CLIMATE RISK AND RESILIENCE ASSESSMENT

CITY OF SUMMERSIDE

This report was prepared as part of '**Municipalities and Utilities Partnering for Resilience**' project led by QUEST (www.questcanada.org)

QUEST

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QUEST

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Executive Summary

What this Report is About

This report assesses the overall resiliency of the City of Summerside to extreme weather events in a context of climate change. The report includes a review of the anticipated impacts of climate change in the decades to come, associated hazards, and an assessment of the resiliency of the community to these events. It identifies assets at risk, areas of strengths and areas of improvement.

This report build on:

- the results of a survey sent to municipal staff representing different departments with the aim to identify policies in place, gaps, and collect other relevant information to prepare the workshop;
- a full-day workshop that consisted of expert guest presentations and three table-top exercises (including a participatory mapping exercise identifying areas subject to specific hazards as well as assets and facilities at risks). The workshop was attended by 14 participants representing diverse stakeholder groups, including utilities, EMOs, staff from various departments and provincial, regional, and/or local organizations.

With these results, QUEST developed an analysis of the municipality's strengths, gaps, and opportunities to improve resilience and adapt to a changing climate. These results will be used to develop tailored recommendations to the City of Summerside.

Who This is Intended For

This report is intended to inform the municipal staff and Councilors about:

- the types of hazards associated with increasing extreme weather events
- areas, assets, and facilities at risks
- the level of preparedness of the community to mitigate risks associated with these events.

The report is intended to be used to inform future planning decisions and provides a benchmark to measure and monitor progress in developing and implementing resilience or adaptation strategy (i.e., to determine where improvements were made or may still need to be made).

QUEST appreciates the opportunity to work with your municipality and local stakeholders to help improve resilience and adapt to climate change.

Next steps

The results contained in this report will be used by QUEST in the second stage of the project to prepare a second workshop and develop a Recommendations Report in 2019 that will improve the City of Summerside's capacity to become more resilient and adapt to climate change.

This report and recommendations within will be discussed in a second workshop in 2019 in order to finalize a strategy for each community.

High Level Summary of Key Findings

Based on climate data as well as results of the pre-survey, first workshop and table-top exercises, the City of Summerside is most concerned with atmospheric and hydrological hazards, as well as power outages, food shortages, and contamination/material spills.

- **Atmospheric hazards** of particular concern include: Increasing frequency of ice storms, as well as sea storms and surges, snow storms and wind storms. In addition, the number of hot days (above 30 degrees Celsius) is expected to quadruple; less relief at night, and an increase in winter temperatures leading to more freeze-thaw cycles.

- **Hydrological hazards** of particular concern include: coastal flooding, sea level rise, and other forms of flooding (e.g., rainstorm) from increased precipitation, especially in winter and spring.

- **Power outages** are a concern. The Community lacks adequate resources (e.g., generators, back-up power) in case of an extended electric power outage.

- **Food security** is a concern. Food is transported to Summerside by truck via the Confederation Bridge. The bridge is susceptible to closure due to weather events, which introduces risk of food shortage.

- **Contamination/material spills** are a concern due to the active port in Summerside. There is risk if ships are transporting hazardous materials to the City.

Through our consultation with municipal staff, local utilities, and community stakeholders, local strengths and areas for improvement were identified in:

- **Vegetation:**
  - Key Strengths:
    - Bio-retention measures are encouraged;
    - Protection of natural buffers;
    - Tree trimming program;
    - Province responsible for forrest forest fire management;
    - Support for restoration, protection and sustainable management of ecosystem services; and
    - Participation from the private sector and civil society in the implementation of environmental and ecosystems management plans.
  - Key Areas for Improvement:
    - Unknown how many public facilities, homes and businesses are adjacent to forests.

