

Climate Change Adaptation and Health Equity Background Report



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TABLE OF CONTENTS

- 1. INTRODUCTION 1
- 2. CLIMATE CHANGE TRENDS AND PROJECTIONS 1
 - Climate change overview 1
 - Climate change in Toronto..... 2
- 3. CLIMATE CHANGE AND HUMAN HEALTH 3
 - Vulnerable populations..... 5
 - The Toronto context..... 12
- 4. EVIDENCE FOR CLIMATE-RELATED HEALTH INEQUALITIES 13
- 5. MEASURING VULNERABILITY 16
- 6. HEALTHY, RESILIENT COMMUNITIES 19
 - Features of healthy, resilient communities 19
 - The importance of adaptation..... 20
 - Key considerations for the City of Toronto..... 23
- REFERENCES..... 28

1. INTRODUCTION

There is strong consensus that climate change is underway and that it will lead to increases in extreme weather events as well as changes in weather patterns that present risks for Toronto, and elsewhere. While the resulting impacts are likely to test the resilience of all populations, the ability of vulnerable populations to cope with the impacts is of particular concern.

Internationally, a number of researchers have drawn attention to the disproportionate impacts of climate change on vulnerable and socially marginalized populations (Global Forum for Health Research 2010; Costello et al. 2009; Commission on Social Determinants of Health 2008). The general consensus is that the poorest countries will suffer the greatest consequences of climate change even though they have contributed the least to greenhouse gas emissions. Although researchers acknowledge that modern society has improved the health and well-being of many people around the globe, health inequities continue to exist within and between countries.

In Canada, the issue of health disparities and their relation to climate change impacts and adaptation is an emerging area of study. The purpose of this report is to explore the available information on climate change adaptation and health equity, with a view to ensuring that Toronto's climate change adaptation efforts do not further widen the health inequality gap. While there is considerable literature available on global health inequity and climate change, this report will focus primarily on research that is relevant in the context of a first-world, urban city.

2. CLIMATE CHANGE TRENDS AND PROJECTIONS

CLIMATE CHANGE OVERVIEW

Climate change trends and projections for Canada and Ontario have been described at length in *From Impacts to Adaptation: Canada in a Changing Climate 2007* (Lemmen et al. 2008) and *Adapting to Climate Change in Ontario* (Expert Panel on Climate Change Adaptation 2009). Some general considerations are provided below; however, readers are encouraged to consult these resources for a more detailed discussion.

In Canada, the last half of the twentieth century (1948–2006) has seen a 1.3°C increase in national annual temperatures (Lemmen et al. 2008). During the same time period, annual average temperatures across Ontario increased between 0 and 1.4°C, with larger increases observed in the spring. Warming is expected to accelerate, with the most pronounced temperature increases occurring in winter, particularly in the Far North. The most recent projections for Ontario in 2050, which are based on moderate assumptions about greenhouse gas reductions, show an increase in the annual average temperature of 2.5°C to 3.7°C compared to 1961-1990 (Expert Panel on Climate Change Adaptation 2009). Recent estimates of greenhouse gas (GHG) emissions suggest that projections based on high

emissions scenarios may be more realistic, and these indicate that the 2050 annual average temperatures could be as much as 4.0°C higher.

Annual precipitation in southern Canada has increased by about 5 to 35% since 1900, and the number of days with precipitation (rain and snow) has increased significantly in the south and central subregions of Ontario (Lemmen et al. 2008). Precipitation in some parts of the province has become more variable, with high-intensity storms becoming more common since the late 1950s. The majority of global climate models suggest that Ontario can expect see slight increases in mean annual precipitation, with more precipitation expected in winter, and more winter precipitation expected to fall as rain rather than snow (Expert Panel on Climate Change Adaptation 2009). Although little change is expected in terms of summer precipitation, an increase in evaporation raises the likelihood of more intense dry summer periods.

Ontario can also expect to see more intense precipitation events, with more precipitation occurring in heavy rain or snow falls. Warmer air is able to hold more moisture, one of the conditions needed to increase the probability of intense rain events (Wieditz and Penney 2006). Unfortunately, this means that the frequency and severity of extreme events such as droughts and floods will increase, while the interval between heavy precipitation events is expected to decrease.

CLIMATE CHANGE IN TORONTO

Although national and provincial climate change trends projections are useful, it is important to have an understanding of how global climate change will be manifested at the local level. Local-scale climate model data are not yet available for the Toronto area¹; however, detailed discussions of recent trends and anticipated changes for the region can be found in *Ahead of the Storm...Preparing Toronto for Climate Change* (Toronto Environment Office 2008) and *A Scan of Climate Change Impacts on Toronto* (Wieditz and Penney 2006).

According to Wieditz and Penney (2006), Toronto has experienced an average temperature increase of 2.7°C since the late 1800s. Not surprisingly, Toronto is expected to get warmer and smoggier. This has certainly been the case in recent years; the summer of 2005, for example, began with the warmest June on record, with the warmth continuing into July, August and September. There were 37 days with maximum temperatures greater than 30°C compared to an average of 13 (1971-2000 normal) most years. Humidex values reached 35 more than 44 times, and a record number of 48 smog days occurred.

Average annual precipitation has changed relatively little in Toronto since the late 1800s (Wieditz and Penney 2006); however, more precipitation has been arriving in heavy rainfall events, such as the intense rainfall event that occurred on August 19, 2005. This rainfall

¹ The Toronto Environment office is currently working with a consultant to develop this data. No information was available at the time of writing.

event was the most severe storm event experienced in Toronto in recent years. The storm washed out a part of Finch Avenue, and caused flash flooding to creeks, rivers and ravines, eroding stream banks and damaging trees and parks. The damage to public and private property has been estimated at \$547 million – the most expensive storm in Toronto’s history (MacLeod 2010). It is likely that Toronto will see less snow and more rain in the years to come, with episodes of freezing rain increasing, at least for the next few decades. It is also expected that there will be more freeze-thaw cycles, which can cause extensive damage to road surfaces and create potholes, create rooftop ice dams, and damage trees and plants (Toronto Environment Office 2008).

Climate changes and related impacts are already being experienced in Toronto; over the last decade, the City has been subjected to extreme heat, floods, droughts, new insect pests, new vector-borne diseases and other problems made worse by climate change (Toronto Environment Office 2008).

3. CLIMATE CHANGE AND HUMAN HEALTH

Current climate extremes and future projections have resulted in growing attention to the health effects of climate on human populations (Ligeti et al. in press). In fact, almost all the impacts of climate change have direct or indirect consequences for human health. According to Confalonieri et al. (2007), climate change will likely bring some health benefits, such as reducing cold-mortality, or reducing the incidence of some vector-borne diseases (for example, where temperatures or the amount of rainfall exceed the upper thresholds for vectors or parasites). However, health impacts are likely to be overwhelmingly negative, with the most severe impacts in low-income countries, where the capacity to adapt is weakest. Developed countries will not be immune to these changes, especially where vulnerable populations are concerned.

