Chapter 3
How Demographic Change and Migration Influence Community-Level Adaptation to Climate Change: Examples from Rural Eastern Ontario and Nunavut, Canada

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Abstract Vulnerability and the capacity to adapt to climatic variability and change are shaped by dynamic interactions between social, economic, cultural, political and institutional processes operating at a variety of scales. Demographic processes and trends are also closely linked to adaptive capacity, as both an influence on vulnerability and as an outcome of adaptation. This chapter outlines the linkages between climate, vulnerability, adaptation and demographic processes, with particular attention to how these play out at the community level. Using case studies from communities in rural eastern Ontario and Nunavut, Canada, this chapter illustrates how various demographic trends affect local level adaptive capacity. Residents of these communities are already engaged in adaptation to changing climatic conditions, but are experiencing very different trends in fertility and migration. Understanding the connections between demographic processes and adaptation facilitates greater understanding of climate change vulnerability more generally, and provides important considerations for policies and programs targeted at building adaptive communities.

Keywords Adaptation • Climate change • Climate migration • Demographic change • Vulnerability

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3.1 Introduction

Given the unequivocal evidence that human activities are driving unprecedented changes to the earth's climate, reducing vulnerability to these changes and building capacity to adapt are of growing public policy concern (Adger et al. 2009). Increasingly, it is being recognized that demographic patterns and processes influence vulnerability and adaptive capacity in various ways (O'Neill et al. 2001; Dyson 2005; McLeman 2011a). Fertility, migration and urbanisation determine the number of people exposed to climate-related risks in particular places (McGranahan et al. 2007; Satterthwaite 2009). Changes in fertility and migration rates are potential outcomes of adaptations made in response to extreme climate-related events such as droughts, floods, and tropical cyclones (Caldwell et al. 1986; Pedersen 1995; McLeman and Hunter 2010). Fertility and migration have particularly significant effects on community-level vulnerability and adaptation. Demographic change within communities has the potential to alter livelihood strategies, distributions of wealth, local institutional arrangements, social networks and capital, and other attributes known to be associated with adaptive capacity (Smit and Pilifosova 2003; Adger 2006; McLeman and Smit 2006).

Successful adaptation to climate change, and planning for it, is context specific. While governments, international organisations and other institutions that function at large scales have important roles to play in building the social, economic and legal infrastructure for adaptation, the particular requirements for building adaptive capacity vary considerably at local levels (Smit and Wandel 2006). Because demographic processes can be both a driver and an outcome of vulnerability, adaptation planning benefits from understanding the influence of demography at regional and local levels. This chapter reviews current scholarly understanding of the linkages between vulnerability, adaptation, fertility and migration, with particular attention to how demographic processes and trends affect the capacity of communities to adapt to climate change. It provides a generalised conceptual representation of how these dynamic interactions are potentially connected, which is then illustrated in greater detail using empirically based case studies of four communities in rural Ontario and Nunavut, Canada. It concludes with suggestions of how understanding the influences of broader demographic processes in climate adaptation is relevant for developing sound legal and policy- recommendations.

3.2 Vulnerability, Adaptation, Fertility and Migration in the Context of Climate Change

3.2.1 Vulnerability and Adaptation

The impacts of climatic variability and change on human populations are typically conceptualized in terms of *vulnerability* (Adger 2006; Parry et al. 2007; Smit and

Pilifosova 2003). Vulnerability, which in its simplest form refers to the potential to experience loss or harm (Weichselgartner 2001), is seen to be a function of three general conditions:

– the nature of the biophysical changes to which a given population is exposed (e.g. droughts, storms, extreme heat or cold events);
– the sensitivity of the population to those biophysical changes (e.g. agricultural regions being especially sensitive to fluctuations in precipitation, coastal communities to storm surge events);
– the capacity of the population in question to cope with and adapt to the changes in question (e.g. through technology, through changing of practices).

Vulnerability is not static. The introductory chapter of this book outlines how the biophysical conditions of exposure are rapidly changing in many regions. As is detailed below, such changes are rapidly emerging in the Arctic and in eastern Ontario, Canada. The social, political, economic, cultural and institutional factors that influence sensitivity and adaptive capacity are also continually changing, being driven by systems operating and interacting at scales from the local to the global (Adger et al. 2009; Leichenko et al. 2010; Smit and Wandel 2006). Within this highly dynamic context, adaptation to climatic variability and change can occur at a variety of scales, from the local to the global, and involve a range of actors, from the individual or household on up to the international community (Smit and Pilifosova 2003). Adaptation may be undertaken in anticipation of risks or in response to events after they occur, and may emerge as planned sets of actions or as autonomous responses. The relationship between demographic change, vulnerability and adaptation is complex, and can play out in a variety of ways that vary from one context to another. Demographic change can be an outcome of vulnerability and adaptation processes, and it can exert a strong influence on the formation/transformation of vulnerability and adaptive capacity.

3.2.2 Demographic Change as an Outcome of Vulnerability and Adaptation

There is evidence that, at least among certain populations, fertility rates can temporarily decline during periods of adverse climatic conditions (Caldwell et al. 1986; Pedersen 1995). There are also concerns that climate change could lead to the spread of insect- and water-borne diseases (Cooney 2011), which could conceivably change future mortality patterns. A third outcome, which warrants some additional discussion, is the effect on migration, a subject that has received considerable interest following reports that climate change will create millions of environmental refugees in coming decades (e.g. Myers 2002; Christian Aid 2007). Current scholarship tends to view climate-related migration in the context of adaptation (McLeman and Smit 2006; Bardsley and Hugo 2010; Tacoli 2009) and increasingly seeks to incorporate broader theories of migration, such as economic explanations (e.g. Todaro 1969), household risk diversification strategies

(e.g. Stark 1991), transnational social networks (e.g. Faist 1998), household access to social and cultural capital (e.g. Nee and Sanders 2001; Palloni et al. 2001) and global institutions and networks, among others (Castles and Miller 2003).

Climate-related migration is typically an autonomous adaptation initiated at the local level, although there are past examples of governments being actively involved, such as in drought-stricken rural Alberta in the 1930s (Marchildon et al. 2008) and in the Ethiopian famines of the 1980s (Ezra 2001). We know from past experience that autonomous climate-related migration may take on a variety of different attributes in terms of duration, destination choice, and participation (McLeman and Hunter 2010). A single climatic event may stimulate a variety of different migration responses within the exposed population, as was witnessed, for example, among residents of New Orleans in the wake of Hurricane Katrina (Elliott and Pais 2006; Fussell et al. 2010). Climate-related migration can be generated by conditions of distress or by people seeking to take advantage of particular amenities or opportunities, such as northerners who retire to sunny climes (Happel and Hogan 2002).