- **Planning, Organization and Coordination**:
  - Key Strengths:

- City Council knows their roles and responsibilities;
- Summerside has an EM Plan (updated in 2018);
- City updating the contact tree, inventory of resources and equipment;
- The City has an alliance with the Red Cross;
- The City participates in provincial exercises;
- Council reviewing EM Plan with the CAO;
- City working on asset management framework and training, draft policy, aiming to consider climate change risk in their decisions;
- Local organizations are well equipped with capacities for disaster risk reduction and climate change adaptation;
- City is somewhat considering future climate change projections/impacts when making infrastructure and land use planning decisions;
- City considers some impacts of hazards on municipal services from the viewpoint of maintaining reliable energy;
- City updating the contact tree, inventory of resources and equipment;
- Regulations for housing and development infrastructure somewhat take current and projected flood risk into account;
- Measures are taken to protect critical public facilities from damage during disasters;
- Schools, hospitals, and health facilities have received special attention for "all-hazard" risk assessments from the province.
- Hospitals and health facilities have some systems in place to remain safe from disasters and remain operational during emergencies;
- Programs in place to assess schools, hospitals and health facilities for maintenance, compliance with building codes, general safety and weather-related risks;
- Risk reduction training available for local officials and community leaders;
- Early warning centres are established;
- The community has an Emergency Operations Centre; and
- Training drills and exercises are carried out somewhat regularly.

- Key Areas for Improvement
  - Summerside does not have the copies of the EM plans for local schools, hospitals and nursing homes;
  - Local government risk assessments are not linked to risk assessments from neighbouring local authorities and provincial government risk management plans;
  - Disaster risk assessments somewhat incorporated into local development planning.
  - Enforcing risk-sensitive land use regulations, building codes, and health and safety codes across all development zones and building types;
  - Improvements could be made to existing regulations to better support disaster risk reduction;
  - It is unknown if local schools and colleges include courses, education or training

in disaster risk reduction as part of the educational curriculum.
    - Generally residents are not adequately aware of evacuation plans and drills for evacuations;
    - Communication between the City and the public about emergency preparedness is lacking; and
    - Disaster risk reduction measures are not well integrated into post-disaster recovery and rehabilitation activities.

- **Communications and Awareness**;
  - Key Strengths:
    - The City uses social media and electronic communications;
    - The EM Plan is being reviewed by Council and the EMO;
    - At least one radio station in Summerside has a backup plan;
    - The City can provide equipment to HAM radio operators;
    - The local government communicates some information to the community regarding local hazard trends and risk reduction measures, including early warnings of likely hazard impact;

  - Key Areas for Improvement:
    - Communication towers have backup power but are at risk of fuel shortages.

- **Energy Infrastructure**:
  - Key Strengths
    - The City has backup power for City Hall/EMO and Public Works;
    - The City has backup generators with identified alternate sources of fuel;
    - Key municipal facilities and lift stations are ready for backup power;
    - Provisions in place to keep fueling stations open during prolonged interruptions;
    - Sea level and storm surge assessments have been partially completed for electrical utility infrastructure;
    - Electric Utility maintains a list of oxygen users; and
    - Hospitals, schools, and some EM shelters are ready for backup power.

  - Key Areas for Improvement:
    - Some emergency shelters are without backup power;
    - Unknown if nursing homes, animal shelters, and banks have backup power; and
    - Unknown if the flood risk (1 in 100 year events) to electrical/utility infrastructure has been assessed.

- **Water and Wastewater Systems**:
  - Key Strengths:
    - Distributed potable water system;
    - Separated storm water and sewer systems;
    - Backup power for water and wastewater treatment, lift stations, two wellfields (St Eleanor’s and Wilmot); however 6 individual wells in the City do not.

- Key Areas for Improvement:
    - No retention ponds;
    - Individual and shared wells are vulnerable to power outages;
    - Local storm sewers can handle 1 in 10 year events but only major intersections can handle 1 in 100 year events; and
    - Doubling of water to sewage during heavy rainfall due to inflow.

- **Transportation**:
  - Key Strengths:
    - Several transportation corridors to enter and exit the community; and
    - Summerside has gas/diesel powered bus transit.

  - Key Areas for Improvement:
    - There are neighborhoods/homes and businesses, with only one access road;
    - Summerside has EVs, but no charging stations have backup;
    - Prolonged Confederation Bridge closure affect supply chain; and
    - Port has no backup power.

- Food.
  - Key Strengths:
    - Summerside has a small community garden and a greenhouse.

  - Key Areas for Improvement:
    - Grocery stores do not have backup power**;** and
    - Unknown how many day supply of food there is.