Health Canada’s recently published report *Human Health in a Changing Climate* (2008) provides an up-to-date and thorough assessment of the human health vulnerabilities to climate change. As outlined in the Health Canada report, and as shown in Table 1, the most significant health impacts likely to be driven by climate change relate to temperature stress, air pollution, extreme weather events, vector-, rodent- and water-borne diseases, and exposure to ultraviolet radiation.

Table 1: Typical climate risks and related health effects

Health Impact Categories	Climate-related Causes	Projected/Possible Health Effects
Temperature extremes	<ul style="list-style-type: none"> • More frequent and severe heat waves • Overall warmer weather, with possible colder conditions in some locations 	<ul style="list-style-type: none"> • Heat-related illnesses and deaths • Respiratory and cardiovascular disorders • Possible changed patterns of illness and death due to cold
Extreme weather events and natural hazards	<ul style="list-style-type: none"> • More frequent and violent thunderstorms, more severe hurricanes and other types of severe weather • Heavy rains, causing mudslides and floods • Rising sea levels and coastal instability • Increased drought in some areas, affecting water supplies and agricultural production, and contributing to wildfires • Social and economic changes 	<ul style="list-style-type: none"> • Death, injury and illness from violent storms, floods, etc. • Health impacts due to food or water shortages • Illnesses related to drinking water contamination • Effects of displacement of populations and crowding in emergency shelters • Indirect health impacts from infrastructure damage and interruptions in health services • Psychological health effects, including mental health and stress-related illnesses
Air quality	<ul style="list-style-type: none"> • Increased air pollution: higher levels of ground-level ozone and airborne dust, including smoke and particulates from wildfires • Increased production of pollens and spores by plants 	<ul style="list-style-type: none"> • Eye, nose and throat irritation, and shortness of breath • Exacerbation of asthma symptoms • Chronic obstructive pulmonary disease and other respiratory conditions • Heart attack, stroke and other cardiovascular diseases • Increased risk of certain types of cancer • Premature death
Contamination of food and water	<ul style="list-style-type: none"> • Contamination of water by run-off from heavy rainfall • Changes in marine environments that result in algal blooms and higher levels of toxins in fish and shellfish • Behavioural changes resulting in an increased risk of flood- and water-borne infections (e.g. through longer BBQ and swimming seasons) 	<ul style="list-style-type: none"> • Outbreaks of strains of micro-organisms, such as <i>E. coli</i>, <i>Cryptosporidium</i>, <i>Giardia</i>, <i>S. typhi</i> (typhoid), amoebas and other water-borne pathogens • Food-borne illnesses • Other diarrhoeal and intestinal diseases
Infectious diseases, transmitted by insects, ticks and rodents	<ul style="list-style-type: none"> • Changes in the biology, ecology and distribution of various disease-carrying insects, ticks and rodents • Faster maturation for pathogens within insect and tick vectors • Longer disease transmission season 	<ul style="list-style-type: none"> • Increased incidence of vector-borne infectious diseases native to Canada (e.g. eastern equine encephalitis) • Introduction of infectious diseases new to Canada • Possible emergence of new diseases, and those previously eradicated in Canada

Source: Adapted from Health Canada 2008

Although everyone is at some level susceptible to the health consequences of changing weather patterns and alterations in the geographic distribution and incidence of climate-sensitive health outcomes, there are populations and geographic regions that have enhanced vulnerability (Ebi 2009; McKeown et al. 2008; Marmot 2007; Public Health Agency of Canada 2005). The section that follows explores these vulnerabilities in more detail.

VULNERABLE POPULATIONS

Human health is determined by complex interactions between social and economic factors, the physical environment, and individual traits and behaviours. These factors are referred to as 'determinants of health', and their combined influence determines the health status of individuals and populations (Health Canada 2008). Climate change puts human health at risk directly, and by affecting the determinants of health. Determinants of health include²:

- **Income and social status:** Income determines living conditions and access to safe housing and neighbourhoods, and sufficient nutritious food. Social status is also related to health, through its relationship to feelings of control over life circumstances and the ability to manage stressful conditions.
- **Social support networks:** Support from family and friends results in an improved sense of satisfaction and well-being and can help people deal with challenging events and circumstances.
- **Education and literacy:** Education is directly related to income and social status which influence health. However, education also contributes to health and prosperity by equipping people with knowledge and skills for problem solving, and increases opportunities for job and income security, and job satisfaction. Education can improve people's ability to access and understand information to help keep them healthy.
- **Employment/working conditions:** Employment has a significant effect on physical, mental and social health, contributing not only to income, but also to a sense of identity and purpose, social contacts and opportunities for personal growth. Unsafe or stressful working conditions, and stress and loss of income associated with unemployment can also influence health.
- **Social environments:** The character of the larger community – the supports available, the existence of social networks, vibrant formal and informal community organizations – can help people to build connections with others and relationships of trust and reciprocity that help reduce or avoid many potential risks to good health.
- **Physical environments:** The physical environment is an important determinant of health. In the built environment, the quality of housing, indoor air quality, and the design of communities and transportation systems can significantly influence an individual's physical and psychological well-being. At certain levels of exposure,

² Health Canada 2008; Lightman et al. 2008; Public Health Agency of Canada 2003.

contaminants in our air, water, food and soil can cause a variety of adverse health effects.

- **Personal health practices and coping skills:** The actions taken by individuals can help them prevent diseases and promote self-care, cope with challenges, solve problems and make choices that enhance health. Socio-economic circumstances often shape these choices.
- **Healthy child development:** The circumstances of early childhood are recognized to influence development, readiness to learn and health later in life. Healthy child development is largely influenced by the socio-economic circumstances experienced in childhood.
- **Biology and genetic endowment:** The basic biology and organic make-up of the human body are a fundamental determinant of health, while genetic endowment provides an inherited predisposition to a wide range of individual responses that affect health.
- **Health services:** Access to health services, particularly those designed to maintain and promote health, to prevent disease, and to restore health and function, contribute to health status.
- **Gender:** The array of society-determined roles, personality traits, attitudes, behaviours, values, relative power and influence that society ascribes to gender can lead to differential health outcomes.
- **Culture:** Some persons or groups face additional health risks due to a socio-economic environment with dominant cultural values that contribute to the conditions such as marginalization, stigmatization, loss or devaluation of language and culture and lack of access to culturally appropriate health care and services.

There are many examples of the ways in which climate change can affect the determinants of health. For example, climate change can affect physical environments, as in the case of a severe storm event that causes property damage, including the collapse of houses and other structures, forcing families to evacuate their homes and communities. Climate change can also reinforce challenges associated with income and social status. For example, individuals who lack adequate employment or financial resources may have greater difficulty accessing financial capital needed to recover from loss of property and displacement in the aftermath of an extreme weather event, leading to increased incidences of stress-related illnesses. Climate change can have an impact on social environments, which include networks of contacts, membership groups and organizations, and wider institutions that are important to the day-to-day livelihood activities. In the aftermath of an extreme weather event, for example, displaced individuals will have fewer opportunities to reestablish their lives, especially in areas where livelihood opportunities are limited without the appropriate skills, capital and contacts.

