CHAPTER 5
Changing Temperatures- Extreme Heat and Cold

5.0 Changing Temperatures: Key Findings

Climate change projections and exposure pathways

Extreme heat:

- Extreme heat events (EHEs) are expected to increase in duration, frequency and intensity. It is very likely (90% to 100% probability) that temperatures in York Region will increase in all seasons by the 2050s with winter and summer months experiencing the most warming
- Urban Heat Islands (UHIs) increase temperatures in urban areas, increasing exposure and exacerbating health risks. Areas most impacted from UHIs include Vaughan, Richmond Hill, Newmarket, Aurora and Markham
- Weather conditions such as humidity, air quality and solar ultraviolet radiation exposure can exacerbate heat impacts

Extreme cold:

- Climate projections indicate York Region will experience warmer winters with increased rainfall
- Even as winters warm, extreme cold events are still possible. Climate projections show days with temperatures below -20˚C will decrease from 8 days per year to 3.1 days per year by the 2050s

Population sensitivity

Extreme heat:

- Seniors are a fast growing population in York Region, and have increased vulnerability
- Future acclimatization to warming summers from the general population may help reduce vulnerability to EHEs

Extreme cold:

- Extreme cold tends to impact younger populations more than seniors in York Region
- Warming winters may reduce the acclimatization and adaptive behaviour for extreme cold events

Adaptive capacity

Extreme heat:

- The Extreme Heat Program provides EHE notifications to the public and stakeholders, including those who engage vulnerable groups such as child care centres and long-term care homes
- Based on surveys of local residents and long-term care homes, the majority of residents and local stakeholders have opportunities for cooling and relief from extreme heat
- Most residents own a home cooling device, such as an air conditioner, but the frequency of use during EHEs is unknown. A recent survey found that only 33% of residents checked on 'at risk' friends or family during heat events
- The majority of York Region residents adopt some protective behaviour during hot summer days. Improvement in practicing heat-protective behaviours would increase personal adaptive capacity

Extreme cold:

- The Extreme Cold Program provides notification of extreme cold events to the public and stakeholders
- York Region provides services for homeless individuals, including shelter services

Health impacts for extreme heat and cold

- There is strong scientific evidence that indicates heat-related illness will increase as a result of rising temperatures due to climate change, particularly impacting those most vulnerable to extreme heat
- Emerging research also indicates the impacts of moderate temperatures to human health

Recent Trends:

- Between 2007 and 2017 there were 497 heat-related illness emergency department (ED) visits in York Region
- Hospital data represents more severe heat-related illnesses, underestimating the burden of illness from extreme heat. EHEs may also exacerbate mental health, cardiovascular and respiratory diseases
- Between 2007 and 2017 in York Region there were 410 ED visits due to extreme cold

There is strong evidence that climate change will impact local temperatures and recent heat waves highlight the significant impact extreme temperatures can have on health. For example, the extended heat waves in Europe in 2003 were estimated to have contributed to up to 70,000 deaths.[52] Heat waves have also had impacts within Canada. Between June 30 and July 8, 2018, a heat wave was a factor in 66 deaths in Montreal alone[53], and contributed to a total of 86 deaths in the province of Quebec.[54]

In York Region, climate projections indicate warmer summer and winter temperatures are very likely to occur by the 2050s.[10] These shifting temperatures, combined with an increased likelihood of extreme temperature events[I], will have important implications for temperature-related health impacts in York Region.

This chapter provides an overview of extreme heat, followed by extreme cold, focusing on how climate change may impact York Region with respect to extreme temperatures. The information includes an overview of health impacts from extreme temperatures in York Region, which populations may be more vulnerable to these impacts, climate projections for York Region, how climate change may impact the future burden of illness based on existing research and what existing services are available to address extreme temperatures in York Region. Additional information on urban heat islands and solar ultraviolet radiation (UVR) exposure are presented within the extreme heat section.

5.1 EXTREME HEAT

5.1.1 Health impacts from extreme heat

Heat-related illness (HRI) can range from minor symptoms, such as heat rash and cramps, to more severe conditions such as heat exhaustion and heatstroke. These illnesses usually result from exposure to high temperatures, high humidity, lack of shade and minimal air movement, indoors and outdoors.

There is strong evidence highlighting the impacts of extreme heat on human health. Studies in multiple cities across North America and Europe have consistently shown extreme temperature contributes to HRI, particularly hospital admissions and mortality.[55] This has also been noted in recent Canadian studies.[56-59] This impact is more pronounced in cities that tend to have cooler climates, likely due to limited adaptation measures and acclimatization.[55]

Extreme heat not only leads to more heat-related illnesses but has been associated with other health outcomes. Recent research suggests extreme heat is associated with other health

[I] In York Region, extreme heat and cold conditions are defined by Environment and Climate Change Canada. Extreme heat warnings are issued when maximum temperatures are above or equal to 31°C and minimum temperatures are above or equal to 20°C; or Humidex is greater than 40 for at least two days. Extreme cold warnings are issued when temperature or wind chill reach -30°C for at least two hours.

outcomes such as mental health, cardiovascular disease, asthma, diabetes and more.[59] An Ontario study showed that every 5˚C increase in temperature was strongly related to an increase in respiratory-related deaths (5.4%) and cardiovascular-related deaths (5.1%).[59]

Other climate factors such as humidity can also contribute to the risk of heat-related illnesses. The risk of heatstroke and heat exhaustion was also found to increase when the combination of temperature and humidity exceed 34°C and 90% compared to 41°C and 30% respectively.[60]

Existing research demonstrates the association between mental health and extreme heat events. In particular, individuals with existing mental health illnesses may experience difficulty with thermoregulation as a side effect of certain medications.[55] A study in Toronto observed a strong association between the number of emergency department (ED) visits and hospitalizations for mental health issues with high daily temperature.[49] Similarly, ED visits for mental health issues in Montreal increased with more moderate temperatures (daily average between 22.5ºC and 25ºC) and humidity (70% to 90%). This trend was noted for all age groups but was highest for seniors.[61]

There is emerging research on contributions of non-extreme temperatures to morbidity and mortality. Emerging research indicates even small changes in temperature can impact mortality rates[55] and other health outcomes such as mental health or diabetes. For example, mild heat has been associated with more diabetes-related hospitalizations in Ontario than extreme heat temperatures.[62] Similarly, recent studies[63] suggest that climate change will also increase the risk of compounded heat wave events, which are heat events with limited days of cooler weather in between. This may increase the vulnerability for heat-related illnesses due to limited recovery time for the general population, particularly those most vulnerable to heat stress.[63]

Exposure to extreme heat in combination with air pollution may result in additive or synergistic health effects. Air quality and extreme heat can act together to increase risks to human health.

The relationship between temperature, air quality and health outcomes is complex and depends on the specific pollutant(s), its interaction with heat and other weather parameters, and individual sensitivity. For instance, Vanos and colleagues[64] found that the relative risk of mortality in 12 Canadian cities related to fine particulate matter and sulphur dioxide tripled in hot weather when compared to moderate weather, and the risks due to ozone and nitrogen dioxide doubled. However, in terms of relative impact, research by Cheng and colleagues[65] estimates extreme heat has a larger contribution to the overall health burden compared to air quality in the Toronto area.

Due to limitations in predicting climate change related air pollution events, it is difficult to determine the health impacts for York Region related to extreme heat and air quality interactions. More information on air quality impacts can be found in Chapter 7.

Vulnerable populations

Populations most vulnerable to extreme heat include those with a modified ability to thermoregulate and those with limited resources and means to adapt to extreme temperatures. The table below highlights key vulnerable populations with respect to extreme heat. See Chapter 4 for more information on vulnerable populations in York Region.

Table 5.1. Summary of vulnerable populations related to extreme heat.

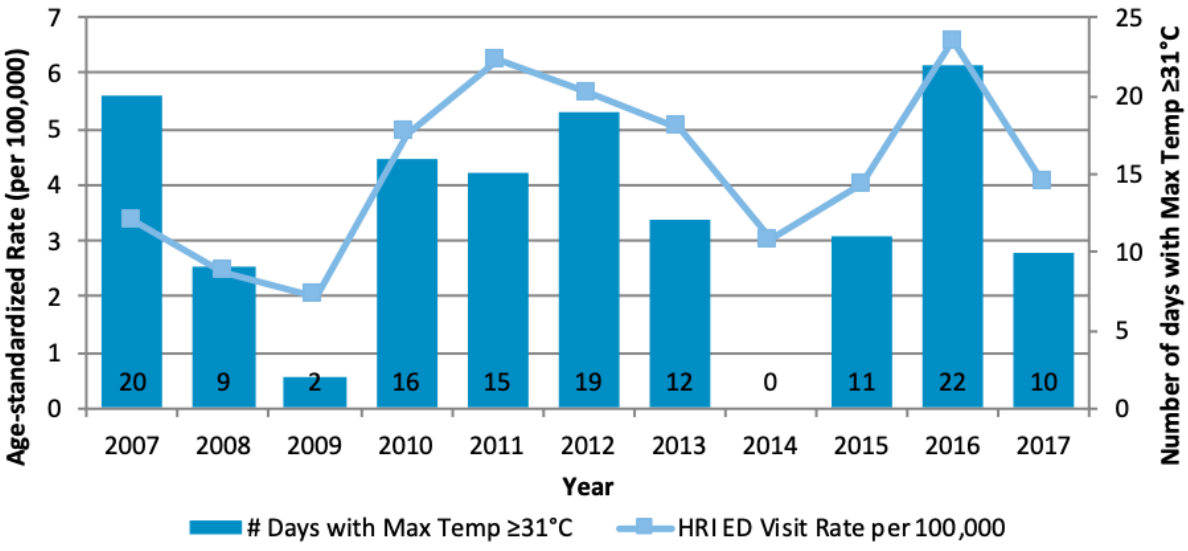
Seniors
Biological sensitivity Seniors have functional and physiological limitations that impede their ability to adapt to extreme heat and regulate body temperature. They are also at higher risk of chronic diseases. High mortality rates during the European heat waves occurred in elderly women with pulmonary diseases.[66] **Behavioural and social factors** Social isolation can increase risk. Older adults may be less likely to undertake protective actions during extreme heat events.[60]
Children
Biological sensitivity Children have less developed thermoregulatory systems than adults and higher metabolic rates. **Behavioural and social factors** Children are more likely to be active outdoors and are less likely to take precautionary measures to protect themselves from extreme heat.
Gender factors
Biological sensitivity Pregnant women are at higher risk of heat-related illness and dehydration. Extreme heat can be detrimental to the fetus, and can contribute to neural tube and heart defects due to maternal hyperthermia, pre-term birth, low birth weight and spontaneous abortion. **Behavioural and social factors** The effect of heat waves on hospitalization for stroke, out-of-hospital cardiac arrest, heat-related illness, and work-related injuries was higher for men than women.[67] This is also supported by RRFSS survey findings that men were less likely to change outdoor activity based on temperature.
Pre-existing conditions
Biological sensitivity There is a higher risk of heat-related illness for people with chronic conditions such as cardiovascular disease, respiratory diseases, overweight/obese, diabetes, renal diseases, gastrointestinal illness and individuals taking particular medications such as psychiatric medications. Li et al.[67] found hospital admission rates during heat waves were higher for people with cardiovascular and respiratory diseases. **Behavioural and social factors** Chronic disease combined with reduced socioeconomic status (SES) can increase susceptibility and reduce adaptive capacity.
SES and recent immigrant populations
Behavioural and social factors Low SES was associated with increased morbidity and mortality due to extreme heat.[67] Higher rates of mental illness are often observed in individuals living with low-income compared to the general public. Individuals living with low-income may lack access to air conditioning. Additionally, Li et al. [67] found individuals living in linguistically and culturally diverse communities were more vulnerable to extreme heat, possibly due to a reduced ability to access resources and information.