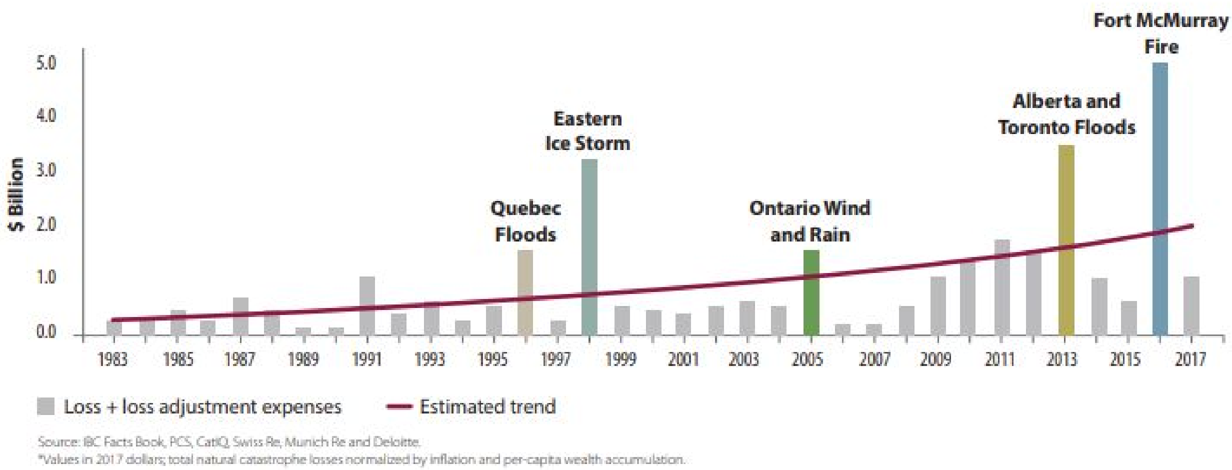
All of the hazards of concern and areas of strength or improvement are described in Section 7: Summary.

0.0 Introduction and Project Presentation

0.1. Climate Changes and Catastrophic Losses in Canada

Municipalities across Canada are already faced with climate change impacts, such as extreme winds, ice storms, flooding, to droughts and forest fires. According to the Insurance Bureau of Canada (IBC), the costs associated with damages to property and infrastructure are rising[1]. Risk exposure may increase with climate change, if GHG emissions continue to rise globally unabated, inevitably requiring municipalities to adapt.

Table 1: Catastrophic Losses in Canada over time



Source: Insurance Bureau of Canada

At the same time, nearly 90 percent of Canadian energy utilities have been significantly impacted by an extreme weather event in the past decade[2]. Both municipal systems and energy distribution systems are essential, interconnected and must work together to maintain the resilience of a community. Reliable energy supply is needed to maintain the essential functions of municipal infrastructure such as water and wastewater treatment, heating and cooling of buildings, operating vehicle fleets, street lighting, powering emergency shelters, etc.; as well as to ensure other critical infrastructure such as health systems, communications infrastructure, transport infrastructure, food production, financial systems, and other systems continue to function. When energy supply is interrupted, especially for prolonged periods, this has a cumulative impact on a community, from impacts on business, to public health and safety, to property and infrastructure.

There is a need for Canadian methods and tools for municipalities and utilities to adapt their systems.

[1] Several IBC studies assess the increased claims frequency and severity resulting from severe weather and natural disasters.For more information, visit IBC webpage on : http://www.ibc.ca/ns/resources/studies.
[2] QUEST's Resilient Pipes and Wires report

0.2. The Project

This report is part is part of the "**Municipalities and Utilities Partnering for Community Resilience**" project led by QUEST with funding from Natural Resources Canada. The project, supports six municipalities across Canada to develop a climate risk and vulnerability assessment, using a combination of validated tools and methods. This project refers to community resilience in terms of what is in place and what may be needed for a community to mitigate risk from prolonged interruptions to energy supply on essential community services and bounce back from climate impacts or extreme weather. Each community receives an assessment (this report) in 2019 and a set of recommendations for improving community resilience and adapting to climate change, tailored to local context (second report in 2019). All lessons learned will be compiled by QUEST into a final guide in 2019, to be shared with other municipalities across Canada.

0.3. Methodology and data collection

To prepare the workshop, QUEST team conducted a detailed survey, to understand local strengths and weaknesses (current status) - see Section 0.3.1 for details.