Climate-related migration tends to take place over short distances within regions; where it does cover longer distances, it tends to follow pre-established migrant networks, its participants drawing upon the social capital vested in transnational communities (McLeman 2011a). Because it is inherently disruptive and costly, migration is rarely the first response undertaken by people exposed to adverse climatic conditions, and rarely does it unfold as a wholesale outpouring of people. Instead, there tends to be great social differentiation in adaptation, with groups and households within a population responding in a variety of ways, their access to economic, social, and cultural capital influencing the range of potential adaptation options available and the relative desirability of each (McLeman and Smit 2006). For example, ownership of fixed capital (like land) and participation in strong local social networks are factors that discourage migration and facilitate adaptation by other means. Conversely, portable economic capital, readily transferable labour market skills and membership in geographically extensive social networks tend to increase the possibility of migration occurring.

3.2.3 Demographic Processes as Influences on Vulnerability and Adaptation

Demographic processes may also influence the creation (or reduction) of vulnerability. Their most obvious effect is to determine the number of people exposed to climate-related risks. For example, developing countries are seen as generally having less capacity to adapt to climate change relative to other nations (Adger 2006). Many developing nations that have a high physical exposure to risks of drought, extreme storms and sea level change associated with climate change also have relatively high rates of natural population increase (McLeman 2011a). High rates of urbanisation, driven by both natural increase and migration, further serve to create

large concentrations of people in areas particularly at risk, such as flood plains, deltas and low-lying coastal areas (Satterthwaite 2009).

Demographics also have a particularly strong influence on the capacity to adapt to climate variability and change, especially at local levels. Community adaptive capacity is tightly linked to the economic, social and cultural attributes of the individuals and households that make up the community, which are in turn influenced by factors such as age, education, family relations, gender, health, income, occupation (or livelihood) and social connectivity (Smit and Wandel 2006). Consequently, when demographic changes occur at the community level, adaptive capacity changes as well. Depending on the nature and direction of demographic change, community adaptive capacity may be enhanced or eroded. For example, when migration out of a given community occurs, it fundamentally alters the characteristics of the remaining population. In some instances, out-migration has the effect of enhancing the adaptive capacity of those left behind by generating remittances or by reducing pressure on household resources (Adger et al. 2002; Rain 1999). In other cases, the loss of members of key socio-economic groups can lead to a steady decline in community well-being by reducing the availability of key labourers or leaving gaps in local social networks. Over time, these may lead to further out-migration or, in extreme cases, precipitate the eventual abandonment of the settlement (McLeman et al. 2008, 2011b).

3.2.4 Capturing Interactions of Demographic Change, Vulnerability and Adaptation

Figure 3.1 provides a simplified conceptual representation of how climate, socio-economic processes, vulnerability, adaptation and demographic change interconnect at the community level. It captures how demographic processes can both act upon the formation of adaptive capacity and result from adaptation in action. It also highlights for policymakers and planners seeking to build highly adaptive communities the importance of not only identifying current and future climatic and socio-economic pressures communities face—which is the common approach to understanding community vulnerability, and is described in the next section—but also to account for the potential impacts of demographic processes on the community in question.

3.3 Demographic Change and Migration as Influences on Community Vulnerability: Case Studies

To illustrate more clearly the interconnectedness of demographic change, vulnerability and adaptation, we now turn to a detailed discussion of four Canadian communities, two in rural eastern Ontario, Canada, and two in the northern Canadian territory of Nunavut, where we have been conducting empirical research for a number of years now. Beyond our own familiarity with adaptation needs and dynamics in

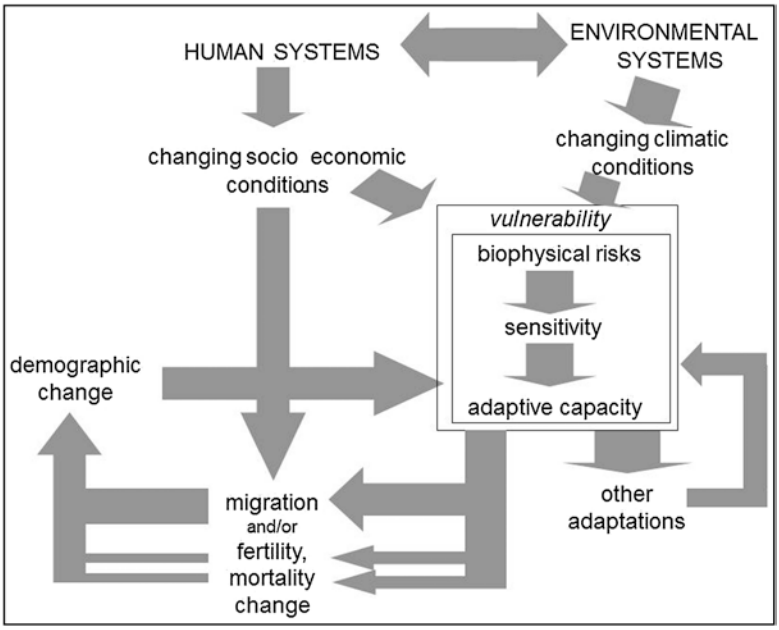

Fig. 3.1 Conceptual diagram linking demographic change to vulnerability, adaptation and migration in the context of climate change

these communities, there are particular reasons why they make for very useful comparisons in this chapter. First, all four communities are currently experiencing documented changes in climatic conditions that pose serious challenges for residents' livelihoods and well-being (Table 3.1). Adaptation is therefore not a hypothetical need, but an actual one. Second, even though the physical trends in climate are similar within each pair of communities, the demographic trends in each one differ, creating differing adaptation challenges in each. While these four cases do not provide anywhere near a comprehensive inventory of all the ways by which demographic trends may interact with vulnerability and adaptation, they do allow us to illustrate the importance of understanding these interactions on a context-specific basis. By doing so, we hope the reader will obtain general insights useful for developing methodologies that may be applied to adaptation planning in communities elsewhere.