5.1.2 Local health impacts in York Region

Recent studies and available hospital data demonstrate the impacts of extreme heat in York Region. A recent study[59] examined impacts of hot and cold temperatures between 1996 and 2010 in Ontario. In York Region, a 5.4% increase in non-accidental deaths was observed for every 5°C increase in temperature between the months of June and August, an impact greater than the provincial average of 2.5%.[59] The heat effects occurred immediately, without a lag.[59] This study also observed higher heat-related mortality among hospital patients in Ontario. These increased rates may be due to a heightened vulnerability among patients and insufficient cooling in hospitals.

Between 2007 and 2017, there were 497 ED visits for HRI[m] in York Region during the summer months between May and September (Figure 5.1). When comparing summer seasons, higher HRI ED visit rates were observed during summers with more days above 30˚C. Consistent with Chen et al.,[59] seniors between 80 to 89 years of age had the highest HRI ED visit rates compared to other age groups. July had the highest HRI rates followed by June. Higher rates earlier in the summer may partly relate to a lack of acclimatization.

Figure 5.1. Annual trends in York Region in heat-related illness (HRI) emergency department (ED) visits during summer months and number of days with daily maximum temperature above or equal to 31˚C, from 2007 to 2017.



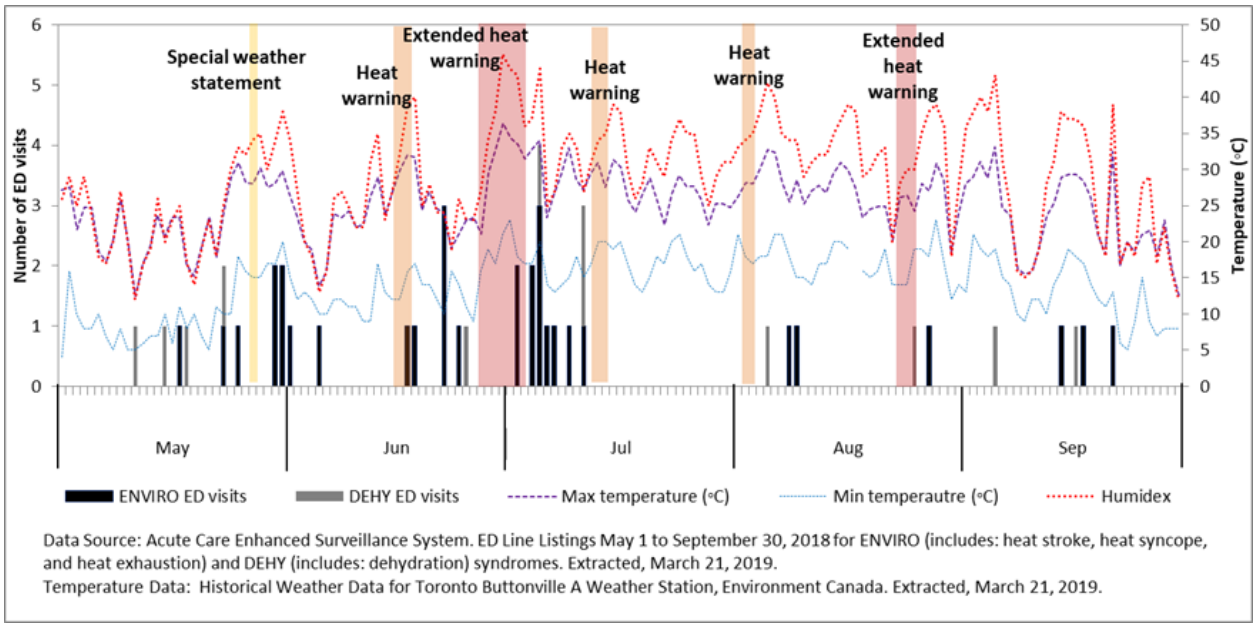
Data Sources: Ambulatory Visits & Population Estimates, 2007-2017, Ontario Ministry of Health and Long Term Care, IntelliHealth Ontario. Extracted December 7, 2018. Heat-Related Illness (HRI) defined as any unscheduled emergency department visits using ICD-10 CA codes X30 or T67. Rates were age-standardized using the 2011 Canadian Census Total Population by Age, from Statistics Canada, catalogue #98-311-XCB2011018.
Temperature Data: Historical Weather Data for Toronto Buttonville A Weather Station, Environment

[m] Heat-Related Illness is defined as any unscheduled emergency visit using ICD-10 CA codes X30 or T67.

Increases in ED visits for heat-related illness in York Region were not consistently observed during an extreme heat event. The relationship between EHEs and HRI was not clear when reviewing daily temperature and hospital data for York Region (Figure 5.2). This may be attributed to individuals not seeking medical attention for heat-related illnesses, and health outcomes exacerbated by extreme heat not coded as such when medical attention is sought (e.g., respiratory or cardiovascular health outcomes).

When examining York Region Acute Care Enhanced Surveillance (ACES) data from the 2018 heat season, a small number of HRI cases were observed following a heat warning. However, the health outcome trend following EHEs was not consistent. This rise in cases following heat events may relate to individuals not continuing with protective measures once a heat warning has ended and/or the cumulative impact from consecutive hot weather days. However, as this analysis only involves data from 2018, additional analysis is required to accurately evaluate temporal trends in heat-related illness rates in the summer season.

Figure 5.2. The number of emergency department visits, based on extreme heat and dehydration syndrome classifications, and weather data for May to September 2018 for York Region.



5.1.3 Climate change impacts on extreme heat and HRI

Climate change projected impacts on HRI

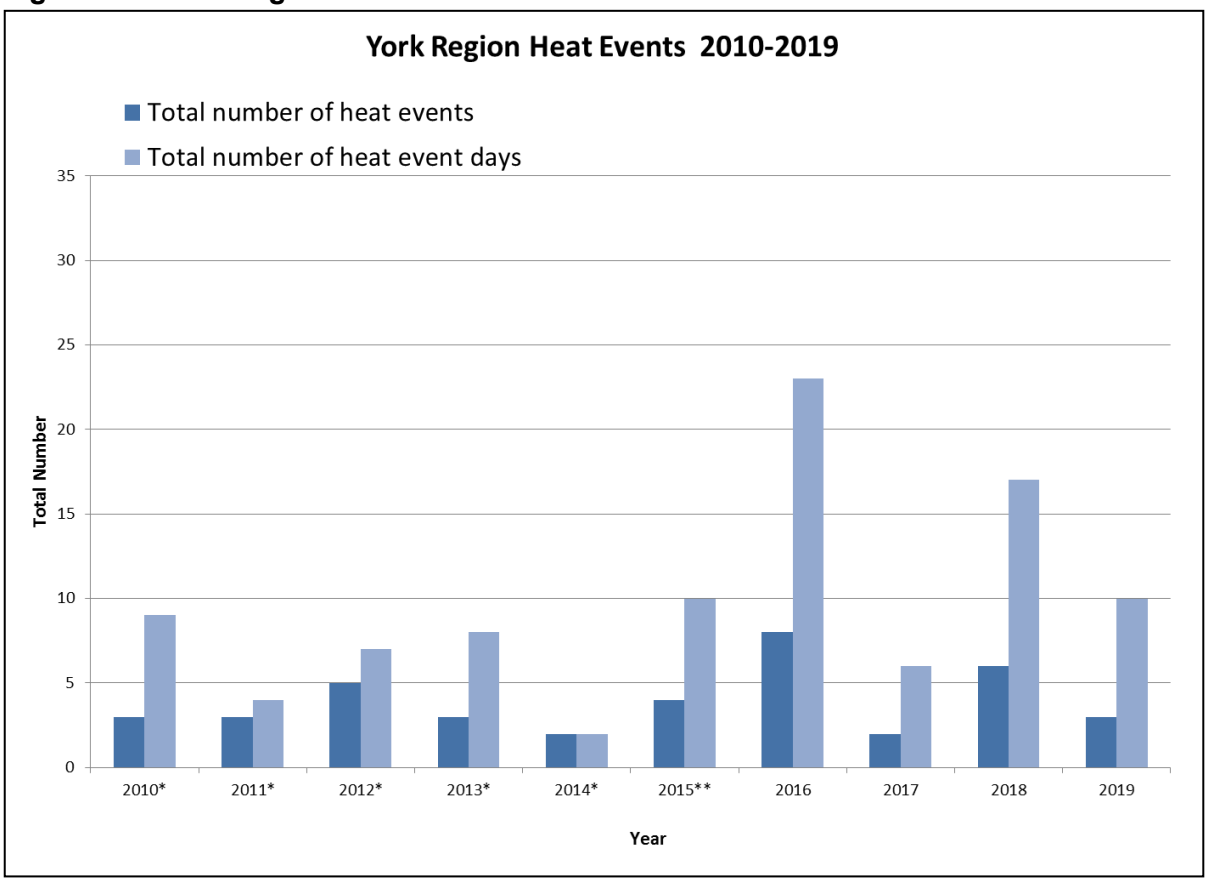
Research from North America consistently highlights the recent impact of extreme heat on human health. However, there are limited studies predicting future impacts in Ontario and in York Region. Martin and colleagues[58] predicted the average annual rate of heat-related mortality for 15 Canadian cities would increase from 1.37 per 100,000 from 1981 to 2000, up to 3.34 per 100,000 by the 2031 to 2050s. However, these projections do not include other related health impacts or cases that may go unreported from health care surveillance systems.