QUEST team also collected geospatial data from Federal, Provincial and Municipal open data portals in order to prepare maps of each community, showing land use, flood risk (where available), key infrastructure, that could be used in table-top exercise during workshop 1. See section - 0.3.2 for details of workshop.

In addition, QUEST team compiled climate data projections for each municipal area, including indicators for temperature, precipitation, freeze-thaw, heating degree days and cooling degree days, etc.. This includes projections for 2020, 2050, 2080-2100, using business as usual (RCP 8.5) scenario, where GHG emissions continue to rise at the current rate. This was used to provide context during workshop 1.

Once these data collected and analysed, QUEST team prepared and facilitated a full-day workshop in each community, engaging municipal staff and elected officials, provincial government, energy utilities, and other key local stakeholders. The workshop included presentations on climate change, resilience, emergency preparedness, energy utilities, and insurance trends. The workshops also included three table top exercises.

All these results were then used to prepare an analysis of the strengths and gaps in each community, in relation to each natural hazard (e.g. atmospheric, hydrological, forest fire, etc), with assistance from the Rural Disaster Resilience Portal of Justice Institute of British Columbia. Based on this analysis, QUEST team prepared this report tailored to the local context of each participating community, including a summary of levels of risk and resilience to each natural hazard, and a summary of strengths and areas of improvement. Findings of this report will be used to prepare the second workshop, focusing on recommendations.

Finally, QUEST conducted an orientation webinar and monthly calls with the municipal lead of each of the 6 participating municipalities. This allowed for project coordination, knowledge exchange, discussion of key challenges and opportunities, and review of materials.

0.3.1. The survey

A pre-survey data collection exercise was conducted to gather information about policy, plans and processes in place in the community and was circulated to municipal staff representing all the departments and services prior to the first workshop. The survey was completed to determine potential strengths and areas of improvement in each municipality, including for energy-dependent municipal services.

Description of sector/areas covered: organization, communication, planning / land use, energy for buildings (heat etc), water/wastewater, transportation, vegetation management and food security. The results of the survey provided context during the first workshop - results were shared with all participants, which led to interactive knowledge sharing and additional information gathering which was captured in this report.

0.3.2. The workshop #1

The workshop included context setting presentations on climate change, resilience, emergency preparedness, energy utilities, and insurance trends, followed by three tabletop exercises. The workshop also included three exercises: a mapping exercise, an exercise using the federally endorsed tool from the UN International Strategy for Disaster Reduction 10 Essentials for Making Cities Resilient, and an action planning exercise.

- An interactive mapping exercise (developed by Spatial Quest): using a map of their community, participants identified hazards, vulnerabilities, strengths/assets, areas for improvement, land use restrictions, transportation improvements etc.. These were denoted using stickers and markers, and items were recorded in a workbook at each table.
- A self-assessment using the UN ISDR 10 Essentials: Participants at each table self-assessed their strengths and weaknesses, and assigned their community a score for each of the 10 Essentials, including for: Organization and Coordination, assigning budget for risk reduction, conducting hazard risk and vulnerability assessment, investing in infrastructure adaptation, assessing the safety of schools and hospitals, applying risk compliant building codes and land use planning principles, ensuring training is in place, protecting ecosystems, developing emergency management capacity, and building back better post-disaster. The results were recorded in a workbook.
- A facilitated action planning exercise: participants identified key needs, goals, and actions on sticky notes and then grouped them by theme.

1.0 Community Profile

1.1 Geography / Location

The **City of Summerside is located** in western Prince Edward Island. Summerside is 60 km northwest of Charlottetown. It is located in Prince Edward Island's Prince County. Summerside was officially incorporated in 1877.

Within community boundaries, there are low-lying neighborhoods near the river and coastal urban front. There has been some erosion. It was unclear if floodplains have been identified, or how many residences, businesses, and municipal facilities might be in the floodplain. There was no overland flooding in the past three years.