3.3.1 Methodology

A similar methodology was used in the collection of data for each of the four case studies. We began with the basic concept of vulnerability as described in Sect. 3.2 above, and through extended periods of community-based research documented and described the biophysical exposures and determinants of adaptive capacity that have shaped past and present vulnerability within the community. In order to understand

Table 3.1 Community case studies: economy, climatic trends, and demographic trends

Community	Type of economy	Climatic trends	Demographic trends
Edwardsburgh -Cardinal, Ontario	Agricultural	Milder winters; hotter summers	Very slow population growth; out-migration by young people; aging population; some in-migration by ex-urban commuters
Addington Highlands, Ontario	Small scale forestry, outdoor recreation	Milder winters; hotter summers; increased risk of fire, storm events	Slow population growth; high-outmigration by young people; in-migration of retirees; very advanced average age
Iqaluit, Nunavut	Government administrative centre; gateway to eastern Arctic	Milder winters; hotter summers; changing snow and ice conditions on land and sea	Rapid population growth; high rates of in-migration within territory; high rates of in-migration by southerners; high birth rates
Igloolik, Nunavut	Regional administrative centre; hunting, fishing	Milder winters; hotter summers; changing snow and ice conditions on land and sea	High natural population growth rate; large average family size; very young average age

these adaptation processes and determinants, we selected a variety of data collection exercises and activities tailored to the particular situations in each community, an approach often described as a "bottom-up" way of understanding the dynamics of vulnerability and adaptation (Dessai et al. 2004; Ford et al. 2010c). Through this approach, we have been able to describe the impacts of climate change not simply as technical measurements (e.g. changes in ice thickness, wind direction, precipitations levels, and so forth) but in terms of what aspects of climate are most challenging for the community in question and why. This contrasts with (and complements) the traditional natural science approach to understanding climate impacts, which is driven by modelling of physical processes, often at fairly coarse spatial scales, and then attempting to downscale these model outputs to the local level and make assumptions about how people are affected and respond (Smit and Wandel 2006).

Once the dynamics of current vulnerability are understood, the researcher then attempts to understand emergent trends in climate and in the socio-economic conditions that will shape future vulnerability in the community of interest (Ford and Smit 2004). Here, again, the data must be meaningful to the community in question. This presents a variety of challenges for the researcher, and may necessitate various methods as one attempts to see over the horizon. In the case of Arctic communities,

for example, there are a number of scientific models of future sea ice conditions, and with the help of community members these can be studied collaboratively to gauge which outcomes are most probable based on past experience, and to single out those that would be most problematic for the community in question. In the case of future adaptive capacity, here, again, a variety of data may be available about social, economic and demographic trends, one of the most easily obtainable in North America being population census data. In the case of Canada, census data are available in five-year intervals, and contain a range of useful information including population change, labour-force characteristics, household income distributions, and so forth. As the research team develops a projection of potential future vulnerability and future influences on adaptive capacity, the findings are 'ground-truthed' by having them assessed and critiqued by community members on a periodic or ongoing basis during the analysis. In this way research conclusions are thus 'policy-ready' and become planning tools to be used by communities as they see fit. While such methods may seem old hat to those working in the many social science fields where theoretically grounded, consultative and community-based research is the norm, they are relatively new in climate change scholarship (Wandel et al. 2007).

In the following sections, we take information generated through our grassroots research in each of these communities and illustrate how various demographic factors influence local vulnerability, thereby adding detail to some of the processes shown in Fig. 3.1. Particular demographic trends at play in the case studies include:

- High rates of out-migration
- High rates of in-migration
- High fertility rates
- High levels of population growth (through migration and fertility)
- Slow population growth or population decline
- Rising average age of population

3.3.2 Eastern Ontario Case Studies

The first two case studies come from rural eastern Ontario, Canada, a region situated between the Ottawa River, flowing from the northwest, and the St. Lawrence River, flowing from Lake Ontario northeastward (Fig. 3.2). The bulk of the region's population, and most of its urban population, live in the two river valleys, where the best agricultural land is also found. The central part of the region is rugged upland, increasingly forested as one travels north, with few large settlements. Unlike the urban centres, which have all experienced steady population growth over the last half-century, rural populations in eastern Ontario have been growing more slowly, if at all. Like rural areas in many parts of the world, out-migration by young people to urban centres is very common.

Climate forecasts generated by general circulation models (GCMs) for Ontario project mid-twenty-first century temperatures will be approximately 4 °C on average warmer than present, with the most obvious warming effects being experienced in

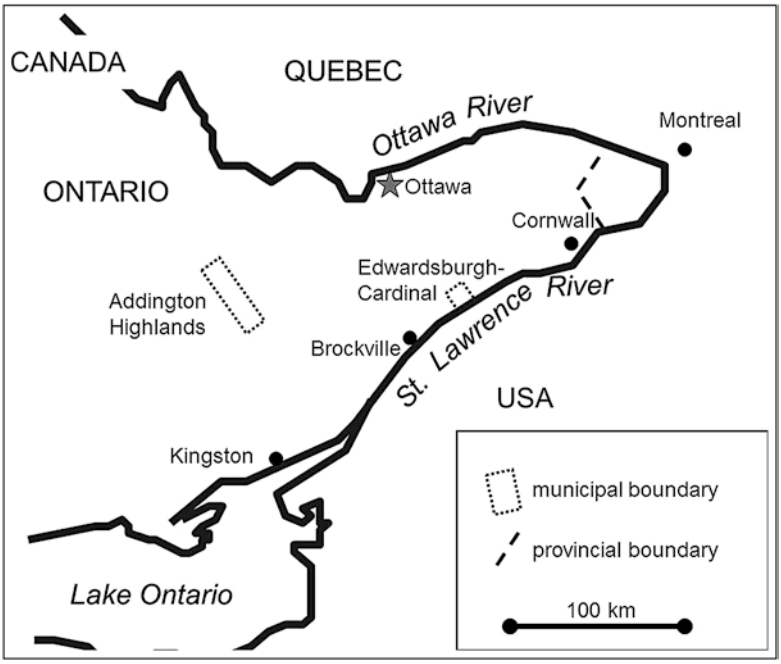

Fig. 3.2 Study locations in Eastern Ontario

winter (Chiotti and Lavender 2008). Extreme summer heat events (i.e. temperatures >30 °C) are expected to double by mid-century (Hengeveld and Whitewood 2005). Precipitation projections from GCMs are less conclusive (Chiotti and Lavender 2008). The past fifty years have seen trends toward warmer average night-time temperatures and more calendar days with precipitation (Vincent and Mekis 2006). Residents of the study area report that winters are becoming increasingly milder, less snowy and shorter in duration, whilst summers are becoming hotter, anecdotal information that is supported by weather station data and proxy data from maple syrup producers[1] (McLeman and Gilbert 2008; McLeman 2008; McLeman 2010; Sander-Regier et al. 2010). Upland residents report that extreme wind events are occurring more frequently than in the past, information for which instrumental or proxy data have not yet been identified. These changes in climatic conditions, and the expected continuance of them, present challenges and opportunities. Rural residents are already adapting, and must continue to do so. Adaptation options and practices in the uplands and agricultural areas differ, as do the impacts of demographic change on adaptation.

