Climate Change and Population Health Vulnerability Baseline Report:

GUIDELINES

NB HealthADAPT Project

*Note : this document was originally produced by the project team as a tool for communities to undertake health vulnerability and adaptation to climate change assessments.

Original authors:

Tracey Wade
Mélanie Madore
Public Health, NB

With support from
Avec l'appui de

Health Canada Santé Canada

Executive Summary

Climate change is a determinant of health. While all Canadians are at risk from the general impacts of climate change, evidence suggests that it poses a significant threat to health of communities, often by exacerbating pre-existing conditions. **Insert the purpose of this report for your community.**

Vulnerability refers to the degree to which an individual, community or health system is likely to be affected by climate change. Vulnerability is defined as the **exposure to climate risks**, the **sensitivity** to that exposure, and the **adaptive capacity** of the population to deal with the climate-related hazard. The focus of this report is specifically on exposure and sensitivity of the population towards climate change impacts.

The **name of your community** is exposed to several climate hazards : **Describe the climate projections that will likely affect your community and their possible health effects.**

All New Brunswick communities are vulnerable to the effects of climate change; however, some populations are at higher risk of experiencing health impacts because they are more sensitive to the challenges of climate change. Depending on the climate-related hazard, these more vulnerable groups include: the elderly and young children, people experiencing poverty and housing challenges, racialized communities, new immigrants, people with disabilities, lone-parent families, those who are pregnant or nursing, outdoor workers, and people with pre-existing and chronic health conditions.

[Climate change hazards and health- Section]

Extreme Temperatures

Projections for extreme heat events for the **name of your community** : **insert climate change projections for extreme temperatures (heat and cold)- RCP 4.5 and 8.5 scenarios (see page 13).** Anticipated further health impacts include an increase in heat-related illnesses (heat stroke, dehydration), increase in hospitalizations, and an increase in death rates due to complications created by extreme heat. Those most at risk are seniors and young children, outdoor workers, people with chronic diseases, and the homelessness. [People living in apartment buildings with no air conditioning may be particularly vulnerable if they live within the urban core where the intense development has created an urban heat island**.- *For city only]**

While projections for extreme cold events are decreasing over time, the warmer winter temperatures mean there is an increase in the freeze/thaw cycle which can damage municipal infrastructure (roads and underground pipes), flooding events, and increase the incidence of slips and falls.

Extreme Weather Events

Storm surge, windstorms (including hurricanes and tornadoes), severe thunderstorms and heavy precipitation events, and winter storms (including ice storms and blizzards) can all have significant impacts on communities affected by these events, including loss of power, flooding, and damaged infrastructure. Health impacts include increased injuries and mortality directly related to the storms, loss of access to emergency assistance and an increase in mental health impacts, such as stress, anxiety, and depression. In these situations, vulnerable populations are location-specific, but include people who live in flood-prone areas, people with mobility issues, people in areas with reduced access to health and emergency services.

Air Quality

The main factors that affect the air we breathe are increasing temperatures and air pollution. Higher temperatures are lengthening pollen and spore seasons and exacerbating pollution problems. As well, the changing climate is affecting precipitation patterns and leading to more forest fires as well as exposure to microbial air impacts. Projected future health risks include higher rates of asthma, COPD, allergies and lung cancers and increased hospitalizations and mortality related to these illnesses. People most at risk are those with pre-existing conditions (COPD or asthma), seniors, young children, and people with allergies.

Water Quality and Safety

Increasing temperatures, drought conditions, runoff from extreme rainfall events, and a change in freeze-thaw cycles can affect both drinking water supplies and recreational waters (beaches and nature parks). Increases in blue-green algal blooms, *E.coli*, and turbidity may be related to these climate hazards. Projected future health impacts are increased rates of waterborne illnesses and increased hospitalizations and mortality related to exposures. Particularly vulnerable populations include anyone (including animals) exposed to contaminated water and people with underlying health conditions or weakened immune systems.

Food Safety and Security

Food safety may be threatened by climate change by consuming food that has been washed with contaminated water or grown in contaminated soil, fish or seafood harvested from waters with higher-than-normal temperatures, and food consumed at public events in extreme heat conditions. As with water quality health impacts, foodborne illnesses will increase as may hospitalizations and mortality related to those illnesses.

Food security is a larger more systemic issue where some people can't afford to eat nutritious food. Food insecurity exists in this region as not enough variety food is produced

to support the population. As well, traditional food harvest for Indigenous populations is being threatened by climate change which affects the local populations. Future health impacts include higher rates of malnutrition as well as a burden on the health system addressing the impacts.

Vector-Borne Diseases

Climate change is extending the range of invasive species northward so that the habitat for ticks and other disease-carrying vectors has now expanded into New Brunswick. Future health impacts are an increased incidence of Lyme disease, West Nile disease, and possible exposure to new vector-borne pathogens. Vulnerable populations include people who are homeless, children, outdoor workers, outdoor enthusiasts, and anyone who spends time outdoors in long grass.

Ultra-Violet (UV) Radiation

Increased exposure to UV radiation will result in more incidence of skin cancers, eye disease, and reduced immune function for some. Vulnerable populations are those who work outdoors, homeless, very young and people who don't take protective measures (e.g., sunscreen, sunglasses).

Table of contents

Executive Summary 2
Table of contents 6
List of tables and figures 8
1 Introduction 10
1.1 Climate Change and Health Vulnerability and Adaptation Assessment (CCHVAA) 10
1.2 Definition of Vulnerability 11
2 Who is Most Vulnerable to Climate Change Health Impacts? 14
2.1 Climate Exposure Variables That Affect Vulnerability in Your Community 14
2.1.1 Geographic and demographic factors 14
2.2 Characteristics that make populations more sensitive to climate change impacts 14
2.2.1 Demographic characteristics 14
2.3 Climate Sensitivity Variables 16
3 Baseline Data for Climate Hazards 19
3.1 What are the climate projections based on? 19
4 Extreme Temperatures 21
4.1 Extreme Heat 21
4.1.1 Historic Temperature Change 21
4.1.2 Projections for extreme heat events in **your community** 21
4.1.3 Extreme Heat Burden of Heat-Related Illness 25
4.1.4 Projected Burden of Illness for Extreme Heat Impacts 25
4.2 Extreme Cold 27
4.2.1 Projections for extreme cold events in **your community** 27
4.2.2 Current Burden of Cold-Related Illness 29
4.2.3 Projected Burden of Cold-Related Illness 29
5 Extreme Weather 31
5.1 Projections for Extreme Weather 31

5.2 Exposure to Extreme Weather Events 32
5.2.1 Development in Flood Zone 33
5.3 Sensitivity to Extreme Weather Events 33
5.4 Projected Burden of Illness from Extreme Weather Events 35
6 Air Quality 37
6.1 Air Pollution 37
6.2 Allergens 38
6.3 Air Conditioners and Disease 39
Source: Statistics Canada. Table 38-10-0019 Air Conditioners; https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3810001901 39
6.4 Current Burden of Illness Related to Air Pollution 40
6.5 Projected Burden of Illness related to Air Pollution 40
7 Water Quality and Supply 42
7.1 Safety of Municipal Drinking Water Supply 42
7.2 Wastewater 42
7.3 Recreational Waters 42
8 Food Safety and Food Security 44
8.1 Food Safety in New Brunswick 44
8.1.1 Foodborne (and Waterborne) Illness 44
8.2 Future Burden of Illness Related to Water Quality and Food Safety 46
8.3 Food Security/Food Systems 48
8.4 Projected Burden of Illness Related to Food Insecurity 50
9 Vector-Borne Disease 52
9.1 Projected burden of illness for vector-borne diseases in New Brunswick 53
10 Exposure to Ultraviolet Radiation 55
9 Summary 56
References 57

List of tables and figures

Tables :

Table 1 : Population demographic and socio-economic profile, **Name of your municipality** and New Brunswick (**most recent census**) 16
Table 2: Number of Births and Human milk-feeding initiation rates 17
Table 3 : Rate of chronic health conditions, **Name of the municipality** and New Brunswick (2017) 17
Table 4 : Future Climate Projections for **your community** 23
Table 5: Number of days with Public Health generated Heat Alerts in **your community** 23
Table 6 : Heat related illness burden in **Your Community** Hospital, April to September from 2019 to 2021 25
Table 7 : Extreme Cold- Current and future projections for **your community** 27
Table 8 : Number of days with ECCC Weather Warnings 29
Table 9 : Falls on ice diagnosis reported to **your area** Emergency Departments by month 29
Table 10 : Precipitation – Current and Future projections for **your community** 32
Table 11 : Number of Days with Weather Warnings in **your community** 32
Table 12 : Mental Health 35
Table 13 : Predominant pollen and spores for **your community** 39
Table 14: Comparison of households with air conditioners in **Your community** and New Brunswick 39
Table 15 : Parlee Beach No Swimming Advisories 43
Table 16 : Selected Enteric Food and Water-borne diseases reported in NB, incidence rates per 100,000 population 46
Table 17 : Health Status related to Food Security 50
Table 18 : Emergency Department visits for Sunburn - **Your community** 55
Table 19 : Number of New Invasive Melanoma Cancer Cases - **Your community** 55
Table 20 : Cataract surgery by year – **Your community** 56

Figures :

Figure 1 : Assessment Process Steps from Health Canada (2019) 11
Figure 2 : Conceptual framework for vulnerability assessment..... 12
Figure 3 : insert a map that describes your territory. 14
Figure 4 : The Representative Concentration Pathways scenarios..... 19
Figure 5: Example for the city of Moncton 21
Figure 6 : Projected Climate Trends for the province 27
Figure 7 : Projected Climate Trends for the province. 31
Figure 8 : Black Legged Tick Risk Areas..... 52

1 Introduction

Climate change is a determinant of health. All Canadians are at risk of the health impacts of climate change; however, some populations are at higher risk. There is a growing body of evidence that climate change is affecting public health here in Canada (Clark et *al*., 2021), often by exacerbating pre-existing conditions (Pan American Health Organization, 2020). While our knowledge of the projected burden of health impacts related to climate change is limited, we do know change is happening at a rapid pace and that New Brunswickers need to prioritize preparedness.

Climate change hazards in New Brunswick include increases in average annual temperatures, increases in extreme weather events, changes in precipitation leading to more droughts, more heat waves, sea-level rise, and an increase in vector-borne diseases carried by pests (such as ticks and mosquitoes). Populations become vulnerable to these effects by the frequency and duration of exposure to the risks, their sensitivity to the situation, and how well they can adapt to the impacts.