Ultimately, future impacts from extreme heat will depend on changes in the sensitivity and adaptive capacity of the population to extreme heat. In North America, there is strong research demonstrating an increasing tolerance to extreme heat, with acclimatization having the potential to reduce future impacts.[55] Cheng and colleagues[65] predict heat-related mortality in Toronto could increase by approximately 100% by the 2050s with no acclimatization within the population. However, if acclimatization of the population occurs, these projections are predicted to increase by 70 to 90% by the 2050s.

Climate change impacts on extreme heat in York Region

In recent years York Region has experienced varying numbers of heat events. Between 2010 and 2018, the most heat events and number of heat event days occurred in 2016 and 2018 respectively (Figure 5.3).

Figure 5.3. York Region Extreme Heat Events from 2010 to 2019.

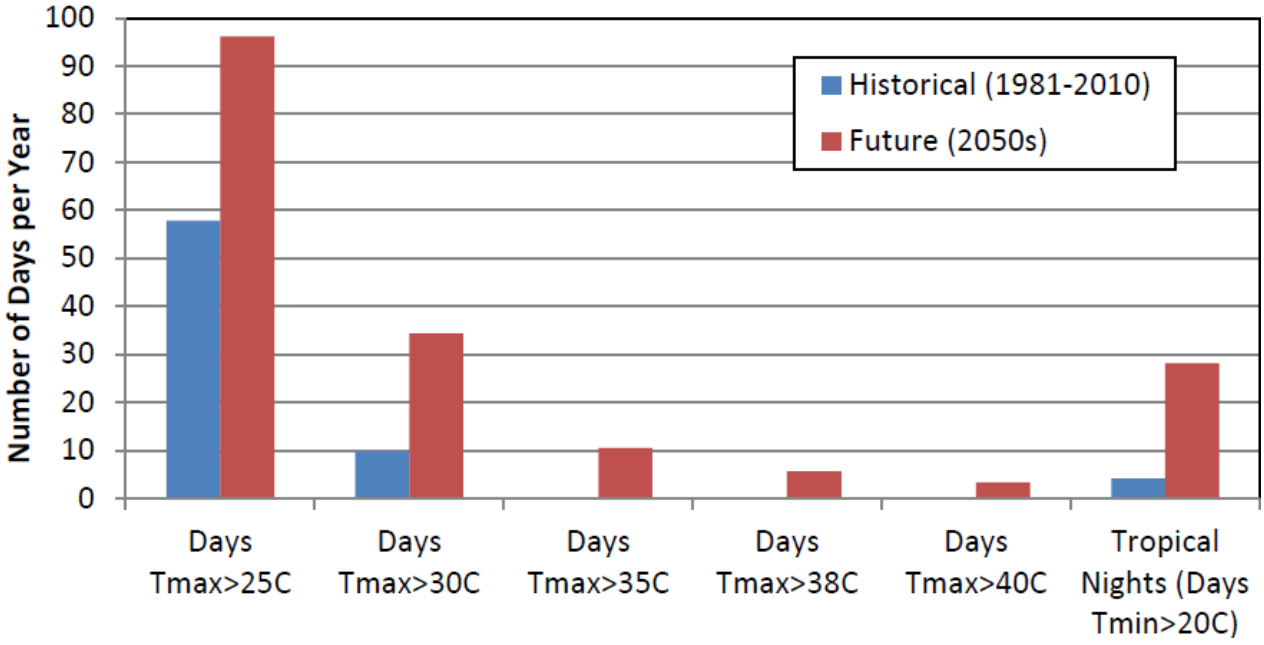


**Heat events were defined differently between 2010-2019. From 2010-2014, Environment Canada issued a Special Weather Statement Humidex Advisory when the temperature was expected to reach 30°C or more and humidex was expected to reach 40 or more OR a temperature of 40°C or greater. **In 2015, Environment Canada issued: Level 1 (Heat Advisory) when Tmax ≥ 31°C and Humidex ≥ 40 for 1 day; Level 2 (Heat Warning) when Tmax ≥ 31°C and Tmin ≥ 20°C OR Humidex ≥ 40 for 2 days; or Level 3 (Extreme Heat Warning) when Tmax ≥ 31°C and Tmin ≥ 20°C OR Humidex ≥ 40 for 3+ days. From 2016- 2019, Environment Canada issued a heat warning when Tmax ≥ 31°C and Tmin ≥ 20°C OR Humidex ≥ 40 for 2 days; and York Region Public Health an extended heat warning when Tmax ≥ 31°C and Tmin ≥ 20°C OR Humidex ≥ 40 for 3+ days.*

There is a high probability York Region will experience warmer summers with more extreme heat events. As a result of climate change, it is very likely (90 to 100% probability) temperatures in York Region will increase in all seasons by the 2050s, with the winter and summer months experiencing the most warming.[10] Currently, York Region experiences 58 days per year where the daily temperature reaches 25°C or higher. By the 2050s, this number is expected to increase by an additional 37 to 39 days (Figure 5.4).[10]

Notably, daily maximum temperatures (T_{max}) greater than 30˚C are expected to increase by 24.6 days annually by the 2050s in York Region. Projections also indicate maximum summer temperatures are very likely to reach over 40°C compared to a historical maximum temperature of 35.9°C. This would result in an increase in the number of heat events and days where extreme heat may pose a risk to health. Furthermore, the number of nights where the temperature remains above 20°C (referred to as "tropical nights") is expected to increase from 4.2 days per year to approximately 28.2 days.[10] This will reduce the important relief that cool nights provide from high daytime temperatures.

Figure 5.4. Projected changes to maximum and minimim temperatures for York Region in the 2050s compared to historical values (1981 to 2000).



Source: Fausto E, Milner G, Nikolic V, Briley L, Basile S, Behan K et al. Historical and future climate trends in York Region: summary report [Internet]. Newmarket: Regional Municipality of York; 2016. Fig C-8, Extreme heat climate indices in York Region using CANGRD (Historical) and MOECC ensemble median values (Future); p. 47. Available from https://climateconnections.ca/app/uploads/2015/02/Historical-and-Future-Climate-Trends-in-York-Region_Report-1.pdf. Reproduced with permission from the copyright holder.

Data uses Canadian gridded data (CANGRD) for historical values and MECP Ensemble Median Values for future projections. Tmax refers to maximum daily temperature.[10]

The Ministry of Health[11] predicts the average number of heat waves in York Region (at least three consecutive days exceeding 32°C) annually will rise from 0.28 (1971 to 2000) to 1.31 by the 2050s and 3.12 by the 2080s.[11] However, this projection does not consider two-day events, nor other weather variables such as humidex and tropical nights.

Urban heat islands in York Region

Urban heat islands (UHIs) can influence local temperatures and increase the risk from extreme heat. Urban heat islands are created when urban areas composed of dark, impervious surfaces, such as roads, parking lots and roofs that absorb the sun's radiation and release it slowly back into the environment. This warms the surface and ambient temperatures, creating a temperature gradient in urban areas ranging from 2°C to 10°C greater than rural areas.[60]

UHIs in combination with building properties - height, heat retention, insufficient ventilation or cooling options - can impact indoor environments. Without access to air conditioning, upper-stories of high-rise buildings can have higher temperatures, increasing exposure to extreme heat. UHI impacts could present a health hazard for residents when combined with buildings without sufficient means for cooling, especially in areas where urban design characteristics result in heat retention and limited airflow. Unfortunately, there is a lack of data on indoor building temperatures in York Region, which would help to better understand the vulnerabilities and exposures of residents.

In 2014, York Region completed an Urban Heat Island study. Through analyzing land surface temperature from Landsat 7 ETM+ taken on August 19, 2011, and using Census data from 2011, the report noted the following key findings:[68]

- Overall, UHIs exist as pockets across York Region, mainly in the larger, southern municipalities of Vaughan, Markham and Richmond Hill
- Cool islands also exist, mainly around parks, water bodies and open spaces or non-agricultural fields
- Vulnerable populations often resided in UHIs. Seniors were mostly living within more urban UHI areas, while children predominately resided in smaller towns and village areas
- Cool roofs were observed to have a dramatic impact on localized hot spot intensity

Using more recent data, Figure 5.5 shows the land surface temperature in York Region based on satellite imagery from August 22, 2015. As expected, the southern municipalities had some of the highest temperatures compared to the average for urban areas. Consistent with population growth, UHIs have expanded in newly developed commercial and residential communities, particularly in the southern municipalities, as well as in Newmarket and Aurora.

Figure 5.5. York Region Land Surface Temperature, 2015.