[1] Maple syrup is produced commercially across the region from naturally occurring sources by collecting the sap from sugar maples, *Acer saccharum*. The sap is collected during spring conditions when overnight low temperatures are below 0 °C and daytime temperatures are above zero. The timing of the sap collection period in eastern Ontario now occurs approximately 10–14 days earlier than it did 50 years ago (McLeman 2008).

3.3.3 Demographic Change and Adaptation in Agricultural Areas: Edwardsburgh-Cardinal

Edwardsburgh-Cardinal is a rural municipality of approximately 6,700 people (Statistics Canada 2007). Agriculture was long the key driver of the area's economy, and small, family operated farms are still found across much of the municipality. Today, however, agriculture provides employment for only a small portion of the population (Fig. 3.3). Most people are employed in the service sector, retail, or at one of the two corn-based product manufacturing plants (one producing ethanol, the other corn starch). Residents are concerned about the potential risks and uncertainty associated with warming temperatures, particularly on crops and livestock, and on groundwater supplies (most households obtain water from wells) (Sander-Regier et al. 2010). The southernmost part of the township borders on the St. Lawrence River, and is home to a small port. Residents have observed significant fluctuations in river levels and worry about possible future impacts of climate change on river transportation, a concern shared in a number of government and academic studies (Chiotti and Lavender 2008). A steady string of mild winters forced the community to abandon a long-standing outdoor winter carnival that attracted tourists and was a significant social event for residents.

As in many rural areas, adaptive capacity in Edwardsburgh-Cardinal with respect to climate change or any other type of stress, regardless of origin, is closely linked to social networks and the social capital present within them (see Wall et al. (1998) for a more detailed review of rural social capital, its creation and importance). This social capital is evident in service clubs, farmer organisations and particularly in a committee that has organized an annual fall agricultural fair for more than a century (Sander-Regier et al. 2010). Members of these organisations are highly active, tightly

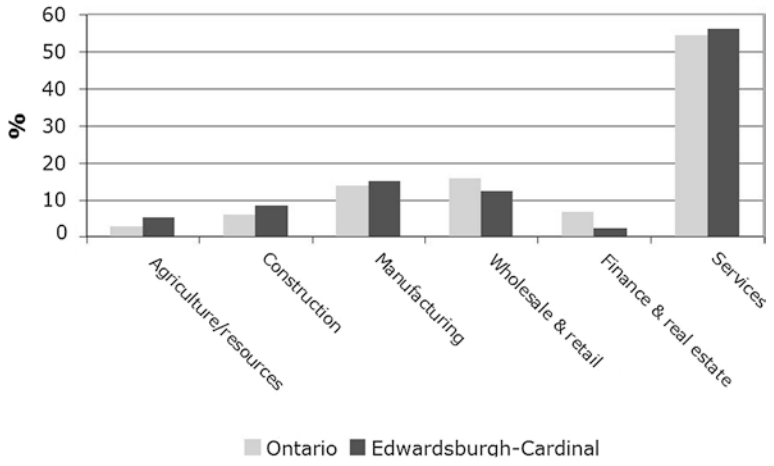

Fig. 3.3 Employment in Edwarsdsburgh-Cardinal, by sector, compared with Ontario province-wide figures

connected and continuously engaged in activities to promote community well-being. For example, when the municipality's only bank branch was shut down by its Toronto headquarters, residents organized and persuaded a regional credit union (i.e. a cooperative member-operated financial institution) to open in its place. Residents raised funds to restore a historic grist mill as a tourist attraction and community event centre, which they now use as a focal point for a new community Christmas celebration that can be held in any weather, and which draws even more visitors than the annual winter carnival that was cancelled after years of inadequate snow.

There is reason to be concerned that this social capital may not be sufficient to meet future challenges associated with climate change. Worrisome in the short term for residents is the effect of prevailing demographic trends. The population has ceased growing and the average age is rising (Figs. 3.4, 3.5). Once they complete secondary school, young people tend to go elsewhere for further education, training or employment, and do not return. Their departure is balanced by a small influx of

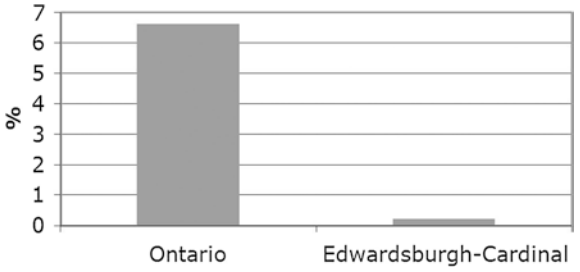

Fig. 3.4 Population change, Edwardsburgh-Cardinal versus provincial average, 2001–2006

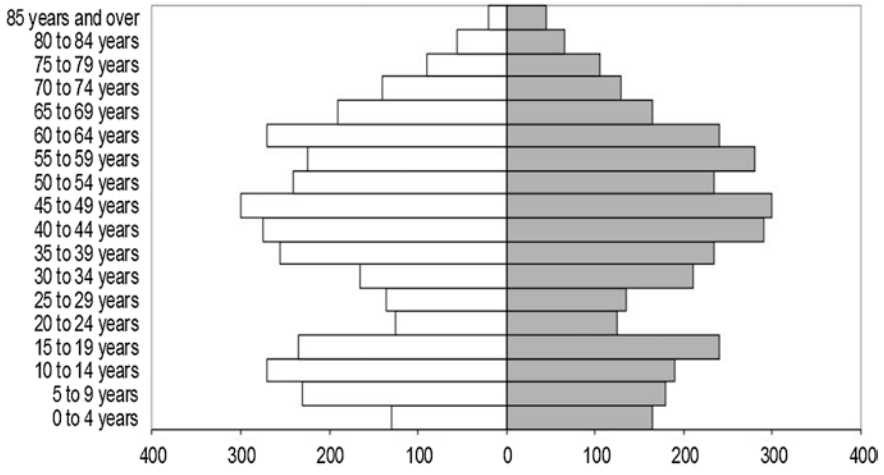

Fig. 3.5 Population profile, Edwardsburgh-Cardinal

people from nearby urban and suburban centres, typically in their 40s or 50s, who are attracted by the affordability of homes and/or perceived amenities of rural living (e.g. larger properties, more space, less ambient noise and traffic). These in-migrants tend not to join local social networks, but maintain their connections to the city through employment, shopping and social activities. With the number of people participating in social networks shrinking, active individuals are becoming burned out and community organisations are saturated in terms of their capacity to take on new challenges. There is no institutional capacity to replace social capital in this community. Like many rural municipalities across Canada and elsewhere, the local government lacks the financial and human resources to do more. Obtaining greater resources from higher levels of government is difficult, given the competition with larger, fast-growing urban municipalities in the region. Building future adaptive capacity in Edwardsburgh-Cardinal consequently entails finding new ways to increase the engagement of newcomers with local social networks.