Insert the purpose of this report for your community – For example: *define vulnerability and outline how various populations are being - and will be - affected by the current and future health impacts of climate change hazards.*

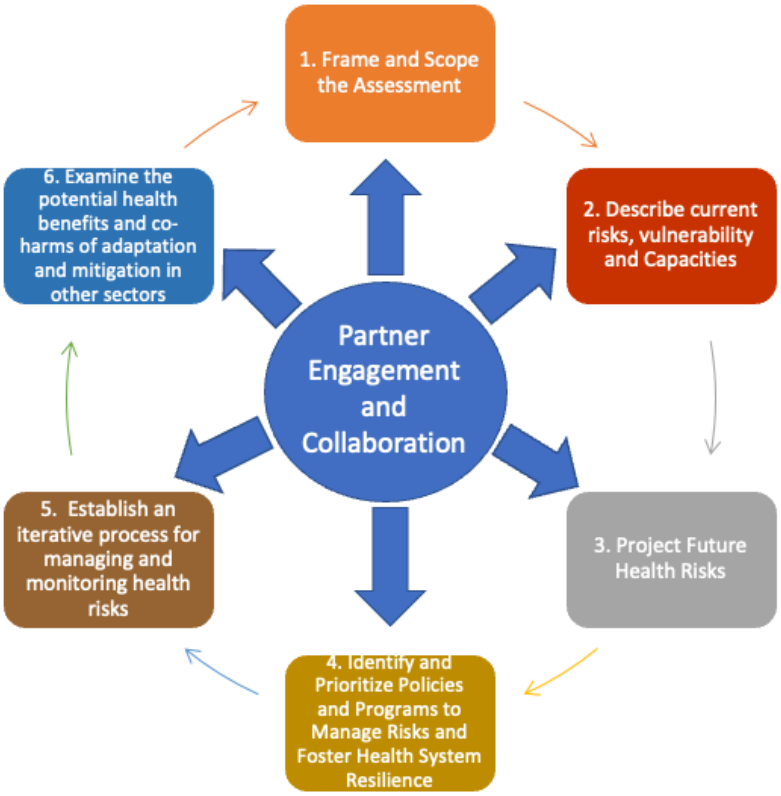
1.1 Climate Change and Health Vulnerability and Adaptation Assessment (CCHVAA)

In 2019, Health Canada released its workbook for the Canadian Health Sector to undertake climate change health vulnerability and adaptation assessments (CCHVAA) (Enright et *al*., 2019). This tool, based on the World Health Organization (WHO) approach, is designed primarily for use by health officials to develop CCHVAAs through participatory processes that engage partners from multiple sectors and organizations. This workbook includes step-by-step guidance focusing on the six steps of its process, illustrated in Figure 1.

Figure 1 : Assessment Process Steps from Health Canada (2019)

Assessment Process Steps

1. Frame and Scope the Assessment
2. Describe Current Risks, Vulnerabilities and Capacities
3. Project Future Health Risks
4. Identify and Prioritize Policies and Programs to Manage Risks and Foster Health System Resilience
5. Establish an Iterative Process for Managing and Monitoring Health Risks
6. Examine the Potential Health Benefits and Co-Harms of Adaptation and Mitigation in other Sectors



Source : Enright et *al*., 2019

1.2 Definition of Vulnerability

Vulnerability is a significant concept that will be used throughout this report and refers to the degree to which an individual, a community or the health system is susceptible to injury, damage or harm. Vulnerability is generally defined by the literature as the **exposure to climate risks**, the **sensitivity** to that exposure, and the **adaptive capacity** or the ability to cope of the population to deal with the impacts experienced.

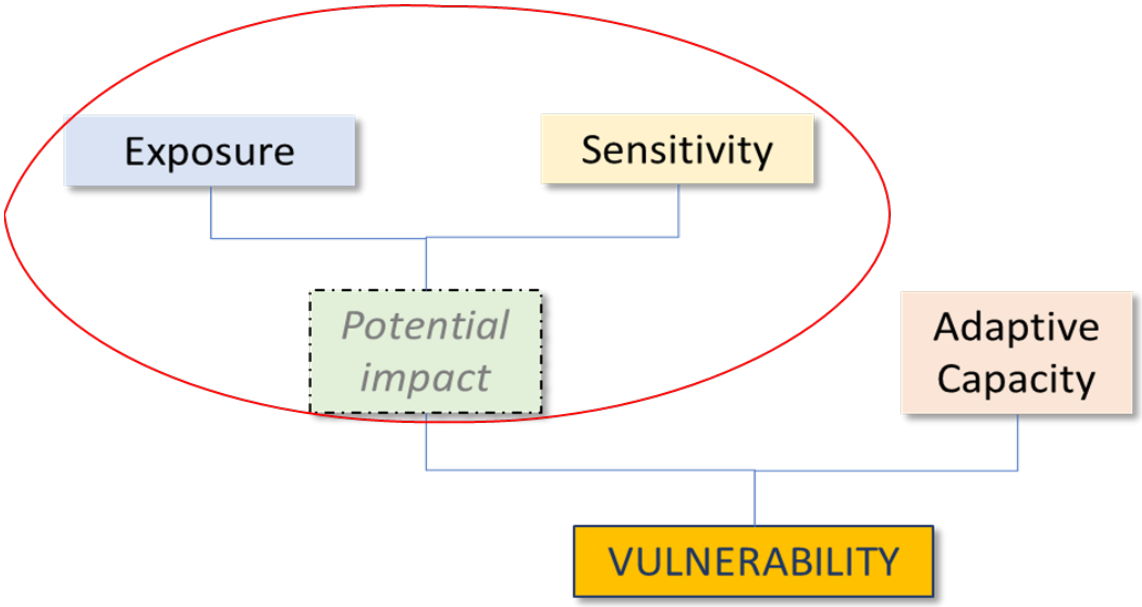
The three main concepts can be defined as follows: (Enright et *al*., 2019):

- **Exposure** – The contacts between a person and one or more biological, psychosocial, chemical, or physical stressors, including stressors affected by climate change. Health Systems may be susceptible to exposure due to poor infrastructure, geographic location (e.g., located in floodplains); being under-resourced (e.g., understaffed or underfinanced); and service delivery can be impacted if roads are blocked or staff are unable to get to work, for example.
- **Sensitivity** – An expression of the increased responsiveness of an individual or community to an exposure, generally for biological reasons (e.g., age or the presence of pre-existing medical conditions), social factors (e.g., marginalized due to race, gender, socioeconomic) and geographic factors (e.g., living on flood plains or in coastal communities).

- **Adaptive Capacity** – The ability of communities, institutions or people to adjust to potential damage, to take advantage of opportunities, or to respond to consequences of climate change-related hazards.

This Baseline report focuses on the potential impact of exposure and sensitivity to health impacts of climate change as emphasized in Figure 2.

Figure 2 : Conceptual framework for vulnerability assessment



Source : Australian Greenhouse Office (2005)

2 Who is Most Vulnerable to Climate Change Health Impacts?

At a global level, almost the entire population is vulnerable to the various health effects of climate change; however, similar to the effects of the COVID-19 pandemic, some populations are more vulnerable to the health impacts of climate change than others. It is the same situation in Canada, as well in New Brunswick. Based on future climate projections, the climate hazards that are likely to impact (or are already impacting) the province of New Brunswick are extreme temperatures, extreme weather/natural hazards, air quality, water safety, food security, vector-borne disease transmission, and exposure to high UV radiation (Roy & Huard, 2016). **Importantly, for the following sections, data collected to date establishes a baseline level to allow for future comparisons and analysis.**

2.1 Climate Exposure Variables That Affect Vulnerability in Your Community

The **name of your community** : add a description of your municipality : geographic location, population size according to the most recent census, etc. - and describe the vulnerabilities that your community faces now and will face in the future- *Examples include geographic factors, land use and development, socio-economic indicators, and an aging population. These key socio-demographic factors are discussed in the next section.*

Figure 3 : insert a map that describes your territory.

2.1.1 Geographic and demographic factors

Add a brief description of the geographic and demographic factors of your municipality: *Examples may include land use, geographic location (coastal, river, urban or rural context), population growth, etc.*

2.2 Characteristics that make populations more sensitive to climate change impacts

2.2.1 Demographic characteristics

Add a demographic description of your community with a provincial comparison based on the categories in Table 1 (age-related indicators, socio-cultural and socio-economic data, etc.)

Table 1 : Population demographic and socio-economic profile, **Name of your municipality** and New Brunswick (**most recent census**)

	City	**New Brunswick**
Population		
2016		747 101
2011		751 171
Population percentage change, 2011 to 2016		-0.5%
Most vulnerable age groups (% of the population)		
0-4 years		4.6%
65 years and over		19.9%
Cultural characteristics		
Recent immigrants (2011 to 2016)		1.3%
Total visible minority population		3.4%
No knowledge of English or French		0.3%
Aboriginal identity		4.0%
Socioeconomic characteristics		
Low-income status for individuals (2015)		
0-17 years		18.3%
0 to 5 years		5.7%
18 to 64 years		62.7%
65 years and over		19.1%
Households spending 30% or more of income on shelter costs		16.8%
No high school diploma or equivalency certificate, population aged 25-64 years		13.9%
1 person households		28.0%
Lone-parent families		16.2%
Renter		25.0%
Occupied private dwellings needing major repairs		8.3%
Housing not suitable*		2.3%

Source: Census Profile, 2016 Census (statcan.gc.ca)

**Housing suitability - Refers to whether the dwelling has enough bedrooms for the size and composition of the household. A household is deemed to be living in suitable accommodations if its dwelling has enough bedrooms.*

2.3 Climate Sensitivity Variables

Insert a description of the segments of the population in your community that are particularly vulnerable to climate risks. - *See below for examples*

1) The first population of concern is **outdoor workers** – these are individuals who are directly exposed to climate hazards because of their work environment. As New Brunswick's economy is largely dependent on its natural resources, many of the workers in this sector are based outdoors including agriculture, fishing, forestry, hunting, mining, quarrying, oil and gas extraction, and construction. **Add the latest data from Statistics Canada on outdoor workers** .

2) Another vulnerable population is those who are **pregnant and nursing**. **If possible, add data from your local hospital surrounding pregnant or nursing women (see examples in Table 2).** Research has shown that climate change hazards such as extreme heat can negatively impact both maternal and fetal health (Zhang et *al.*, 2019).

Table 2: Number of Births and Human milk-feeding initiation rates

Fiscal Year	Number of Births	breast milk-feeding initiation rate
2016-2017		
2017-2018		
2018-2019		
2019-2020		

Source – Hospital reports to Perinatal NB, Client Services Delivery System for **XXX Hospitals**

3) The third, and probably largest population that is more susceptible to climate change (in addition to those directly exposed to climate risks) are people who live with **pre-existing health conditions** such as chronic obstructive pulmonary disease (COPD), heart disease, asthma, weakened immune systems, and mental health issues. Based on data compiled by the New Brunswick Health Council, Table 3 illustrates the percent of the population suffering from a chronic health condition.