Land area in square kilometres: 18.58 sq. km

1.2 Population Characteristics / Trends

Municipal Staff Size: 130
Population Size: 15000
Trend: Slight increase in population. Population percentage change from 2011 to 2016: 0.5%
Average age of the population: 44.4
Median age of the population: 46.7

Total - Distribution (%) of the population by broad age groups:

Age Group	% of population
0 to 14 years	15.4
15 to 64 years	61.8
65 years and over	22.8
85 years and over	3.0

The culture of the area is a mix of Canadian, Scottish, English, French and Irish with the predominant language being English.

Languages Spoken:

Item	Language	# of people
First Official Language spoken	English French	13810 625
Language spoken most often at home	English French	13910 210

	Non-official languages	220

Median Income:

Median Income	$
Median after-tax income of one-person households in 2015	24,333
Median after-tax income of two-or-more-person households in 2015	60,194

Highest Education:

Highest Certificate, Diploma, or Degree (population 25 to 64)	# of people
No certificate; diploma or degree	1100
Secondary (high) school diploma or equivalency certificate	2265
Postsecondary certificate; diploma or degree	4090
Apprenticeship or trades certificate or diploma	495
Trades certificate or diploma	310
Certificate of Apprenticeship or Certificate of Qualification	190
College; CEGEP or other non-university certificate or diploma	2130
University certificate or diploma below bachelor level	105
University certificate; diploma or degree at bachelor level or above	1365
Bachelor's degree	935
University certificate or diploma above bachelor level	70
Degree in medicine; dentistry; veterinary medicine or optometry	40
Master's degree	300
Earned doctorate	20

Type of Dwellings:

Type of Dwellings	# of dwellings
Single-detached house	3290

Semi-detached house	375
Row house	615
Apartment or flat in a duplex	250
Apartment in a building that has fewer than five storeys	1205
Other single-attached house	10
Movable dwelling	480

Age of Dwellings:

Age of Dwellings	# of dwellings
1960 or before	1890
1961 to 1980	1900
1981 to 1990	810
1991 to 2000	790
2001 to 2005	335
2006 to 2010	410
2011 to 2016	375
Major repairs needed	475

All of the above data was sourced from Statistics Canada, from their last Census (2016).

1.3 Environmental Characteristics / Trends

Trend: Population slowly decreasing and milder winters. Summerside has a humid continental climate which is moderated by the warm waters of the Gulf of St. Lawrence. Though winter temperatures are moderate, ranging from -3 to -11 degrees Celsius, there is often a significant wind chill, bringing the apparent temperature down to -25 degrees Celsius. Summers are warm, as temperatures ranges between 20 and 34 degrees Celsius. Summerside receives an average total yearly snowfall of 277.9 centimeters and an average total yearly rainfall of 809.1 millimeters.

1.4 Economic Characteristics / Trends

Summerside is the primary service centre for the western part of the island with Summerside Tax Centre being the largest employer. Summerside's two largest industries are retail (14%) and manufacturing (12%), followed by health and social services, government and accommodation, food, and beverages. Other major employers in the region are StandardAero, Honeywell, and Cavendish Farms in nearby New Annan. In the health industry, Summerside's Prince County Hospital is western PEI's main referral hospital.

1.5 Energy Characteristics

Summerside owns its electrical utility, Summerside Electric. Electricity is generated by the Summerside Wind Farm and the Summerside Diesel Generation Plant. The Summerside Wind Farm's four wind turbines hold the capacity to generate 12 megawatts of electricity at a time. The Diesel Generation Plant has the capacity to generate 12.5 megawatts of electricity at a time. Approximately 46% of the City's electricity is generated by wind power. Summerside Electric is responsible for the production, transmission, and distribution of electricity. They service over 7000 commercial and residential customers. Summerside Electric also sells electricity to NB Power.

2.0 Key Hazards and Climate Projections

2.1 Introduction

To help with our assessment, QUEST compiled baseline climate information (today's climate) and prepared a forecast of climate indicators specific to your community/region, with the technical assistance of Lansdowne Technologies.

The forecast is based on the assimilation of climate data from Environment Canada, weather stations in your area, and 40 global climate models, grouped into three GHG concentration pathways (low, medium, and high / business as usual), with projections for 2020, 2050, 2080 to 2100. These have also been compared against available Provincial data for future climate conditions. See modeling method details in the Annex.

Here we present a summary of the climate indicators and projections, for the business as usual scenario (where GHG emissions continue to rise at current rate).

