers will assist in evaluating the HRIV approach and contribute to its on-going improvement.

Any information resulting from this research study will be kept strictly confidential. You are specifically requested not to write your name on your questionnaire. All documents will be identified only by code number and kept in a locked filing cabinet and you will not be identified by name in any reports of the completed study. Any computer data based on these documents will be kept on floppy discs which will be kept in a locked filing cabinet and will only be accessible by password. Please note that while your participation is desirable, you are under no obligation to complete this questionnaire; however, if the questionnaire has been completed, it will be assumed that consent has been given.

Please return the questionnaire to the researcher after completion; however, should you wish to complete the questionnaire at a later date, please return the completed questionnaire to the Co-Investigator listed below. For any further information regarding this study, including a copy of the summary report on these findings, please feel free to contact either of the following:

Principal Investigator: **Dr. Olav Slaymaker** Dept. of Geography University of British Columbia 604-822-3246	Co-Investigator: **Laurie Pearce** 5750 Indian River Drive North Vancouver, B.C. V7G 1L3 604-929-4560

QUESTIONNAIRE ON AN INTEGRATED APPROACH FOR COMMUNITY HAZARD, IMPACT, RISK AND VULNERABILITY: HIRV

Please take the time to read each question on the following pages carefully. If you have difficulty understanding the question please feel free to ask the researcher to clarify. Each question is based on information that was provided to you at the HIRV workshop and is based on your understanding of how the HIRV approach has assisted you, or will assist you and your community, in completing a successful hazard, risk, impact, and vulnerability assessment.

On the following pages, each statement is followed by a rating scale ranging from 1 to 5. An answer of 1 indicates that you strongly disagree with the statement; an answer of 5 indicates that you strongly agree with the statement. Please circle the number which most closely represents your belief about the statement.

Before beginning those questions that relate directly to the HIRV process, please circle the most appropriate response to the following general questions:

a. I have lived in this community for:

less than 1 year   1 to 4 years   5 to 9 years   more than 10 years

b. I am employed by the municipality

Yes   No

c. I have been involved in other hazard, risk and vulnerability processes in my community

Yes   No

1. The HIRV approach integrates both disaster management and community planning in order to successfully focus on sustainable hazard mitigation.

1	2	3	4	5
Strongly Disagree		Somewhat Agree		Strongly Agree

Additional Comments: ____

____

____

2. The HIRV process includes widespread public participation on the part of various community members including: experts, high technology/high risk industry, special interest groups, the media, and members of the general public.

1	2	3	4	5
Strongly Disagree		Somewhat Agree		Strongly Agree

Additional Comments: ____

____

____

3. The HIRV approach ensures that dialogue among and between the community residents and experts (such as community planners and hazards experts) will take place in order for research data to be easily understood by all.

1	2	3	4	5
Strongly Disagree		Somewhat Agree		Strongly Agree

Additional Comments: ____

____

____

4. The HIRV approach makes sure that community residents have access to existing quantitative (e.g., statistical) and qualitative (e.g., historical or narrative) data about hazards, their likelihood of occurring, their potential impact, and existing community vulnerabilities.

1	2	3	4	5
Strongly Disagree		Somewhat Agree		Strongly Agree

Additional Comments: ____

____

____

5. The HIRV approach takes into account how risk is perceived by the people directly affected by a hazardous event as well as by the individuals and organizations involved in responding to it.

1 2 3 4 5

Strongly Disagree Somewhat Agree Strongly Agree

Additional Comments: ______________________________

6. I learned something new about my community by completing the HIRV workshop.

1 2 3 4 5

Strongly Disagree Somewhat Agree Strongly Agree

Additional Comments: ______________________________

7. In every community some residents are more likely to be negatively impacted by hazards than others. The HIRV process provides an adequate forum to acknowledge and address issues of equity and fairness.

1 2 3 4 5

Strongly Disagree Somewhat Agree Strongly Agree

Additional Comments: ______________________________

8. The HIRV process provides an opportunity for those residents, who are more likely to be impacted by hazardous events, to influence community decision-makers to take positive action on their behalf.

1 2 3 4 5

Strongly Disagree Somewhat Agree Strongly Agree

Additional Comments: ______________________________

9. In many cases the community does not have adequate information about hazards and their impacts. The HIRV approach provides a means for determining the accuracy and availability of scientific knowledge.