The relationship between climate change and health determinants contributes to vulnerability. Vulnerability, the degree to which individuals and systems are susceptible to or unable to cope with the adverse effects of climate change, is a function of:

- **Exposure** to the weather or climate-related hazard, including the character, magnitude and rate of climate variation (Kovats et al. 2003): Exposure to climatic variables often depends on geographic location, but can also be influenced by a range of occupational and behavioural factors. Socioeconomic factors can also influence exposure; for example, a family with low income may have no other option but to live in substandard housing, which in turn may increase their exposure to climate-related hazards such as the risk of injury during an extreme weather event (Health Canada 2005).
- **Sensitivity**, or the degree to which an individual is affected (adversely or beneficially) by climate-related stimuli (Health Canada 2005): Health status is a key factor in determining a person's susceptibility to the impacts of weather events. For example, individuals with pre-existing health conditions (e.g. a respiratory illness), may be more sensitive to the health risks of air pollution than others (Health Canada 2005).
- **Adaptive capacity**, or the ability to adjust to climate change, moderate potential damages, take advantage of opportunities or cope with the consequences (Health Canada 2008, with reference to the Intergovernmental Panel on Climate Change 2007): Adaptive capacity is influenced by many interrelated factors, such as economic resources, technology, information and skills, infrastructure, institutions, existing inequalities in health status and pre-existing disease burdens (Health Canada 2005, with reference to Grambsch and Menne 2003). For example, older individuals may have a much lower capacity to adapt to natural hazards due to limited mobility, physical or social isolation, or lower incomes (Health Canada 2008).

The health status of Canadians is generally believed to be quite good, providing a strong foundation for coping with the diverse stresses that climate change will place on health and well-being (Health Canada 2008). However, there are notable disparities within the population, and as such, certain populations will face a greater than average risk due to increased exposures, existing sensitivities or low adaptive capacity (Health Canada 2005). Table 2 identifies some examples of these vulnerable populations.

Table 2. Examples of vulnerable groups

Vulnerable Groups	Examples of Vulnerabilities
Infants and children	<ul style="list-style-type: none"> • Young children are vulnerable to natural hazards because their perception of danger is not fully developed, and they require more assistance to move out of harm's way and adopt protective behaviours • Young children and infants are more vulnerable to water- and food-borne illnesses because they have immature immune systems and are unable to avoid the risks on their own • Children's thermoregulatory capacities are underdeveloped and their higher ratio of surface area to body mass makes them more vulnerable to heat stress
Women	<ul style="list-style-type: none"> • Pregnant women and their developing fetuses may be at special risk during extreme weather events. Anxiety and stress as a result of the extreme weather can give rise to obstetric and developmental complications • Women may be more vulnerable to psychosocial health impacts during extreme events because they are more likely to bear the burden of recovering from the event, and of continuing to meet multiple demands in and outside the household
Seniors	<ul style="list-style-type: none"> • Seniors are more likely to have underlying health problems that need regular medical attention, reduce mobility or impair their ability to care for themselves • Seniors are at particular risk of heat-related illnesses and death because heat tolerance and thermoregulatory capacity decrease with age • Seniors are often on fixed income, which can make it more difficult for them to meet the costs associated with natural hazards • As networks of families and friends tend to decrease in size as people age, social isolation and loneliness tend to increase
People with underlying health problems	<ul style="list-style-type: none"> • Chronic health conditions, acute illnesses, neurological disorders, mental illnesses and limited mobility increase vulnerability to natural hazards • Neurological and mental illnesses can affect a person's ability to function effectively during a natural hazard event or during a disaster • Reliance on medical services can increase vulnerability in times when health centres or emergency shelters become overwhelmed during a disaster
Low income and homeless people	<ul style="list-style-type: none"> • Low income limits the ability of individuals and families to reduce their risk to natural hazards, such as choosing where to live, adopting protective behaviours and adaptations, and accessing measures that facilitate recovery • People without permanent shelters are more vulnerable to extreme weather events because they are more exposed, they may not have the means to protect themselves, and they are less able to physiologically adapt
People living off the land	<ul style="list-style-type: none"> • Individuals whose livelihoods depend on natural resources as a source of employment or as a direct source of food can be particularly vulnerable to the impacts of natural hazards • Industries that rely on natural resources (e.g. forests, fisheries, agriculture) may be unable to protect their assets from natural hazards and changes in climatic conditions
First Nations communities	<ul style="list-style-type: none"> • Many factors affect the vulnerability of First Nations communities, such as poor health status, socioeconomic conditions and inadequate infrastructure, making them more vulnerable and less resilient to natural hazard events • There is a higher incidence of some chronic diseases among First Nations people compared with the general population, such as heart disease and diabetes • The isolation of many First Nations communities makes evacuation and access to emergency and health services difficult and costly during disasters

Source: Health Canada 2008 and Health Canada 2005

When we look at specific climate change hazards more closely, additional layers of vulnerability begin to emerge. Health Canada (2008), for example, provides a detailed overview of the projected climate change impacts that will be faced by Canadians, including natural hazards and extreme weather, air quality, and water-, food-, vector- and rodent-borne diseases. In each section, vulnerable and high-risk populations are identified, as in the example given in Table 3 for natural hazards.

Table 3. Key weather-related natural hazards in Canada and their associated health impacts

Extreme Weather Event	Examples: Health Impact Pathway(s)	Examples: Potential Health Effects	Populations at Higher Risk
Extreme heat	<ul style="list-style-type: none"> • Body temperatures are elevated beyond normal range • Increased growth and abundance of disease-causing organisms and vectors • Air quality is negatively affected 	<ul style="list-style-type: none"> • Dehydration • Heat-related illnesses (heat stroke, fainting, heat cramps, heat rash) • Existing medical problems made worse, such as asthma and allergies • Physical and mental stress • Respiratory and cardiovascular disorders • Vector-borne infectious diseases 	<ul style="list-style-type: none"> • Young children • Seniors (especially those who are bedridden, unable to care for themselves or socially isolated) • Chronically ill individuals • People living in areas with poor air quality • People working or exercising outdoors • People without access to air conditioning • People on certain medications
Extreme cold	<ul style="list-style-type: none"> • Body temperature is reduced below normal range 	<ul style="list-style-type: none"> • Frostbite • Hypothermia • Death • Increased risk of injury due to accidents (car, slipping on ice, shoveling snow) 	<ul style="list-style-type: none"> • People without shelter • People who play or work outdoors • Children • Seniors
Extreme rain or snowfall	<ul style="list-style-type: none"> • Flooding and its after-effects (e.g. poor indoor air quality from growth of moulds) • Increase in populations of mosquitoes and other disease carriers • Contamination of drinking water by chemicals or wastes in surface runoff • Failure of essential infrastructure (e.g. sewers, water treatment facilities) • Algal blooms and other changes in aquatic ecology 	<ul style="list-style-type: none"> • Physical injury, shock and trauma • Death by drowning • Respiratory illnesses • Outbreaks of cryptosporidiosis, giardiasis, amoebiasis, typhoid and other water-borne infections 	<ul style="list-style-type: none"> • Children • Seniors • People living along coasts or waterways • People with chronic illnesses • People with compromised health status • People with impaired immune systems • People with inadequate or no housing

