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CLIMATE CHANGE AND NATURAL HAZARDS IN NORTHERN CANADA: INTEGRATING INDIGENOUS PERSPECTIVES WITH GOVERNMENT POLICY

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Abstract. A study of the relationship between natural hazards and climate change in the international context provides the background for a discussion of the expected changes. In the context of this global discussion, this paper reviews the current perspectives of those natural hazards that are likely to be influenced by climate change, using northern Canada as a regional case study. The northern implications of the United Nations Framework Convention on Climate Change are examined, including the status of climate change action by the northern territorial governments, the evolving role of indigenous people, and the responsibility for climate change impacts. The difficulties surrounding natural hazards research in remote locations, and the approaches of indigenous people to natural hazards are then presented. The paper concludes with a suggested policy approach for climate change and natural hazards in northern Canada, underscoring the need for more comprehensive adaptive strategies to complement the current tendency to focus on the mitigation of greenhouse gases produced in this region.

Keywords: adaptation, climate change, indigenous people, local knowledge, mitigation, natural hazards, northern Canada, policy, traditional knowledge

1. Introduction

This study addresses four principal themes: (i) natural hazards and climate change research in northern Canada is limited and poorly linked; (ii) the contribution of indigenous people to this research area has also been limited, is primarily qualitative, and has been ignored or largely discounted by scientific investigations, though it is beginning to show substantial promise; (iii) the international and national climate change focus on greenhouse gas (GHG) reductions, while important, is misplaced for northern Canadian residents, yet the adaptation agenda here is nascent, despite the evident need; and (iv) connecting climate change research in the North (which has political profile) more closely with natural hazards research (which does not) could help diversity and bring closer both research agendas and in so doing influence the long term quality of life for northerners.

The risks of environmental disasters and the management of their impacts have long been a concern for natural scientists, engineers, and the humanitarian assistance community among others. Physical scientists led this exploration with intensive and wide-ranging research efforts from ice core analysis to permafrost studies.

Relatively, social scientists have been less active, though some community-focused studies of indigenous cultures address local and culturally specific behaviour related to risks of environmental disasters and their management. Anthropogenic and rapid climate change is a relatively new phenomenon that has challenged the ability of scientists and indigenous people to understand and predict future conditions with much certainty. Concurrently over the last two decades, climate change has emerged onto the international environmental agenda as a serious problem, which has international implications, the need for wide participation, and many unanswered questions[1].

This paper addresses the linkages and interactions between approaches to climate change in northern Canada and the views of indigenous people living in this region, more specifically the Dene Nation. Furthermore, we will explore, in a tentative manner, how natural hazards may be influenced by changes in climate and whether consideration of local knowledge is essential. Given the paucity of applied research surrounding climate change, natural hazards and traditional knowledge in the North the paper is exploratory in nature, underscoring the need for focused research efforts to support or refute the linkages suggested. In addition, it is anticipated that this exploration will be of interest to other northern circumpolar nations (see Figure 1) with similar climate change and natural hazard concerns.

Communities across northern[2] Canada are home to an indigenous population of First Nations, Aboriginal people, Inuit and Métis. The population of the three northern territories is approximately 100,000 in total – 30,000 in Yukon (21% indigenous), 42,000 in NWT (50% indigenous) and 29,000 (85% indigenous) in

Figure 1. Northern Circumpolar Region. Source: CAFF: 2001, *Arctic Flora and Fauna: Status and Conservation.*

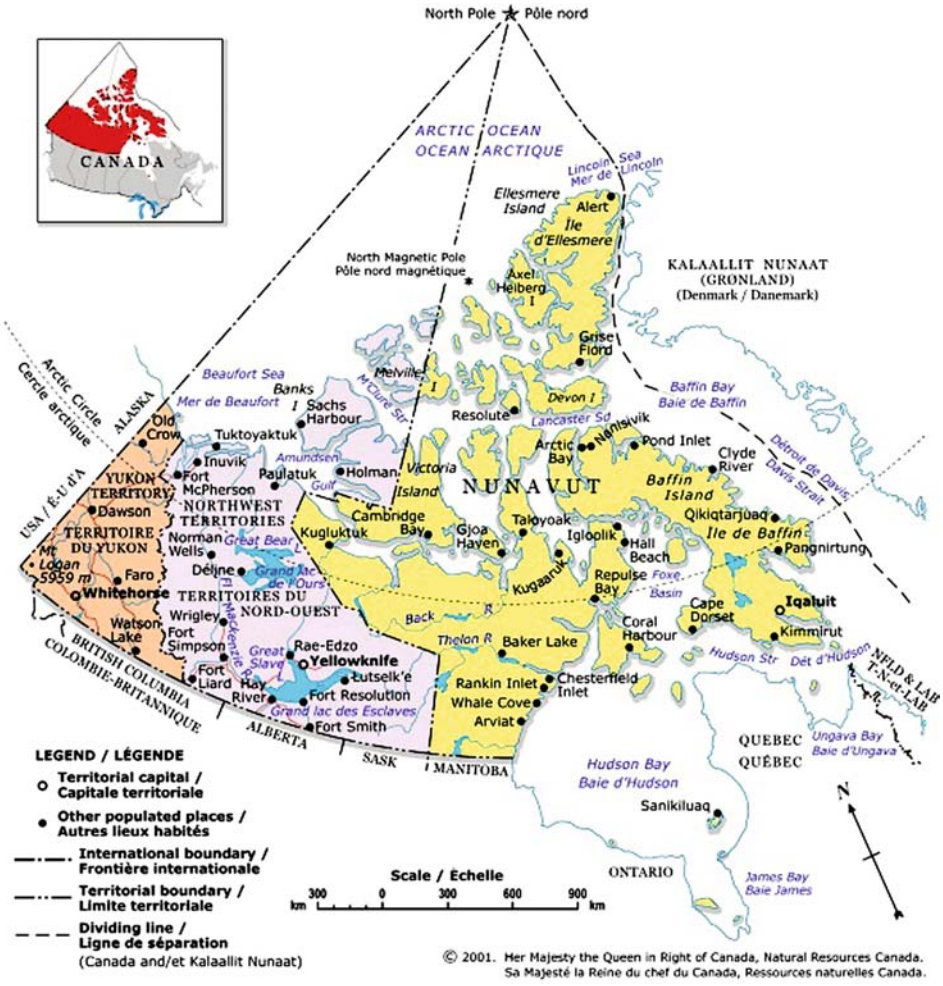

Figure 2. Northern Canada.

Nunavut according to territorial government figures available on the government websites. These three territories (see Figure 2) comprise the geographic focus of this paper. The region has a dual economy consisting of traditional First Nation communities heavily reliant upon government and social services supplemented by hunting and fishing, and a modern sector dominated by people of European origin engaged in mining, transport, administration, defence and service occupations.

Viewed from the perspective of northern Canada, especially First Nation communities, the emphasis on climate mitigation, while an acknowledged part of the national climate change agenda, will do little to affect the projected changes. Nonetheless, it represents the primary focus, due largely to national priorities and the availability of funding. At the outset we wish to clearly state, as will

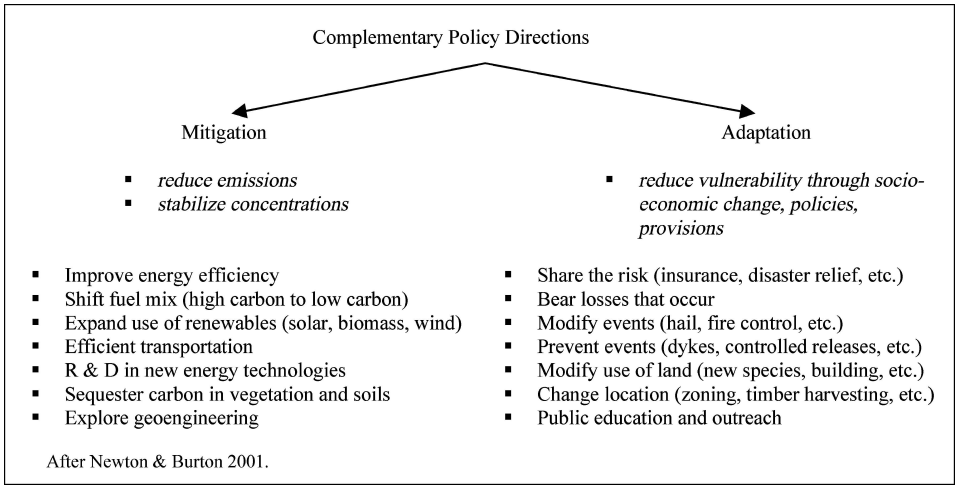

Figure 3. Potential climate change policy directions and measures.

be explored further in the subsequent discourse, that while GHG reductions are needed globally, the authors feel adaptation is a far more important, and in the long term, effective primary policy direction (see Figure 3) for the Canadian North. This situation presents a political and climate program conundrum for all jurisdictions, as the current overriding focus on GHG reductions fails to address the issue of vulnerability and to prepare communities to cope with unanticipated events.