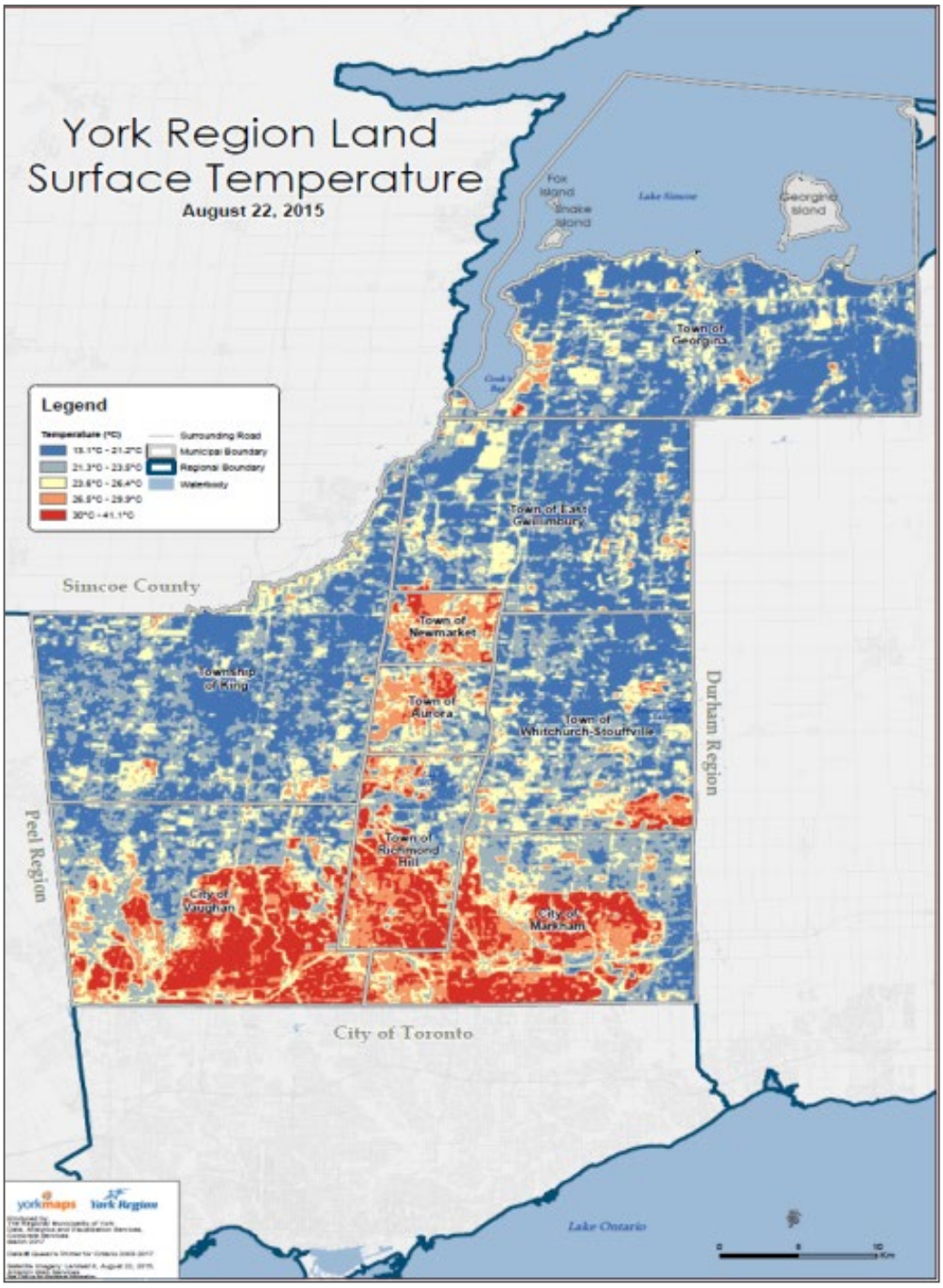
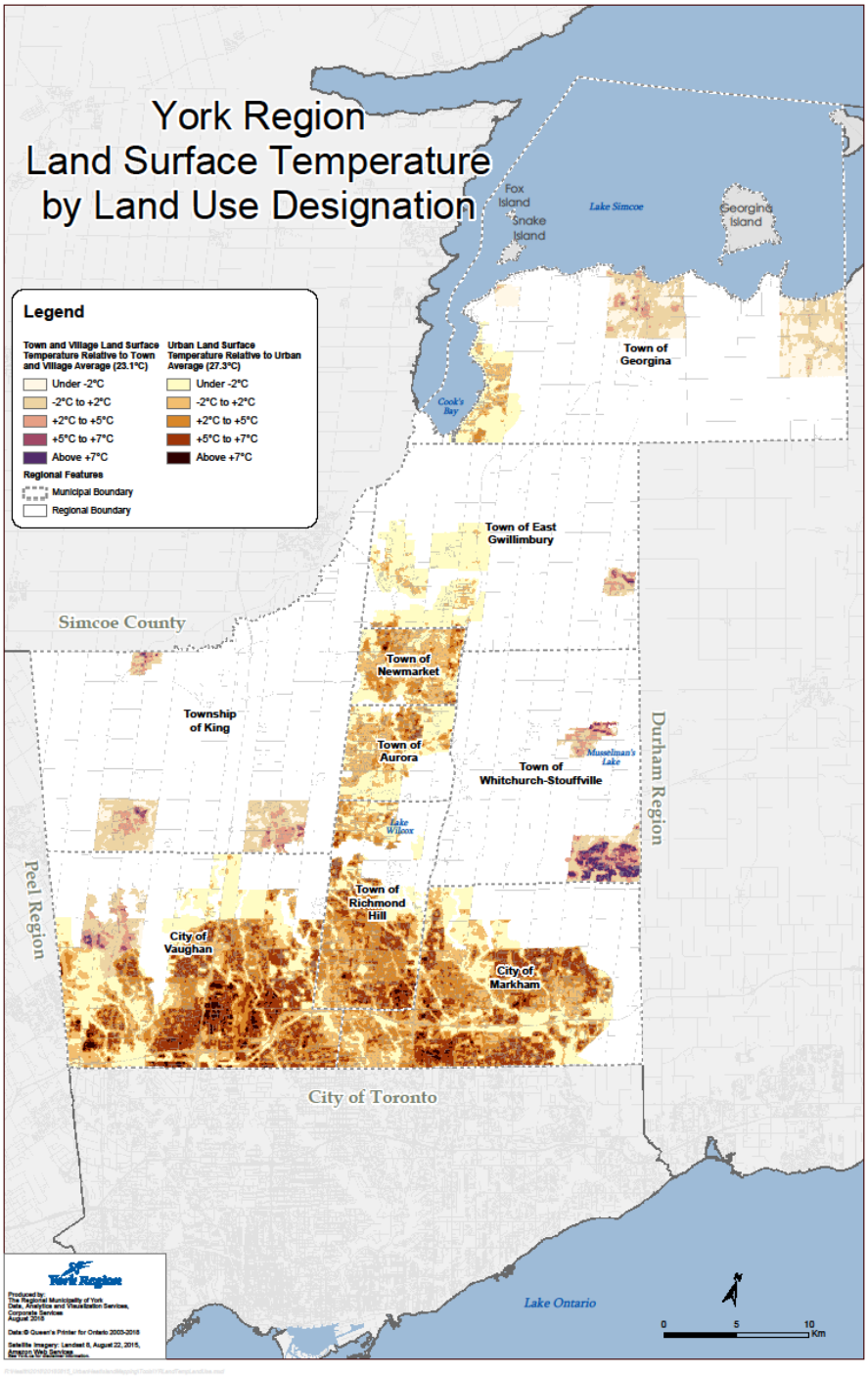


Figure 5.6 highlights how land surface temperature differs within urban areas and towns and villages. Overall, urban areas were 4.2˚C warmer on average than towns and villages. Within towns and villages, new residential and commercial development has likely increased land surface temperature compared to the average, particularly for the Town of Whitchurch-Stouffville.

Figure 5.6. York Region land surface temperature by land use designation, 2015.