Extreme Weather Event	Examples: Health Impact Pathway(s)	Examples: Potential Health Effects	Populations at Higher Risk
Extreme drought	<ul style="list-style-type: none"> • Water shortages • Crop failures • Reduced water quality • Wildfires • Air pollution due to dust and smoke 	<ul style="list-style-type: none"> • Respiratory illnesses from dust and smoke from fires • Outbreaks of water-borne illness due to increased concentration of contaminants • Hunger, malnutrition and associated stress disorders due to crop failures and economic hardship • Injury or death (in extreme cases) • Stress from loss of property, livelihood, displacement and community disruption 	<ul style="list-style-type: none"> • People living in drought-prone areas • Agriculturally dependent communities • People without insurance • People without resources (e.g. financial and social)
Severe storms	<ul style="list-style-type: none"> • High winds • High waves and storm surges • Flooding • Property damage • Damage to essential infrastructure (e.g. power lines, hospitals, water treatment plants) • Damage to personal property • Increased risk of automobile accidents 	<ul style="list-style-type: none"> • Physical injuries or death from falls, collapsing building, windblown debris, house fires, motor vehicle accidents, etc. (especially head injuries, fractures and lacerations) • Hypothermia • Electrocutation • Food-borne disease • Respiratory illness and asthma due to pollen and spores • Drowning • Stress disorders from loss of loved ones, property and livelihoods 	<ul style="list-style-type: none"> • People living in storm-prone areas • People living in low-lying coastal areas or in regions prone to flooding • People living in areas where environmental degradation has created hazardous conditions

Source: Health Canada 2008

Unfortunately, few studies in Canada go beyond a general discussion of climate change vulnerability to really delve into the health equity implications, that is, to examine the root causes of these health disparities and find ways to address them.

There is an established body of research showing that the roots of health disparities lie in broader social and economic inequality and exclusion (Gardner 2008). For example, while we know that people living in areas of poor air quality are at higher risk during an extreme heat event, we need to be aware that there are subpopulations within these areas (e.g.

marginalized populations, new immigrants, non-English speakers, etc.) that may face additional barriers to protecting their health during such an event. Thus, a better understanding of how these underlying inequalities are distributed among the general population combined with understanding of how barriers affect adaptive capacity differentially is urgently needed.

There is also an important consideration to be made with respect to costs. According to the Public Health Agency of Canada (2005), people in the lowest quintile of income groups – who are often more severely sick or injured – use approximately twice as much in the way of health care services as those in the highest quintile. Based on estimates of health care resources used by Canadian households, approximately 20% of total health care spending is believed to be attributable to income disparities. However, despite this higher overall use of health services, health disparities continue to persist among individuals or groups of lower socioeconomic status (SES) (Public Health Agency of Canada 2005). Without effective and widespread planning, the costs of climate change will extend beyond the direct health impacts (injury, disease, death, etc.) to include economic costs to health care and social systems (Health Canada 2005, with reference to the Institute for Population Health 2002), threatening the sustainability of health care systems that are already faced with significant resource constraints.

THE TORONTO CONTEXT

The current and projected makeup of the City of Toronto has been extensively documented by Statistics Canada, the City of Toronto and other sources. What emerges from these sources is a picture of a city that is rapidly growing and transforming, and that encompasses a number of vulnerable populations. While a thorough discussion of Toronto's population and demographics is beyond the current scope of this report, some notable facts are worth mentioning:

- **Toronto's population is growing.** According to the 2006 Census, there were 2.5 million people living in the City of Toronto – 8% of Canada's total population. The City's population is projected to grow to 3.3 million people by 2036 (Ontario Ministry of Finance 2009).
- **Toronto's population is uniquely diverse.** Nearly 47% of Toronto's population comprises visible minorities³. This represents an increase of nearly 11% per cent since 2001, and 32% per cent since 1996. The largest visible minority groups are: South Asian, Chinese, Black, Filipino and Latin American. Toronto's diversity is also reflected in the many languages spoken by its residents, with 47% of the population

³According to Statistics Canada: "Visible minority refers to whether a person belongs to a visible minority group as defined by the Employment Equity Act and, if so, the visible minority group to which the person belongs. The Employment Equity Act defines visible minorities as "persons, other than Aboriginal peoples, who are non-Caucasian in race or non-white in colour". The visible minority population consists mainly of the following groups: Chinese, South Asian, Black, Arab, West Asian, Filipino, Southeast Asian, Latin American, Japanese and Korean."

(<http://www.statcan.gc.ca/concepts/definitions/minority-minorite1-eng.htm>)

reporting a mother tongue other than English or French. While English is the predominant language spoken by Torontonians, Statistics Canada reports that other widely spoken languages include Chinese, Portuguese, and Italian.

- **Toronto is a city of (new) immigrants.** Half the City's population was born outside of Canada. In fact, as of 2006, almost 70% of immigrants to Canada had settled in the Toronto Census Metropolitan Area (CMA), demonstrating that Toronto is a prime immigrant reception area in Toronto. Half of all immigrants in Toronto have lived in Canada for less than 15 years, meaning that many are relatively new immigrants.
- **There is a significant First Nations population in the City.** According to Statistics Canada, in 2006, there were 13,605 aboriginal persons living in the City of Toronto⁴, an increase of 20% since 2001. This represents over 0.5% of the total City population, and 43% of the First Nations population in the Greater Toronto Area (GTA).
- **Toronto's population is aging.** According to Statistics Canada, more than 350,000 seniors lived in the City of Toronto in 2006, representing 14% of the City's population, and 53% of all seniors living in the GTA. According to research conducted by the City's Social Development, Finance and Administrative Division, seniors are expected to make up 17% of the City of Toronto population by 2031.
- **A growing number of Torontonians are poor.** In 2005, there were 134,247 family households and 165,156 persons not living in family households with before-tax income below Statistics Canada's Low Income Cut-off (LICO)⁵. From 2000-2005, the number of low-income families and individuals in Toronto grew by 9,242 and 23,776 respectively. The incidence of low income families and individuals in 2005 is higher than it was at the beginning of the 1990s, and is almost double that in the rest of the GTA, Ontario and Canada.

A number of these changes in Toronto's population suggest a need for closer study, with a view to documenting potential increases in vulnerability within the population to the impacts of climate change.

4. EVIDENCE FOR CLIMATE-RELATED HEALTH INEQUALITIES

It is not possible to identify definitively all or most of the health impacts of climate change because climate is projected to continue changing for the foreseeable future, and the impacts are likely to amplify. However, evidence of recent weather events and their health effects can certainly give us an indication of potential vulnerabilities and impacts.