2. Natural Hazards and Climate Change in the Canadian North

With projections of more extreme natural events occurring in northern Canada (IPCC 2001; Dotto 2000), research is crucial to shape climate change policies respectful of local indigenous wisdom and the aspirations of residents to share more fully in the growth and development of northern Canada. It is by no means an easy balance to achieve, but it must be done thoughtfully, guided by integrating a strong social dimension within the much-needed integration between hazards and climate research. To date these discourses have followed largely separate paths in the north and elsewhere.

It is virtually impossible to fully remove the risk associated with natural hazards; there will always be a slight residual risk. Survival (and progress) is learning to live *with* risk. However, steps can be taken to minimize damage from impacts (whether due to climate or natural sources). Response, particularly to such northern natural hazards as floods and forest fires, comes from a number of sources, as no single agency or level of government has the required resources. Forging partnerships between agencies that prepare for and cope with major natural hazards is an essential part of an effective response model, particularly for small, remote communities.

Partners must focus their efforts on the same goal and work towards the same result – safer more resilient communities.

As noted earlier, the annual rate of weather-related disasters is increasing globally (Loster 2003; IPCC 2001; McMichael et al. 2003). At the same time, given the increased investment and population in hazard-prone locations (e.g., ocean front, river edges, deltas, earthquake zones, etc.) the cost to respond and recover is growing. Munich Re reports insured losses from natural hazards were 15 times higher in the 1990s than in the 1960s (Hewitt 2003). To a significant extent, the global increase in the cost of natural disasters is due to increased population, asset values, wealth and expanded infrastructure, particularly in hazardous locations (e.g., coastal regions and earthquake zones). Such factors are only part of the answer, for climate change may influence the increase in the magnitude and frequency of disasters (Loster 2003). Are data available on the rate of occurrence of natural disasters in the North? Anecdotal information shows that more forest fires and potentially more flooding have occurred in the central Yukon over the past 10–15 years, but there is, as yet, no strong evidence that these increases are related to changes in the region's climate. Elsewhere, data are thin and inconclusive, although the global upward trend is likely to be reflected once northern data are compiled.

Nonetheless, if capacity is enhanced for individuals and communities to cope with current natural hazards, they will be better prepared for more frequent occurrences in the future. Increases in frequency will likely entail greater cumulative damages and costs to society, which may result in a more effective and efficient response as communities adapt to a new normal. With more advanced preparation to reduce impacts from extreme weather events and improved response and recovery due to actual events, eventually the costs should be less.

Regardless of whether or not climate change increases the magnitude and frequency of natural events, individuals, communities, and the institutions that govern them must take responsibility for being prepared to cope effectively. Building this capacity will require a better understanding of the linkages between climate change and natural hazards than we possess today, together with an appreciation of the evolving trends in global and Canadian climate change policy and thinking.

2.1. Coping with natural hazards in northern Canada

When considering the historical record of natural disasters on the North American continent, Canada, has experienced far fewer natural disasters than the United States, whether measured by frequency, magnitude, or economic impact. In recent memory, a few events do stand out: the 1997 Red River floods, the 1998 ice storm, and the 2003 British Columbia forest fires. Shifting the view to the situation within northern Canada, natural disasters are even more infrequent than in the rest of the country.

Predominant hazards among those living in isolated northern Canadian communities are flooding, forest fires, and severe winter storms. Landslides also occur in

the north, though the impact on communities is infrequent. Avalanches are common to the mountainous areas of the northwest. The resilience of northern communities to such natural hazards is remarkable and underscores the adaptive capacity developed by inhabitants over generations of experience with the vagaries of the natural environment. However, only a few research studies published to date (Krupnik 2002; Berkes 1999; Newton 1995) have considered the more immediate natural hazards affecting northerners and indigenous people. Nonetheless, increased dependence on western-style community services, changes in social structures and reduced experience living on the land have caused a slow erosion of this historical coping capacity, to say nothing of changes to the frequency, intensity and expanded range of natural hazard events.

It is acknowledged that catastrophic disasters caused by these natural hazards have occurred (e.g., 1985 Winisk flood) and will continue to occur in the future. As discussed above, northerners and indigenous people have experience with such events, and while they can be devastating to those directly affected, the threats are largely known, localized to a single community or a few communities at most and ones they are able to cope with. In Aklavik, N.W.T., located in the Mackenzie River delta and known for being flooded during spring break-up, many residents have built houses on "stilts" or spend break-up at their outlying camps.

At the other end of the spectrum, we find natural hazards that are slow, incremental and almost imperceptible if one is not observing the change. Erosion in its many forms is constantly reshaping the landscape generally through the relentless movement of water. Similarly, amid the wide ranging annual climatic cycle in the north there is appearing variability that points to long term incremental changes whose source is now considered anthropogenic, but whose representation is seen in natural systems. Both catastrophic events and incremental shifts are of concern to northern residents, though from a human perspective, little can be said about how these conditions affect people living in the north, therefore, research in northern Canada and elsewhere is thin compared to physical science investigations. Why does this disparity in research focus exist? Is it driven by funding, national regional priorities, or the global agenda explored above? Any answers to date, ours included, are speculative and without a solid research foundation. It may be that governments have traditionally put more funding into quantitative research, driven by a deterministic philosophy, and a desire to collect data and "facts" to hopefully lead to better decisions, rather than softer qualitative research efforts.

Salient literature of direct practical value to natural hazards research in remote regions is scarce. There have been assessments in developed nations with regional approaches (Cohen 1995), which have focused on ecosystems and economic impacts on mainly urban residents (Kenny et al. 1995; Knight 2000; Fisher et al. 2000). Where it does appear, reference to remote regions is often cursory, embedded in anthropological studies (Honigmann 1956, 1961), or mentioned in geographic overviews of national assessments (Mackay 1963; Dresler 1999). The anthropological literature on human adaptations to natural hazards in isolated locations comes

from research such as that by Waddell (1983) in New Guinea and Morren (1983) in the Kalahari, or more commonly where the investigation of disasters is not the primary focus (Oliver-Smith 1986, p. 13). With few exceptions (generally government projects), research addressing natural hazards in remote regions, even tangentially, has been undertaken in foreign countries, but not in northern Canada. While the Arctic Climate Impact Assessment (ACIA) will address information gaps for the circumpolar north, hazards will not be a central focus.

Despite the logistical challenges of conducting research in remote locations in northern Canada, funding cutbacks and government downsizing over the past decade have resulted in a decline in research activity and training on northern issues at Canadian universities. The situation became so serious that in 1998, the northern science community was called upon by a group of alarmed researchers to alert the Canadian government to take action to secure the future of northern science before Canada's capacity to perform northern research collapsed (England et al. 1998). This situation effectively hinders the ability of those interested in pursuing large-scale research efforts that are essential to help northerners cope with extreme natural hazards as well as unprecedented social and economic challenges.

2.2. Northern climate changes and research

In the North, climate change is no longer an abstract idea. The North is demonstrating clear evidence of climate change that is consistent with what is expected to result from warming temperatures, and matches trends in the scenarios developed by global climate models (IPCC 2001). According to the most recent assessment carried out by the Intergovernmental Panel on Climate Change (IPCC), extensive land areas in the North show a 20th century warming trend in air temperature by as much as 5 °C accompanied by an increase in precipitation (IPCC 2001).