Table 3 : Rate of chronic health conditions, **Name of the municipality** and New Brunswick (2017)

Condition	Your community	New Brunswick
Emphysema or COPD		3%
High blood pressure or hypertension		27%
Arthritis		17%
Cancer		8%
Chronic Pain		14%
Depression		15%
Gastric reflux (GERD)		16%

Heart disease		8%
Mood disorder other than depression		3%
Stroke		3%
Someone in the household has a memory problem		10%

Source: NB Health Council - **https://nbhc.ca/data/browse/health-zones**

3 Baseline Data for Climate Hazards

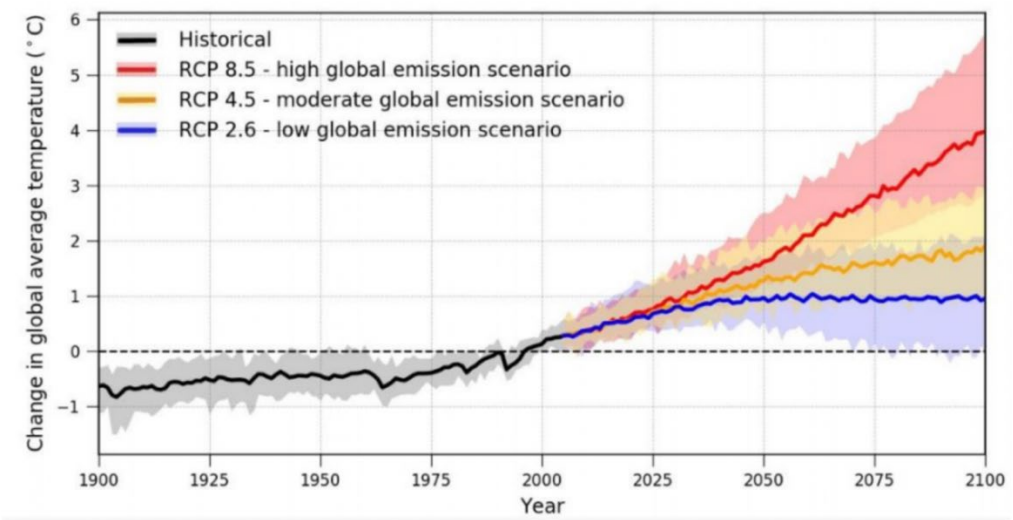
Various reports and studies have identified key climate change hazards in this province, such as increased heat waves, coastal erosion, sea-level rise, inland flooding, increased precipitation, or increased frequency of storm surges. In this section of the report, we will define the climate projections under the Representative Concentration Pathways (RCPs) scenarios.

3.1 What are the climate projections based on?

The RCPs serve as a possible future scenario for human-caused Greenhouse Gas (GHG) emission trends. These scenarios provide a range of possible futures, based on a range of future emissions, deforestation, population growth and many other factors.

- **RCP 2.6 : low** emission global scenario requires strong mitigation actions. This scenario indicates average global warming levels of 0.9 to 2.3 °C by 2090. While considered the ideal scenario, it is widely recognized that humans are not currently on this path so planning solely based on these projections would ignore the much higher probability scenarios.
- **RCP4.5 : medium** global emission scenarios include measures to limit (mitigate) climate change, and indicates average global warming levels of 1.7 to 3.2 °C by 2090. This scenario is generally considered plausible if global emissions can be curbed as promised during global climate change conferences.
- **RCP8.5 : high** global emission scenarios indicates average global warming levels of 3.2 to 5.4 °C by 2090. This scenario is often used as a default for planning because humans are currently on this trajectory, and because planning for "worst case" leaves little room for unexpected consequences.

Figure 4 : The Representative Concentration Pathways scenarios



Source: Canada, 2021, Scenarios and climate models https://www.canada.ca/en/environment-climate-change/services/climate-change/canadian-centre-climate-services/basics/scenario-models.html#toc0

For this Report and the NB HealthADAPT Project, the research team used scenarios RCP 4.5 (medium) and RCP 8.5 (high), as those RCPS are designed to provide plausible future scenarios of human emission patterns.

4 Extreme Temperatures

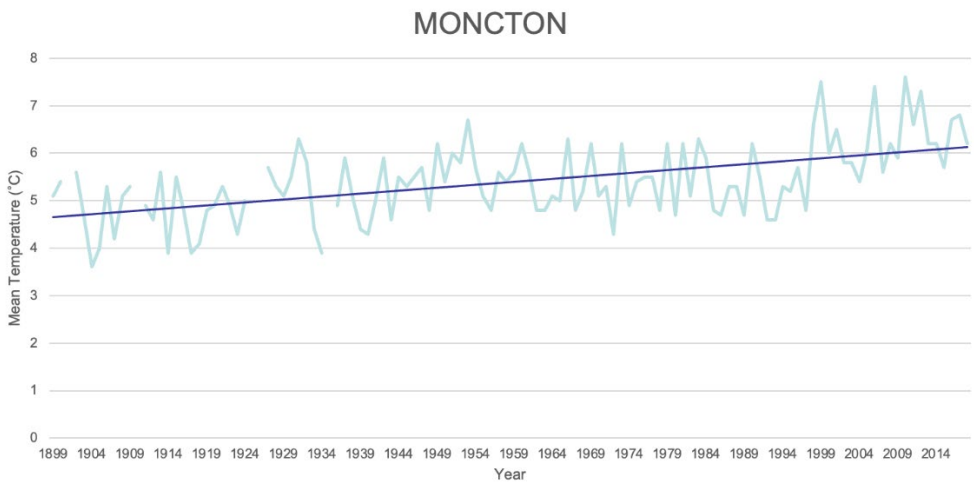
Extreme temperatures are one of the most noticeable impacts of climate change. The following section outlines the projections for extreme temperatures for both heat and cold in **your community**, the baseline burden of illness associated with each, and the projected burden of illness based on climate change projections.

4.1 Extreme Heat

4.1.1 Historic Temperature Change

Add the climate trend over the last decade for your community. – *Figure 5 shows that **Your community** historic temperature has increased by **X**°C over the past century.*

Figure 5: Example for the city of Moncton



Source: Climate Change presentation to RHAs (2020) based on the climate data from Environment and Climate Change Canada, 2019

4.1.2 Projections for extreme heat events in your community

With the average increase in temperature comes extreme heat events. Although difficult to predict, we do know that these events are expected to increase in frequency in the future

based on the RCP scenarios and the recent number of heat-related alerts. Table 4 outlines the future climate projections for the extreme heat for **your community**.

Table 4 : Future Climate Projections for **your community**

	Baseline (1990)	Medium emissions scenario **(RCP4.5) By 2080**	High emissions scenario **(RCP8.5) By 2080**
Average annual temperature (°C)			
# days above 30°C			
# days above 35°C			
Average summer temp (°C)			

Source: Commission de Service Régionaux- Nord-Ouest https://csrno.ca/climat/

The provincial Heat Alert and Response System (HARS) was initiated in 2010 in anticipation of rising global temperatures and deadly heat waves that had been experienced in other countries such as France (2003), the United States (1995), Russia (2010). Canadian provinces also experience extreme heat as evidenced in British Columbia and Alberta in 2021. The goal of the HARS is to alert the population of a heat wave so that people can take measures to protect themselves. Table 5 shows the amount of heat alerts through HARS for the past five years.

Table 5: Number of days with Public Health generated Heat Alerts in **your community**

Years	**Level 1** *Humidex >= 36* ***for 2+ days***	**Level 2** *Humidex >= 40-44* ***for 2+ days***
2016		
2017		
2018		
2019		
2020		
2021		

Source: HARS NB program data (2021)

Finally, because **if your community** is an urban centre with a high density of development in the city core, it is experiencing what is called the urban heat island (UHI) effect which exacerbates extreme heat events.

What is an Urban Heat Island?

The urban heat island effect happens when closely packed buildings and paved surfaces traps and intensify heat. Because cities also generate their own heat - from higher density of furnaces, air conditioners, and vehicles, urban and suburban areas tend to have higher surface and near-surface air temperatures than surrounding rural areas.

4.1.3 Extreme Heat Burden of Heat-Related Illness

The effect of extreme heat on public health is well documented and includes, for example, heat illness, chronic dehydration, heat stroke, fatigue and lack of energy, difficulty sleeping and underlying mental health problems. Those most at risk include participants in large outdoor events, homeless people, outdoor workers, people living in homes without air conditioning, the elderly, very young, pregnant people, and people with chronic diseases such as heart disease, breathing difficulties, diabetes, high blood pressure and obesity.

In that respect, Table 6, shows the data from acute care for heat-related illnesses that may be related to heat events and the Emergency Department visits for the hospital **in your region**. *These numbers provide a baseline against which to compare numbers in the future as the climate continues to warm and the number of extreme heat events rises.*

Table 6 : Heat related illness burden in **Your Community** Hospital, April to September from 2019 to 2021

Year	**2019**	**2020**	**2021**
Emergency room visits for heat exhaustion, heat stroke, and dehydration			
Acute care discharges for myocardial infarction (heart attack)			
Acute care discharges for hypertension			

Source: Data from the **XXX** Hospital from the ACDM and DAD.

4.1.4 Projected Burden of Illness for Extreme Heat Impacts

Various studies have been undertaken around the world to project the impacts of excess heat on the health and mortality rates of populations. Results of one international study found that, "if there is no adaptation, heatwave-related excess mortality is expected to increase the most in tropical and subtropical countries/regions (close to the equator), while European countries and the United States [and Canada] will have smaller percent increases in heatwave-related excess mortality. The higher … the greenhouse gas emissions, the higher the increase of heatwave-related excess mortality in the future." (Guo et *al*., 2018) Further, with adaptation strategies related to heatwave thresholds implemented, it is

projected that heatwave-related excess mortality would level off for all countries/regions, with a lowered expected heatwave-related excess mortality. (Guo et *al.,* 2018)

Importantly, it should be emphasized that heatwaves have a greater impact on mortality and illness than the reported number due to classical heat illness would indicate. This is because heatwaves can induce the onset of other diseases, such as cardiovascular diseases, respiratory diseases, and diabetes, which may not be reported as being attributed to heatwaves. Indeed, deaths from high temperatures and heat waves are greater than deaths from other weather events such as tornados and flooding, and these deaths are not only a result of heatstroke. (Sanderson et *al*., 2017)

One study on outdoor workers' health found that for every degree (1°C) of increase in daily maximum summer temperatures from 2001 to 2016 resulted in an increase of 28-51% in the daily claims of heat-related problems by workers. In a similar vein, in Quebec, "higher rates of ambulance transports, emergency room admissions and deaths were reported during regional extreme heat waves than during comparative periods" by outdoor workers. (Adam-Poupart et *al*., 2021)

A synthesis of scientific studies found that additional climate change is projected to increasingly compromise safe work activity and worker productivity during the hottest months of the year since higher ambient temperatures and humidity levels place additional stress on individuals engaging in physical activity. (Ebi et *al*., 2014). Further, global warming of +1.5°C is projected to reduce working hours worldwide by 6% due to heat stress. Environmental heat stress in 2050 is projected to reduce worldwide labour capacity by 20% in hot months from a 10% reduction today, assuming no change in worker behaviour or workplace conditions. (Ebi et *al.,* 2014)