1	2	3	4	5
Strongly Disagree		Somewhat Agree		Strongly Agree

Additional Comments: ____

____

____

10. Once the HIRV process is complete communities will have an accurate identification of potential hazards.

1	2	3	4	5
Strongly Disagree		Somewhat Agree		Strongly Agree

Additional Comments: ____

____

____

11. The HIRV approach allows community residents to easily understand why certain areas are at greater risk from potential hazards than other areas.

1	2	3	4	5
Strongly Disagree		Somewhat Agree		Strongly Agree

Additional Comments: ____

____

____

12. It is difficult to predict exactly when and where the next disaster will take place. The HIRV process allows for community residents to understand this uncertainty and the inability of scientists and experts to accurately predict most potential hazardous events.

1	2	3	4	5
Strongly Disagree		Somewhat Agree		Strongly Agree

Additional Comments: ____

____

____

13. The HIRV approach is not highly dependent upon technology and is an affordable process for local communities.

1	2	3	4	5
Strongly Disagree		Somewhat Agree		Strongly Agree

Additional Comments: ____

____

____

14. The HIRV process recognizes that adopting mitigative strategies is a political process that will involve the diverse social interests (e.g., protection of the environment) and various competing interests (e.g., land developers) that exist within the community.

1	2	3	4	5
Strongly Disagree		Somewhat Agree		Strongly Agree

Additional Comments: ____

____

____

15. Do you have any other comments you would like to make?

____

____

____

____

Thank you for participating and completing this questionnaire.

Appendix I Invitation to Host A HIRV Workshop

AN INTEGRATED APPROACH FOR COMMUNITY HAZARD, IMPACT, RISK AND VULNERABILITY ANALYSIS: HIRV

The cornerstone of a successful disaster management program is access to an adequate hazard, risk, and vulnerability (HRV) analysis. We know that disasters occur, and every community is aware that there are numerous potential hazards that entail varying degrees of risk and vulnerability. Many communities have not had access to adequate HRV analyses. The consequences of this are numerous:

1. without a complete analysis of potential hazards communities are unable to develop effective warning and evacuation systems;
2. planning for hazards that are unlikely to occur (or, when they do occur, have little impact) may waste time and resources;
3. without an understanding of how a community is vulnerable to a particular hazard, mitigation projects may fail to reduce the risk of a disaster or its consequences;
4. ill-informed communities are ill-prepared communities and, thus, are likely to suffer preventable losses.

The ***HIRV*** approach is intended to guide communities and regional districts through:

1. the process of identifying potential hazards;
2. assessing the risk that these hazards pose;
3. assessing vulnerabilities and the potential impacts of disasters;
4. developing a list of priorities to assist in the management of hazards, risks, and vulnerabilities; and
5. providing the basis for comprehensive community development.

Using maps and a workbook, in a participative fashion, workshop participants will be able to walk through the ***HIRV*** process. Participants will be given the following handouts:

1. List of Objectives of a successful HRV process
2. Comprehensive List of Hazards
3. Definitions and Discussions on 17 Selected Hazards
4. Selected Readings on Risk Perception
5. Risk Factors for Selected Hazards
6. Vulnerability Factors for Selected Hazards
7. ***HIRV*** Workbook

Participants will have the option of completing a questionnaire.

If you and your community are interested in being introduced to the *HIRV* approach, please contact:

Laurie Pearce
604-929-4560
<Laurie_Pearce@telus.net >

5750 Indian River Drive
North Vancouver, B.C. V7G 1L3

Appendix J Implementation of the Hazard, Impact, Risk, and Vulnerability (HIRV) Process

The goal of the HIRV model for HRV analysis is to assist the community to develop sustainable mitigative strategies vis-à-vis hazards. Mitigation is interpreted in the broadest possible sense and includes, on the one hand, pre-disaster projects such as structural retrofitting, adopting non-structural mitigation measures (e.g., strapping a hot-water tank), supporting neighbourhood emergency plans, and developing warning messages, and, on the other hand, post-disaster activities such as setting up counselling services for vulnerable populations, improved building codes, zoning changes, and debris management policies.