North landscapes have begun to reveal the impacts of climate change as well. Regions underlain by permafrost have decreased in extent. A general warming of ground temperatures and the thickening of the active soil layer has been observed in many areas, particularly at the southern margins of the North, close to and south of the treeline (IPCC 2001).

Important ecological changes that appear to have been triggered by warming are also beginning to be documented in terrestrial ecosystems across the North. Reduced nutritional value of caribou and moose browse and increased forest fire tendencies have been detected – a direct link to one of the dominant natural hazards in the region (Weller and Lange 1999). The North Transitions in the Land-Atmosphere System (ATLAS) program has recorded an advance and infilling of trees at the treeline, as well as an expansion of shrubs in the northern portion of the North (Chapin 2002). Currently, boreal forests are expanding northward at a rate of about 100 km/°C rise in temperature (Weller and Lange 1999).

Support for northern climate research is improving. The federal government has renewed support for the Northern Ecosystem Initiative, the Polar Continental

Shelf Program, and other northern research initiatives such as Arcticnet and the Aboriginal Northern Community Action Program. In September 2000, a task force established by the Natural Sciences and Engineering Research Council (NSERC) and the Social Sciences and Humanities Research Council (SSHRC), two of the primary funding agencies of university-based research in Canada, released a report that described the current situation as a crisis and urged Canada to rebuild its university-based northern research capacity. To explore this situation, NSERC-SSHRC and the Canadian Institutes for Health Research (CIHR) sponsored a northern dialogue on research in Whitehorse, Yukon, March 2004. There is considerable interest within the federal government in developing partnerships with institutions in the North to deliver climate change programs and services. For example, the Northern Climate ExChange (NCE), a partnership of the Government of Canada, Government of Yukon and Yukon College, was established in 2000 to enhance information exchange and facilitate research on climate change. The relative success of these institutional arrangements will depend on building successful partnerships with indigenous governments and their organizations. Clearly, challenges lie ahead for climate change research in northern Canada. It requires a long-term commitment to capacity-building and new flexible funding initiatives, which could well be driven by the mounting evidence (IPCC 2001) of the magnitude of the projected impact of GHG emissions on the North.

Government agencies, universities, and non-governmental organizations have already initiated many climate change research and monitoring projects in Canada and elsewhere. Individual communities, particularly in the North, are beginning to undertake their own projects related to climate change. The IPCC (2001) documented the global state of climate change research, and the NCE (2002) coordinated a major project aimed at assessing the current state of knowledge about climate change and its impacts in northern Canada. The Mackenzie Basin Impact Study (Cohen 1995), a six-year scientist-stakeholder collaboration to conduct an integrated regional impact assessment, contributed greatly to the state of knowledge of climate change impacts in northern Canada. As well, an international assessment of North climate impacts is currently underway, the North Climate Impact Assessment.

The substantial increase in climate change research in the past decade has made it difficult for researchers to keep track of all the various projects related to understanding, preventing, and mitigating climate change impacts. This situation has almost certainly led to overlapping research, unnecessary duplication of effort, and ineffective use of limited time and resources. In addition, there has been no overall vision guiding the allocation of efforts and resources.

Communication has been limited among the various groups and organizations involved in and concerned about climate change: researchers, communities, indigenous people, non-government organizations, industry, and all levels of government. This has made it difficult to exchange findings, to correlate scientific knowledge and local information, and to return the results of research to the people experiencing

the effects of climate change most directly. Sharing information among all parties and interest groups can be a challenge, but it is essential. When knowledge is not shared, everyone's understanding of climate change and its impacts is diminished.

2.3. Projected impacts of climate change in the 21st century

Changes in northern climate are expected to continue throughout the 21st century and persist for many centuries to come, bringing with them major physical, ecological, sociological and economic transformations (IPCC 2001). The greatest changes in temperature are projected to take place during the winter months – extreme cold temperatures are expected to be less severe and occur less often. By 2080, the Global climate model output projects "large increases in the frequency of continuous days with extreme high temperatures" (Kovats et al. 2003, p. 56). Over land in the North, we expect temperatures to increase by 4.0–7.5 °C in summer, and by 2.5–14 °C in winter above present air temperatures (IPCC 2001).

Over the same period of time, precipitation in northern terrestrial ecosystems is projected to increase by 10–20% in summer months and by 5.0–80% in winter months (IPCC 2001). In almost all regions, these projections are well beyond the range of variability of the current climate patterns.

As warming occurs, there will be changes in species compositions with a tendency for a poleward and elevational shifts in species assemblages, the establishment of new assemblages of species, and the loss of some polar species (IPCC 2001). Vast areas of the North may develop entirely different ecosystems from those that exist currently (Everett and Fitzharris 1998). Ecosystem models predict that the area of tundra will decrease by two-thirds from its present size, due to an expansion of the boreal forest (Everett and Fitzharris 1998), which could be an asset to communities with a dependence on wood as a heating fuel.

The hydrology of the North is particularly susceptible to warming, since snowmelt drives virtually all of the major hydrological processes and related aquatic ecosystems in the North (IPCC 2001). Over the past decade, the Mackenzie GEWEX[3] Study (MAGS) has been studying the interrelationships between the atmospheric and hydrologic systems of the Mackenzie River Basin in northern Canada to evaluate the impact of both human-induced climate change and natural climate variability on Canada's water resources. The goal of MAGS is to improve the understanding of the water and energy cycle of the Mackenzie River Basin in particular and of cold regions in general. Because the ice cover on lakes and rivers will be thinner, freeze-up later, and break-up earlier, the rates of primary productivity in aquatic ecosystems will be affected (Rouse et al. 1997) as well as the use of winter roads to bring goods to isolated communities. Changes in freeze-up and break-up dates might also affect animal migration patterns in the North, especially the large-scale annual movements of ungulates. However, unless winter precipitation rates increase the amount of snow in mountainous areas, thus increasing river

flows during break-up, the impact of a shifting timeframe may have little distinct change from a flooding perspective.

Northern landscapes are particularly sensitive to temperature changes because of the impact on surface albedo (reflectivity), permafrost distribution, active-layer thickness, and snowmelt (IPCC 2001). In areas where the temperature of the permafrost is only a few degrees below 0 °C, particularly at the southern margins, the permafrost is considered to be particularly vulnerable to warmer summer temperatures. Permafrost melting may substantially alter ecosystems where it causes soil subsidence and landslides, leading to poor water quality that is detrimental to fish and other wildlife. In communities where permafrost is susceptible to warmer summer temperatures, melting may cause building foundations to shift unevenly, pipelines and storage tanks used for water and sewage to rupture and buckle, and the structural integrity of older buildings, water supplies and waste disposal infrastructure could be threatened. Because of the way in which increased temperatures in the North may affect industrial activity, engineering designs will need to take climate change into account to minimize additional risk to the environment that is posed by these developments.

2.4. Is community vulnerability increasing?

In the natural hazards and climate change literature, the recognition of the importance of vulnerability reduction was not spontaneous. Natural hazards and disasters policies and institutional responses were long dominated by the urgent requirements of human safety, relief services, and humanitarian assistance. Similarly, climate change investigations placed emphasis on understanding the phenomena and seeking means to affect observed upward trends. By contrast, the historical record of survival shows that in indigenous northern communities efforts were focused on the avoidance of known hazards by minimizing vulnerabilities through reduced exposure and effective preparedness (Newton 1995). Residents of northern communities, especially the remote, isolated ones, had some economic and social incentives to change established behaviour patterns to protect family and scarce resources (e.g., firearms, camping kit, boats, etc.), however, this need dissipated in the later half of the 20th century with permanent communities and increased governmental involvement.