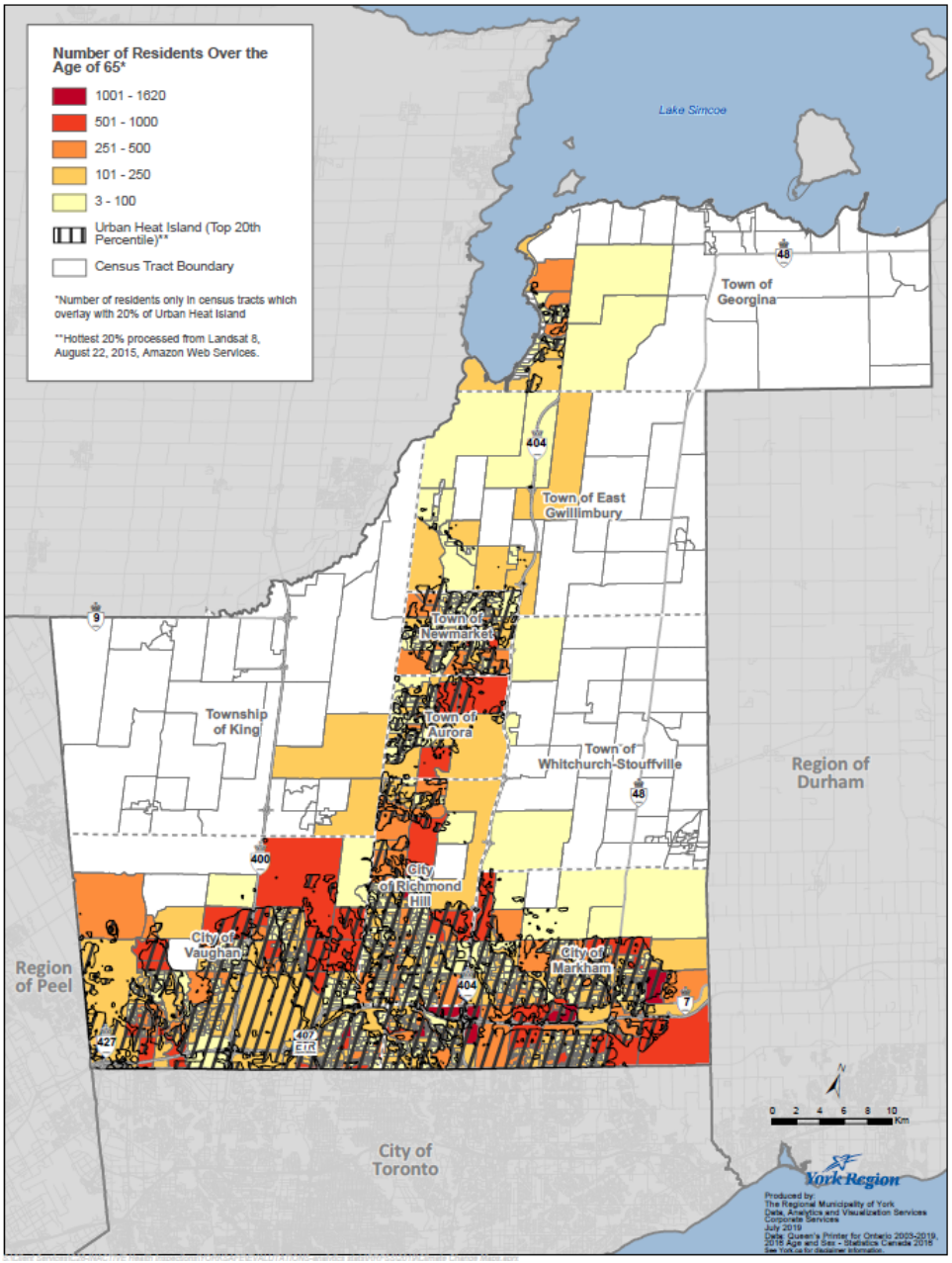


Vulnerable populations, such as seniors, low SES households and children, residing in UHI impacted areas may be at greater risk to heat-related illnesses. Using 2016 Census data and land surface temperature from August 22, 2015, Figure 5.7 highlights where there is a larger proportion of seniors residing in areas with the highest land surface temperature in the Region (top 20% of

UHI in the Region). In particular, the southern municipalities tend to have the highest land surface temperatures, and also have areas with a high proportion of seniors.

While this analysis provides an indication of vulnerability to extreme heat, the risk of heat-related illness also depends on the adaptive capacity of residents, such as owning an air conditioning system, and behavioural practices. Further research is still needed to assess the linkages between UHI and heat-related illness, and help inform future policy and programs.

Figure 5.7. Number of seniors within census tracts and top 20% of land surface temperatures.



5.1.4 Adapting to extreme heat

York Region Public Health's extreme heat program

To help prevent HRI and support stakeholders' response to extreme heat events, Ontario implemented a Harmonized Heat Warning and Information System (HHWIS) in 2016. The HHWIS helps to increase consistency in the way public health units respond to heat events to better protect residents, communities and visitors.

The Extreme Heat Program takes into account evidence-based triggers for intensity and duration of extreme heat. York Region Public Health's (YRPH) Extreme Heat Program runs annually from May to September, seven days a week. It involves collaborating with internal and external stakeholders to communicate risks from heat events. YRPH monitors weather and Environment and Climate Change Canada (ECCC) Heat Warnings for York Region. In York Region, a heat warning is issued when either of the following conditions are met for at least two days: The maximum daily temperature is expected to reach or exceed 31°C and the minimum nighttime temperature is expected to reach or exceed 20°C, or humidex values of at least 40 are expected. YRPH may issue an extended heat warning if these conditions are expected to last three days or more. ECCC may also issue a Special Weather Statement when no defined heat warning thresholds have been met. During heat events, YRPH issues communications through a variety of channels, such as email, media releases, news items and social media, to internal partners, external stakeholders and the public. This communication provides information on precautions to reduce heat-related illness and support residents and vulnerable populations in staying safe during the heat event.

Different actions may be taken by local municipalities during a heat event. Heat warning notifications have been used by local municipalities to determine appropriate responses for their communities, such as whether or not to open cooling centres or increase public pool hours. Actions implemented by local municipalities vary based on the heat event and the resources and risk for each individual municipality. Moving forward, the municipal responses will need to account for the increased length and frequency of heat events when determining appropriate responses for their communities. Further research on best practices would help inform and support local stakeholders in determining what responses may be suitable for different heat event circumstances.

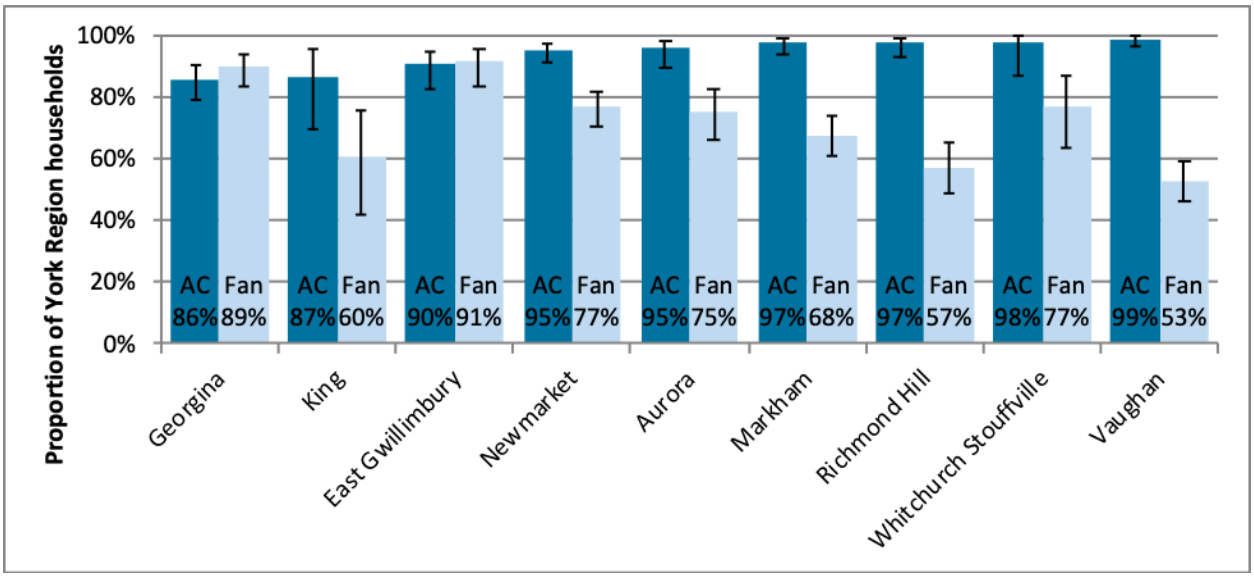
Long-term care homes (LTCHs) in York Region have plans and measures in place to address extreme heat and potential health impacts. LTCHs are considered stakeholders and are included in heat warning notifications by YRPH. In 2016, YRPH conducted a survey to access the adaptive capacity of LTCHs in York Region. All LTCHs have some form of cooling - central air, portable/window air conditioners or cooling areas. Most have backup generators and policies to adapt to poor air quality days.

Protective measures of York Region residents

Many residents have air conditioners or fans that can provide cooling in homes but it is still unclear how they are used during hot days. In 2016 and 2017, the RRFSS telephone survey asked about residents' capacity to adapt to extreme heat days. It was estimated that 95%

(95% CI: 93%-96%) of households have an air conditioner and 70% (95% CI: 68%-73%) have a fan, suggesting the majority of households have some means to cool their homes (Figure 5.8). However, this estimate does not reflect the use of air conditioners or fans during extreme heat events. Additionally, building design factors and UHIs are not accounted for, which can decrease the impact these measures may have in certain households.[16,69]

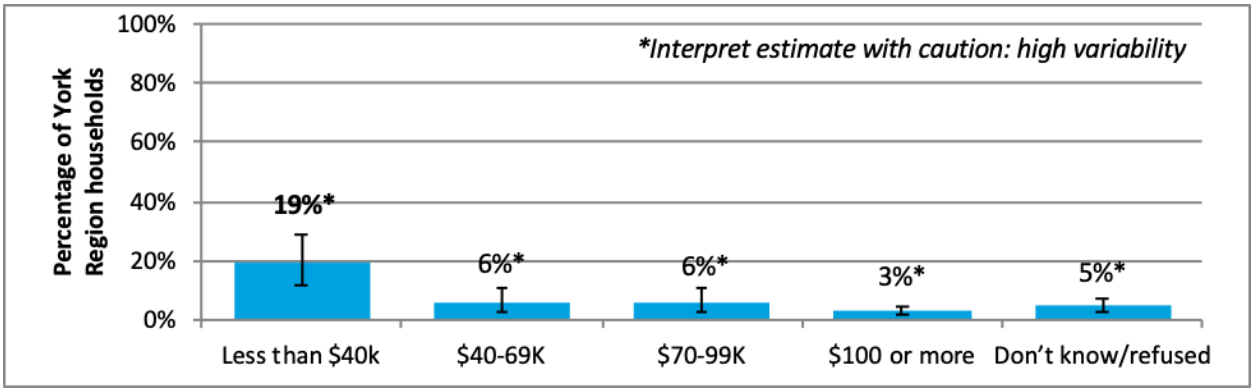
Figure 5.8. The proportion of York Region households, by municipality, that have an air conditioner (AC) or a fan.



Source: Rapid Risk Factor Surveillance System (RRFSS), 2016-2017, Regional Municipality of York, Community and Health Services.

Household income was found to be significantly associated with air conditioner ownership in York Region.[16,69] Almost 20% of low-income households reported lacking an air conditioner, compared to only 3% of high-income households (Figure 5.8).[16,69] Although access to air conditioners is high among York Region residents, operational costs may be prohibitive and reduce the likelihood of use. It must be noted that fan use in certain temperature conditions, such as in high temperatures with differing humidity conditions, can increase body temperatures and heart rates, reducing the ability to cool through sweating, and therefore may not reduce the risk of HRI.[70]

Figure 5.9. Proportion of York Region households without an air conditioner by income.



Source: Rapid Risk Factor Surveillance System (RRFSS), 2016-2017, Regional Municipality of York, York Region Community and Health Services.