Climate change and health inequality have been studied extensively in the United States and parts of Europe, particularly in the context of extreme heat events (e.g. Morello-Frosch et al. 2009; Shonkoff et al. 2009; Climate Change Public Health Impacts Assessment and Response

⁴ Agencies serving the First Nations community in Toronto estimate that there may be closer to 70,000 residents who belong to this community.

⁵ The LICO for single person and a family of four was \$20,778 and \$38,610, respectively.

Collaborative 2007; Kovats and Ebi 2006; Vandentorren et al. 2006; Klinenberg 1999). Shonkoff et al. (2009) and Morello-Frosch et al. (2009) showed that during the 2006 California heat wave, emergency department visits for heat-related causes increased across the state, especially in the Central Coast. Further, emergency department visits showed statistically significant increases in acute renal failure, diabetes, cardiovascular disease, diabetes, electrolyte imbalance, and nephritis. Children (0-4 years of age), the elderly (≥ 65 years of age) and low-income African Americans were disproportionately affected.

While these and other researchers acknowledge that heat exposure alone can cause morbidity and mortality, physiological, social and economic factors are integral in explaining the uneven distribution of these and other adverse heat-specific health outcomes across diverse populations. Intrinsic factors such as age or disability and extrinsic factors such as housing, access to cooling centres and transportation can exacerbate existing risk factors. Low-SES groups, for example, are disproportionately affected by medical conditions, such as cardiovascular and/or psychological illnesses which increase the risk of dying during heat waves. Low-income urban communities and communities of colour in the U.S. are particularly vulnerable to increased frequency of heat waves and higher temperatures because they are often segregated in the inner city, which is more likely to experience the urban heat island effect (Shonkoff et al. 2009). Similar observations have been made about populations that were affected by the heat waves experienced in Chicago in 1995 and France in 2003 (e.g. Kovats and Ebi 2006; Vandentorren et al. 2006; Klinenberg 1999).

The literature on vulnerabilities to climate change has not been limited to heat events. For example, a significant amount of attention has been paid to the disproportionate impact of Hurricane Katrina in 2005 on elderly and African American populations (e.g. Sharkey 2007; Elliott and Pais 2006; Gabe et al. 2005). According to an analysis conducted by Sharkey (2007), for example, the impact of the storm was felt most acutely among specific groups within New Orleans. The elderly were the most vulnerable to Katrina, as evidenced by their extraordinarily high death rates⁶. Although biological factors likely contributed to the vulnerability of elderly populations to extreme events, social factors, such as the social isolation of the elderly, especially in violent urban areas, may offer an additional explanation for the extraordinarily high death rates that were found among the elderly in New Orleans, a finding that is consistent with other literature.

Sharkey's analysis showed that African Americans were disproportionately represented among both elderly and nonelderly victims. Elliott and Pais (2006) took this analysis a step further, to look at class and racial disparities both in the recovery period after the hurricane event. Elliott and Pais show that African American workers from New Orleans were far more likely to lose their jobs after the storm, a disparity that would have a strong effect on who is able to return to the city as it rebuilds. They go on to suggest that without targeted

⁶ According to Sharkey's analysis, approximately 67% of the victims from New Orleans were 65 years of age and older. The death rate for the elderly population in the city was more than 15 that of the death rate for the nonelderly population.

assistance low income African Americans, who may have limited options in terms of resettlement, will likely face the most difficulty putting their lives back together again. Mortgage foreclosures and precarious employment opportunities will threaten not only their livelihoods, but also those of their families.

In the Canadian context, there is a significant amount of literature on health equity (e.g. McKeown et al. 2008; Lightman et al. 2008; Raphael 2002). Many of these studies focus on the relationship between income and health outcomes. As an example, a recent study by McKeown et al. (2008), titled *The Unequal City*, clearly demonstrated that areas of Toronto with a greater proportion of low income people experience greater risk factors for illness, higher rates of disease, and early mortality than higher income areas. While this study does not focus on climate change explicitly, it clearly illustrates the challenges currently being faced by low-SES individuals and populations in maintaining their health and well-being, challenges that will no doubt be exacerbated by the effects of climate change.

Another study recently conducted by PollutionWatch (2008) looked at the intersection between pollution and poverty in the Great Lakes Basin. In this study, researchers identified Toronto as one of 27 census subdivisions in the Great Lakes basin that experiences high air toxic pollutant levels and high poverty rates. Within Toronto, there are 17 neighbourhoods where high levels of combined air pollutants and high poverty rates coincide, suggesting that people living in these communities may face a double burden when it comes to protecting their health. Again, while climate change was not addressed specifically in this study, there are climate change links to be made. Toronto is downwind of the Ohio Valley airshed, where a large number of coal-fired generating stations are located. When heat waves occur, energy demand for air conditioning increases, and much of the extra demand is provided by these plants, which increases the level of air pollutants. In the 17 neighbourhoods already suffering from high pollution levels, more hot days and heat waves will increase this exposure, potentially interacting with the effects of the high temperatures themselves.

One of the few recent studies exploring the connection between low-SES populations and potential climate change impacts on health assesses the vulnerability to climate change (exposure-sensitivity and adaptive capacity) of homeless people in the urban areas of Waterloo Region (Wandel et al. 2010). Over the course of July and August 2009, four interviewers conducted qualitative interviews with 48 individuals who have experienced absolute homelessness in Waterloo, documenting how they experience and cope with weather and climatic conditions. Not surprisingly, the researchers found that the exposure sensitivity to extreme weather conditions among the homeless is high. Weather conditions such as extreme rain, heat and cold exacerbated pre-existing conditions such as mental illness, respiratory and cardiovascular diseases, social isolation and drug and alcohol use. Thus, there is a real risk that people experiencing absolute homelessness will be vulnerable to the increasingly frequent and severe impacts of climate change.

Studies such as these are hard to find. There is very little empirical research available that addresses the climate change related vulnerability of groups with limited access to

resources in Canadian urban context (e.g. people experiencing absolute homelessness, low-income families, recent immigrants, elderly individuals, etc.) (Wandel et al. 2010; Ramin and Svoboda 2009). Nevertheless, there is much to be learned from the experiences of other jurisdictions and as such, actions to reduce health inequalities in the face of climate change will be urgently needed here in Toronto.

5. MEASURING VULNERABILITY

Vulnerability assessments can be undertaken to identify populations at risk, and to inform the development of adaptation options to reduce the effects of climate change (Health Canada 2008). Several conceptual and analytical frameworks for assessing vulnerability and adaptive capacity have been developed and are widely used (e.g. Lim et al. 2005; Kovats et al. 2003; Feenstra et al. 1998). However, in order to develop effective public health adaptation strategies, evaluate their success, and project the impacts of climate change on human health, indicators of vulnerability and preparedness along with accurate surveillance data on climate-sensitive health outcomes, are urgently needed (English et al. 2009).