The overall process involved in the HIRV model for HRV analysis entails committee membership and extensive use of the media to meet its key objectives. A committee, composed of both laypersons and experts, will lay the groundwork for the implementation of the HIRV model. This committee is dedicated to public involvement, which is a form of direct interaction with members of the community for the purpose of solving specific problems. It typically holds a series of meetings and hearings involving experts and policy makers on the one hand and selected members of the public and interest groups on the other hand. This committee enables experts to gain an understanding of community concerns and to benefit from local knowledge, while it enables community representatives to gain information that can only be supplied by local experts. Obviously, it is important to choose committee members carefully. The HIRV committee should include participants from the areas and offices represented in the following list (additional experts can and should be invited to attend when appropriate):

- *Local elected official*
- *Disaster management planning*
- *Community planning*
- *Community resident*
- *Member from local media*
- *Public relations*
- *Social planning*
- *Representative from any major local industry*
- *Environmentalist*
- *Scientist or expert in potential natural hazards*
- Representatives from major resource sectors (e.g. forestry, fisheries)
- *Public health inspector or medical health officer*
- Representative from the insurance industry
- Engineering (i.e., particularly structural engineering, others would also be useful)
- Representative from the local business association
- Principal from a development company
- Utilities
- Local firefighter familiar with hazardous materials

While all positions have a role to play, some may be more (or less) relevant, depending on the size and structure of the community. Those positions that are italicized are the most critical in the HIRV process, therefore, let us review them and the roles that they play.

An elected council member should sit on the HIRV committee in order to help maintain the profile of the committee within the community. Clearly, the disaster manager or emergency coordinator needs to be on the committee. In order to ensure that community planning is part of the disaster management process it is equally important to have the community planning department represented . The planning department benefits by gaining an awareness of where the hazards, risks, and vulnerabilities are located and, thus, being able to make informed decisions regarding future land use.

By ensuring that the public participates in each step of the HRV process, the HIRV approach increases the likelihood that it will provide the political impetus to allocate resources towards mitigative actions — especially given the many competing interests (e.g., recreational space, infrastructure maintenance, policing, etc.). Benefit is derived not just from public involvement on the HIRV committee but also from the dissemination of information to the general public. Thus, the local media is a key player on the HIRV committee. At each step of the process, it is important that the findings of the HIRV analysis be presented in a way that renders it useful (i.e., it must not be jargon-ridden and unintelligible to the layperson). Ensuring that the public is well represented on the HIRV committee should reduce the level of jargon and contribute to producing easily understood findings.

The participation of a community resident on the committee, coupled with representation from the local media, can help to ensure that information is adequately shared. As well, having a media representative on the HIRV committee can assist with the collection of historical data on hazards and disasters. Some of the findings may be controversial, and having someone from the community's public relations department on hand can be of assistance with regard to the dissemination of information within City Hall as well as with regard to how best to present information to the local community.

Another important reason for having community residents on the HIRV committee is that it is has been recognized that, in many cases, it is local residents rather than scientists and experts who are truly knowledgeable about the local environment. As identified in a number of situations indigenous risk knowledge is a very important factor in assessing hazards and risks.

Social planners benefit from having social vulnerabilities identified, as this information helps them to deal with social inequities, poor housing, and so on. The community benefits overall by having a mechanism to bring risks and vulnerabilities to a public forum, thus enabling people to work together towards a healthier and safer community. A member from a Non-Government Agency (NGO) or non-profit society which is involved in working with vulnerable populations would be a useful member on the HIRV committee.

As is evident in the fourteen key objectives of an HRV analysis, it is important that the industrial sector be represented, especially the high technology/high risk industry (if it exists in the community). Since many industrial hazards are likely to have an environmental impact upon the community, and since one of the objectives of an HRV analysis is to recognize the various competing interests that exist in the community, it is strongly suggested that a recognized environmentalist be appointed to the HIRV committee.

As previously recognized, it is just as important to have an industrial-sector expert as it is to have a scientist or natural hazards expert. This person can assist in evaluating data and ensuring that scientific data are adequately "translated" for the layperson. It would be impossible to have all of the relevant experts sitting around the committee table, so it is suggested that experts be invited, as ad hoc members) to contribute information whenever appropriate. However, one expert with an overall understanding of potential hazards should sit on the committee.

A public health officer or medical health officer is also a valuable member of the HIRV committee, as she/he could contribute information regarding potential diseases and epidemics. The other suggested positions (e.g., representatives from utilities, a local business association, a development company) on the HIRV committee serve to recognize the social diversity of the community.