In more recent times, the rush of institutions to provide assistance and often evacuation (Indian and Northern Affairs Canada budgets millions for such needs each year) in response to disaster situations has enhanced the erosion of long-term cultural processes of reducing vulnerability. Moreover, such “assistance” might contribute to counter-productive tendencies such as the further expansion of human activities in high hazard zones, the lack of adequate building codes and design standards, or the lack of their enforcement, which could sometimes increase the vulnerability of northern residents. While these problems have by no means been fully overcome, the work of the International Decade for Natural Disaster Reduction

(IDNDR), 1990–1999, has done much to refocus the emphasis on the need for mitigation. Recent efforts by the International Strategy for Disaster Reduction (ISDR), the UN agency that evolved from IDNDR, continue this focus with the publication of *Living with Risk* (2002), an attempt to enhance understanding of policy and process through a global review of natural disaster reduction initiatives. Nonetheless, it would appear that, despite good intentions and significant efforts, the vulnerability of isolated northern communities could be increasing as a result of climate change, natural threats, and more disturbingly, the interaction of both phenomena in extreme natural events. While not proven, this latter condition is predicted and thus cause for concern throughout the north where temperature changes over the next century are among the highest projected.

How much attention to give to short-term disaster vulnerability and long-term climate change and how best to integrate them depends very much on local circumstances? In northern Canada both issues are important, and this region is a useful case study for considering how to cope with both climate change and natural disasters. The Canadian North shares some of the characteristics of both developed and developing countries. Although it is part of a developed country, it lacks the economic resources and embedded industrial engines characteristic of the southern Canadian regions and is thus relatively underdeveloped, despite the variable economic infusion from mining and energy projects.

2.5. Terminology and language

Natural hazards and disasters have a long history of study and debate from early work by Gilbert White (1942) to the present day, and policies on managing the impacts have been in existence for decades. By contrast, climate change has only recently emerged on the international environmental agenda. Therefore, it is not surprising that different technical languages have developed. Prominent among the terms that cause confusion are the words adaptation and mitigation.

In the natural hazards community, mitigation is defined as the wide array of actions that can be taken to reduce vulnerability. Such mitigation actions can be considered either structural (e.g. diversion channels, fire breaks, etc.) or non-structural (e.g. awareness, information, policy, etc.). In the language of the United Nations Framework Convention on Climate Change (UNFCCC) established in 1992, the reduction of carbon dioxide and other GHGs and carbon sequestration in soils and biomass is referred to as "mitigation", thus potentially confusing communications between the natural hazards and climate change communities. Also, in the climate change world, the idea of vulnerability reduction is called "adaptation" which further affects the clarity of this discourse. Moreover, when considering natural hazards, many are now defining adaptation as "building resilience" and "increasing capacity" within human and natural ecosystems to cope with change (Berkes and Folke 1998; Folke et al. 2002; Holling 1973). Ecologists also define adaptation slightly differently – it is defined in the evolutionary sense – which can add to the

overall confusion and demand a careful assessment of the context in which terms are used.

In addition, where the focus is on creating safer more resilient communities, discussions and documents routinely use such concepts as reducing risk, reducing vulnerability, natural disaster reduction, and hazard reduction without drawing distinctions and assuming understanding (ICLR and EPC 1998a, b). Such terms and concepts expand the lexicon of risk management and can provide helpful distinctions, if they are well explained and placed in context. The purpose here is not to discuss these terms in detail, but rather to note the need for clarity in literature addressing issues related to hazards and the risks they pose to humans. Underlying all such terms is the desire to better understand human exposure and, from this knowledge, influence decisions towards achieving safer communities throughout the North for all populations groups.

While many key words in the natural hazards/climate change dialogue are similar in meaning, disaster mitigation is an exception as it refers to all kinds of disasters, including non-natural disasters and those natural disasters that are not climate related such as earthquakes, tsunamis, and other geophysical events. Such definitional differences and subtleties are an integral part of the research landscape, whatever the subject. However, it is worthwhile underscoring such anomalies, when we endeavour to shed light on complex issues and potential linkages between different, but related, fields of research. In this paper, the terms will be used as they apply and are understood, in their respective climate change and natural hazards fields of research.

3. The Contribution of Traditional Knowledge

The effects of climatic warming on local environmental conditions have been registered by the indigenous people living in the North. Elders report that they are seeing species of birds and animals farther north than previously recalled, and new species are appearing that have never been seen before. Elders also note that the weather is more unpredictable that it used to be (Krupnuk and Jolly 2002)[4].

3.1. Dene approaches to natural hazards

Indigenous people have a long history of survival in vulnerable environments, using their mobility to find needed resources. Traditional indigenous cultural systems, for example, adapt housing to local conditions, representing sensitivity to environmental risks. Moreover, their oral history speaks to avoidance of locations associated with natural hazards (Tetso 1989, p. 8). In part, this attention and the ability to assess risk are cultural mechanisms, which have enhanced group survival under often difficult, but predictable conditions. We will illustrate the general view, noted as indigenous, by making specific reference to Dene. This approach has the usual

strengths and weaknesses. For example, not all indigenous people behave as the Dene, just as not all Dene are consistently the same over time. The particular actions of each indigenous culture do not necessarily reflect what other indigenous people have done. Given this inherent variability within cultures, it is important to be careful not to generalize to a pan-generic "Indigenous." Most indigenous people themselves, for example the Sami, will make specific reference to how people cope with natural hazards, down to the level of particular families or noted individuals. Having said this, there is value in making general comments about the relationship between natural hazards and indigenous people, to illustrate the problems related to the influence of climate change on how indigenous people interact with the natural hazards they must cope with.

Some indigenous people traditionally avoided locations such as those high in naturally occurring heavy metals and radionuclides, for example the Sahtu Dene avoided the mine site of Port Radium before mines were established there (Blondin 2002, p. 13). Indigenous people found various ways to minimize risk, as risk avoidance was embedded in their cultures and cosmologies, as much as was the maximization of benefits (i.e., harvesting species at times of peak concentrations, such as spawning). In many cases though, particularly the location of communities, the avoidance of natural hazards is limited and requires effective adaptive strategies and lately some structural mitigation. Attawapiskat, Ontario, a Cree community slightly upstream from James Bay on the Attawapiskat River, was situated, as were many other communities in northern Canada, where trading, religion and later education and medical services were provided. Organizations were drawn to such locations as they functioned as traditional summer gatherings spots, in part due to adequate food sources, often fish. Thus over time, temporary meeting places became permanent settlements, with little or no consultation or consideration of local knowledge about devastating spring floods caused by ice jamming. Recently, amid much controversy, dykes have been built around Attawapiskat to cope with the flood hazard, though success is questionable and the visual impact disturbing to some. The sad implication of the location choice of many northern communities is a significant exposure to flooding. Indigenous people throughout northern Canada continue to live with this risk, which could well be exacerbated by extreme weather resulting from global climate change.

Risk assessment can be found in traditional and sacred stories. For example, one of the traditional stories told about the creation of the Dehcho (Mackenzie River) is that the spring came and then the snow returned before there was summer (Tetso 1989, p. 8). The snows returned and the people suffered greatly. Eventually the Dehcho was created and the Dene were able to find much food and dry meat along the great river. Telling this story would remind the people to always maintain a supply of food, even when there was the assumption that spring and summer would lessen the hardships of winter, bring greater availability of game, ease travel on the land, and bring expected conditions. The stories would teach where the highest opportunity to find food was, but they would caution Dene to show respect for the land,

whose climate could change from the usual conditions to being unexpectedly cold. Are such approaches adaptive or purely cultural in achieving enhanced resilience to change? Either way, indigenous people have a heritage to draw on that has the potential to mitigate the impacts of unusual conditions, though the capacity will be constrained by reduced transmission of traditional stories, the value the stories are given as communities modernize, and the conditions indigenous people have inherited with permanent communities. To reiterate an earlier point, the inherent adaptive capacity of indigenous people, for example spring flooding, can be romanticized, when in fact it may be eroding. If this is so, then we risk encouraging the belief that adaptive skills remain strong, while vulnerability to more extreme events may be increasing. Put another way, should climate change lead to more extreme events then the 1:500-year flood could become the 1:200-year flood and the 1:25 the 1:10, creating an increased return period of events of the same magnitude? Few have asked these questions, and fewer still have presented answers, however tentative.