A Canadian report outlined that "even under the low-emission scenario, heat-related hospitalization rates will increase by 21 per cent by mid-century compared to the current average and double by the end of the century. Further, the costs of death and reduced quality of life from heat-related deaths are substantial. By mid-century, we project these costs will range from $3.0 billion to $3.9 billion per year. Rising temperatures are projected to have a large negative impact on productivity, especially in economic sectors where work takes place outdoors or in poorly cooled spaces. Our modelling estimates that under a high-emission scenario climate change could lead to a projected loss of 128 million work hours annually by the end of the century—the equivalent of 62,000 full-time equivalent workers, at a cost of almost $15 billion." (Clark et *al*., 2021)

4.2 Extreme Cold

4.2.1 Projections for extreme cold events in your community

As illustrated in Figure 6 and Table 7, the projections for 2080 in both medium and high emissions scenarios show that **your region** is going to see significantly *fewer extreme cold days during the winter*. **The next lines are for illustrative purposes - insert a description of the effects that the reduction or increase of extreme cold events will have on your area.** *As well, annual-freeze thaw cycles will change over time as well. As winter's warm, the number of days with nights below 0°C and daytime high above freezing will increase. These freeze-thaw cycles can have major impacts on infrastructure. Water expands when it freezes, so the freezing, melting and refreezing of water can, over time, cause significant damage to roadways, sidewalks, and other underground pipes. Potholes that form during the spring, or during mid-winter melts, are good examples of the damage caused by this process.*

Figure 6 : Projected Climate Trends for the province

Variable | Baseline (1981-2010) | Projections for 2080 (RCP8.5)

Source: Roy & Huard, 2016 in WSP, 2019, pp.4-5

Table 7 : Extreme Cold- Current and future projections for **your community**

	Baseline (1990)	Medium emissions scenario **(RCP4.5) By 2080**	High emissions scenario **(RCP8.5) by 2080**
◆Winter freeze -thaw cycles days			
# days <-10°C			

# days <-20°C			

◆*Annual Freeze-thaw days: the average number of days per year when the daily maximum temperature equals or exceeds 0 degrees Celsius AND the daily minimum temperature is less than 0 degrees Celsius.*

Source: Commission de Service Régionaux- Nord-Ouest https://csrno.ca/climat/

Table 8 provides a baseline for comparison against future trends of extreme cold warnings which will likely decrease over time.

Table 8 : Number of days with ECCC Weather Warnings

Type of Event	Year	**Your region**
Extreme Cold[1]	2016	
	2017	
	2018	
	2019	

Source: Health and Air Quality Forecast Services, Environment and Climate Change Canada; http://www.weather.gc.ca/warnings/index_e.html

4.2.2 Current Burden of Cold-Related Illness

While the burden of heat-related illness is well documented, the cold-related burden is often given less consideration because of the warming climate trend. Nonetheless, cold-related health illnesses include hypothermia and the risk of injuries due to falls. **If possible, include data from your local hospital for falls on ice diagnoses, using table 9.** The populations at risk are outdoor workers, the homeless or underhoused, seniors, people who live with a chronic condition, and the people with disabilities.

Table 9 : Falls on ice diagnosis reported to **your area** Emergency Departments by month

2017/18	2018/19	2019/20

Source: Data from **XXX Hospital**. ACDM / Health Analytics.

4.2.3 Projected Burden of Cold-Related Illness

Temperature increases for Canada given the high emissions scenario are expected to result in a decreased cold-related mortality burden and an increased heat-related mortality burden, but the balance of these changes varies among cities. While increased burdens are predicted in the major cities in Canada, although no evidence was found to show a consistent trend toward increased temperature variation. However, these predictions should not diminish efforts to mitigate temperature stress, as the ultimate burden of hot

[1] *Extreme cold warnings are issued in Atlantic Canada when the temperature or wind chill is expected to reach -35C for at least 2 hours https://www.canada.ca/en/environment-climate-change/services/types-weather-forecasts-use/public/criteria-alerts.html#extremeCold*

and cold temperature-related mortality will depend on societal decisions regarding issues spanning urban design and investment in health care (Martin et *al*., 2012)

5 Extreme Weather

Extreme weather events, such as floods and drought, are becoming increasingly more common, intense and less predictable. The following section outlines the precipitation projections for New Brunswick, **your community**, the baseline of extreme weather events, population sensitivity to extreme weather, and the projected burden of illness for the future.

5.1 Projections for Extreme Weather

The increased precipitation for the entire province and **for your community** means, **the next lines is for illustrative purposes - insert a description of the effects that extreme weather events will have on your area.-** *in addition to the volume of water to be managed, increased impacts on outdoor activities, agriculture, construction and maintenance of buildings and infrastructure. In addition, heavy rainfall is often accompanied by other challenges, such as storm water runoff and sewerage discharges, flooding, damage to infrastructure (roads) and damage to crops.*

Figure 7 : Projected Climate Trends for the province.

Variable	Baseline (1981-2010)	Projections for 2080 (RCP8.5)

Source: Roy & Huard, 2016 in WSP, 2019, pp.4-5

Add climate projections precipitation for your region in table 10, with a description of the possible impacts on the health of your population.

Table 10 : Precipitation – Current and Future projections for **your community**

	Baseline (1990)	Medium emissions scenario **(RCP4.5) by 2080**	High emissions scenario **(RCP8.5) by 2080**
total winter precipitation (mm)			
total spring precipitation (mm)			
total summer precipitation (mm)			
total fall precipitation (mm)			
total annual precipitation(mm)			
*Annual amount of rain days			
**Annual amount of snow days			

**Annual Total Rain Days is the average number of days per year with at least 0.2 mm of rainfall.*

***Annual Total Snow Days is the average number of days per year with at least 0.2 cm of rainfall.*

Source: Commission de Service Régionaux- Nord-Ouest https://csrno.ca/climat/

5.2 Exposure to Extreme Weather Events

Extreme weather events require timely resource management, such as emergency response for municipalities, and preparation of those who find themselves most at risk. **Add the number of warnings and the annual average (for each type of event) issued by Environment Canada for the last few years in Table 11.**

Table 11 : Number of Days with Weather Warnings in **your community**

Type of Event	**Year**	**Region**
Storm Surge (Annual average)	2016	
	2017	
	2018	
	2019	
Wind Storm (Annual average)	2016	
	2017	
	2018	
	2019	
Tornado/Severe Thunderstorm (Annual average)	2016	
	2017	
	2018	
	2019	
	2016	

Type of Event	Year	Region
Tropical Storm/ Hurricane (Annual average)	2017	
	2018	
	2019	
Blizzard (Annual average)	2016	
	2017	
	2018	
	2019	
Freezing Rain (Annual average)	2016	
	2017	
	2018	
	2019	
Winter Storms (Annual average)	2016	
	2017	
	2018	
	2019	

Source: Health and Air Quality Program Meteorologist Health and Air Quality Forecast Services, Environment and Climate Change Canada.

5.2.1 Development in Flood Zone

If your community has a recent adaptation to climate change plan with a risk analysis of flood-prone areas, please include it here.

5.3 Sensitivity to Extreme Weather Events

According to the literature, almost everyone is at risk from extreme weather events. New Brunswickers are not immune, as witnessed during the 2017 ice storm in northeastern and part of southeast New Brunswick, drought conditions of the summers of 2018 and 2020, and Saint John River valley flooding in 2018 and 2019. Certain characteristics also contribute to increased vulnerability of a population such as where people are physically situated in relation to an event, people with mobility issues, and people in areas with reduced access to health and emergency services.

One of the increasingly recognized outcomes of extreme weather events is the stress and mental health burden that is experienced by people who have been directly impacted by floods, drought, or damage caused by wind (buildings, structures or land). "Mental health

outcomes related to climate change can include post-traumatic stress disorder (PTSD), anxiety, depression, complicated grief and survivor guilt, recovery fatigue, and suicidal ideation…. Other psychological impacts may include weakened social ties, increased stress levels, substance misuse, aggression, and violence…" (Hayes et *al*., 2019).

Using the New Brunswick Health Council latest data as a baseline, indicate in Table 12 the numbers of self-reported mental health of people from your community, in comparison to New Brunswickers in general.

Table 12 : Mental Health

Indicators	Your community	New Brunswick
Youth (Grades 6-12) Reporting symptoms of depression (2015–2016)		31%
Youth (Grades 6-12) Reporting symptoms of anxiety (2015–2016)		33%
population who see their mental health as Very Good or Excellent (18-64 years)		67%
population who see their mental health as Very Good or Excellent (65+ years)		60%
Youth (grades 6-12) diagnosed with a mental health disability (2015-2016)		2.3%

Source: NB Health Council : https://nbhc.ca/data/browse/health-zones

5.4 Projected Burden of Illness from Extreme Weather Events

It is a challenge to project the burden of illness from specific events (ice storms, droughts, hurricanes, etc.) because they are location specific, and only impact those in the path of the storm. One can assume that with the more frequent severe weather events, there will be increased health impacts and mortality related to such storms. However, one area where the future consequences of extreme events have been considered is in terms of mental health outcomes.

Canadian researchers found that mental health outcomes related to climate change affect the way people think, act, feel, and interact, and they can arise from short-term hazards, such as flooding or hurricanes, or from an understanding of the potential long-term effects of climate-related extreme weather events such as heatwaves, floods, hurricanes, and wildfires or long-term hazards such as rising heat levels, rising sea levels, and episodic droughts. (Hayes et *al.,* 2019)

In one study, researchers concluded that environmental stressors produced by climate change pose threats to human mental health by quantitatively assessing temperature changes and mental house outcomes. The study suggests that "shifting from monthly

temperatures between 25°C and 30°C to more than 30 °C increases the probability of mental health difficulties by 0.5% points, that 1°C of 5-year warming associates with a 2% point increase in the prevalence of mental health issues." (Obradovicha et *al.,* 2018) Indeed, "exposure to hurricanes and floods is associated with symptoms of acute depression as well as posttraumatic stress disorder. ...Furthermore, both heat and drought amplify the risk of suicide (28–30%), and psychiatric hospital visits increase during hotter temperatures." (Obradovicha et *al*., 2018)

6 Air Quality

Air quality is affected by climate change directly as a result of increased temperatures, and indirectly by the impacts higher temperatures have on human and natural systems. Higher temperatures create a higher demand for air conditioning, which consumes energy, most of which is generated from non-renewable sources. Increased temperatures and extreme weather events create conditions for forest fires, and a longer growing season in plants extends pollination. The following sections outline the indicators for air quality, establish the baseline burden of illness as a result, and discusses the projected burden of illness in the future.

6.1 Air Pollution

Everyone is exposed to air pollution at some level every time we breathe. Even at low levels, air pollution has an impact on human health. In fact, "Science has clearly shown that air pollution leads to disease, increased hospitalizations, and even premature death" (Health Canada, 2021).