The HIRV model for HRV analysis must ensure that the rationale for the prioritization of hazards and mitigation areas is both justifiable and easily communicated to politicians, policy makers, and the community at large. In order to promote the robustness of the HIRV model, the following implementation guide (see Table 1) has been adapted from the Federal Emergency Management Agency's (Region 8) and the National Park Service's (Rocky Mountain Region) (1994, 8-11) *A Multi-Objective Planning Process for Mitigating Natural Hazards*. Its outline is designed to maximize the efficiency and effectiveness of group participation in multi-objective planning sessions.

Table 1: Implementation of HIRV Process

Time-Frame	Tasks:
At least six months before the first planning session	• Identify the area for which planning is to be done. • Find and meet with potential project partners from local, regional, state and federal government, and private organizations • Set a date and location. • Begin notifying potentially interested groups and individuals about the planning session. • Start identifying planning issues by meeting or speaking informally with local groups and individuals. • Begin area reconnaissance and logistics. • Draft a planning session agenda.
At least three months before the planning session:	• Find and invite committee members. • Find and invite recorders. • Draft guidelines for facilitator and recorders. • Find and invite a keynote speaker or emcee. • Find and invite individual members of the community. • Finalize the agenda. • Get ready to document. • Maximize public involvement. • Make sure public affairs work is under way.
At least one month before the planning session:	• Ensure local publicity is arranged for the first committee meeting.
The day before the planning session:	• Do a last-minute check. • Meet with facilitator.
Phases	**Tasks - The following steps are to be completed over several months**
First day of the planning session:	• Prepare the meeting place. • Follow the agenda. • Convene the introductory session. • Get committee ready to begin identifying issues. • Continue media coverage. • Become familiar with the educational material provided.
Hazard Identification:	• Become familiar with the educational material provided. • Identify all potential hazards. • Attempt to identify potential multi-hazard events. • Obtain historical data on potential hazards. • Conduct field reconnaissance. • Publish and provide access to information for the community at large.
Risk Analysis:	• Become familiar with the educational material provided. • Eliminate all hazards for which there exists no possibility of occurrence. • Conduct field reconnaissance. • Establish the location of the potential hazard and the area of impact. • Determine whether the community is equally affected by most hazards or whether it should be divided into significant areas for comparative purposes and ease of analysis. • Review the risk factors for each hazard, using experts to justify the evaluation of risk whenever possible. • Determine the likelihood of a specific hazard occurring. • Complete the Risk Analysis recording sheet with all ratings. • Publish and provide access to information for the community at large.
Vulnerability Analysis:	• Become familiar with the educational material provided. • Review the vulnerability factors for each hazard and rate each factor in terms of whether or not the area is highly vulnerable. • Complete the Vulnerability Assessment recording sheet with all ratings. • Publish and provide access to information for the community at large.

Table 1 Implementation of HIRV Process cont'd

Phases	Tasks - The following steps are to be completed over several months
Impact Analysis	• Become familiar with the educational material provided. • Review the ratings for vulnerability and determine and rate the social, environmental, economic, and political impacts for each hazard and area. • Complete the Impact Assessment recording sheet with all ratings • Publish and provide access to information for the community at large.
Risk Management:	• Become familiar with the educational material provided. • Compare the risks and impacts for all hazards and study areas. • Using the Risk Management Recording Forms determine the high and low priorities for application of mitigation strategies. • Group remaining hazards and study areas into areas of secondary priority (if desired, additional levels may be used). • Get committee ready to formulate specific aspects of its recommendations. • Publish and provide access to information for the community at large.
Prior to Initial Presentation:	• Have the committee revise and update its suggested solutions. • Combine the committee's written materials into a draft plan. • Make copies of the finished draft plan.
Presentation to Elected Officials and Policy Makers:	• Distribute copies of the draft plan. • Have experts stand by to answer questions on recommendations. • Present the draft plan to local officials. • Have a meeting of project partners. • Obtain public input through public meeting and broadcast. • Encourage public involvement. • Publish and provide access to information for the community at large.
Ongoing Sessions:	• Establish a monitoring system to evaluate how the recommendations are being acted upon. • Continue to update the analysis.