3.3.4 Demographic Change and Adaptation in Upland Communities: Addington Highlands

In the upland region of eastern Ontario, the average age of the population is even more advanced than in the rural valleys, as seen in the population profile for Addington Highlands township (Fig. 3.6). Over recent years many villages and hamlets have withered away to small collections of lonely houses. Out-migration by young adults is very high here as well. Despite this, overall population numbers are actually increasing in the more accessible upland areas. For example, the

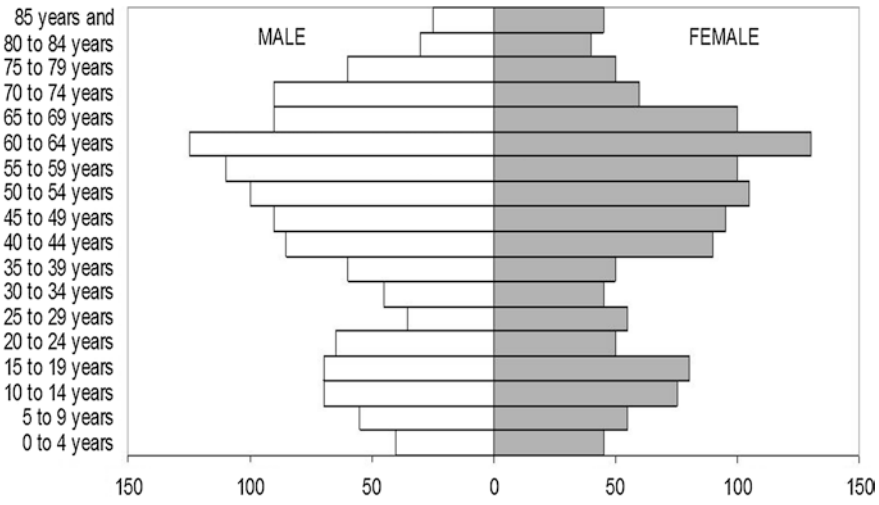

Fig. 3.6 Population profile, Addington Highlands township

population of Addington Highlands township grew by 4.6 % over the period 2001–2005 (Statistics Canada 2007). It may seem counterintuitive that an area of high youth out-migration and rapid aging is growing in population, but it is because of a large influx of environmental amenity-seeking retirees (McLeman 2010). The idea of 'retiring to the cottage' (i.e. a waterfront recreational property) is popular among many urban Canadians, and eastern Ontario's upland region offers impressive scenery, clear lakes and waterfront property prices that are lower than average urban house prices. Some retirees previously visited the region regularly on a seasonal basis or for summer vacations; others have no previous connections.

Socially, economically and culturally, the incoming retirees have little in common with lifelong residents. The uplands are one of Ontario's poorest regions, with residents' median incomes being less than half the provincial average (Statistics Canada 2007). Historically, small-scale forestry, mining and other resource-based activities were the main source of employment, but these sectors have declined in the face of global competition. Summer tourism is now the main driver of economic growth and employment. Most people find work in the retail and service sector catering to visitors, typically at minimum wage and often on a seasonal basis.

The impacts of current climate trends are felt quite strongly in the uplands areas (McLeman 2008). Some changes are beneficial. Milder winters mean less firewood is consumed and less snow needs to be cleared from around homes which, given the advanced age of the population, are important considerations. Longer, warmer summers are beneficial to an economy that is increasingly dependent on summertime outdoor tourism. Hot summers do, however, bring increased risk of forest fires, wind and stormy weather. Milder winters shorten the winter forestry season,[2] and the frequent freeze–thaw conditions they bring are damaging to road infrastructure and require greater expenditure on sand and salt to keep roads safe. The small but important winter tourism industry, based on snowmobiling and ice fishing, suffers in mild winters.

Adaptive capacity in the uplands areas has historically been based on a mix of household self sufficiency and tightly-knit social networks (McLeman 2010). Because of the heavy forest cover, harsh weather events often down trees that knock out electricity wires and close roads. Lifelong residents are prepared to live self-sufficiently for extended periods, and to deal with small emergencies. Their homes are heated with wood stoves, using wood residents split themselves. Most households own a combination of vehicles, including pick-up trucks, snowmobiles and all-terrain vehicles, and most adults can operate chainsaws and other equipment. Many residents supplement their food supplies with wild-caught game and fish. The skills necessary for self-sufficiency are learned through hands-on experience, and through inter-generational participation in outdoor recreation. With these skills distributed widely across the population, community members could safely be relied upon to help one another whenever times of need arose. As in Edwardsburgh-Cardinal, community service clubs, hunting and fishing organisations and church groups have long been key elements in maintaining and reinforcing social networks.

[2] The ground must be frozen solid to support the weight of the heavy equipment that is used.

Incoming retirees do not mix well socially with lifelong residents. The retirees tend not to hunt or fish, nor join church groups or other organisations popular with residents. Instead, they gravitate toward their own formal and informal organisations centred on activities like horticulture, art and nature appreciation. Retirees typically lack the skills and aptitudes of residents, and must hire others to perform work residents can easily accomplish on their own. Many retirees leave for more southerly climes during the worst parts of winter, a time when lifelong residents most value community social events. Some lifelong residents express contempt for the newcomers, perhaps resentful of their relative affluence. A dialectic situation has arisen whereby the waterfront properties owned by seasonal residents and retirees have risen rapidly in value over past decades, whereas property values of other homes have not changed. In other words, retirees see their wealth continue to grow even in retirement, while lifelong residents, many of whom lack stable employment let alone retirement pensions, remain relatively poor.

Unsurprisingly, significant social fractures now exist within upland communities and these are eroding overall adaptive capacity. Where once people could rely upon their neighbours for help and support whenever needed, now they may know little about their neighbours. Retirees have the financial means to hire others for assistance or to leave during the hardest seasons; lifelong residents do not. As lifelong residents age, their physical robustness and independence ebbs. Splitting wood and hunting game are activities not easily done as one ages. The departure of young people magnifies the vulnerability of older residents, because there are few to take over such responsibilities within households. Participants in the social organisations most relevant to community adaptive capacity are aging. Many of these organisations will wither and disappear within a decade or so if current trends prevail.

The lack of institutional adaptive capacity is even more pronounced in the uplands areas than it is in Edwardsnurgh-Cardinal. The large distances, low population densities and small property tax base (which makes up a large percentage of municipal revenues), mean that local government provides few services beyond basic road maintenance, waste disposal and policing. There are no hospitals or emergency medical clinics in the uplands area, and firefighting is done on a volunteer basis. Mobile phones do not work across much of the area, and most homes lack access to broadband internet (McLeman 2008). It is possible in coming years that the impacts of climate change may render the uplands region less attractive to retirees which, were it to reverse present trends, would lead to a precipitous population decline. In the meantime, the situation is one of increasing population, increasing age, increasing social friction, growing vulnerability and fading adaptive capacity.