The majority of York Region residents adopt some protective behaviours during very hot summer days. More than 75% of residents reported they drink more water, use curtains to block out the sun or spend time in air-conditioned environments during hot summer days (Figure 5.10).[16,69]

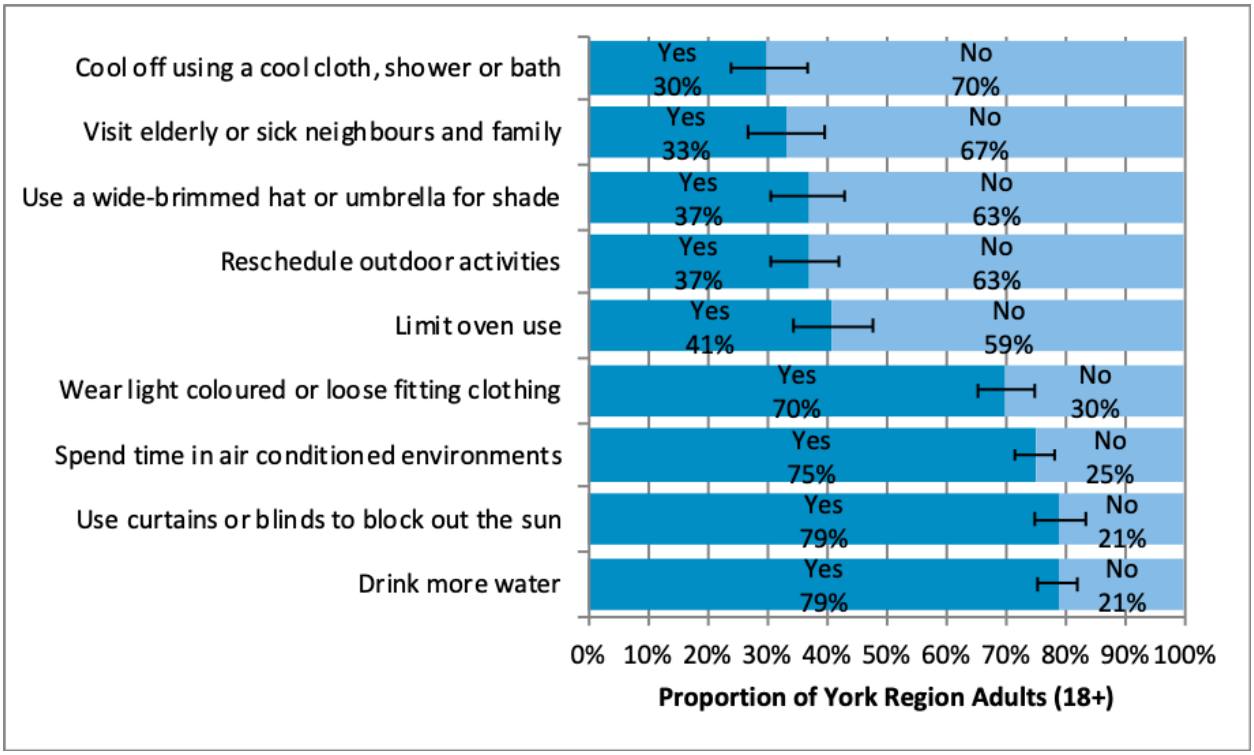
Protective behaviours and findings:

- 57% (95% CI: 45-68%) reported limiting oven use
- 82% (95% CI: 70-90%) reported wearing light and loose-fitting clothing
- 53% (95% CI: 51-65%) reported shading themselves by wearing a wide-brimmed hat or using an umbrella
- 53% (95% CI: 45-61%) reported rescheduling their outdoor activities to cooler parts of the day

Seniors were significantly more likely to take precautions against heat-related illness than younger age groups.[16,69] However, the survey was not able to compare behavioural differences that may exist within senior populations, such as low-income, socially isolated or new immigrants.

The least frequently reported heat-protective behaviours reported were cooling off with a cool shower, bath or cloth (30% [95% CI: 24-37%]) and visiting elderly or sick neighbours and family members to ensure they are cool and hydrated (33% [95%CI: 29-38%]) (Figure 5.10).[16,69] Recent research of HRI risk factors in Quebec found that high social participation was an important protective measure, suggesting the importance of decreased social isolation for seniors during extreme heat events.[71] Only 37% (95% CI: 33-41%) of residents reported they would reschedule activities to cooler times of the day, with men (30% [95% CI: 24-36%]) significantly less likely than women (43% [95% CI: 38-49%]) to do so.[16,69]

Figure 5.10. The proportion of York Region adults who adopt protective behaviours during very hot summer days.



Source: Rapid Risk Factor Surveillance System (RRFSS), 2016-2017, Regional Municipality of York, Community and Health Services.

SOLAR ULTRAVIOLET RADIATION AND CLIMATE CHANGE

While solar ultraviolet radiation (UVR) can have positive benefits such as synthesis of vitamin D, it is also a primary cause of skin cancer. In Ontario UVR is the leading environmental cause of skin cancer, contributing between 2,090 and 2,990 new cancer cases (mainly melanoma cases) per year.[72] There are three major types of skin cancer: Basal cell carcinoma, squamous cell carcinoma and melanoma. Melanoma is the most fatal and is linked to a history of sunburn, especially at a young age; however, non-melanoma skin cancers are 12 times more common than melanoma.[72]

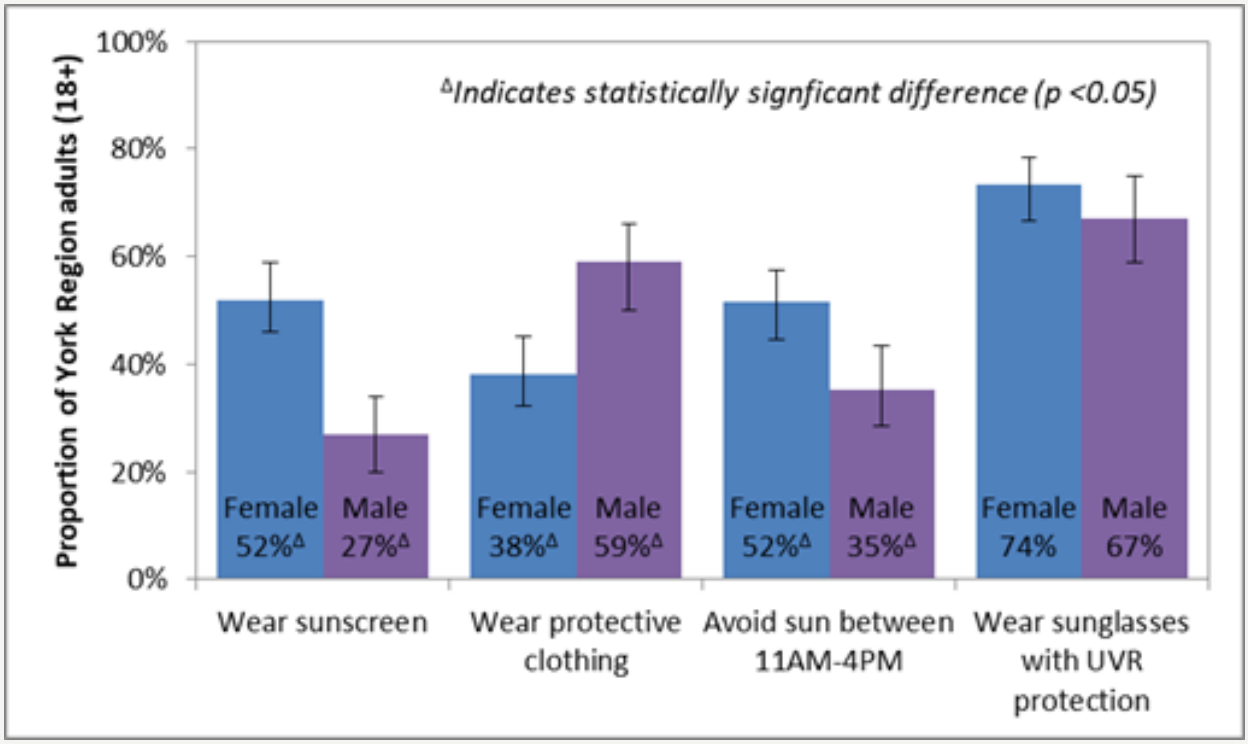
It is estimated that 80% of Ontario's melanoma cases are caused by UVR exposure.[72] The incidence rates of melanoma in Ontario are projected to increase significantly with age[73], with the highest incidence rate in 2018 in those 80 years of age or older, followed by the 60 to 79 year-old age group. In 2018, the incidence of new melanoma cases is projected to be higher in males than in females (2,372 versus 1,757; age-standardized rate of 32.5 for males, 21.6 for females).[73]

Exposure in York Region: Past telephone surveys of York Region adults found the younger populations reporting being sunburned in the past year.[74,75] Almost half (49% [95% CI: 41-57%]) of young adults reported they had been sunburned in the past year.[74,75] Males were more likely to report they had been sunburned in the past year (31% [95% CI: 28-34%]) compared to females (25% [95% CI: 23-28%]).[74,75]

York Region hospital data indicate individuals between 15 and 29 years of age consistently had the highest age-specific sunburn rates, with rates of 10 sunburn cases per 100,000 or higher, more than double the average for the overall population. Seniors (80+) had the highest rates of melanoma compared to all other age groups. Given York Region's aging population, it is likely melanoma rates will increase in the future.

Protective behaviours: In a telephone survey of York Region adults (aged 18+), approximately half of respondents indicated they have adopted various behaviours to protect themselves from UVR exposure, such as wearing sunscreen or protective clothing, avoiding sun exposure during peak UVR times (11 a.m. to 4 p.m.) and wearing sunglasses with UVR protection (Figure 5.11).[74,75] There were some significant gender differences identified with regards to the adoption of protective behaviours, with females more likely to report avoiding the sun during peak UVR periods and wearing sunscreen compared to males.[74,75] However, males were more likely to report wearing protective clothing in the sun compared to females.[74,75]

Figure 5.11. The proportion of York Region residents, by gender, who report adopting various behaviours to protect themselves from UVR exposure.