Canada employs a rating system of 0-10 for air quality through the Air Quality Health Index (AQHI). The AQHI considers a wide range of pollutants and there are many air quality monitoring stations situated in strategic locations throughout the country, including eight in New Brunswick.

While air pollution is complex, most health effects are associated with the major components of smog: ozone (O_3); nitrogen dioxide (NO_2); and fine particulate matter ($PM_{2.5}$). Air Quality Monitoring Stations have been established throughout New Brunswick and **should include one in your region**.

In establishing baseline data : show levels of 1) Ozone, 2) Nitrous Dioxide and 3) Particulate Matter detected in your area for the recent years.

1) **Ground-level ozone** is a colourless and highly irritating gas that forms just above the earth's surface which is known to have significant effects on human health. Exposure to ozone has been linked to premature mortality and can increase hospital admissions and asthma symptoms days. The national average concentrations[2] are 39.2 ppb[3] for annual ozone and 42.4 ppb for summer ozone (Health Canada, 2021).

[2] *Specifically, these are the population-weighted average ambient concentrations of Ozone.*

[3] *Ppb = parts per billion*

According to the Province of Alberta, 76 ppb is in the high-risk zone for O_3 (Alberta Provincial Government).

2) **Nitrogen dioxide** is a gas generated from gas-burning appliances and vehicles. It can decrease lung function and make asthma worse. Long-term exposure to low levels of nitrogen dioxide can increase the risk of developing breathing problems. Averaged over 2015 to 2017, the average national concentration[4] is 7.4 ppb for NO_2 (Health Canada, 2021). According to the Province of Alberta, 159 ppb is in the high-risk zone for nitrogen dioxide readings (Alberta Provincial Government).
3) **Fine Particulate Matter** is made of particles in the air that measure less than 2.5 micrometres (µm) in diameter, and typically consist of a mix of things like smoke, soot, liquid or solid particles in aerosols, or biological matter like mould, bacteria, pollen and animal dander. Increasing wildfire events in Canada create specific risks from $PM_{2.5}$ pollution. "For firefighters and people living near wildfires, the direct health effects include burns, injuries, mental health effects, and death due to exposure to flames or radiant heat. ...In addition, firefighters are at high risk for heat-related illnesses ranging from dehydration-induced heat cramps to life-threatening heat stroke." (Xu et *al*., 2020) $PM_{2.5}$ poses a risk to human health because, when inhaled, it can travel deeply into the lungs. The average national $PM_{2.5}$ concentration[5] for the years 2015 to 2017 was 6.1 µg/m^3 (Health Canada, 2021). According to the Province of Alberta, 80 micrograms per cubic metre for fine particulate matter is in the "very high" risk zone (Alberta Provincial Government)

6.2 Allergens

With climate change comes longer growing seasons and that is having an impact on naturally occurring cycles for pollination and sporulation. Partnered with The Weather Network, the Aerobiology Research Laboratories monitor and forecast pollen and spore seasons for population centres across Canada. The lab suggests that while asthma and allergy rates are increasing in all parts of the world, the number of children being diagnosed with seasonal allergies is increasing most noticeably in countries like Canada. Indeed, climate change over the past 50 years had led to increased pollen levels and lengthened pollen seasons. **Add baseline information on allergens in your community to be**

[4] *Specifically, these are the population-weighted average ambient concentrations of Nitrous Dioxide*

[5] *Specifically, these are the population-weighted average ambient concentrations of fine particulate matter.*

compared against future levels to determine climate impacts (Only available for Fredericton, Moncton and Saint John).

Table 13 : Predominant pollen and spores for **your community**

Predominant pollen	Predominant spores
•	•

Source: https://www.pollenexperts.ca/monitoring-network/ (only available for Fredericton, Moncton and Saint John)

6.3 Air Conditioners and Disease

Legionella species are normally present in outdoor environmental reservoirs such as lakes or streams. However, these bacteria can establish and proliferate in potable water systems and cooling towers. Inhalation of water droplets containing Legionella species can cause lung infections (Legionnaires' disease) which can be fatal. According to the US Environmental Protection Agency, " increases in community-acquired Legionnaires' disease may be associated with climate change." The increased incidence of the disease has been associated with rainfall during warm and humid weather, particularly following extreme weather events.

The increased use of air conditioning during heat events also creates a potential air quality concern. Under-maintained air conditioning systems can lead to increased moisture and mold growth indoors. Adequate cleaning and maintenance of air conditioning systems (be they individual portable systems or building-wide) is required to prevent microbial growth.

Statistics Canada compiles data on air conditioners by household for larger urban centres and for each province. **If applicable to your community, please enter the Statistics Canada data in table 14.**

Table 14: Comparison of households with air conditioners in **Your community** and New Brunswick

Year	Your community	New Brunswick
2013		41%
2015		41%
2017		47%

Source: Statistics Canada. Table 38-10-0019 Air Conditioners; https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3810001901

6.4 Current Burden of Illness Related to Air Pollution

Everyone is at risk of air pollution at some level; therefore it has a significant impact on human health. Health Canada (2019), estimated that air pollution in Canada results in 14,640 premature deaths per year, for a total economic value of $114 billion (death and illness). The population at higher risk includes young children, the elderly, individuals with chronic respiratory diseases (asthma, COPD), and socially and economically disadvantaged populations.

Add data from your regional hospital for acute care hospital discharges for 1) COPD, 2) Asthma rates and 3) new invasive lung cancer cases.

6.5 Projected Burden of Illness related to Air Pollution

In a Canadian report on the health costs of climate change, researchers suggest with temperature projections for the end of the century, it is estimated that average level of summer concentration of ground-level ozone will increase across Canada by 22%. As ground-level ozone increases, so do deaths and healthcare costs. Over a ten-year period at the end of the century, ozone-linked respiratory illnesses could be associated with 270,000 hospitalizations and premature deaths. (Clark et *al*., 2021)

Research in the United States shows that "low-income communities and communities of colour are more likely to have neighbourhood characteristics that increase exposure to climate-related air pollution, such as proximity to highways, rail yards, polluting industries, lack of green space and urban heat islands. … [In Oregon], industrial facilities reporting air emissions are disproportionately located in areas with higher proportion of low-income households and racial and ethnic minorities." (York et *al*., 2020). This research also suggests that projected rises in regional temperatures and atmospheric CO_2 levels are expected to increase the number of people affected by seasonal allergies, and that that climate change will expand the start, duration and intensity of the pollen season and exacerbate the synergistic effects of pollutants and respiratory infections on asthma." (York et *al*., 2020) Further, there is increasing evidence that high ambient levels of CO_2 concentrations could affect human health by increasing the production and allergenicity of pollen and allergenic compounds and by decreasing the nutritional quality of important food crops. (Ebi et *al*., 2014)

Smoke from wildfires contains many air pollutants and studies have identified associations between exposure to wildfire smoke ($PM_{2.5}$) and mortality and respiratory illnesses, as well as a possible association with cardiovascular health impacts (Matz et *al*., 2020). The findings of one longitudinal Canadian study found that "the health impacts were greatest in the provinces with populations in close proximity to wildfire activity, though health impacts were also noted across many provinces indicating the long-range transport of wildfire-$PM_{2.5}$. ...[Specifically], exposure to wildfire-$PM_{2.5}$ has been clearly associated with respiratory morbidity, including exacerbation of asthma and chronic obstructive pulmonary disease (COPD), and all-cause mortality." (Matz et *al*., 2020) Further, "in areas surrounding a wildfire, heavy smoke can cause eye irritation and corneal abrasions and can substantially reduce visibility, increasing the risk of traffic accidents. As far as 1000 km away, wildfire smoke can increase ambient air pollution, along with associated risks of illness and death." (Xu et *al*., 2020)

7 Water Quality and Supply

Climate change from both the impacts of increasing average temperatures, extreme precipitation events impact water quality and quantity. Further, the quality of both drinking water sources and recreational waters have the potential to impact human health. This section establishes some baseline metrics on the municipal drinking water supply, on-site wells, threats to quality of both drinking water and recreational waters.

7.1 Safety of Municipal Drinking Water Supply

If your municipality services are dependent on a reservoir or watershed for its drinking water, add a description of reported bloom (blue-green algae) or the presence of cyanobacteria toxins reported in recent years.

7.2 Wastewater

If your municipality's wastewater is handled by a Wastewater Commission, add a description of the latest data collected (bacteria sampling, etc.)

7.3 Recreational Waters

Recreational waters may become contaminated with fecal material containing enteric pathogens from numerous sources such as discharged sewage, treatment wastewater effluent, stormwater runoff from agricultural or urban areas, and wild or domesticated animals. Through the NB Department of Environment and Local Government's Provincial Park Beaches Monitoring Program, beach waters in eight provincial parks are tested for bacteria concentrations of *E. coli* and Enterococcus. *E.coli*[6] is a toxin-producing bacteria that can infect humans when ingested. Throughout the world, drinking and swimming in water

[6] *Escherichia coli (E.coli) is the only member of the total coliform group of bacteria that is found only in the intestines of mammals, including humans. The presence of E.coli in water indicates recent fecal contamination and may indicate the possible presence of disease-causing pathogens, such as bacteria, viruses, and parasites. Although most strains of E.coli bacteria are harmless, certain strains, such as E.coli 0157:H7, may cause illness.*

impacted by fecal contamination has caused infection and outbreaks. Possible health risks of swimming in water with a high Enterococci or *E.coli* count could include gastrointestinal upset, skin irritation or infection, and upper respiratory illness. Swimming in waters with bacteria levels above acceptable values does not mean that one will get sick, but it increases the risk beyond everyday levels. The level of risk will depend on for how long and by how much the accepted values are exceeded.

Anyone who has been exposed to contaminated water can be at risk of waterborne illnesses related to use of recreational waters. As well, people with underlying conditions or weakened immune systems may be more susceptible to waterborne illnesses if exposed.

There are several recreational waters that are used by residents (i.e., boating, kayaking, fishing, water parks, beach), include data here for water quality monitoring (advisories and closures) and research programs. See Table 15, for example at Parlee Beach in Shediac.