3.3.5 Nunavut Case Studies

The second set of case studies comes from the Qikiqtaaluk or Baffin Region of Nunavut Territory, in Canada's eastern Arctic. Covering one tenth of the Canadian land mass but with a population of 15,765 and an area of one million km^2, Nunavut

is one of the least densely populated areas globally (0.015 inhabitants per km^2). The population of the region is predominantly Inuit (>90 %), inhabiting 14 settlements, 13 of which are hamlets ranging in size from a few hundred people to nearly 2,000, and one city with approximately 7,000 people (Statistics Canada 2007). Communities are small, remote and invariably situated on the coast, accessible year-round by air, or by boat during the ice-free summer period. The economy of the region is based on a mix of wage employment and subsistence activities. The wage economy is largely based on public administration, resource extraction, and the production of arts and crafts. Tourism is important in some communities. Many Inuit retain a close relationship with and detailed knowledge of the environment, and hunting, fishing and gathering are of great social and cultural importance to them (Ford et al. 2008, 2010a). These activities also provide much of the Inuit diet; over 40 % of Nunavut residents obtain more than half of their food from traditional sources (Poppel et al. 2007). Traditional foods include ringed seal (*Pusa hispida*), caribou (*Rangifer tarandus*), Arctic char (*Salvelinus alpinus*), walrus (*Odobenus rosmarus*), beluga whale (*Delphinapterus leucas*), narwhal (*Monodon monoceros*) and a variety of wild berries.

Once a semi-nomadic hunting people, in the second half of the twentieth century the federal government resettled Inuit (in some instances forcibly) into permanent communities, leading to sweeping social, cultural and economic changes (Wenzel 1995; Damas 2002; Ford et al. 2006b). Today, the socio-economic and demographic characteristics of Inuit communities in Qikiqtaaluk are similar to those associated with developing nations, having relatively high levels of unemployment, poor health, overcrowded and poor quality housing, lower levels of educational achievement and uneven access to basic services like water and sanitation (AHDR 2004; Furgal and Seguin 2006; Ford et al. 2010a, b).

Given the nature of their livelihoods, Inuit communities are highly sensitive to local environmental conditions, wildlife and natural resources (Furgal and Seguin 2006; Ford and Pearce 2010). The climate of the region is characterized by short cold summers and very cold, long winters. The ocean is typically frozen for seven to nine months of the year. Sea ice conditions are a crucial influence on Inuit livelihoods, the ice being used as a route for transportation to hunting areas and as a platform from which to hunt (Eicken et al. 2009). In recent years, climatic conditions have been changing rapidly (Prowse et al. 2009a, b). Temperatures in the region are increasing at twice the global average, leading to a dramatic reduction in summer sea ice cover, and more frequent and intense extreme weather conditions (Moore 2006; Hochheim and Barber 2010). Inuit communities are already having to adapt to these changes, which are projected to continue in the future (Serreze and Francis 2006; Holland et al. 2010).

3.3.6 Demographic Change and Adaptation in a Small Northern Community: Igloolik

Igloolik is a coastal Inuit community of approximately 1,600 people located on an island at the northern end of Foxe Basin (Fig. 3.7). The community's wage

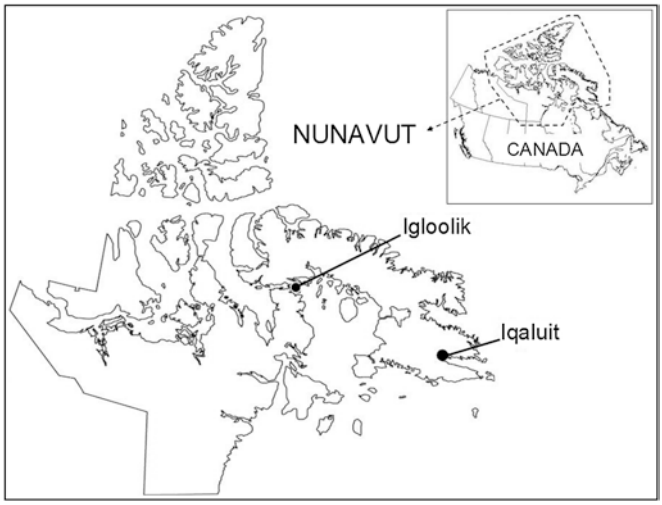

Fig. 3.7 Location of Nunavut case study communities

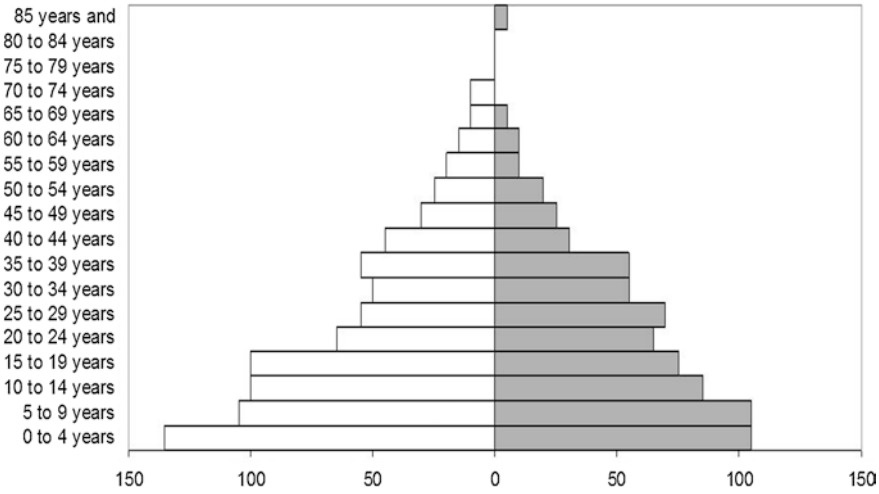

Fig. 3.8 Population profile, Igloolik

economy is largely based on public administration and tourism, including the production of traditional art, the guiding of southern sports hunters and small scale film production. In recent years, mining development has provided well-paying seasonal-jobs in summer. Money earned through wage employment is used to capitalize and support hunting activities (Ford and Beaumier 2011). The community's demographic profile (Fig. 3.8) is similar to that of many small Inuit communities in Nunavut, with over 40 % of the population being under the age of 15, and more than 2/3 under the age of 30 (Statistics Canada 2007). The median age

is 18.9 years. Between 2001 and 2006 the population grew by 20 %, and between 1996 and 2006 by 31 %, largely through natural increase.