Source: Rapid Risk Factor Surveillance System (RRFSS), 2012-2013, Regional Municipality of York, Community and Health Services.

UVR and climate change: Exposure to UVR is influenced by latitude, geography, topography, altitude, ozone depletion, air pollution and weather conditions. Climate change is expected to affect UVR exposure by changing precipitation patterns, cloud cover, air pollution and ozone levels.

Gough et al.[11] estimate climate change may increase basal cell and squamous cell carcinoma rates in York Region by 7.8% and 13% respectively by the 2050s. However, there have been few studies providing a clear relationship with UVR levels of exposure and cancer risk, and tend to use temperature as a proxy measure.[11] As a result, there is insufficient information to adequately assess future UVR exposures and health impacts in York Region.

Adaptive capacity: Important measures for building adaptive capacity and climate resiliency for reducing exposure to UVR include conducting additional research to better assess UVR impacts on health, increasing surveillance screening of York Region melanoma rates, advocating for shade policies and integrating UVR protection messaging with existing extreme temperature program activities.

5.2 EXTREME COLD

5.2.1 Health impacts related to extreme cold

Serious health problems can result from prolonged exposure to the cold, such as frostbite and hypothermia.[4] Hypothermia is a serious cold weather injury that can lead to brain damage and even death. Hypothermia usually occurs in extremely cold temperatures, but can also occur at more moderate temperatures if a person loses heat due to exposure or submersion in water.

In York Region, cold temperatures have not been associated with excess mortality. A province-wide study examining mortality impacts of temperature found that cold temperatures generally have a greater impact on mortality than hot temperatures.[59] Specifically, a decrease of 5°C in the daily mean temperature during the cold season was associated with a 3.0% increase in non-accidental deaths, resulting in an estimated seven excess deaths per day in Ontario, with the effect persisting over seven days.[59] However, in York Region, the study observed that cold did not have a significant impact on excess mortality (0.2% (-3.7% to 4%) increase in non-accidental deaths).[59]

Similar to extreme heat, research suggests health outcomes from chronic diseases may be associated with extreme cold events. Research has found strong associations with cold mortality from a cardiovascular cause, ischemic heart disease, acute myocardial infarction and stroke.[59,76] Cold-related health effects are also associated with bronchoconstriction, which suppresses mucociliary defences and other immunological reactions, resulting in local inflammation and increased risk of respiratory infections.

Cold-related morbidity and mortality do not exclusively occur in extreme cold temperatures. Exposure to milder cold temperatures can have significant health impacts because they are more common than extreme temperatures.[77] Wang and colleagues[49] found a nine percent increase in the number of ED visits for neurotic disorders, such as phobias, anxiety, panic and stress, associated with cold in Toronto. Research suggests the immediate effect of two-day extreme cold events on mortality was insignificant. However, events lasting three or more days were significantly associated with an increased risk of mortality in a study conducted across the U.S.[78] Evidence on the relationship between cold-related mortality, mean winter temperature and adaptation over time is lacking.

Vulnerable populations

Individuals most vulnerable to cold are similar to those vulnerable to extreme heat. Although everyone can be affected by extreme cold, the following people are at a higher risk for cold weather injuries: Seniors, infants and children, people with pre-existing medical conditions, people who lack appropriate shelter, newcomers to Canada, outdoor workers and sport/outdoor enthusiasts.[4,55] In the Ontario study looking at cold temperatures and excess mortality, the impact were mostly for individuals under 65 years of age n York Region.[59]

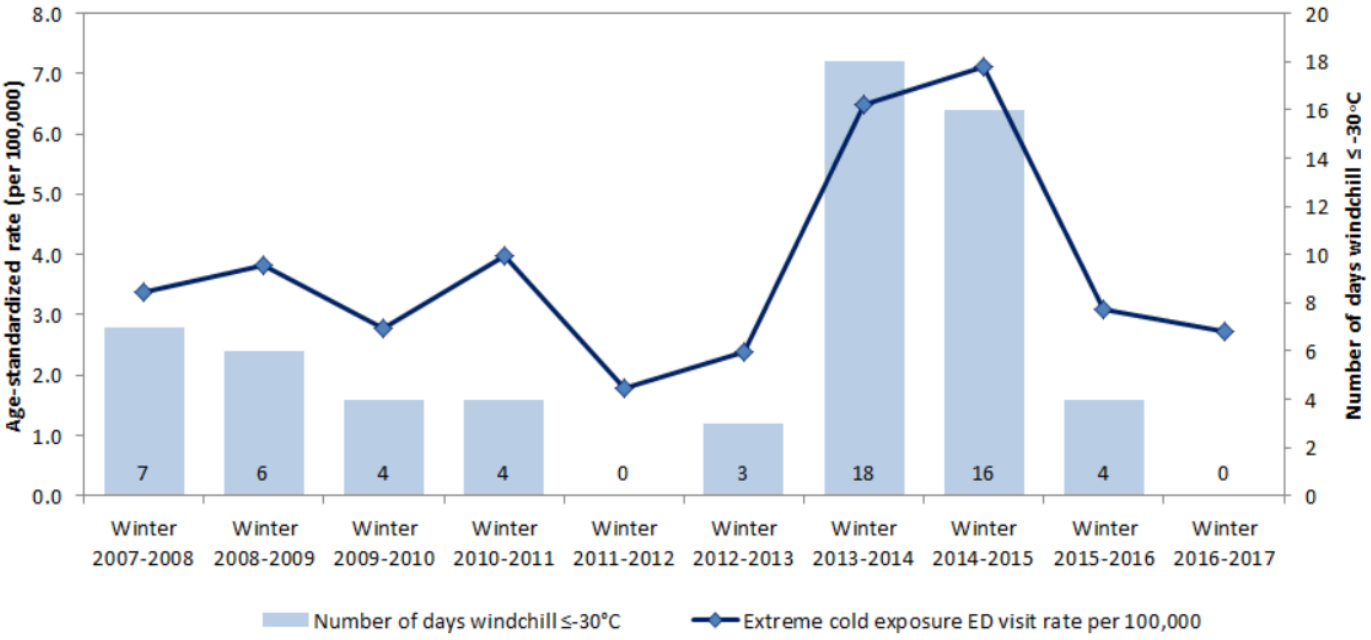
Populations most at risk of illness or mortality from exposure to extreme cold include those less able to regulate their body temperature. This may be due to age, pre-existing conditions or chronic

diseases, and the use of drugs and alcohol. Individual vulnerability to extreme cold has also been found to vary with sex and race.[55] See Chapter 4 for more information on vulnerable populations in York Region.

5.2.2 Local health impacts from extreme cold

Between 2007 and 2017, there were 410 ED visits from exposure to cold in York Region (Figure 5.12).[50] The highest rates across all age groups were for seniors, particularly those 85 years of age and older, and were often 10 times higher than the age-standardized rate for ED visits. The second highest rates were noted in youth 15 to 19 years of age. Certain years with extreme cold temperatures, such as winter 2013 to 2014 and winter 2014 to 2015, had much higher ED visit rates compared to other years.

Figure 5.12. Age-standardized rate of extreme cold emergency department visits from 2007 to 2017.



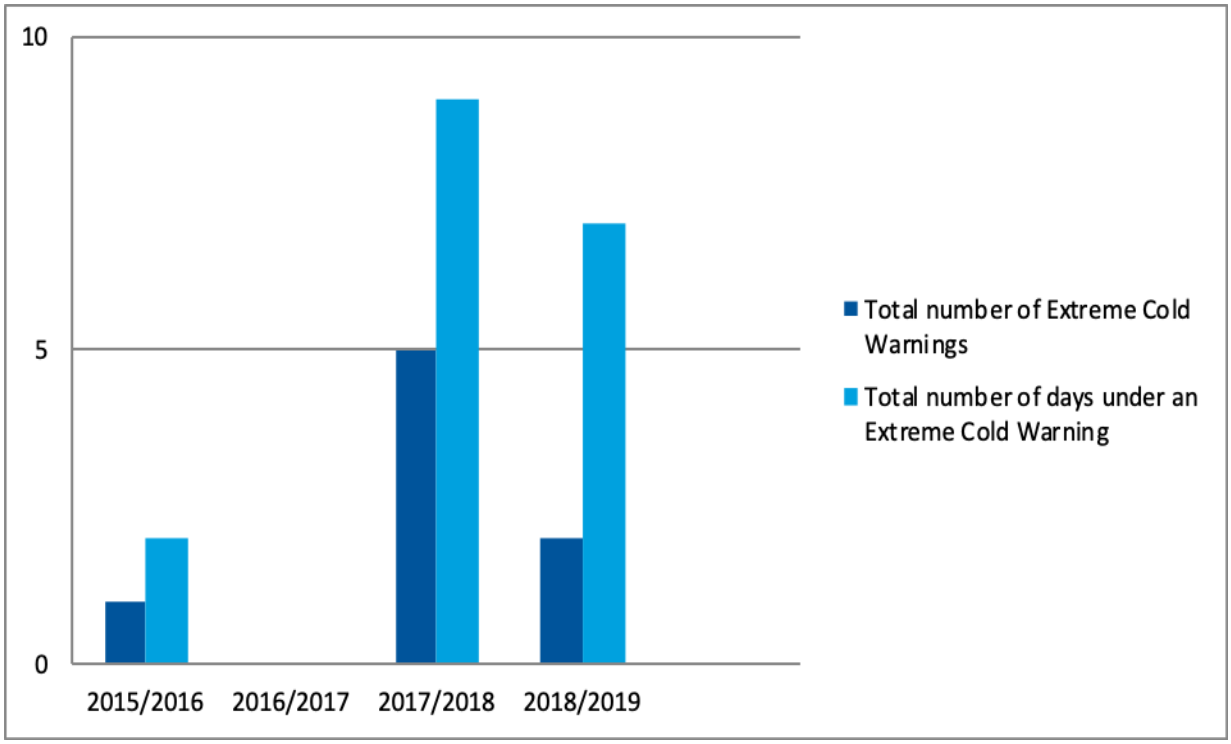
Data Source: Ambulatory Visits & Population Estimates, 2007-2017, IntelliHealth Ontario. Extracted April 30, 2019. Exposure to extreme cold was defined as any unscheduled emergency visit using ICD-10 CA codes T33-35, T68-69, and X31. Rates were age-standardized using the 2011 Candian Census Total Population by Age, from Statistics Canada, catalogue #98-311-XCB2011018.
Winter was defined as October to April.
Temperature Data: Toronto Buttonville A weather station via Environment Canada (climate.weather.gc.ca).