Research on climate change vulnerability and the development of vulnerability indicators is growing (English et al. 2009; Frumkin et al. 2008; Climate Change Public Health Impacts Assessment and Response Collaborative 2007). Perhaps the most comprehensive suite of climate change health indicators to date has been developed by English et al. (2009), who conducted a review of the scientific literature to develop a suite of health indicators (environmental, vulnerability, mitigation, adaptation, and policy) for inputs into US health vulnerability assessments for climate change. Examples of these indicators are provided in Table 4 below.

Table 4. Examples of proposed (national level) environmental health indicators for climate change

Type of Indicator	Examples
Environmental indicators	<ul style="list-style-type: none"> • Greenhouse gas emissions • Stagnation of air mass events • Ozone estimates due to climate change • Maximum and minimum temperatures, heat index • Increase in heat alerts/warnings • Pollen counts, ragweed presence • Frequency, severity, distribution and duration of wildfires • Droughts: standardized precipitation index, surface water supply index • Harmful algae blooms: human shellfish poisonings, algae outbreak monitoring in freshwater and ocean waters • Morbidity and mortality indicators (excess mortality due to extreme heat; excess morbidity due to extreme heat) • Number of injuries/mortality from extreme weather events • Human cases of environmental infectious disease/positive test results in reservoirs/sentinels/vectors • Respiratory/allergic disease and mortality related to increased air pollution and pollens
Vulnerability indicators	<ul style="list-style-type: none"> • Elderly living alone, poverty status, children, infants, and individuals with disabilities • Flooding vulnerability (elderly, those in poverty, infants, and disabled living in 100- and 500-year flood zones) • Sea level rise vulnerability (population by county within 5 km of coast with “very high” vulnerability to sea level rise)
Mitigation indicators	<ul style="list-style-type: none"> • Energy efficiencies • Use of renewable energy • No. of vehicle miles traveled
Adaptation indicators	<ul style="list-style-type: none"> • Access to cooling centres • Number of heat wave early warning systems • Number of municipal heat island mitigation plans • Number of health surveillance systems related to climate change • Public health workforce available/trained in climate change research/surveillance/adaptation
Policy indicators	<ul style="list-style-type: none"> • Number of cities/municipalities covered by Kyoto Protocol • Number of states/cities participating in climate change initiatives

Source: Adapted from English et al. 2009

However, such research is not without its limitations. English et al. admit that these are national level indicators, therefore some will not be applicable at the local geographical scale, at least not until finer scale surveillance methods and modeling techniques become available and are implemented. This underscores an important need to develop indicators of climate change and health disparities that are applicable at the local scale, particularly for an area such as the City of Toronto.

The City of Toronto has taken some steps in this direction. As an example, Toronto Public Health recently commissioned a report on the development of a Toronto-specific, spatially-

explicit heat vulnerability assessment (Rinner et al. 2009). The report reviews the literature on risk factors for heat impacts on humans, provides an overview of hot weather response measures, describes methods for vulnerability analysis and corresponding tools based on a geographic information system, and proposes a conceptual framework for heat vulnerability assessment.

Importantly, the report provides a rationale for selecting Toronto-specific heat vulnerability indicators, which can be used to support cartographic maps that explore spatial patterns of heat vulnerability and identify areas where interventions should be prioritized. These indicators, listed in Table 5 below, are grouped according to the three aspects of vulnerability (exposure, sensitivity, and adaptation) and are consistent with indicators in the literature (in the case of exposure and sensitivity) and current facilities and services in place (in the case of adaptation).

Table 5. Indicators for a Toronto-specific heat vulnerability assessment

Exposure	Sensitivity	Adaptation
<ul style="list-style-type: none"> • Outdoor surface/air temperature • Lack of tree canopy, green spaces • Old dwellings without air conditioning • High-density dwellings without air conditioning • Behaviour (recreation and events) 	<ul style="list-style-type: none"> • Pre-existing/chronic illness • Cognitive impairment • Elderly residents • Infants and young children • Low-income households • Rental households • Socially isolated people • Homeless • Low education level • Not English speaking • Recent immigrants • Racialized groups 	<ul style="list-style-type: none"> • Home cooling, common cool rooms • Hostels, drop-in centres • Participating community outreach centres • Cooling centres, libraries, malls

Source: Rinner et al. 2009

This approach presents a limited notion of adaptation indicators. Other cooling measures, for example, the expansion of the City’s tree canopy and green spaces, or the uptake of green and white roofs on residential buildings, can confer important health benefits, and should be incorporated into future vulnerability assessments. Nevertheless, this is an important step forward, and similar efforts should be made to address other climate-related impacts.

6. HEALTHY, RESILIENT COMMUNITIES

FEATURES OF HEALTHY, RESILIENT COMMUNITIES

Recent events in Canada and abroad have demonstrated that developed countries can be overwhelmed by extreme weather events. Losses from floods, storms and droughts occur annually in Canada, amounting to hundreds of millions of dollars, and sometimes even billions of dollars (Health Canada 2008, with reference to Public Safety and Emergency Preparedness Canada 2005). However, the impact of these events on the health and well being of affected populations goes well beyond the reported monetary costs.

Healthy, resilient communities are communities capable of dealing with adverse situations by actively influencing and preparing for economic, social and environmental changes. This type of community is able to respond to these changes in a positive way, and is able to maintain its core functions as a community in spite of them. This type of community will best be able to deal with the challenges of climate change.

According to Morrow (2008), a resilient community is one that comprises physical resilience (e.g. the strength to deal with an impact, such as the ability of a house to withstand high winds or the physical health of an individual which enables her to survive a disaster) and economic resilience (e.g. the robustness and diversity of the economy which sustains recovery from a disaster). However, in the context of health equity, social resilience cannot be ignored. Social, or socioeconomic, resilience describes abilities within

human societies to adjust to change, particularly “to absorb recurrent disturbances such as hurricanes and floods so as to retain essential structures, processes and feedbacks” (Morrow 2008, with reference to Adger et al. 2005). At the community level, resilience is closely tied to the economic and political circumstances of a community, as well as to the strength of its social institutions and social networks. At the individual or household level, resilience is associated not only with economic resources but also cultural resources, such as literacy and education, and social resources, such as family and friends. All of these factors come together to ensure that individuals and families are healthy and safe.

This is where adaptation has an important role to play. As discussed in Maguire and Cartwright (2008), rather than simply returning to a pre-existing state, a healthy, resilient community is one that changes to a new state that is more sustainable in the context of a new environment. A resilient community is able to use the experience of change to continually develop and to reach an improved state of functioning. Rather than simply ‘surviving’ the stressors or changes it faces, a resilient community responds in creative ways that transform the basis of the community. Viewing resilience from this perspective draws the focus to the adaptive capacities of a community – the characteristics which enable it to develop and innovate in response to a change – rather than simply focusing on its vulnerabilities.