Table 15 : Parlee Beach No Swimming Advisories[7]

Parlee Beach Status (Advisory)	2017	2018	2019	2020
No swimming advisory due to sample result (*)	8	11	12	13
No Swimming Advisory due to rainfall (**)	15	13	N/A	N/A
No Swimming Advisory due to sample result and rainfall (**)	0	3	N/A	N/A
Beach closures	0	0	2	0
Accumulated Totals	23	27	14	13

(*) data for all year (**) data only available for 2017 & 2018

Source: Department of Environment and Local Government Provincial Park Beaches Monitoring Program

[7] *The Guidelines for Canadian Recreational Water Quality – Third Edition - Canada.ca have established guideline values that strike a balance between potential health risks and the benefits of recreational water use in terms of physical activity and enjoyment. There is always a slight risk of health effects when swimming, just as there are risks associated with other common activities, such as driving a car. The Guidelines consider the water safe for swimming when bacteria levels are below the guideline values listed in the table below. In these cases, the water is open and suitable for swimming. If any of the guideline values are exceeded, it is no longer considered an acceptable risk, and the public is warned that the water is not suitable for swimming.*

8 Food Safety and Food Security

"Food safety, food security and food system challenges are thought to represent the most significant climate change-related threats to human health globally." (Smith & Fazil, 2019) Indeed, the effects of climate change on food safety and public health are closely linked to effects on food security and the food systems in which we live. For food safety, climate impacts of increasing temperatures and changes in precipitation will affect the persistence and occurrence of bacteria, viruses, parasites, harmful algae, fungi and their vectors, and the patterns of their corresponding foodborne diseases and risk of toxic contamination (WHO, 2021).

"The climate variables that most influence foodborne illness are increased air temperature, water temperature and precipitation. These variables affect foodborne illness through three mechanisms: abundance, growth, range and survival of pathogens in crops, livestock and the environment; human exposure factors, including cooking practices, food handling and food preferences that are influenced by a longer period of warm temperatures; and transmission factors, such as wildlife vectors, that transfer pathogens to food."(Smith & Fazil, 2019)

8.1 Food Safety in New Brunswick

Food safety concerns related to climate change impacts, generally relate to consuming food that has been washed with contaminated water, grown in areas that have been subject to extreme weather events (e.g., fiddleheads that grew in the aftermath of the Saint John River flooding in 2018 (CBC News, 2018)), fish or seafood harvested from waters with higher-than-normal temperatures, or foods that are supplied to the community at public events in extreme heat conditions. Generally, public notifications are issued by Public Health in relation to concerns about food safety.

8.1.1 Foodborne (and Waterborne) Illness

Vibrio parahaemolyticus is a naturally occurring bacterium in sea water. Its numbers increase when water temperature rises during the summer months. The bacteria may grow in shellfish such as clams, oysters and mussels when seawater temperatures are warmer. Health impacts are more likely to occur when these products are consumed raw. Outbreaks of Vibrio have been known to occur in New Brunswick in the past, including 10 cases in 2020 (PHAC, 2021).

Table 16 on the next page outlines some of the more common food and water-borne illnesses that have been reported in New Brunswick. **While monitoring individual enteric is not necessary or appropriate at the community level, these numbers can be considered a baseline of information to compare against in future years.**

Table 16 : Selected Enteric Food and Water-borne diseases reported in NB, incidence rates per 100,000 population

Food and Water-borne diseases	**Definitions** (BC CDC)	**2016**	**2017**	**2018**
Giardia	Caused by a parasite, it can be ingested by drinking contaminated water, eating contaminated food, or coming into contact with feces of an infected animal. While generally not a serious illness, it can have some long-lasting side effects if left untreated and is a problem primarily for people with weakened immune systems.	12.6	9.6	11.7
Cryptosporidiosis	Caused by a parasite which can infect the intestines leading to diarrhea. Most people with healthy immune symptoms will recover. People who have poor health or have a weakened immune system can have more severe and prolonged illness. Cryptosporidia are passed in the stools of animals, and can contaminate food, the environment and water supplies.	4.2	2.4	4.7
Vibrio species	The risk of food-borne illness is greatest when those infected shellfish are eaten raw or undercooked. People most at risk for complications are pregnant women, young children, the elderly, and people with weakened immune systems, liver disease.	0.5	0.4	1.3

Source: Health Analytics – Enterics database, OCMOH, Disease Prevention and Control (March 2019)

8.2 Future Burden of Illness Related to Water Quality and Food Safety

As noted above, precipitation will change with extreme rainfall events separated in time by prolonged droughts. A study in Vancouver on risk of water-borne illnesses found that as a result of the periods with extreme rainfall, the annual rates of cryptosporidiosis and giardiasis would rise by approximately 16% by the 2080s corresponding to an increase of 55–136 additional cases per year. (Chhetri et *al*., 2019). Indeed, "[e]xtreme precipitation may increase pathogen transfer from environmental reservoirs (e.g. animal manure) into surface water either directly, by increasing stream discharge, which increases turbidity and promotes the re-suspension of infectious cysts/oocysts from river sediments, or indirectly, by increasing overland runoff into water systems. … [E]xtreme precipitation led to significantly increased turbidity, and cryptosporidiosis and giardiasis risk and the risk was greater for precipitation following a dry period." (Chhetri et *al*., 2019)

Similarly, in a study in the state of Oregon, results suggest that the "predicted increase in droughts due to climate change will affect the availability and quality of water and likely lead to water insecurity. Future extreme precipitation events could increase the risk of

exposure to water-related illnesses as the runoff introduces contaminants and pathogens (such as Cryptosporidium, Giardia and viruses) into drinking water." (York et *al*., 2020)

In a report on climate impacts on microbial foodborne disease in Canada, Smith and Fazil (2019) found that studies from regions with similar climate and seasonality to Canada have linked foodborne contamination and disease incidence with seasonal trends. "These studies reported a strong association between increasing air and water temperatures and an altered and extended summer season for non-cholera Vibrio species infections. So strong was this sensitivity to climate that it was proposed that non-cholera Vibrio spp. can act as a barometer of climate change in marine systems. Similarly, a time-series analysis showed that rates of enteric illness varied seasonally within Canada, with a strong association between infections with Campylobacter spp., pathogenic Escherichia coli and Salmonella spp., and ambient air temperature." (Smith & Fazil, 2019)

"The growth, survival, abundance and range of pathogens will be affected by climate change throughout the food chain. Growth and survival of pathogens are intrinsically linked to climate factors (often ambient temperature). … Livestock stressed at higher temperatures may shed greater numbers of enteric pathogens, affecting pathogen prevalence in crops, the environment and produce. Pathogens could expand their range and become established in new regions of Canada as climate conditions become more favourable for their growth. Precipitation events can move pathogens through the environment and contaminate food sources such as crops or livestock facilities." (Smith & Fazil, 2019)

Smith and Fazil (2019) also noted that human exposure factors are also related to climate change. As the summer season lengthens, a greater amount of food mishandling events leading to cross-contamination or undercooking may occur. Increased food mishandling is due, in part, to summer-type food experiences such as barbequing and picnicking. Because consumption of fresh food is linked to foodborne illness, increased incidence of these illnesses may result from extending growing seasons because food preferences already tend to change during summer with increased availability of fresh food.

Another reason climate change may further increase the incidence of foodborne illness is indirectly related to increased activity, range expansion and reproduction rates of wildlife vectors. (Smith & Fazil, 2019) Pathogens can be transmitted to food through wildlife (insects, rodents and deer) which interact with food sources (domesticated animals or plants). Also, "Vibrio ssp. can be transmitted to oysters in marine environments through phytoplankton, zooplankton and copepod vectors." (*ibid*.)

In summary, of the five bacteria that account for over 90% of foodborne illnesses in Canada (norovirus, Clostridium perfringens, Campylobacter spp., Salmonella spp. and Bacillus

cereus), four of these pathogens have been shown to be influenced by climate variables. "Given the projected changes to climate in Canada, it is anticipated that the overall burden from these and other pathogens will increase. ...The incidence of Vibrio spp. has been linked to air temperatures, consumption practices and water temperatures and it is anticipated that the relative ranking of Vibrio spp. will increase with climate change." (Smith & Fazil, 2019)

8.3 Food Security/Food Systems

Climate change will have a significant impact in all parts of the food system from food production to processing to consumption patterns. While the latter has a direct impact on human health and the future burden of illness related to food insecurity, it is important to consider the impacts to food production from climate change. "Climate conditions such as rainfall and temperature have a primary influence on food production through impacts on water yields and flows, which are often modulated by irrigation and other water-management techniques. Other climate-related factors that can affect food production ...include impacts on freshwater, biodiversity, soil degradation, fisheries, and carbon dioxide fertilization, with attendant impacts on nutritional food quality." (Schnitter et *al*., 2019) While there are some positive outcomes related to climate change such as longer growing season for crops and extended outdoor feeding season for livestock, the negative outcomes of more drought and the introduction of invasive species/pests tend to offset and outweigh the benefits. (Schnitter et *al*., 2019)

Regarding food processing, climate change can disrupt food distribution networks through acute shocks such as extreme weather events, as well as through creeping climatic change. Rural and remote regions, where there is low capacity to produce and/or store food products locally, may be particularly vulnerable. (Schnitter et *al*., 2019)

In 2021, Food For All NB released its *Eater's Guide to Climate Change* to help educate New Brunswickers on the state of food security in the province in light of climate change (Reinsborough et *al*., 2021). The guide highlights the status of food insecurity in the province as well as pointing out how the global food system will be profoundly impacted by climate change both internationally and locally. Extreme weather events can affect crop production and harvests, as well as disrupt the food system through power outages and flooded roads. Rising temperatures are related to droughts and higher incidence of invasive species, both of which can affect crop harvest. In New Brunswick, fishing remains a significant part of our economy and culture. Waters near New Brunswick, including the Gulf of Maine, is warming

faster than virtually all the rest of the world's oceans, bringing a change in marine biodiversity and in the distribution and availability of species (Eos, 2018).

The *Eater's Guide* reiterates that climate change is a "threat multiplier" meaning that it makes conditions worse for people who are already vulnerable. New Brunswick's high rate of household food insecurity puts many New Brunswickers at risk. Thirteen percent (13 %) of New Brunswick households are food insecure. When considering youth and children (under the age of 18), the numbers rise to one in every five children. The changing climate is also having a significant impact on the traditional food harvest of Indigenous communities in New Brunswick, further contributing to all already food-insecure vulnerable population.

The New Brunswick Health Council considers various factors of healthy living in its community-based assessments. If food security is not only about access to food, but access to "healthy" food, then the self-reported healthy eating and healthy weight of children, youth and adults helps paint a picture of food security in the province. While all segments of the population are affected by health issues such as obesity, food insecure and low-income people can be especially vulnerable due to the additional risk factors associated with inadequate resources and under-resourced communities.

Table 17 (insert the data for your community) on the other page outline health status related to food security in terms of healthy eating habits as well as malnutrition, defined by comparison to healthy body weight norms. From a food security perspective, the people at most risk are those experiencing poverty, families with low-income, the working poor, or people who can't afford to eat well (broad spectrum of individuals and families); the homeless population; and indigenous population who cannot access traditional foods as a result of climate change.