Source: Adapted from Federal Emergency Management Agency (Region 8) and the National Park Service (Rocky Mountain Region) (1994, 8-11)

Materials for HIRV Workshop

The following lists materials that would be helpful for the use of participants to complete an HIRV analysis. If the community has access to GIS data base, it will be helpful, but it is not necessary for the HIRV analysis.

The one essential element is to have at least a large map (ideally around 6 feet by 4 feet) with topographical details (ideally with contour lines) of the community. Either a laminated map or accompanying mylar sheet overlays (so that use of markers is possible) are important.

The following list includes items which would be useful to have printed on the map. If not available in that format, then working blueprints, maps, etc. or information on the location of various items will be very helpful:

- marked zoning areas (i.e., industrial, commercial, residential);
- all federal, provincial, and district parks;
- Native reserves;
- all streets, with the main transportation corridors marked;
- bridges, rivers, and streams;
- schools (i.e., elementary, middle schools, high schools, colleges);
- critical facilities (e.g., hospitals, police stations, fire halls);
- shopping malls;
- neighbourhood names (e.g., Deep Cove, Edgemont Village);
- key industrial sites (e.g., chemical production plant);
- railways;
- ferry terminals and marinas; and
- key infrastructure sites (e.g., dams, a power sub-station).

Additionally, the following information will be very useful:

- demographics – population base by age, socio-economic status, number of households
- tax assessment rates (i.e., the approximate value of buildings for tax purposes)
- pre-dominant construction type (e.g., wood frame homes, tilt-up commercial property, etc.)
- financial and other information on economic sectors (e.g., tourism, resource based industries)
- number of businesses; number, location and type of industry;

Appendix K Results of Questionnaires from the Participatory Case Studies

Table 54: Findings for Barriere Workshop Questions A, B, and C; and Questions 1 to 14

	Question	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	Mean	Median
Years in Community	**a**	>10	>10	>10	>10	>10	>10	>5	>10	<1	>10	>5	N/A	>10	N/A		
Employed by Municipality	**b**	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes		
Involved in Previous HRV	**c**	No	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No		
Integration of DM & Com. Planning	**1**	5	3	5	4	4	4	4	5	4	4	4	4	3	4	**4.07**	**4.00**
Public Participation	**2**	5	5	5	4	4	4	5	4	5	4	3	5	4	4	**4.36**	**4.00**
Dialogue with Experts & Residents	**3**	5	3	3	4	4	4	5	5	4	3	3	3	4	4	**3.86**	**4.00**
Access to Data re: Hazards	**4**	5	3	4	3	4	4	5	5	4	2	3	4	3	4	**3.79**	**4.00**
Risk Perception	**5**	5	3	4	4	4	4	4	5	4	3	5	4	4	4	**4.07**	**4.00**
Educational	**6**	4	2	2	4	4	3	4	4	5	4	4	4	5	5	**3.86**	**4.00**
Addresses Issues of Equity	**7**	5	3	4	4	4	4	4	4	4	3	3	3	5	4	**3.86**	**4.00**
Influence Decision-Makers	**8**	5	3	4	4	3	5	4	3	4	4	5	3	5	5	**4.07**	**4.00**
Accuracy of Scientific Knowledge	**9**	5	2	4	4	3	4	3	3	4	4	5	4	5	4	**3.86**	**4.00**
Accurate Identification of Hazards	**10**	5	4	5	4	4	4	4	4	5	4	5	4	5	4	**4.36**	**4.00**
Areas of Greater Risk	**11**	5	5	5	4	4	4	5	5	4	4	5	4	5	4	**4.50**	**4.00**
Assess Uncertainty	**12**	5	4	5	3	4	3	4	4	5	5	4	3	5	4	**4.14**	**4.00**
Affordable and Not High Technology	**13**	5	5	5	4	4	5	4	5	5	4	3	4	5	4	**4.43**	**4.00**
Political Process	**14**	5	3	5	4	3	4	4	4	4	4	3	4	5	3	**3.93**	**4.00**
Mean Scores by Participant		**4.93**	**3.43**	**4.29**	**3.86**	**3.79**	**4.00**	**4.21**	**4.29**	**4.36**	**3.71**	**3.93**	**3.79**	**4.50**	**4.07**		