THE IMPORTANCE OF ADAPTATION

While a growing body of literature exists on climate change adaptation as it relates to health, research suggests that the actual uptake of adaptation measures in Canada and globally has been slow; to date, much of the focus of middle- and high-income countries has been on mitigation rather than adaptation (Ligeti et al. in press). Mitigation strategies can certainly help to reduce health risks and/or improve health outcomes. However, the goal of these strategies is to reduce the long term impacts of climate change. Because of historical and current GHG emissions, a significant level of climate change will occur over the short- to medium-term, and adaptation is necessary to address the impacts.

As Ligeti et al. (in press) demonstrate, there is no shortage of adaptation measures that can be implemented to help urban populations cope with the impacts of climate change. These include:

- **General adaptation measures that will reduce health risks**, such as:
 - Incorporation of climate change information and projections into standards, policies and codes, such as those relating to the construction and maintenance of stormwater and flood control systems, transportation infrastructure and buildings;
 - Reducing impermeable surfaces through provision of green space, urban trees, vegetation, and other means such as permeable pavements and green roofs;

- Extension and maintenance of essential infrastructure services, taking account of changing climate conditions;
 - Energy and water conservation programs.
- **General adaptation measures for the health sector**, such as:
 - Understanding and mapping health hazards related to climate variability and change;
 - Developing climate-based early warning systems coupled with response plans and activities to evaluate their effectiveness;
 - Tracking and assessment of diseases and health trends related to climate change;
 - Health communications on the health effects of climate change to inform the public about potential health effects and what they can do to protect themselves from weather-related illnesses and injuries;
 - Collaboration with city officials and communication with community leaders.
- **Adaptation measures for specific health risks.** Examples of sector specific adaptation measures are provided in Ligeti et al. (in press) and Health Canada (2008). Examples include:
 - Early warning systems to reduce the impacts of extreme heat and cold events;
 - Urban agriculture to reduce the impacts of decreased food availability (e.g. in response to droughts, floods, rising food prices, etc.)
 - New vaccination programs to reduce the incidence of vector-borne diseases;
 - Public education programs to alert the public to the potential threat of food contamination and ways to avoid foodborne illnesses;
 - Surveillance and forecasting to reduce the impacts of extreme events such as floods, tornadoes and hurricanes.

The City of Toronto is taking steps to incorporate adaptation into its planning processes. The City's Climate Change Adaptation Strategy (adopted by Council in 2008) commits to the development of a long-term, comprehensive adaptation strategy that identifies key vulnerabilities to climate change of the City. Many innovative programs have already been implemented, such as the Heat Alert System and Hot Weather Response Plan, while others, such as a new Risk Assessment Tool, are presently under development.

Adaptation in high-rise buildings is an area that has garnered recent attention. According to a report published by the United Way (2011), the City's aging high-rise apartment buildings have increasingly become sites of concentrated poverty within Toronto's neighbourhoods. Low-income families make up a growing share of the City's tenant population; in 1981, one out of every three low-income families in the City of Toronto (34%) rented a unit in a high-rise building; however, by 2006, this had increased to 43 per cent, with much of the growth concentrated in the inner suburbs of the City.

In 2008, Toronto launched the Tower Renewal project (<http://www.towerrenewal.ca/index.php>) in an effort to revitalize the City's high-rise apartment buildings. Although the project focuses primarily on climate change mitigation through high-rise building retrofits and other measures, the project does present some important adaptation benefits (for example, improving building insulation through the addition of external cladding), as well as a number of important social benefits through a series of complementary neighborhood revitalization projects (for example, providing space for neighborhood meetings and interactions). Clean Air Partnership recognizes that greater effort is needed in this area, and is working to advance the discourse on climate change adaptation in high-rise residential buildings through the development of an expert-led technical workshop under the Community Adaptation Initiative, to be delivered in the Fall of 2011.

Part of the challenge lies in identifying the adaptation options that are appropriate for a City such as Toronto, and tailoring these in such a way that they are able to reach the most vulnerable members of the population. Engagement of individuals and communities is needed to ensure that messages designed to reach vulnerable groups provide the information and motivation necessary for individuals to make appropriate choices (Ebi 2009).

As an example, Kovats and Ebi identify socially isolated, elderly individuals as particularly susceptible to the risks of an extreme heat event, especially if their perception of ambient temperature is poor, or if they suffer from mental illnesses or disabilities that cause cognitive or behavioural problems. According to these researchers, passive dissemination of heat avoidance advice is insufficient to protect these individuals; targeted programs and messages are required. The City of Philadelphia's Heat Health Watch Warning System is a good example of a program designed to reach out to these vulnerable individuals through a number of channels including media announcements, a 'buddy system' that encourages the public to visit older friends, relatives and neighbors, 'block captains' that check in on local residents; telephone 'Hotline' activation and home visits by public health staff (Clean Air Partnership 2007).

Ramin and Svoboda (2009) suggest that the City of Toronto has made some important progress in tailoring its adaptation initiatives to homeless populations. For example, outreach to the homeless is a key component of the City's Heat-Health Warning Systems; on days when a heat alert is in effect, homeless shelters are requested to remain open, cooling stations are identified, transit tokens are distributed to homeless individuals, and outreach programs are initiated. Other adaptation programs have some ways to go with respect to targeted outreach; the City's West Nile Virus program, for example, provides information specific to homeless populations; however the reliance of this program on internet and other mass media renders this targeted outreach largely ineffective (Ramin and Svoboda 2009). There is still a great deal of work to be done to ensure that the City's adaptation initiatives effectively reach out to the City's most vulnerable residents.

KEY CONSIDERATIONS FOR THE CITY OF TORONTO

The City of Toronto has demonstrated leadership in addressing the pressing impacts of climate change, and is well positioned to begin tackling the issue from a health equity perspective. Below, we outline five key considerations for the City as it moves forward:

1) Make health equity a part of the climate change adaptation discussion.

The term health equity suggests that all people can reach their full health potential and should not be disadvantaged from attaining it because of their social position or other socially determined factors (Dahlgren and Whitehead 2006).

There is a close relationship between the challenges of climate change and the challenges of health inequalities, not least because both impact most on the poor and disadvantaged (The Marmot Review 2010). As such, health equity needs to be made a part of the climate change conversation. As was discussed in previous sections, health equity is an important area of discourse in Toronto (and Canada for that matter); however, little effort has been made to explore the intersection between health equity and climate change. These two issues need to be addressed simultaneously (Walpole et al. 2009). Addressing one while ignoring the other is simply inadequate; we need to look for ways to seek out responses that are synergistic and that offer co-benefits.

However, addressing the issues of climate change and health equity requires that we also take a step back and consider the bigger picture. These are complex, interrelated issues but they are only a component of overall community well-being. Therefore, we need to be clear on our vision for a healthy, resilient city, and what it is we hope to achieve over the long term. Although it may be challenging to articulate a common vision for the City of Toronto, this is a critical conversation that needs to happen.

2) Document evidence of existing health inequalities in Toronto, in the context of current climate variability and climate change.

As discussed previously, the links between climate change and its health impacts are not fully understood. However, documenting evidence of recent weather events and their health effects can give us an early indication of vulnerabilities and impacts, and greater efforts need to be made in this regard.