3.2. Indigenous involvement in climate change research

Indigenous people had to adapt to constant environmental changes and have consistently employed coping actions, such as temporarily shifting camps, to reduce their vulnerability to hazards and disasters (Newton 1995). Life in the North demanded such capacities, just to survive. Traditionally, indigenous people have been highly resilient to the forces of change, and consequently, did not consider themselves, their families or their communities to be vulnerable. Survival skills were handed down from generation to generation and became part of everyday life. However, the rapidity of recent changes in the North makes it more difficult for Indigenous people to maintain this way of life, eroding some coping skills. Similarly, southern Canadians, especially urban dwellers, have few of the adaptive coping skills of their forefathers. The cumulative effects of climate change and other forces of change affecting the region – such as globalization, oil and gas development, population expansion, diamond mining, and wilderness tourism – has resulted in many communities taking steps to ensure that their culture and ways of life continue to be sustained in the long term.

Variation of climatic conditions is integral to how indigenous people have lived, making change common and thus accepted. In general, they have both local information and sacred stories that speak about the way climate was and is meant to be. Recently, Tampere Polytechnic initiated a multi-year education oriented project to document indigenous observations of climate change in the northern regions (www.snowchange.org). The phenomenon of general atmospheric warming and accumulation of greenhouse gases following industrialization is influencing how indigenous people are thinking about climate change, in particular, discourse from international discussions of greenhouse gas emissions and global warming (Brown et al. 2000, pp. 5–6). For northern communities, changes in climate are being lived as locally specific impacts, often due to extreme or unusual natural hazards, as well

as being felt through policies and programs aimed at mitigation and adaptation. The latter often has little to do with the local or even regional realities.

In 2002, Dene began to document their observations and knowledge of climate change, keeping pace with other indigenous people who had contracted academics, students, and environmental NGOs to do this work (Paci et al. *in press*). These projects contributed to larger policy initiatives around the Kyoto Protocol, UNFCCC, and the Arctic Council's Arctic Climate Impact Assessment (ACIA). Furthermore, the way that international agreements are implemented by national governments, and in turn initiated at the provincial/territorial or other regional or local level has had a profound impact on how indigenous knowledge is, if at all, entering the climate change discourse. A good example of this is the establishment of Arctic Energy Alliance in Yellowknife and the Northern Climate ExChange in Whitehorse. Indigenous people created neither institution, however, both have relied on indigenous knowledge, anecdotally, to implement climate change programming designed south of 60° latitude. Another example is the Government of the Northwest Territories Greenhouse Gas Strategy, a strategy that negates indigenous knowledge by focusing solely on measures that reduce greenhouse gas emissions. To some extent the development of national government policy and programs frame indigenous understanding of climate change.

Since the 1980s, for example, the Canadian government has developed various programs for dealing with climate change in northern Canada. In particular, Canada developed the North Environmental Strategy (AES) and Canadian Climate Action Fund (CCAF). These two examples of government policy had a profound influence on how the response to climate change is being shaped for northern Canada. The diverse interests of academics and scientists have been driving northern climate change research independent from local communities. In addition, several government departments have dedicated climate change programs and policies, which continue to follow the trajectory of the North as hinterland or colony (Innis 1956).

The problem with many of the Canadian national programs and policies are that they are largely divorced from real and meaningful public participation by northern citizens. For example, the Canadian Climate Change Secretariat is engaged in a number of initiatives, most notably the modelling of climate change impacts. The 2002 national roundtables, which were part of Canada's Climate Change Plan, "commits to ongoing collaboration with Aboriginal and northern Communities to build capacity to address their particular priorities" (Markbek Resource Consultants 2002). However, to date collaboration has not occurred. Part of the salve to this weakness is to set priorities in consultation with Aboriginal and northern communities and the federal, provincial, and territorial governments.

At the circumpolar level, indigenous people are approaching climate change independently and as a result there has been an uncoordinated input of their views, needs, and priorities in the international discourse. The value of bringing forward indigenous views and knowledge and of including local knowledge of climate change is a significant issue (Nunavut Tunngavik Incorporated, Kitikmeot Inuit

Association and Qikiqtani Inuit Association 2001; Dene Nation 2002, 2003). It will be equally important to continue to examine how traditional knowledge is interpreted and communicated to people who may lack the historical and anthropological knowledge necessary to understand what indigenous people are saying (Krupnik and Jolly 2002). This problem of translation is particularly pronounced in climate change because of its heavy reliance on physical scientists who may make scientifically sound, but locally inappropriate recommendations and decisions. One method used in the Canadian North has been for the national and regional indigenous organizations to host workshops to share, document, and protect local and traditional knowledge as an efficient way of contributing to national and international discussions on climate change. For example, Dene Nation has hosted two climate change meetings of the Denendeh Environmental Working Group.

Climate change impacts on food security are a significant concern for most indigenous people in the North. This area of concern has lead to a research project (by H.M. Laurie Chan at the Center for Indigenous Nutrition and Environment (CINE) at McGill and Chris Furgal of the University of Laval), which is currently in the data collection phase and anticipates results towards the end of 2004. The research is being undertaken in partnership with Dene Nation (Chris Paci), Council of Yukon First Nations (Cindy Dickson), and Inuit Tapariit Kanitami (Scot Nickels). In Denendeh (NWT) Deh Gah Got'ie Dene Council (Fort Providence) is participating in the research to establish potential vulnerabilities and opportunities of climate change in relation to the traditional Dene food system. One objective of this research project is to understand the potential health impacts of climate change. Health impacts vary from physical health of individuals to the mental and spiritual health of families and communities. Climate change may be a threat to traditional cultural practices, for example warming may decrease the ability of hunters to find species, such as caribou, as other species, such as deer, migrate in from southern regions. Other implications of climate change may include decreasing the reliability of traditional knowledge in decision-making around understanding and predicting local weather patterns. Such negative feedback may lead to rejection of traditional knowledge and elders in the overall social structure of Dene communities. Consequently, climate change may have more impacts than the physical vulnerabilities and hazards leading to increased rates of land and water-based accidents. Village life and access to harvest sites can be disrupted by the melting of permafrost which can also damage roads, pipelines, and infrastructures, leading to sanitation and contamination concerns, and even the need to relocate entire communities. Climate change may result in new and increased rates of infectious disease, including those found in wildlife that can be transmitted to humans. Plants used in traditional medicine may be more difficult to find. The migration patterns of some wildlife may be changed, thus influencing the diet of local residents with important direct and indirect implications to health.

Deh Gah Got'ie is participating as a "case study" representing a Dene community with strong ties to the land, in particular hunting, trapping, berry picking, and fishing.

Researchers are looking to document the adaptive strategies based on Dene knowledge of climate change with the goal of finding ways to minimize potential impacts on food security. A research agreement has been developed to protect the community and to share with the academic community important traditional knowledge. The project will take three years and should be complete in 2007. The research team is now gathering documentary sources specific to the question of climate change and food security. The research team hopes to develop a comprehensive resources management scheme that will respect Dene traditional knowledge, wildlife biology, information on toxicology of environmental contaminants, food composition and nutrient requirement, food availability and effects of environmental changes, cultural and socioeconomic factors. In each year, education and communication initiatives are planned to assist individuals in making informed decisions about their food choices. The research strives to be participatory and to ensure community members' involvement and/or training at all stages of research, including the initiation, planning, implementation, and communication of research findings.

4. The Northern Implications of the UNFCCC

Under the United Nations Framework Convention for Climate Change (UNFCCC), emphasis was placed for most of the 1990s almost exclusively on the need to reduce GHG emissions with the ultimate objective of stabilizing greenhouse gas concentrations in the atmosphere. From a northern perspective, a fundamental concern with the UN Convention is that the level of discourse, as has traditionally been the case, is at the international level between nation states. The current operational focus on national state-to-state dialogue and negotiation leaves the most pressing problems of climate change in the circumpolar north – the regional affect of greenhouse gas emissions – without a direct, strong voice at this table. Consideration of northern issues is indirect, through Canada's designated representatives. The interest of the three territories becomes only one aspect of a national agenda with many other important, though different, considerations. Nonetheless, it is extremely important for the international dialogue between nation states regarding climate change to be strengthened, as this is the primary hope for the North in terms of reducing the projected impacts. However, largely because the international process has not yet succeeded in stabilizing greenhouse gas emissions, adaptation actions by northern governments and residents are now becoming an immediate and necessary component of the northern climate change agenda, though unfortunately not yet a central, strong part of the national policy. This need is not expected to subside given the degree and magnitude of climate change that is projected for this region and the challenges of mobilizing concerted global actions, at a scale sufficient to realize even the initial reductions in GHG emissions proposed within the Kyoto Accord.