***Note that B1 represents Barriere participant #1, B2 represents Barriere participant #2, etc..*

Table 55: Comments Included in Barriere Questionnaires

Comments Questions	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14
1														
2							More likely to be based on fact instead of emotion.							
3											I live in a very little community so my resources are limited.	Not all partici-pated in this session.		
4											Only if we get the information to them.			
5														
6				This process helps to define where concerns and issues in a community fall.										
7														
8														
9														
10														
11														
12														
13														
14														
15					Thank you for doing.	The problem remains: motivating the general public to participate and internalize emergent information.		Thank you for choosing Barriere to test your process and help us to proceed successfully in the future development of a community plan.	Excellent intro-duction.		I enjoyed the course provided. I feel Little Fort will benefit from my day here. Thank you.		Good planning tool for community emergency plans.	

Table 56: Findings for Taylor Workshop Questions A, B, and C; and Questions 1 to 14

	Question	T1	T2	T3	T4	Mean	Median
Years in Community	a	N/A	>10	>1	>5		
Employed by Municipality	b	No	No	Yes	No		
Involved in Previous HRV	c	Yes	No	Yes	Yes		
Integration of DM & Com. Planning	1	5	5	4	5	4.75	5.00
Public Participation	2	5	5	5	5	5.00	5.00
Dialogue with Experts & Residents	3	4	5	4	5	4.50	4.50
Access to Data re: Hazards	4	5	5	5	5	5.00	5.00
Risk Perception	5	5	5	5	5	5.00	5.00
Educational	6	5	5	4	5	4.75	5.00
Addresses Issues of Equity	7	5	4	5	5	4.75	5.00
Influence Decision-Makers	8	5	5	5	5	5.00	5.00
Accuracy of Scientific Knowledge	9	5	5	5	5	5.00	5.00
Accurate Identification of Hazards	10	4	5	5	5	4.75	5.00
Areas of Greater Risk	11	5	5	5	5	5.00	5.00
Assess Uncertainty	12	5	4	5	5	4.75	5.00
Affordable and Not High Technology	13	4	5	5	5	4.75	5.00
Political Process	14	5	5	5	5	5.00	5.00
Average Scores by Participant		4.79	4.86	4.79	5.00		

Table 57 Comments Included in Taylor Questionnaires

Comments Questions	T1	T2	T3	T4
1			Seemed to be much more emphasis on community planning than disaster management	Course covered all aspects of disaster planning in a community. Good examples given.
2	Puts pressure on local government when public is informed about risk			Encouraged to bring all of the community into play for best results and ability to answer all questions.
3			There wasn't a lot of discussion about who should be a part of the process except for calling in experts to answer questions. There was information in the materials.	Encourages everyone to meet and have input into final solutions.
4	Makes local authorities aware of local problems - then local authorities cannot hide from responsibilities			By publishing all information in each different area and decision.
5				Points of view on issues are an important part of final plan.
6				Learned history that I was unaware of before course.
7				By dividing up the community into separate areas for different hazards.
8				High risk areas will be identified and all possible cautions will be taken.
9				Encouraging all walks of the community to get involved.
10		Knowing process, but remembering to continually go back and adjust when needed		Identifying new hazards as they arise will be easier after plan is in place. We will know what to look for.
11				By graphing gives people a visual display of why different areas are at a higher risk.
12				Teaches us to learn to identify hazards that could occur.
13				Presented in a way for everyone to understand.
14		Great very informative and easy to follow information (user friendly)		Mitigation is brought into all aspects of the plan.
15	This process would be a great asset to show due diligence and liability protection in legal actions against local authorities		This will be an extremely valuable tool for our planning and training	Enjoyed the program glad I was given the opportunity to partake. Will make putting our hazard analysis together much easier.

Table 58: Findings for Kamloops Workshop Questions A, B, and C; and Questions 1 to 14