Globally, the World Health Organization and other organizations have called for greater efforts to collect and share evidence on the ways in which social determinants influence population health and health equity and on the effectiveness of measures to reduce health inequities through action on social determinants (World Health Organization 2008); without it, there is very little to support the need for action. Although we have seen research efforts emerge in the U.S. and Europe, Canada lags behind. There is currently very little empirical research available that addresses the climate related vulnerability of groups with limited access to resources in the Canadian urban context (Wandel et al. 2010).

More importantly, greater effort needs to be made to document evidence of existing health inequalities in the context of climate change, but at the local level. While Toronto has been home to active discourse around the issue of health equity in recent years, very little has been done to explore the health equity implications of a changing climate.

3) Develop tools to measure the impacts of climate change on vulnerable populations.

Measuring the impacts of climate change on health is challenging because health outcomes are strongly influenced by multiple factors (Health Canada 2008). An understanding of causal pathways, the sensitivity of different populations to a range of climate-related risks, and the adequacy of existing coping strategies is necessary to devise effective climate change adaptation options.

Provided that they are selected with care and scaled appropriately, indicators can be useful for assessing the level of vulnerability of individuals and populations and to help practitioners identify priority areas for action. Much of the current literature focuses on vulnerability indicators that are applicable at the national level, suggesting that reliable indicators and surveillance data to assess health vulnerability at the local level are still lacking.

Toronto Public Health has already demonstrated that a suite of indicators can be developed to assess and map vulnerability to extreme heat events. Similar efforts need to be made to identify vulnerabilities to other climate-related events that are of relevance to the City of Toronto.

4) Ensure that adaptation strategies are responsive to the needs of vulnerable populations.

As we have seen from recent experiences in Canada, the US and Europe, the impacts of recent hurricanes and heatwaves show that even high-income countries are not fully prepared to cope with extreme weather events (Confalonieri et al. 2007).

Adaptation measures need to be prioritized, with a view to addressing current vulnerability to climate change as well as health risks projected to occur over the coming decades. However, this is not enough. Although everyone is, at some level, susceptible to the health consequences of changing weather patterns and alterations in the distribution and incidence of climate-sensitive health outcomes, there are populations and geographic regions that clearly have enhanced vulnerability (Ebi 2009). Adaptation measures need to be taken a step further to ensure that the needs of these vulnerable populations are taken into account.

As the World Health Organization states, research on climate change and health must be placed more firmly within the overall context of improving global health and health equity, rather than being considered as a stand-alone issue (World Health Organization 2008). However, the health effects of climate change will inevitably be felt at the local level,

therefore responses will be largely dependent on the local characteristics and resources of individual communities. As English et al. (2009) argue, increased focus on adaptive public health responses at the local level is critical now more than ever.

Given that adaptation can occur at different scales, be it City-wide plans and policies or community-based interventions, different approaches will need to be taken for each. As discussed in Frumkin et al. (2008), public health agencies have an important role to play in informing city-wide adaptation plans and policies to ensure that they support community health by taking health equity into consideration. This could include providing evidence of health impacts resulting from climate change, developing the health rationale for new plans and policies, or identifying priority areas or communities for implementation. This is where cross-sectoral collaborations, as discussed in Section 5 below, will be instrumental. However, City-wide initiatives may not go far enough to address all of the root causes of vulnerability; public health agencies, therefore, have a critical role to play in engaging individuals and communities directly to ensure that they have the tools needed to respond to the impacts of climate change, such that messages designed to reach vulnerable groups provide the information and motivation necessary for individuals to make appropriate choices, enhancing their resilience to climate stressors in the process.

5) Seek out opportunities for cross-sectoral collaboration.

The wide range of health issues associated with climate change necessitates the collaborative involvement of a broad spectrum of decision makers, especially at the municipal level where many of the public health programs are delivered (Health Canada 2001). Additionally, given that many climatic risks to health lie at least partly outside the health sector's normal sphere of action (Campbell-Lendrum et al. 2007), public health responses to climate change can only benefit from collaboration with other departments, agencies and organizations.

This is no less true when we consider the equity dimension. As Lettner (2008) points out, the roots of health disparities often lie in broader aspects of social and economic inequality and exclusion (e.g. income/wealth distribution and poverty, education, employment, housing, gender, race and ethnicity, citizenship and immigration status, language, etc.), producing health disparities that go beyond the jurisdiction of the health care system. As discussed in Gardner (2008), much of the solution to health disparities therefore lies in macro social and economic policy and in policy collaboration and coordination across governments.

Public health agencies still have a key role to play in developing and implementing city-wide adaptation strategies, yet they can't be expected to do this alone. Many adaptation measures are so complex or expensive that they can only be undertaken with the support of other city departments, external agencies and organizations, and other levels of government (Ligeti et al. in press). As such, if the City wishes to develop and implement adaptation strategies that are effective and equitable, it should be prepared to involve representatives of multiple departments and agencies from the planning stages onward. For example,

involving departments or agencies that work on housing, education, or social services can be useful for tapping into existing knowledge about vulnerable populations, and identifying areas where joint planning and delivery would be most effective. Working with these additional stakeholders has the added bonus of helping ensure individual and community acceptance of, and the success of, adaptation measures, along with reducing many of the constraints to implementation (Ebi 2009).

Broadly speaking, there are four groups of stakeholders that Toronto Public Health should consider engaging. These include:

- External government agencies, such as:
 - Federal agencies (e.g. Health Canada, Environment Canada, Public Health Agency of Canada, etc.)
 - Provincial agencies (e.g. Ministry of the Environment, Ministry of Health and Long-Term Care, etc.)
- City of Toronto Divisions, such as:
 - Affordable Housing Office
 - City Planning
 - Emergency Medical Services
 - Employment and Social Services
 - Long-Term Care Homes and Services
 - Office of Emergency Management
 - Parks, Forestry and Recreation
 - Shelter Support and Housing Administration
 - Social Development, Finance and Administration
 - Toronto Environment Office
 - Toronto Water
 - Transportation Services
- Toronto Public Health Directorates (e.g. Healthy Public Policy, Emergency Planning and Preparedness, Healthy Environments, etc.)
- External organizations in Toronto, such as:

- Research organizations (e.g. Clean Air Partnership, The Wellesley Institute, etc.)
- Social service agencies (e.g. United Way Toronto, Canadian Red Cross, Covenant House Toronto, CultureLink, Native Child and Family Services of Toronto, Silver Circle West Toronto Services for Seniors, etc.).

Engaging these and other relevant organizations around climate change adaptation and health equity will be a critical step toward achieving a healthy and equitable vision for the City of Toronto.

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About the Clean Air Partnership

The Clean Air Partnership (CAP) is a registered charity that works in partnership to promote and coordinate actions to improve local air quality and reduce greenhouse gases for healthy communities. Our applied research on municipal policies strives to broaden and improve access to public policy debate on air pollution and climate change issues. Our social marketing programs focus on energy conservation activities that motivate individuals, government, schools, utilities, businesses and communities to take action to clean the air.