Table 17 : Health Status related to Food Security

Indicator	Age Group	Your community	New Brunswick
Healthy Eating (eats 5 or more fruits and vegetables per day)	Kindergarten to Gr. 5		49%
	Grades 6-12		46%
	Adults (18-64 years)		51%
	Seniors (65+)		46%
Body Mass Index: • Overweight/obese • Underweight	Kindergarten to Gr. 5 Grades 6-12 Kindergarten to Gr. 5 Grades 6-12		36% 27% 7% 9%
Body Mass Index • Overweight • Obese	Adults (18-64 years) Seniors (65+) Adults (18-64 years) Seniors (65+)		35% 41% 31% 28%

Source: NB Health Council : https://nbhc.ca/data/browse/health-zones

8.4 Projected Burden of Illness Related to Food Insecurity

"Food safety and nutrition may be the pathways through which climate change impacts have the most direct effect on human health." (Schnitter et *al*., 2019) Climate change exacerbates the risk of food insecurity and the breakdown of food systems, particularly for poorer populations in both urban and rural settings. In a synthesis of studies to consider impacts of a 1.5 C increase in global temperature, Ebi et al., found that the interaction of climate change with food security can exacerbate undernutrition, increasing the vulnerability of individuals to a range of diseases. (2014) Specifically, that synthesis highlighted the following findings:

- Climate change-related changes in dietary and weight-related risk factors are projected to increase mortality due to global reductions in food availability;
- The rise in tropospheric ozone has already reduced yields of wheat, rice, maize, and soybean ranging from a 3% to a 16% reduction globally;
- While climate change is very likely to decrease agricultural yield, the consequences could be reduced substantially at 1.5°C with appropriate investment and adaptation;

- Elevated CO_2 concentration lead to faster growth rates and lower protein values in several important cereal grains;
- Climate-induced species redistribution could see the range of key insect crop pollinators shrink with increasing temperatures, and habitats for certain pest and disease species will result in species moving to areas where they become invasive or harmful in certain agricultural areas;
- Climate change will negatively affect childhood undernutrition, particularly stunting, through reduced food availability, and will negatively affect childhood mortality;
- The projected global health risks for undernutrition are greater at 2° vs 1.5°C warming.

In short, "[c]limate change impacts on dietary and weight-related risk factors were projected to increase mortality due to global reductions in food availability, fruit and vegetable consumption, and red meat consumption. Further, temperature increases are reducing the protein and micronutrient content of major cereal crops, which is expected to further affect food security." (Ebi et *al*., 2018)

In northern and Indigenous communities, "there has been an observed diet shift from country and traditional foods to market foods…[which] are often prepared, processed, and/or frozen, while fresh foods such as fruits and vegetables are not always available. Foods purchased and consumed is often less nutritious and high in sodium, sugars, and fat, which may contribute to various forms of malnutrition." (Schnitter et *al*., 2019) Further, "[t]raditional and country foods have long been established as an important "enabler of food security and health" for Indigenous communities and provide both spiritual and nutritional value. There are unique food security considerations that have not traditionally been included in conceptualizations of western food systems and food security concepts." (Schnitter, et *al*., 2019).

9 Vector-Borne Disease

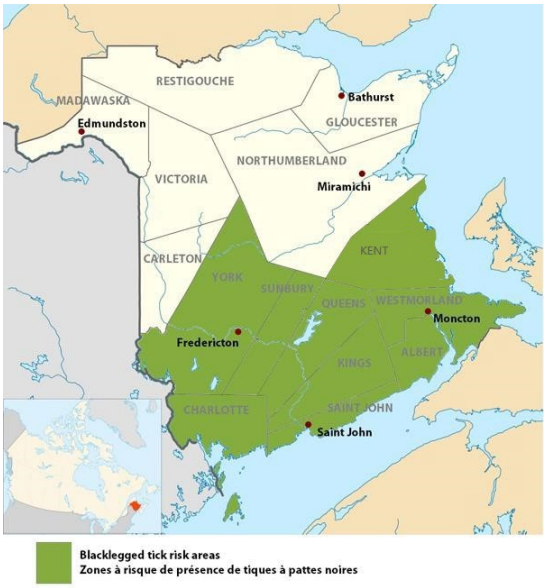
There is strong evidence that changing weather patterns associated with climate change is shifting the geographic range, seasonality, and intensity of transmission of selected climate-sensitive infectious diseases, with increases and decreases projected with additional warming (Ebi et *al*., 2014). Warmer global average temperatures are expected to expand the range of the West Nile Virus and the range and seasonality of Lyme disease and other tick-borne diseases in parts of North America and Europe, particularly along the current edges of transmission areas. These changes are larger with greater degrees of warming. Climate change is already worsening the adverse health outcomes associated with Lyme disease in Canada. (Ebi et *al*., 2014)

Vectors are living organisms that can transmit infectious pathogens between humans, or from animals to humans. Vector-borne diseases are human illnesses caused by parasites, viruses and bacteria that are transmitted by vectors. Many of these vectors are bloodsucking insects, which ingest disease-producing microorganisms during a blood meal from an infected host (human or animal) and later transmit it into a new host, after the pathogen has replicated (WHO, 2020).

Mosquitoes are known to spread several infections including West Nile virus. In New Brunswick, the risk of exposure to West Nile virus and other mosquito-borne illness is currently very low (GNB).

Lyme disease is a vector-borne disease caused by bacteria called *Borrelia burgdorferi*. Lyme disease is spread by the bite of an infected blacklegged tick. While numbers are too low to be reportable to date, Lyme disease was only recently introduced into New Brunswick as temperatures have increased expanding the supportive habitat for these ticks further north. (Ogden et *al*., 2008).

Figure 8 : Black Legged Tick Risk Areas



Although it is possible to be bitten by blacklegged tick anywhere in New Brunswick, the risk is highest in areas where blacklegged tick populations are established or could become established. Black legged Tick Risk Areas are based on provincial tick surveillance data and are identified on a county level because it is difficult to exactly define the geographic limits of tick populations. Although blacklegged ticks are more likely to be found within risk areas than in other parts of the province, the distribution of ticks within Black legged Tick Risk Areas is not uniform because suitable habitat is not found everywhere. Figure 8 outlines the current risk areas for the establishment of black-legged tick habitat.

Source: GNB/ Public Health/ Vectorborne and Zoonotic/Tick Borne Diseases/ Risk
https://www2.gnb.ca/content/gnb/en/departments/ocmoh/cdc/content/vectorborne_andzoonotic/Tick-Borne_Diseases/risk.html

9.1 Projected burden of illness for vector-borne diseases in New Brunswick

"The health risks increase with greater warming. Projections suggest that climate change will further expand the geographic range of these diseases, with increases and decreases projected depending on the disease (e.g., Malaria, Dengue, West Nile virus, and Lyme disease), the region, and the degree of temperature change. ...The magnitude and pattern of future impacts is expected to depend on the extent and effectiveness of additional adaptation and vulnerability reduction, and on mitigation for risks past mid-century." (Ebi et *al*., 2014)

The risk from infectious diseases is based on the likelihood of exposure and sensitivity (i.e., severity of infection). Exposure likelihood depends on the number of infective organisms in the environment and the rate of contact of humans with infectious organisms. These will likely increase with climate change. The severity of infectious disease outcomes will likely be greater in populations that are increasingly elderly and affected by chronic diseases. (Odgen, 2019)

"Most projections concluded that climate change may expand the geographic range or shift the seasonality of Lyme and other tick-borne diseases in parts of North America and Europe. ...If increased temperatures result in greater abundance of ticks and increased contact rates with humans, an earlier onset of the disease season may result in more cases with greater degrees of warming." (Ebi et *al*., 2018) Canadian projections under a low emissions future, suggest that "additional cases of Lyme disease due to demographic change and climate change will rise to about 8,500 annually by mid-century and 9,900 by the end of the century, up from an average of about 600 cases per year." (Clark et *al*., 2021).

For mosquito-vector illnesses such as West Nile, minimum and maximum temperatures are known to influence survival and reproduction, while precipitation is a likely determinant of the presence of habitats suitable for mosquito breeding (e.g., excess standing water). (Khan et *al*., 2020) Indeed, over the last 20 years, the incidence of most endemic mosquito-borne diseases has increased approximately 10% in Canada, due in large part to climate change. (Ludwig et *al*., 2019) Under projected climate scenarios, the general trend was for ecological niches that could support infected mosquitos would move northward. However, it is anticipated that those niches will only reach the southern borders of Quebec and southcentral Ontario by 2100, leaving New Brunswick outside the expected range for West Nile virus. (Khan et *al*., 2020)

10 Exposure to Ultraviolet Radiation

Changes to the Earth's stratospheric ozone layer is leading to an increase of solar ultraviolet (UV) radiation reaching the Earth's surface. According to Berry et al., ambient UV radiation levels vary with geographic location, season, time of day, altitude, cloud cover, and atmospheric pollution. Warmer temperatures associated with climate change may result in increased exposure by the population to UV radiation in Canada due to higher levels of ambient UV radiation along with changes in human behaviour (e.g. more outdoor activities, limited use of personal protective measures) (Berry et *al*., 2014).

According to the World Health Organization, there are several known health effects from prolonged exposure to ultraviolet (UV) radiation. One of the most common includes impacts on exposed and unprotected skin in the form of sunburns, aging, and various forms of skin cancer (basal cell, squamous cell carcinomas and melanoma). UV also impacts on eye health from snow blindness to cataracts to cancer of the eye. Research also suggests that exposure to UV levels can alter the immune response, enhancing the risk of infection or reducing the body's defences against skin cancer (WHO, 2017).

In New Brunswick, we can use several diagnoses to establish the current burden of illness from the impacts of UV radiation. **Use Tables 18, 19 and 20 to illustrate baseline data (for your area hospitals), for 1) sunburns during summer, 2) new invasive melanoma cancer cases, and 3) number of cataract surgery by year.** In terms of sensitivity to UV radiation, everyone who spends time outdoors are susceptible to damage to skin or eyes, or certain cancers, if necessary, precautions are not taken (i.e., sunscreen, hats, sunglasses, protective clothing). Individuals who work outdoors and people who have no permanent shelter are at most significant risk.

Table 18 : Emergency Department visits for Sunburn - **Your community**

2018	2019

Source: ACDM / Health Analytics.

Table 19 : Number of New Invasive Melanoma Cancer Cases - **Your community**

Year of diagnosis	Your community	NB
2014		180
2015		205
2016		209
2017		238

2018		215
Total		1047

Source: ACDM / Health Analytics.

Table 20 : Cataract surgery by year – **Your community**

Year	Number of surgery
2017/2018	
2018/2019	
2019/2020	

Source: DAD / 3M / Health Analytics

9 Summary

Many experts remind us that climate change is the greatest threat to population health in the 21st century. Today, climate change affects the social and environmental determinants of health, by impacting the air we breathe, the water we drink, our access to healthy food and the way we build our houses and neighbourhoods. The main goal of this Climate Change and Health Vulnerability Assessment is to identify the exposure to climate-related hazards and the sensitivity of the population to those impacts. The next step will be to identify measures and strategies to enable New Brunswickers to cope with climate hazards.