Both indigenous people and national/regional governments in the North are reliant on fossil fuels to heat homes, power transportation, and drive industries. Fossil

fuel is enabling the development of northern urban centres, such as Yellowknife, NWT, and to a lesser extent, Inuvik, NWT, which are contributing to GHG emissions, though to a very small degree when compared to the rest of Canada. Further compounding this problem is that over the last 50 years most indigenous communities in the north became more established and dependent on the available technologies of the day (e.g., diesel generated electricity, air access, electric heating, energy-efficient housing, etc.). Such technologies were, and still are, based on a southern model which indigenous communities were encouraged to embrace, and in their own way, felt a right to have. Improvements have been made to respect the harshness of the winter environment, particularly in better housing, although the application is uneven and a large backlog of old housing stock remains throughout remote communities.

Not all indigenous people living on the land willingly accepted the move to permanent locations. As mentioned earlier, the provision of health care and education drew families to settle in trading centres, which in most cases evolved into today's communities that exist primarily as isolated off-grid settlements of 800–3000 people, accessible by air, winter roads, and occasionally major water ways. Today, some elders are questioning the wisdom of this path, although the momentum towards urban style housing, electricity, and motorized transport has become culturally integrated, encoded in policies and programs, and increasingly viewed as part of everyday life. Such inverse logic represents part of the hidden, and thus largely unaddressed, contradiction between the historical indigenous capacity to cope with hazards and the evolution of permanent communities in a manner that may inadvertently undermine that capacity – witness the tragic destruction of Winisk, Ontario (located a few kilometres from Hudson's Bay on the Winisk River) in 1985 by raging flood waters that swept away over 100 buildings, though miraculously caused only two deaths. After much debate, the community was rebuilt further upstream on higher ground and renamed Peawunack.

Northern development is trapped in an escalating cycle of use and impacts caused by reliance on fossil fuels that can be mitigated somewhat by adopting less damaging (from a GHG perspective) technologies such as wind, solar, hydro, and photovoltaics. However, whether these technologies will be made available in the North and to indigenous people, once development catches up, remains to be seen. Demonstration projects during the 1980s, such as the Fort Severn wind-powered generation or the Big Trout Lake photovoltaic installation, were encouraging but have not translated into widespread application. More encouraging advances have been made in energy efficient building construction and high efficiency wood stoves, perhaps due to the resultant improvements in quality of life as well as energy saving.

Since 1999 emphasis is beginning to be given to the reduction of vulnerability to climate change, called "adaptation". Adaptation is in fact recognized in the UNFCCC as a necessary part of the portfolio of responses to climate change and provision is made for the developed country parties to the Convention to assist the most vulnerable (developing country) parties in meeting the costs of adaptation.

While the global stabilization and reduction of GHG is the best long-term solution for the North to reduce climate change impacts, adaptation will be, by default, a necessary strategy to allow northern communities, industries and ecosystems to cope with projected impacts until international greenhouse gas emission reduction programs take effect (Rosentrater and Ogden 2003). The magnitude and diversity of pressures facing the North are unprecedented in human history, and the pace at which change is occurring in the North leaves no room for delay in developing a fuller understanding of the coping capacity needed over the next 10–30 years.

4.1. Regional status of climate change action

Each of the three territories – Yukon, Northwest Territories (NWT) and Nunavut – are at different stages striving towards the concurrent tasks of: (1) developing strategy and action plans, and (2) initiating the implementation of those plans, or where that is premature, identifying the climate change components of existing programs and initiatives. As well, the various components of each territory's climate change policy vary in focus, and have yet to attain an operational balance between impacts and adaptation initiatives and GHG mitigation actions. Some would argue that the recent emphasis on promoting oil and gas developments in the Yukon and NWT would indicate that northern governments have not yet achieved a balanced energy strategy (CARC 2003). The Mackenzie Valley natural gas pipeline, a large-scale energy development project, has the potential to dramatically alter the emissions projections from the North, not to mention the associated economic, environmental, social and cultural impacts.

The largely singular focus on the stabilization of GHG is natural, but must be augmented to deal with the time lag of even the most optimistic timing of global GHG reductions. The tendency to place emphasis on mitigation activities evolves from the global attention to the reduction of GHG and a history of off-oil and energy conservation efforts. By comparison, tangible policy options for adaptation are harder to grasp, seem to address a less immediate need, and are less of a focus in national policy. However, on an international scale, adaptation is gaining wider support. It is well recognized that many long-standing programs and initiatives, particularly in the areas of energy efficiency and alternate energy, will help northern jurisdictions address their climate change objectives. The high cost of transporting fuel to northern communities makes the argument compelling, though as the federal Remote Community Demonstration Program found in the 1980s, there are many challenges to achieving energy reduction in northern communities. The challenge here, which has been taken up in collaboration with sectorial and national programs, is to integrate the territorial components of these programs into the evolving national strategies and action plans. Progress has been made and more will follow in the coming years. On the climate change file, the three territories are cooperating to deliver their message in Ottawa and international fora.

4.1.1. *Northwest Territories*

In March 2001, a draft Greenhouse Gas (GHG) Strategy (GNWT 2001) was approved by Cabinet to guide the stabilization and reduction of GHG emissions in the Northwest Territories (NWT), however, a companion adaptation strategy remains to be developed in order to achieve a balanced approach. The strategy included an action plan structured according to the five national theme areas: (1) enhance public awareness and understanding; (2) government leading by example; (3) encourage action across and between sectors; (4) promoting technology development and innovation; and (5) investing in knowledge/building the foundation (GNWT 2001). Initiatives were identified under each theme. Some initiatives have been started while others await implementation in coming years as specific activities are structured, approved, and funded. In the NWT there are three primary sources of emissions: electrical generation (diesel), space heating (fuel), and transport. The North Energy Alliance plays a key role in the emissions reduction strategy through education, awareness and community consultations.

To reach their objectives, greenhouse gas considerations will need to be integrated into NWT projects in all sectors. The strategy is viewed as a "living document" and will therefore be revised in future years as more information becomes available. Following the schedule of the National Implementation Strategy on Climate Change, the NWT Greenhouse Gas Strategy has three year rolling business plans that will be updated by January 2004. An advisory panel oversees the implementation of the strategy under the direction of the Minister of Resources, Wildlife and Economic Development.

In light of energy efficiency activities already underway, the initial thrust of the strategy is to slow emission increases. Progress on climate change in the NWT will be dependent on funding levels and the need to consider the implications of a recent upswing in the oil and gas industry. Moreover, the NWT will need to re-assess subsidies to remote communities, and provide stronger support for community efforts to reduce greenhouse gas emissions. A complementary approach directed towards assisting residents, businesses, and other organizations adapt to future changes in climate is under consideration. Over the long term an effective strategy for the Northwest Territories must incorporate both approaches. Given the pulse of gases already in the atmosphere from international sources, it is evident that some form of adaptation will be required, no matter what reduction efforts are made in the NWT, across Canada, or globally.

In July 2003, the Government of NWT released the NWT Energy Strategy (GNWT 2003). The document outlines the directions the NWT can take to reduce the cost of energy, the use of imported fossil fuel and the impact of energy development on the natural environment.

4.1.2. *Nunavut*

Since the establishment of Nunavut in 1992, strategies and action plans to address climate change implications have been under development. The two-part Nunavut

Climate Change Strategy was initiated in 1999. It was developed to reduce increases in emissions, and address adaptation to anticipated impacts, with a business plan to meet the goals and objectives of this strategy, modelled after the national plan. Expanding and updating the database of key information is a crucial task. Nunavut must collect and document information on climate change, and this knowledge must be effectively communicated between science and government. In addition, the government of Nunavut will continue to support its energy management and renewable energy projects.