5.2.3 Climate change impacts on extreme cold

Climate change impacts on extreme cold in York Region

In recent years, there has been a wide range of extreme cold events in York Region. The winter season of 2017 to 2018 had one of the highest number of extreme cold days (14), while the preceding winter season did not reach extreme cold thresholds[n] at all (Figure 5.13).

Figure 5.13. York Region Extreme Cold Warnings, 2015 to 2019.



Climate projections indicate York Region will experience warmer winters with increased rainfall. The number of days below -5°C is expected to decrease by 31 to 37 days from the baseline of 84 days per year by the 2050s. Model projections vary in terms of the number of days annually below -20˚C in the 2050s but range from 0.5 to 4.9 days less than the historical annual average of 8 days.

Although there has been an overall warming trend in winter, it should be noted southern Ontario has recently experienced extreme cold temperatures due to a shifting polar jet system.[10] These conditions have not been incorporated into climate modelling, resulting in uncertainty for future predictions. While the trend of warming winters decreases the probability of extreme cold days by the 2050s, extreme cold temperatures, such as due to a shifting jet stream, may be experienced more regularly in the short-term future.[10]

[n] Extreme cold warnings are issued for York Region when temperature or wind chill is expected to reach -30°C for at least two hours.

Climate change projected impacts on cold-related illness

There are limited studies in Ontario that have projected future cold-related morbidity and mortality. One study in Toronto predicted cold-related mortality to decrease by 60% by the 2050s due to warmer winter temperatures.[79] When assessing climate change impacts on cold and heat-related mortality in 15 Canadian cities, Martin et al.,[58] observed an overall decrease in mortality rates in most of the cities as a result of projected warmer winters. However, the use of protective measures during cold weather can impact the adaptive capacity of residents, and as such, it is unclear how warming temperatures will impact cold morbidity and mortality.[55]

5.2.4 Adapting to extreme cold

York Region Public Health's Extreme Cold Program

To help prevent cold-related illness and support stakeholders' response to extreme cold events, York Region Public Health provides notifications to stakeholders and the public during extreme cold warnings. York Region Public Health's Extreme Cold Program runs from December to March, seven days a week. The program is designed to alert stakeholders of extreme cold events, and involves collaborating with internal and external stakeholders to communicate risks from extreme cold events.

Extreme cold warnings are issued by Environment and Climate Change Canada for York Region when temperature or wind chill is expected to reach -30°C for at least two hours. During extreme cold warnings, York Region Public Health issues communications through a variety of channels, such as email, media releases, news items and social media, to internal and external stakeholders and the public. This communication provides information on precautions to reduce cold-related illness and helps residents and vulnerable populations stay safe during the extreme cold event.

5.3 CONCLUSION

With strong evidence of the health impacts and the high likelihood of increasing summer temperatures, climate change will likely play a significant role on health impacts from extreme heat in York Region. These impacts will be exacerbated by UHI conditions as the Region continues to grow and urbanize. In terms of extreme cold, projections for the winter months suggest fewer extreme cold days, but there is still emerging research on how climate conditions may impact polar jet streams and in turn extreme cold events in York Region.

While vulnerabilities remain present throughout York Region, such as decreased cooling options among low-income residents and a decreased social network among seniors, there are opportunities to enhance adaptive capacity, such as exploring health outcome data to inform future extreme heat and cold programming activities.

Certain gaps in understanding local impacts from extreme temperatures have been identified for York Region:

- Additional health data to better understand the health burden from extreme temperatures. This includes additional data (e.g., reported incidents at schools, workplaces, or long-term care homes), other health outcomes (e.g., mental health, cardiovascular disease) and the geographic distribution of cases
- Limited information on thermal comfort conditions in residential units, including vulnerable populations
- Understanding health impacts that may occur in conditions that do not meet warning criteria, such as moderate temperatures or impacts from multiple episodes of warm conditions
- Limited temperature layer maps to more accurately capture UHIs
- Determining if previously developed vulnerability indexes are valid measures of risk and assessing whether UHI areas correlate to greater exposure and health outcomes
- Better understanding of barriers of residents to address extreme temperatures, particularly for vulnerable populations

Addressing some of these gaps will provide valuable information to support adaptation planning, including a better understanding of UHI impacts and thermal comfort to inform policy and plans for land use development, recommendations to building codes and by-laws, and tree planting activities across the Region. Additionally, as the public health program relies on communication tools with stakeholders and the public, a better understanding of these gaps can inform the communication strategies that may be more effective in reaching target audiences.

While there is strong evidence of the increased risk of heat-related illnesses resulting from climate change, there are many factors that can shift vulnerabilities. For instance, future building and community designs may help alleviate some of the UHI conditions. As populations grow in York Region, shifts in demographics, such as more seniors and increases in low-income households, can create more climate-vulnerable populations. Impacts of extreme heat on health will also depend on how populations acclimatize to changing temperatures, which can reduce the sensitivity to extreme heat.

As mediating factors evolve, it is important for future adaptation planning to include continual surveillance of extreme heat and cold risks and York Region's adaptive capacity. Engagement of stakeholders will also be important to ensure the relevancy of identified strategies throughout the community and among partners. Table 5.2. provides a list of existing activities and potential opportunities that can inform future adaptation planning.

Table 5.2. Summary of extreme temperature related activities and adaptation planning opportunities.

	Ongoing and Completed Activities	Opportunities
Population Health Assessment and Surveillance	**Environmental monitoring:** Receiving and monitoring ECCC Alert Me notifications for extreme heat (including early notification stakeholder emails) and cold events. Completed UHI mapping assessment (2014). **Health surveillance:** Monitor extreme cold and heat-related hospital data (e.g., syndromic surveillance of extreme cold and heat-related hospital visits).	**Additional data and analysis:** Consider further analysis of past temperature related illnesses to provide better temporal and spatial resolution. • Explore observed heat-related illness cases occurring below heat event thresholds (e.g., mental health outcomes) • Consider trends relating to UHI areas. • Consider analysis methods from similar studies and available toolkits. Consider other data that can support better burden estimate (e.g., school-related cases, physician offices, 911 dispatch data, health line calls). Assess cases of sunburns in relation to extreme heat events and warmer summers. Surveillance planning: • Explore thresholds for real-time surveillance of the health impacts related to extreme temperature • Review updated climate change projections for extreme temperatures • Consider developing a plan for updating UHI maps
	Conducted RRFSS surveys (2016 to 2017) on extreme heat.	Consider modifying RRFSS Heat-Related Illness Protective Equipment to include other relevant health protective questions. Consider RRFSS questions for vulnerability factors (e.g., senior, low-income, socially isolated, thermal comfort).

Program and policy	Early warning system for extreme heat and cold notifications to stakeholders	**Health Equity:** Consider other methods to reach the most vulnerable populations.
	Recommending policy and program measures to reduce UHI effects • Supporting urban forest planning to increase shade in UHI priority areas • Supporting land use planning policy recommendations to reduce UHI (e.g., increasing tree coverage, retrofitting existing buildings with a high albedo and/or lighter coloured roof surfaces, ensuring buildings have air conditioning)	Explore effective built environment interventions for UHIs and increasing thermal comfort indoors (e.g., green infrastructure, cool pavements, and cool roofs). Continue advocating for built environment measures that reduce UHI and UVR exposure to the general public. Consider co-benefits of extreme heat best practices and interventions such as shade policies and guidelines. **Health Equity:** Incorporate health equity considerations in policy and programming to ensure all vulnerable populations are reached.
	Consulted with stakeholders on the York Region Public Health Extreme Heat program: • Survey of long-term care homes • Consultation with Regional partners and local municipalities	**Emergency Preparedness and Response:** Consider incorporating extreme heat adaptation measures for emergency plans relating to power outages.
Health Promotion	Extreme heat and cold key messaging and recommendations on York Region's website and social media. Cross-promotion of sun safety /checking UVR index through Extreme Heat program. **Forestry and Health Collaborative:** Promotion of the benefits of trees key messages, planting trees, build shade for your health and the environment factsheet as part of Local Enhancement and Appreciation of Forests' backyard tree planting program; social media messaging; articles; events.	Further public education on the health risks of extreme heat and cold resulting from climate change and measures to take to reduce exposure (for the general public and vulnerable groups). Integrate UVR exposure to Extreme Heat messaging. Health Equity: Targeted messaging for vulnerable populations (e.g., seniors).

Key stakeholder activities (outside of Public Health)	**Addressing extreme temperatures** Area municipality cooling centres and cooling options (e.g., splash pads, reflective pools, community centres and parks, community swimming pools). The Street Outreach Van (operated by Loft/Crosslinks) provides mobile services for homeless or street-involved people at no cost. York Region Public Health is one of several community partnering agencies that provide services through the Street Outreach Van. Winter shelters such as Inn from the Cold, Blue Door Shelters, Mosaic Interfaith Out of the Cold, Adult Emergency Housing Facilities, Family and Youth Shelters (360 Kids). **Addressing UHI** Assisting Forestry with the development of their tree planting prioritization tool, York Regional Forest management plan (2019-2038), York Region Forestry's Benefit of Trees strategy, and Urban Forest studies.	More effective engagement of key stakeholders in responding to extreme temperature events: • Consider additional consultations on response options for extreme temperature events (e.g., better understand health care system plans and measures to address extreme temperatures) • Consult on approaches and best practices to respond to extreme temperature events and reduce risk • Consider approaches to help address those most vulnerable and health equity considerations (e.g., subsidized air conditioning and fan distribution to provide cooling for vulnerable populations) Consider extreme heat impacts on the Mental Health Initiative and developing adaptive capacity for service delivery during extreme heat events.

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