The province of New Brunswick has multiple geographic contexts that contribute to the challenges posed by climate change. These challenges include a large proportion of coastal areas, forested areas, small rural communities, and cities of different sizes. New Brunswickers living in these areas face climate change in different ways but remain vulnerable to its effects. Depending on the climate hazard, many indicators increase the health vulnerability of the population: for example, seniors and very young, people in poverty and housing difficulty, racialized communities, people with low education, single-parent families, outdoor workers, and people with pre-existing and chronic diseases.

Similar for the province of New Brunswick, identify the climate risks for your community and the resulting vulnerabilities.

References

Adam-Poupart A, Nicolakakis N, Anassour Laouan Sidi E, Berry P, Campagna C, Chaumont D, Hamel D, Labrèche F, Sassine M-P, Smargiassi A, Zayed J. (2021) « Changements climatiques et vulnérabilités à la chaleur des travailleuses et travailleurs canadiens – regard sur les provinces du centre et de l'ouest du Canada. » Institut national de santé publique du Québec (INSPQ).

Alberta Provincial Government. Air Quality Health Index Calculations. https://www.alberta.ca/air-quality-health-index--calculation.aspx

Australian Greenhouse Office (2005) "*Climate change risk and vulnerability: promoting an efficient adaptation response in Australia*" Australian Department of Environment and Heritage. http://www.greenhouse.gov.au/

Barette, N., Vandermissen, M.-H., & Roy, F. (2018). *« Atlas web de la vulnérabilité de la population québecoise aux aléas climatiques : Rapport de recherche* ». Université Laval. (281 p.)

Berry, P., Clarke, K., Fleury, M.D. and Parker, S. (2014): *Human Health; in Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation*, (ed.) F.J. Warren and D.S. Lemmen; Government of Canada, Ottawa, ON, p. 191-232.

British Columbia Centre for Disease Control. http://www.bccdc.ca/health-info/isease-types/foodborne-waterborne-diseases Accessed June 9, 2021

CBC News "Contaminated fiddleheads" May 9, 2018. https://www.cbc.ca/news/canada/new-brunswick/nb-flood-fiddleheads-unsafe-contaminated-1.4656021#:~:text=The%20Emergency%20Measures%20Organization%20and%20the%20Department%20of,in%20flooded%20areas%20could%20be%20contaminated.%20%28Shane%20Fowler%2FCBC%29

Chhetri, B.K., Galanis, E., Sobie, S. et al. (2019) "Projected local rain events due to climate change and the impacts on waterborne diseases in Vancouver, British Columbia, Canada." In *Environ Health* 18, 116 (2019). https://doi.org/10.1186/s12940-019-0550-y

Clark, D. G., R. Ness, D. Coffman, D. Beugin, (2021). "*The Health Costs of Climate Change: How Canada Can Adapt, Prepare, and Save Lives. Canadian Institute for Climate Choices."* https://climatechoices.ca/reports/ the-health-costs-of-climate-change/

Ebi, K., Campbell-Lendrum, D., and Wyns, A. (2014) "The 1.5 Health Report - Synthesis on health and climate science in the IPCC SR1.5" (summary of IPCC 5th Assessment Report (AR5), published in 2014)

Ebi, K., Hasegawa, T., Hayes, K., Monaghan, A., Paz, S., and Berry, P. (2018) "Health risks of warming of 1.5 ◦C, 2 ◦C, and higher, above pre-industrial temperatures." *Environmental Research Letters* 13(2018) 063007.

Enright, P., Berry, P., Paterson, J., Hayes, K., Schnitter, R., and Verret, M. (2019) "*Climate Change and Health Vulnerability and Adaptation Assessment: Workbook for the Canadian health sector."* s.l. : Health Canada, 2019.

Environment and Climate Change Canada, "Health Effects of Air Pollution." Accessed May 31, 2021 https://www.canada.ca/en/health-canada/services/air-quality/health-effects-indoor-air-pollution.html

Eos (2018) "Why is the Gulf of Maine Warming Faster than 99% of the Ocean?" https://eos.org/features/why-is-the-gulf-of-maine-warming-faster-than-99-of-the-ocean

Food Research Access Center. "Understanding the Connections between Food Insecurity and Obesity" https://frac.org/hunger-obesity Accessed June 21, 2021.

Government of New Brunswick. Office of the Chief Medical Officer. https://www2.gnb.ca/content/gnb/en/departments/ocmoh/cdc/content/vectorborne_andzoonotic/west_nile.html

Guo, Y., Gasparrini, A., Li, S., Sera, F., Vicedo-Cabrera, A. M., de Sousa Zanotti Stagliorio Coelho, M., ... & Tong, S. (2018). "Quantifying excess deaths related to heatwaves under climate change scenarios: A multi-country time series modelling study." PLoS medicine, 15(7), e1002629.

Hayes, K., Berry, P., & Ebi, K. L. (2019). "Factors influencing the mental health consequences of climate change in Canada." *International journal of environmental research and public health*, *16*(9), 1583.

Health Canada (2021) "Health Impacts of Air Pollution in Canada: Estimates of morbidity and premature mortality outcomes – 2021 Report" https://www.canada.ca/en/health-canada/services/publications/healthy-living/2021-health-effects-indoor-air-pollution.html#a3.2

Khan, S.U., Ogden, N.H., Fazil, A.A., Gachon, P.H., Dueymes, G.U., Greer, A.L., and Ng, V. (2020) "Current and Projected Distributions of Aedes aegypti and Ae. albopictus in Canada and the U.S." *Environmental Health Perspectives* Vol. 128, No. 5 Published:22 May 2020CID: 057007 https://doi.org/10.1289/EHP5899

Ludwig A, Zheng H, Vrbova L, Drebot MA, Iranpour M, Lindsay LR.(2019) "Increased risk of endemic

mosquito-borne diseases in Canada due to climate change." *Can Commun Dis Rep* 2019;45(4):90–7.
https://doi.org/10.14745/ccdr.v45i04a03

Martin, S. L., Cakmak, S., Hebbern, C. A., Avramescu, M. L., & Tremblay, N. (2012). "Climate change and future temperature-related mortality in 15 Canadian cities." *International journal of biometeorology*, 56(4), 605-619.

Marushka L, Kenny T-A, Batal M, Cheung WWL, Fediuk K, Golden CD, et al. (2019) "Potential impacts of climate-related decline of seafood harvest on nutritional status of coastal First Nations in British Columbia, Canada." PLoS ONE 14(2): e0211473.
https://doi.org/10.1371/journal.pone.0211473

Matz, C. J., Egyed, M., Xi, G., Racine, J., Pavlovic, R., Rittmaster, R., ... & Stieb, D. M. (2020). "Health impact analysis of PM2. 5 from wildfire smoke in Canada (2013–2015, 2017–2018)." *Science of the Total Environment*, 725, 138506.

Morey, Philip, "Climate Change and Potential Effects on Microbial Air Quality and the Built Environment," September 15, 2010. Prepared on behalf of the US Environmental Protection Agency.

National Air Pollution Surveillance (NAPS) Program. Environment and Climate Change Canada Data. https://data-donnees.ec.gc.ca/data/air/monitor/national-air-pollution-surveillance-naps-program/?lang=en

Obradovicha, N., Migliorinic, R., Paulusd, MP., and Rahwana, I. (2018) "Empirical evidence of mental health risks posed by climate change," In *Proceedings of the National Academy of Sciences of the United States of America*. Edited by B. L. Turner, Arizona State University, Tempe, AZ, and approved August 21, 2018 (received for review January 26, 2018)

Ogden, Nicholas (Ed). (2019) *Canada Communicable Disease Report: Volume 45-4*, April 4, 2019. "Climate change and infectious diseases: The challenges."

Ogden, N. H., St-Onge, L., Barker, I. K., Brazeau, S., Bigras-Poulin, M., Charron, D. F., ... & Thompson, R. (2008). "Risk maps for range expansion of the Lyme disease vector, Ixodes scapularis, in Canada now and with climate change." *International Journal of Health Geographics*, *7*(1), 1-15.

Pan American Health Organization, (2020). *Climate Change for Health Professionals: A Pocket Book.* Washington, D.C.: License: CC BY-NC-SA 3.0 IGO.

Reinsborough, L., & *al*. (2021) *The Eaters Guide to Climate Change*. Food For All NB. https://foodforallnb.ca/media/docs/EatersGuidetoClimateAction.pdf

Roy, P. & Huard D. (2016). *Future Climate Scenarios - Province of New-Brunswick*. Montreal: Ouranos

Sanderson, M., Arbuthnott, K., Kovats, S., Hajat, S., & Falloon, P. (2017). "The use of climate information to estimate future mortality from high ambient temperature: a systematic literature review." PloS one, 12(7), e0180369.

Smith BA, Fazil A. (2019) "How will climate change impact microbial foodborne disease in Canada? "
Canadian Communicable Disease Report 2019;45(4):108–13.
https://doi.org/10.14745/ccdr.v45i04a05

Southeast Regional Service (2020) *Commission Annual Report*. Published on-line at AR20-Final-E-2021-05-12.pdf (nbse.ca).

Trans- Aqua website. https://www.transaqua.ca/wastewater-treatment/facts Accessed June 10, 2021

Thériault, F. (2019). *Îlots de Chaleur Urbains (ICU) : Le cas du Grand Moncton* [Thèse de maîtrise]. Université de Moncton.

Taylor, Nicole. Manager, Water and Wastewater, City of Moncton, personal email May 12, 2021.

Watts, N., Amann, M., Arnell, N., Ayeb-Karlsson, S., Beagley, J., Belesova, K., ... & Costello, A. (2020). "The 2020 report of The Lancet Countdown on health and climate change: responding to converging crises." *The Lancet*. Vol 397, Issue10269. Published December 2, 2020 https://www.thelancet.com/journals/lancet/issue/vol397no10269/PIIS0140-6736(21)X0002-5

World Health Organization (2017). "Radiation: the known health effects of ultraviolet radiation." https://www.who.int/news-room/q-a-detail/radiation-the-known-health-effects-of-ultraviolet-radiation Accessed June 21, 2021.

World Health Organization (2020) "Vector Borne Diseases" https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases

World Health Organization (2021) Food Safety and Climate Change
https://www.who.int/foodsafety/publications/all/Climate_Change_Summary.pdf?ua=1

Xu, R., Yu, P., Abramson, M. J., Johnston, F. H., Samet, J. M., Bell, M. L., ... & Guo, Y. (2020). "Wildfires, global climate change, and human health" In *New England Journal of Medicine*, 383(22), 2173-2181.

York EA, Braun MJF, Goldfarb GG, Sifuentes JE. "Climate and health in Oregon: 2020 report." Oregon Health Authority. December 2020: Portland, OR

Zhang, W., Spero, T. L., Nolte, C. G., Garcia, V. C., Lin, Z., Romitti, P. A., ... & Botto, L. (2019). "Projected changes in maternal heat exposure during early pregnancy and the associated congenital heart defect burden in the United States." *Journal of the American Heart Association*, *8*(3), e010995.