The challenges faced by Nunavut, including climate, size and population distribution, complicate climate change action, as does community dependence on diesel-generated electricity. Equally problematic for Nunavut are the challenges associated with adapting to a changing climate where the options are few and the projected impacts appear to be severe, though not as dramatic as the models projected for the western North. As well, economic activity has increased because of industrial development. The government has approved a climate change strategy for Nunavut that acknowledges the dependence of a significant portion of the population, who live in small isolated communities or camps on the natural environment for food and sustenance through hunting, fishing and trap lines. Nunavut's strategy also includes initiatives to reduce greenhouse gas emissions and raise awareness of climate change, though the small dispersed population, harsh climate, and long travel distances make meaningful reductions, in the Canadian context, impossible.

4.1.3. *Yukon*

The Yukon government has played a major role at national and international meetings on climate change, including the recent Sixth Conference of the Parties to the Kyoto Protocol (COP 6), insisting that Canada highlight Northern concerns at these conferences and in day-to-day negotiations in the future.

The Yukon Government is working towards completing a climate change strategy for the Yukon. A key element in that plan is the Northern Climate ExChange (NCE) at Yukon College, designed to act as a catalyst for climate change action and as a hub for public education and outreach in the North. One of NCE's initiatives is to increase awareness of climate change issues and responses through community workshops and the compilation and dissemination of research information. Other initiatives are the Energy Solutions Centre and an inventory of climate change actions. In the Yukon, immediate climate change action will focus on the development of a climate change action plan, reviewing provincial and territorial plans, and refining the greenhouse gas inventory.

4.2. BROADENING THE CONTEXT OF CLIMATE CHANGE

Losses from natural disasters and the impacts of climate change both depend to some degree on the way and extent to which people and their governments have

chosen to expand industrial activities, develop settlements, and guide economic growth. Economic factors, such as transportation, often directed the location of human activities close to high hazard zones, and minimal building and design standards contributed to increases in vulnerability. Whether in the North or elsewhere, all governments have contributed to the vulnerability of their populations, often knowingly so, by their own policy choices and development practices. Perhaps the main difference is the ability of wealthy nations to more easily sustain the economic impact of hazards (e.g., earthquakes in Japan or hurricanes on the American east coast) without international aid.

Similarly, the vulnerability of all countries to natural hazards and to the implications of climate change depends to some degree on their own domestic or internal policies and on their international context (e.g. net providers or recipients of wealth). Nobody, either person or country, can be said to be entirely without responsibility for their own circumstances, nor can they be said to be entirely independent. No person is truly isolated, however no person, or country, is without some isolationist characteristics. And indeed, some possess a greater isolationist tendency than others, which often hampers effective discourse on issues such as climate change, and the natural hazard extremes this change can create, as these conditions transcend borders.

It is our observation that in the post IDNDR era the situation has dramatically changed. Not only has the disaster community come to realize the importance and the potential advantages of linking their efforts to climate change and the UNFCCC, it has also become apparent to the climate change community that the significance of climate change to those impacted will not be only or even primarily in changes in mean temperatures, but much more in the changing pattern of climate variability and extreme climatic events at specific localities. The interests are converging, and the search is on for ways of bringing the climate change and disaster communities into closer cooperation for their mutual benefit.

The delay in arriving at this understanding is due in large part to the different social construction placed upon natural disasters and climate change, and their historical evolution described above. There is another regional (north-south) factor that has also played a role. Severe natural disasters are most prominently the concern of developing countries, as their development can be hindered or set back years when a major disaster strikes. By comparison, long-term changes in mean temperatures seem much less significant. The industrialized countries also suffer losses from major natural disasters, but the losses are a relatively small fraction of their GDP, and the countries are sufficiently wealthy to be able to recover very rapidly. Therefore, developed countries are more interested in the prospect of longer-term changes in climate norms and the potential threat to their well-established socio-economic development model to which, since the Bruntland Report (WCED 1987), the word "sustainable" has increasingly been applied. While developing countries are still inclined to the short-term view and the pressing problems of development, developed countries have become more aware of the short-term as well, particularly as

losses rose exponentially during the 1990s. Moreover, widespread media reporting of extreme events (the 2002 floods in eastern Europe and the 2003 heat waves in western Europe, for example) enhanced interest and stimulated discussion of linkages to climate change, even though atmospheric scientists tend to deny a direct attribution and say only that more variability and extreme events are what one might expect with climate change (Reinhart 2003).

Economic imperatives, often combined with physical attraction, have often spawned significant efforts to control the natural hazards threatening a location. Most communities on rivers and coastal locations, including those in northern Canada, are examples of this tendency towards trade dominating, and driving enhancements to achieve a minimum level of safety. Conversely and historically, indigenous people avoided fixed locations, thus reducing vulnerability while maximizing resources wisely. Development (such as fur trading posts, settlements, and churches) had no such concern. Over the last 50 years many people have been drawn to permanent though vulnerable locations (e.g., flood plains), because it was economically advantageous to locate in such places, or because property rights or goods trans-shipment hubs were established there. Too often the exposure to such hazards was not factored into individual or collective decisions.

Over time, the transition in northern Canada from a gathering and hunting lifestyle to one dominated by living in a permanent location has, and will continue to have, implications for who will be impacted by climate change, and how those impacts will be felt by northern citizens. How is responsibility to be distributed and who is to decide? Under the UNFCCC this question is a matter of contentious and ongoing debate. But at least there is a forum where the matter can be debated and there is agreement in principle that responsibilities have to be shared. In the language of the Convention, there are "common but differentiated responsibilities". No such forum exists for natural disasters, especially the linking of such disasters to the evolving influence of climate changes. And while the Decade (IDNDR) led to the creation of the International Strategy for Disaster Reduction (ISDR) this, and its Secretariat, carry nothing approaching the weight of the Climate Convention. This circumstance has led to a growing recognition in the natural disaster community that there is much to be gained by linking natural disaster vulnerability to climate change vulnerability. The UNFCCC might be used as a vehicle to go beyond what the IDNDR and the ISRD have achieved and to make more rapid progress, especially in making international funds available for disaster mitigation on a non-charitable/humanitarian basis.

Consideration of any such linkage was nascent, and has only just begun to emerge in the post-IDNDR era. At the time the IDNDR was getting underway in the late 1980s, those involved gave little attention to climate change. The negotiation of the UNFCCC in 1992 came as a surprise to many in the disaster community. Similarly in the climate community, the priority problem was seen as the need to bring under control the long-term problem of atmospheric pollution by greenhouse gasses. The Convention was justified by the global nature of the threat (disasters were seen as

local), and the recognition that it would take decades of concerted action to bring GHG emissions under control. Consequently, politicians and advisors viewed the climate change issue as long-term and requiring board-based engagement, action, and institutional frameworks.

The activities within each country designed to assist indigenous communities, such as those in northern Canada, to cope with the projected impacts of climate change have yet to enter significant national and international discussions. The UNFCC reference to traditional and indigenous knowledge, and the resulting adaptation capacity, has been given little attention because of the dominant focus on the reduction of GHG emissions. However, it is important to note that the climate change initiative should be viewed in the larger context of Agenda 21 (United Nations 1992), which embraces a much wider range of community-focused initiatives.

The existence of funds for adaptation under the UNFCC highlights another important difference between hazard mitigation and climate adaptation. Action at the international level to promote adaptation to climate change has been agreed in principle as part of the UNFCCC. Assistance to developing countries is being suggested as a mechanism to mitigate development, which will lead to greater GHG emissions. Some level of "rent" to assist developing countries is seen as a means to pay for valuable environmental services. The provision of financial assistance is in principle, mandatory, although the level has not been specified, and there is currently no agreement about it. There is no such Convention for natural disasters and the funds that are provided for both humanitarian relief and disaster mitigation are therefore in the form of charity/humanitarian assistance. The rationale for this difference is that the developed industrialized countries have accepted the point that they are responsible historically for the overwhelming part of the greenhouse gasses now resident in the atmosphere, and that this makes them collectively responsible for climate change in a way that they are not for natural disasters. The pattern of GHG emissions is set to change as energy production and consumption grow rapidly in the developing countries, especially from a few of the larger ones, such as Brazil, China, and India, although there is still debate about the rate and distribution of changes. No developing countries have yet agreed to manage their own emissions in the way that the overwhelming majority of the developed countries have done by ratifying the Kyoto Protocol to the Convention.