	Question	K1	K2	K3	K4	K5	K6	K7	K8	Mean	Median
Years in Community	a	>10	>10	>10	>10	>10	>10	>1	>10		
Employed by Municipality	b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Involved in Previous HRV	c	No	No	Yes	No	No	Yes	Yes	Yes		
Integration of DM & Com. Planning	1	4.00	4.00	4.00	5.00	4.00	5.00	3.00	4.00	**4.13**	**4.00**
Public Participation	2	4.00	4.00	4.00	5.00	4.00	5.00	3.00	5.00	**4.25**	**4.00**
Dialogue with Experts & Residents	3	4.00	3.00	4.00	5.00	4.00	5.00	3.00	3.00	**3.88**	**4.00**
Access to Data re: Hazards	4	3.00	3.00	3.00	5.00	3.00	3.00	3.00	4.00	**3.38**	**3.00**
Risk Perception	5	4.00	4.00	3.00	5.00	5.00	4.00	3.00	4.00	**4.00**	**4.00**
Educational	6	4.00	4.00	4.00	4.00	4.00	5.00	3.00	2.00	**3.75**	**4.00**
Addresses Issues of Equity	7	4.00	4.00	4.00	4.00	4.00	5.00	3.00	3.00	**3.88**	**4.00**
Influence Decision-Makers	8	4.00	4.00	3.00	3.00	3.00	5.00	3.00	3.00	**3.50**	**3.50**
Accuracy of Scientific Knowledge	9	4.00	3.00	3.00	4.00	2.00	4.00	3.00	4.00	**3.38**	**3.50**
Accurate Identification of Hazards	10	3.00	5.00	3.00	3.00	4.00	5.00	3.00	4.00	**3.75**	**3.50**
Areas of Greater Risk	11	4.00	5.00	3.00	4.00	3.00	5.00	3.00	4.00	**3.88**	**4.00**
Assess Uncertainty	12	4.00	4.00	4.00	5.00	3.00	5.00	3.00	4.00	**4.00**	**4.00**
Affordable and Not High Technology	13	4.00	4.00	4.00	4.00	3.00	5.00	3.00	N/A	**3.86**	**4.00**
Political Process	14	4.00	4.00	3.00	3.00	5.00	5.00	3.00	N/A	**3.43**	**4.00**
Average Scores per Participant		**3.86**	**3.93**	**3.50**	**4.21**	**3.64**	**4.71**	**3.00**	**3.67**		

Table 59: Comments Included in Kamloops Questionnaires

Comments Questions	K1	K2	K3	K4	K5	K6	K7	K8
1								Would be a good idea to simplify the process even more.
2								
3								
4								
5								
6								
7								
8								
9								
10								If they complete the entire process. It is time consuming and complex.
11								
12								
13								
14								
15				Very enjoyable	More videos please			This process is more refined than the one I was involved in previously. Good luck with your defense and dissemination of this tool.

Table 60: Summary of Averages and Means for the Workshops in Barriere, Taylor, and Kamloops

	Question	Barriere Mean	Barriere Median	Taylor Mean	Taylor Median	Kamloops Mean	Kamloops Median	Total Mean	Total Median
Integration of DM & Com. Planning	**1**	4.07	4.00	4.75	5.00	4.13	4.00	4.19	4.00
Public Participation	**2**	4.36	4.00	5.00	5.00	4.25	4.00	4.42	4.50
Dialogue with Experts & Residents	**3**	3.86	4.00	4.50	4.50	3.88	4.00	3.96	4.00
Access to Data re: Hazards	**4**	3.79	4.00	5.00	5.00	3.38	3.00	3.85	4.00
Risk Perception	**5**	4.07	4.00	5.00	5.00	4.00	4.00	4.19	4.00
Educational	**6**	3.86	4.00	4.75	5.00	3.75	4.00	3.96	4.00
Addresses Issues of Equity	**7**	3.86	4.00	4.75	5.00	3.88	4.00	4.00	4.00
Influence Decision-Makers	**8**	4.07	4.00	5.00	5.00	3.50	3.50	4.04	4.00
Accuracy of Scientific Knowledge	**9**	3.86	4.00	5.00	5.00	3.38	3.50	3.88	4.00
Accurate Identification of Hazards	**10**	4.36	4.00	4.75	5.00	3.75	3.50	4.23	4.00
Areas of Greater Risk	**11**	4.50	4.00	5.00	5.00	3.88	4.00	4.38	4.50
Assess Uncertainty	**12**	4.14	4.00	4.75	5.00	4.00	4.00	4.19	4.00
Affordable and Not High Technology	**13**	4.43	4.00	4.75	5.00	3.86	4.00	4.32	4.00
Political Process	**14**	3.93	4.00	5.00	5.00	3.43	4.00	4.08	4.00
Total		**4.08**	**4.00**	**4.86**	**5.00**	**3.79**	**4.00**	**4.12**	**4.00**