Igloolik's environment is changing rapidly. Autumn temperatures have increased by approximately 5 °C over the last 30 years, which in turn causes ice to form nearly a month later and to break up earlier in the spring (Laidler and Ikummaq 2008; Ford et al. 2009). Wind patterns have changed and become more unpredictable, and temperatures in the area are increasingly variable. These changes make hunting more dangerous, make it difficult to access hunting areas at key times of the year, and have affected the area's wildlife, creating acute shortages of traditional foods (Laidler et al. 2009; Beaumier and Ford 2010). Autumn has always been a time of food shortage, and the delay in sea ice formation is exacerbating the hardship by delaying the start of hunting. In the summer, the changing sea ice dynamics are causing walrus to stay at locations much farther from the community (Ford et al. 2009).

Igloolik residents are adapting by adjusting the timing and location of their hunting activities, hunting more caribou inland when the sea is impassable, increasing their fishing and whaling activities, taking greater caution when travelling, and investing in satellite telephones, GPS and other safety equipment (Ford et al. 2006a; Aporta 2009; Laidler et al. 2009; Ford and Pearce 2010). Such adaptations are based upon the acquisition and transfer of traditional knowledge and land skills from one generation to the next, which in turn requires strong social networks within the community (Ford et al. 2009).

Demographics influence adaptive capacity in Igloolik in two main ways. First, across the north, and in Igloolik in particular, younger members of the population are not learning the necessary land skills and knowledge to engage safely in land-based activities. The rapid growth in population means there are too many young people relative to the number of elders and experienced hunters from whom young people would traditionally learn hunting skills from observing and doing (Ford et al. 2006a, b; Laidler et al. 2009). In addition to there being fewer opportunities for interaction between generations, younger residents often have different employment and cultural aspirations, having been more greatly influenced by western culture. In some cases, young people have only a poor knowledge of their traditional language, while elders have a poor knowledge of English.

Second, while social networks within Igloolik remain generally strong, there are signs of erosion. Younger community members exhibit a greater unwillingness to pool resources with extended family members, which is resulting in the emergence of buying and selling of traditional foods, a practice that did not exist previously. While part of this may be evidence of changing cultural values, a demographic reality is that as households become larger and younger, ever more people are dependent on a small number of experienced hunters. These hunters are in turn obliged to divert their financial resources to purchasing new equipment to hunt in the now more difficult conditions, leaving fewer resources to be shared with others. This situation may be sustainable when resources are abundant, but presents real challenges when they are not.

An emerging worry is that the local wildlife population is not sufficiently large enough to support the rapid population growth in Igloolik and other hunting communities. Before being moved to permanent settlements, Inuit lived in

small hunting groups that followed animal migration patterns, a highly effective way of minimizing hunting pressure (Damas 2002). Many communities have begun reporting that animals can no longer be found close by, and harvest data indicate that total catch has not changed despite rising population (Beaumier and Ford 2010). In light of these stresses, some believe there may emerge greater levels of Inuit migration to Iqaluit or southern Canadian cities in coming years. While out-migration from Igloolik and other small settlements is already happening, it is primarily driven by the education and employment opportunities and services available in larger cities. By reducing the ability of community members to partake in hunting, that key mainstay of Inuit culture and tradition, climate change could accelerate out-migration from smaller settlements if present trends continue.

3.3.7 Demographic Change and Adaptation in a Northern Regional Centre: Iqaluit

Iqaluit is the rapidly modernizing and growing territorial capital of Nunavut, with a population of approximately 7,000 (Statistics Canada 2007). It has a large base of wage employment, attracting Inuit and non-Inuit alike (Lardeau et al. 2011). The traditional subsistence economy remains strong, with seal, caribou, walrus, beluga whale and various fish species regularly harvested in the area. Iqaluit has Nunavut's only hospital and prison, and is one of the few communities where students can pursue higher education. A magnet for Inuit from other settlements, Iqaluit's population is more transient than other Nunavut communities. The Inuit population in Iqaluit grew by 17.6 % between 2001 and 2006 through the combined effects of natural increase and migration, as compared to 9.2 % in Nunavut as a whole (Statistics Canada 2007). The community's demographic profile (Fig. 3.9) also differs from smaller communities in the region, although still remains quite youthful compared with population centres in southern Canada. In Iqaluit, 25 % are under the age of 15, 47 % are under 30, with a median age of 28.8 years (Statistics Canada 2007).

Over the last thirty years, annual temperatures in the Iqaluit area have been increasing by 1.3 °C per decade (Ford and Pearce 2010). This has been accompanied by a corresponding decline in sea ice cover, less predictable weather patterns and more intense and variable winds. Additionally, there is less snow on land in winter, making overland trails more treacherous, while in the summer greater amounts of fog affect navigation in small boats. All these changes have impacts on Iqaluit's subsistence hunting sector and the availability of traditional foods in the community. Iqaluit hunters are adapting in ways similar to hunters in Igloolik, with traditional knowledge and land skills, strong social networks and resource use flexibility being critical underpinnings of adaptive capacity.

Unlike Igloolik, hunters in Iqaluit and the families dependent on them have greater access to wage employment. Not only are wage incomes higher, living expenses are lower in Iqaluit because of the better connections to southern Canada. These factors allow Iqaluit hunters to obtain computers and high speed Internet

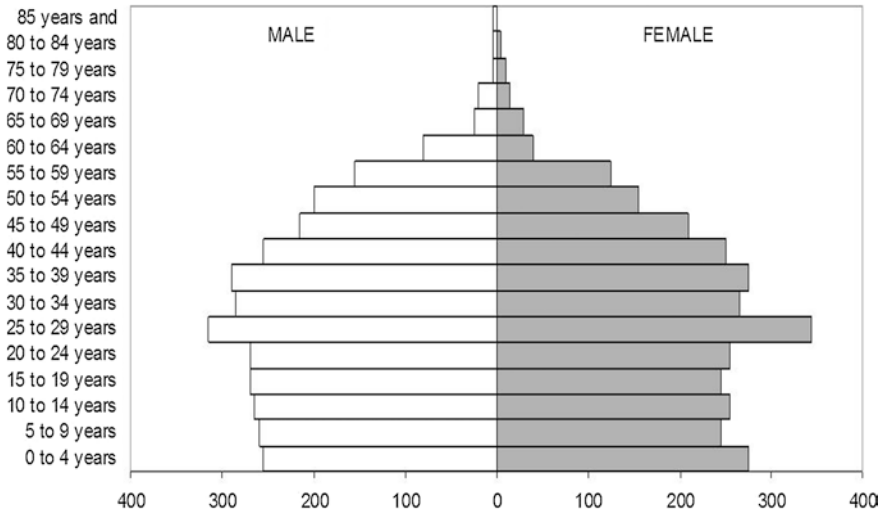

Fig. 3.9 Population profile, Iqaluit

connections to consult weather forecasts and ice conditions before embarking on hunting trips. Iqaluit also has a well-equipped search-and-rescue program should accidents occur.