Global circulation models (GCMs), sometime also called global climate models, have been developed to generate scenarios of world climate patterns in the latter part of the 21st century when GHG concentrations have been projected to reach double (or later triple) their pre-industrial levels (IPCC 2001). The projections have been translated into expected increases in global mean temperature (IPCC 2001). While the global distribution of mean temperature increases was reported, little or nothing was said about climate variability in this Third Assessment Report (IPCC 2001). The spatial coarseness of the models was also such that little could be said about the specifics of climate change in particular

localities. Consequently, advising policy makers how much impact climate change would have in the long-term and therefore how much urgency should be given to getting on with the process of GHG "mitigation" presented a difficult scientific challenge.

5. Current and Future Policy Implications

Every so often international bodies create a point of departure for an issue that can become a benchmark. In 1997, the Bruntland Commission (WCED) issued *Our Common Future* and placed "sustainable development" in our lexicon. In 1992 the Earth Summit in Rio sought to address global issues creating hope but delivering little more than good intentions. In 1997 the Kyoto Accord provided a global policy context for action on climate change, the realization of which remains in question. History will show that these efforts to address complex global issues were helpful, even necessary precursors to actions yet to be taken, but not sufficient to move leaders and populations from their path of perceived progress. Such initiatives focus attention, momentarily, and provide a point of departure as well as much needed reference points to chart progress, or lack thereof, on issues of import. Reflection on the past 15 years shows a political ineptness to grapple successfully with the complexity of these issues in a concerted manner, leaving the way forward murky, uncertain, and inconsistent.

The inability for climate change to be managed effectively by international dialogue is to be expected despite good intentions, given the divergence of national agendas and the tendency for local interests and domestic protective policies to take precedent. With over a decade of regional and national initiatives to investigate and address sustainability, climate change, and natural hazards in Canada, and to a more limited extent in the Canadian North, the hope placed in the continuation of these efforts is questionable and calls for a reassessment and exploration of different approaches. Perhaps a course similar to the *Disaster by Design* (Mileti 1999) approach proposed for natural hazards in the United States should be considered. No route will be free of setbacks and challenges that in the best of situations redirect effort and energy on new, more fruitful paths where small, incremental steps begin to achieve complementary objectives. However, unless such concerted efforts are integrated at the community, regional, national, and on the more difficult international scale, progress will be limited, resulting in further climatic shifts in northern Canada and the subsequent increase in extreme natural hazards. To move towards results that are meaningful to individuals and communities, an increasing effort must be placed at the local, community level, not just to use energy more efficiently but to also grapple more directly with an understanding of these extremes and how individuals and communities might cope better. Placing emphasis on the local community level allows citizens to assume responsibility and can empower them to act in their own best interests as a more cohesive group. This approach bears

investigation. To stimulate thinking and discussion, we present some preliminary ideas with respect to a framework of action, tools needed for implementation, and indicators of progress.

The framework we propose is organic in character; a coarse integration of three ideas that build on concepts yielding progress elsewhere. First, any step that is taken must possess the integration among immediate benefit and longer-term regional, national and global implications. This builds on the holistic character of indigenous knowledge and reinforces that, to engage people, the benefit must be local and improve their quality of life. Second, a concerted effort is needed to identify and reduce local threats through an assessment of vulnerability and actions that minimize the potential of loss should the threat be realized. In taking such local actions, which in the climate change lexicon would be considered adaptive strategies, sustainability is enhanced and safer communities created. Third, to achieve a modicum of success with the first two areas requires a better understanding of how people cope with changing conditions, in this case an increased frequency of natural hazards (Newton 1995), for the foundation of progress is change, which has been exceedingly rapid in northern communities. The results of people's capability to mould themselves to changing conditions and environments are evidenced by the tenaciousness of human survival in the Canadian North and elsewhere. Yet more extreme events will test this resolve, and extract a high economic and human price if individuals and northern communities are not better prepared to cope. Only through embracing the inevitability of climate change, and drawing on their strength and knowledge to cope, will residents have a hand in shaping the emergence of the future face of northern Canadian communities.

Efforts to cope with more frequent extreme weather conditions affecting northern communities will need simple, intermediate technologies, hands-on methodologies, and the incorporation of local indigenous knowledge applied through local government and institutions (e.g., Band Councils, schools, churches, businesses, etc.). Such approaches must have the ability to interpret each community's context, and evolve relative to the vulnerability caused by extreme conditions. For example, the food security study previously mentioned involving Fort Providence has recently been initiated in a Yukon First Nation community. As well, Nunavut and northern Quebec are modelling a decision-making matrix, plugged into various climate change scenarios to explore the nature and contribution of related traditional knowledge.

In keeping with the dominant approach adopted under the UNFCCC, Canada, has focused most of its attention on climate change mitigation. By ratifying the Kyoto Protocol, Canada has made a commitment to reduce greenhouse gas emissions six percent below the 1990 level by 2010. Most effort at the Federal level is currently directed to developing the means of achieving this goal. This has little relevance to the Canadian North, which is now the source of only a minute fraction of Canada's greenhouse gas emissions, though this could increase if widespread

thawing of the permafrost results in substantial methane emissions. However, such conditions result from changes in natural systems, not by actions of residents. The primary cause is still global.

Consequently, the Premier of Nunavut stated in a speech at the Arctic Climate Workshop (CFCAS in press) that the focus of his government is on GHG mitigation, however, they also need to address adaptation now, and will certainly have to in the future. Unfortunately, such actions do not fit the current national and international policy position and there is concern that any deviation towards adaptation might undermine the constant message of GHG reductions. Moreover, any indication that northerners and indigenous people can adapt successfully may cause others to consider their adaptive capacity and raise disturbing questions about the necessity of taking costly and difficult actions to reduce GHG. Nonetheless, as has been noted (Rosentrater and Ogden 2003), adaptive strategies, if implemented in the north, may do little more than "buy time" while broad based international mitigation measures take effect and recalcitrant nations are encouraged to participate.

The intent of the Whitehorse Declaration on Northern Climate Change (n.a. 2001) was to present a balanced perspective of the need for both mitigation and adaptation, as reflective of the political and policy framework at the time. This balanced approach was deemed to be necessary because conference delegates recognized that northerners are, per capita, the largest emitters of greenhouse gases in Canada, although the volumes are a minute percentage of Canadian GHG emissions and the result of unique environmental and transport conditions. Moreover, regardless of the efforts of northerners reducing emissions, adaptation measures (see Figure 3) are deemed essential to help the region prepare for the inevitable impacts of climate change, quite possibly resulting from more severe natural disasters. Current Government of Canada initiatives, including the Climate Change Action Fund, continue to reinforce the emphasis on emissions reduction rather than a more diversified agenda respectful of the conditions and needs of northern Canada.

In the North, a shift of emphasis toward adaptation is required as there is very little northerners and indigenous people can do about GHG levels because they contributes so little to global emissions. More consideration should be given as a matter of priority to how to move the adaptation agenda forward in the North, including how to develop synergy between climate adaptation, sustainable development, and mitigation of GHG emissions, and how to link and integrate climate change adaptation with natural disaster reduction. In conclusion, we would argue that northern jurisdictions should insist that emissions in southern Canada and globally be reduced to limit the significant changes projected. Concurrently, northerners require financial assistance to understand adaptation better, explore the climate change – natural hazard linkage, and implement adaptive strategies relevant to all northern residents. Only through a comprehensive, coordinated program of policies and actions will northern communities attain improved capacity to cope with projected changes, thus creating over the long term safer, more resilient communities in which to live.

Notes

1. The authors would like to thank Ian Burton, Ph.D., Scientist Emeritus, Meteorological Service of Canada, for his assistance and contribution to early drafts of this paper.
2. For the purposes of this document "Northern Canada", or simply the "North" is defined as the combined jurisdictional boundaries of the Yukon, the Northwest Territories and Nunavut, the Hudson-James Bay lowlands of Ontario and Manitoba, northern Québec, and Labrador. It is, however, recognized that other perspectives of "the North" exist based on geophysical, ecological and cultural characteristics.
3. For further information on this initiative see www.gewex.org.
4. The publication *The Earth is Faster Now: Indigenous Observations of North Environmental Change* documents observations of change from the perspective of 23 indigenous communities in the North (Krupnik and Jolly 2002).

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