Social, cultural, economic and demographic factors make vulnerability to climate change in Iqaluit different than in other, smaller settlements in the north. The number of full-time hunters in Iqaluit is small relative to the size of the community. Iqaluit residents who may not have been born and raised in the area nonetheless go out on the land and onto the sea ice for occasional hunting trips or for recreation. They do not have the in-depth knowledge of local environmental conditions and safety awareness of experienced hunters native to the Iqaluit area. This is especially the case with migrants from southern Canada who lack the cultural and linguistic skills to participate in Inuit networks. Deaths have already been linked to a lack of land skills, with young people being particularly at risk of harm.

The ratio of experienced hunters to people dependent on them for traditional foods is even greater in Iqaluit than in smaller communities, and is becoming even larger because of natural population increase and in-migration. Social networks within Iqaluit are also relatively weaker than in the smaller communities (Ford et al. 2007, 2008; Lardeau et al. 2011). Closely intertwined social networks and the presence of successful hunters within them are fundamental to Inuit adaptive capacity. As these erode, the economic and cultural well-being of Inuit households goes into decline, pushing them into a more southern, non-Inuit style of engagement with the environment and with one another. Such an engagement privileges wealth over sharing and technology over tradition, dynamics that are alien to Inuit society and that quickly make some families less able to adapt to climatic change than others. Its emergence in Iqaluit stems partly from the sheer size of the city, where houses may be up to 45 min walk from each other and public transportation

is minimal. Inuit who have migrated from elsewhere may have few pre-existing connections to Iqaluit families. To provide traditional foods to those without access to family-based food sharing networks, some hunters have started to sell food on the Internet, going door-to-door or at an occasional open air market. This commercialisation of the traditional, sharing-based food economy may reinforce and accelerate erosion of social networks in Iqaluit.

3.4 Discussion and Conclusions

Several common themes run through the case studies presented above, ones that are likely to resonate with residents of other resource-dependent communities in other regions. To begin with, even relatively small changes in local climatic and environmental conditions are presenting significant challenges for the case study communities. It is important to recognize this first and foremost, because the scale of these environmental changes may seem modest or even trivial in comparison with the social, economic and demographic changes sweeping over these communities. Nonetheless, even modest climatic changes oblige residents to implement adaptive strategies so as to minimize the harm done to local livelihoods and well-being. Understanding these implications requires methodologies that include active, on-the-ground engagement with individuals and households in the communities at risk.

These adaptation strategies and the resources necessary to implement them are not delivered by governments or through formal institutions; in each example adaptation is undertaken primarily by individuals, households and communities working together. This is consistent with observations of adaptation more generally (Berrang-Ford et al. 2011; Ford et al. 2011). It is therefore unsurprising that social networks and social capital are a key theme in each case study. Adaptation entails costs, and where wealth is lacking social capital provides a substitute. With the exception of Iqaluit, the communities described in the case studies have relatively modest economic infrastructure, making social capital the critical asset for building adaptive capacity. The juncture between social capital and adaptation is one where demographic forces become very influential.

In the case of Nunavut's smaller settlements, a demographic challenge is that there are large numbers of young people relative to their elders. In the subsistence economy of Nunavut, the lack of access to elders means a growing number of young people cannot acquire the skills and aptitudes that have helped Inuit people survive for so long in an incredibly harsh environment. The penetration of western culture into Inuit communities has helped weaken young residents' interest in traditional language and practices, but even so, the lack of access to elders from which to learn has become a growing concern across Inuit communities. The high rate of natural population increase exacerbates the need to rely on technologies and commercialisation of traditional foods, further contributing to the process of social erosion. Such erosion is already plainly evident in Iqaluit. This is not to say

that Inuit communities will disappear from the north, or that the population must inevitably abandon land-based activities for a purely western economy. What it does mean, however, is that socially, culturally and economically, Inuit communities will become very different from what they once were because of the combination of rapid climatic change and rapid demographic change.

In rural eastern Ontario, the demographic challenge is an opposite one: there are too many elders relative to young people. Among the ever diminishing numbers of residents under the age of twenty few will remain in their communities. They may enjoy the social and cultural amenities of their rural home region, but these connections to land and community are not sufficient to overcome the draw of opportunities elsewhere. Once young people leave these rural Ontario communities for higher education or employment, they tend not to return. With the declining importance of forestry, agriculture and other resource-based industries in eastern Ontario, the skills and aptitudes that served their parents' generation have little value on today's job market. However, those traditional skills and aptitudes are still important in terms of the household self-sufficiency on which adaptive capacity is based, and they are becoming increasingly scarce.

In-migration is further changing the face of rural eastern Ontario. Those who were raised in rural communities and those who have migrated to them all place great value on environmental amenities and the rural way of life. However, their cultural background and their ways of experiencing nature differ so greatly the two groups do not mix as they participate in their different social activities. This situation is reminiscent of the famous observation made by Putnam in *Bowling Alone* (1995) that bowling remained a popular social activity in the US even as membership in bowling leagues declined. In rural eastern Ontario, the desire to enjoy a rural lifestyle is, like bowling, as strong as always, but the activities carried out as part of the rural lifestyle no longer bond community members as strongly as they once did.

In-migration is also changing the face of Iqaluit, in similar but more dramatic ways. Southern Canadians entering the community often enjoy hunting, fishing and being on the land, but they do not become members of the broad social networks centred upon those activities, and the food acquired in such ways does not hold the same cultural significance. While Inuit who come to Iqaluit from other settlements share a common cultural appreciation for land-based activities, their challenge is gaining entry to Iqaluit's social networks, where kinship remains important. In aggregate, community adaptive capacity is becoming increasingly tied to imported southern technologies, the commercialisation of traditional foods, and economic linkages with the south—a process that is self-reinforcing.

Demographic change in the north and in rural eastern Ontario is creating populations that are less independent and less resilient in the face of environmental stresses than the people who came before. This increases the need for institutions to play a greater role in future adaptation, something that places rural and remote communities at a distinct disadvantage as they compete with larger urban centres for resources necessary for adaptation. The situation necessitates policies, programs and approaches to adaptive capacity building that are flexible, innovative,

inclusive, low-cost and able to integrate traditional environmental knowledge with emergent technologies. Such attributes do not necessarily come naturally to institutions. They can be helped in this direction by scholars interested in influencing adaptation policy and who recognize that even as climatic conditions change and demand new adaptations, those who must do the adapting are continually changing.

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