2.2 Current Climate

Summerside has a humid continental climate with warm but somewhat moderate summers. It has cold winters with heavy snowfall, with some maritime moderation compared to areas farther inland.

2.3 Key Hazards of Concern

Hazards of most concern identified in the pre-workshop survey and in workshop 1, include:

- **Atmospheric** (e.g., wind events, blizzards, ice storms);
- **Hydrological** (e.g., wharfs are too low for sea level rise. A lot of development in the flood area, unable to handle the storm surges. Risk from coastal flooding is high, but lower from overland flooding);
- **Food security** (52 hours is the threshold for import security – closure of bridge).

Here is an example of recent events provided in the pre-survey:

Type of Hazard	Location	Date / Duration	Description	Risk of Re-occurring	Power Outage	Cause of Event	Impact on Community
Severe weather events	PEI	Up to several days	Nor'Easters	High	Yes	-	Temporary shutdown

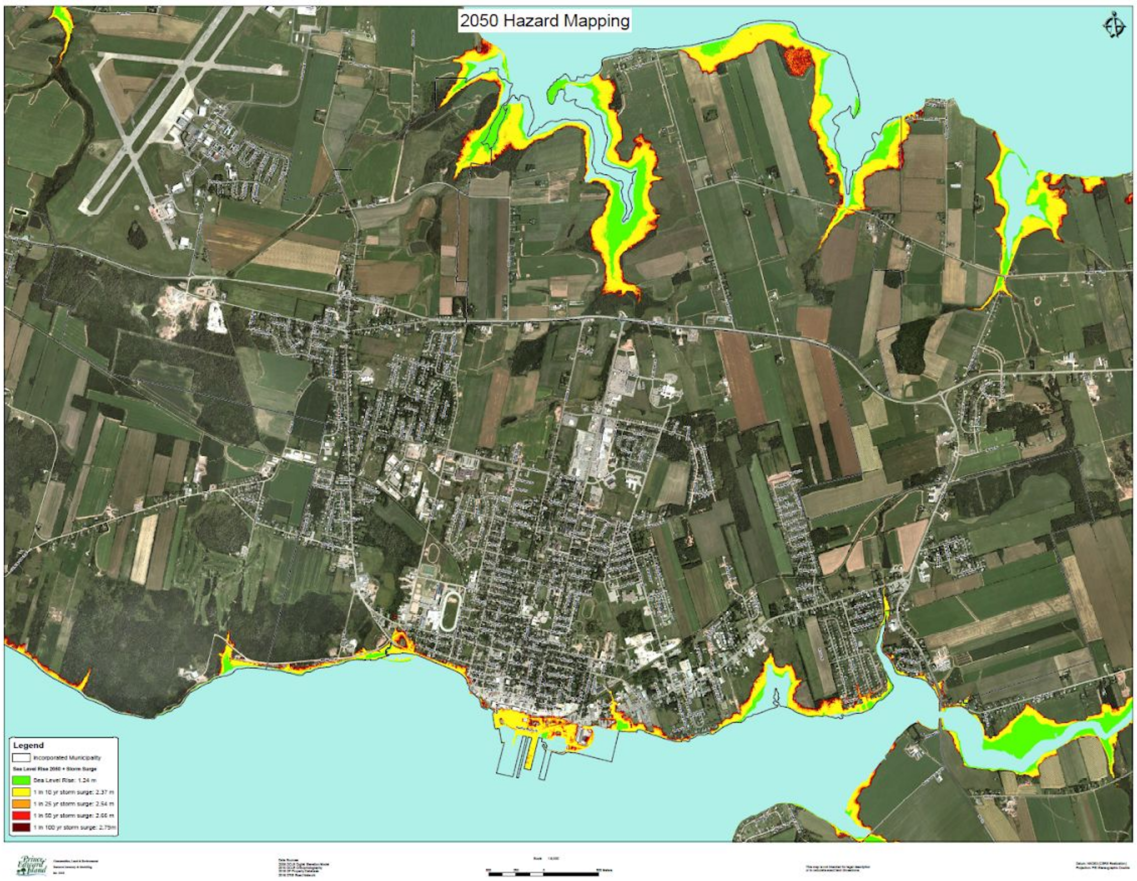
2.4 Climate Projections

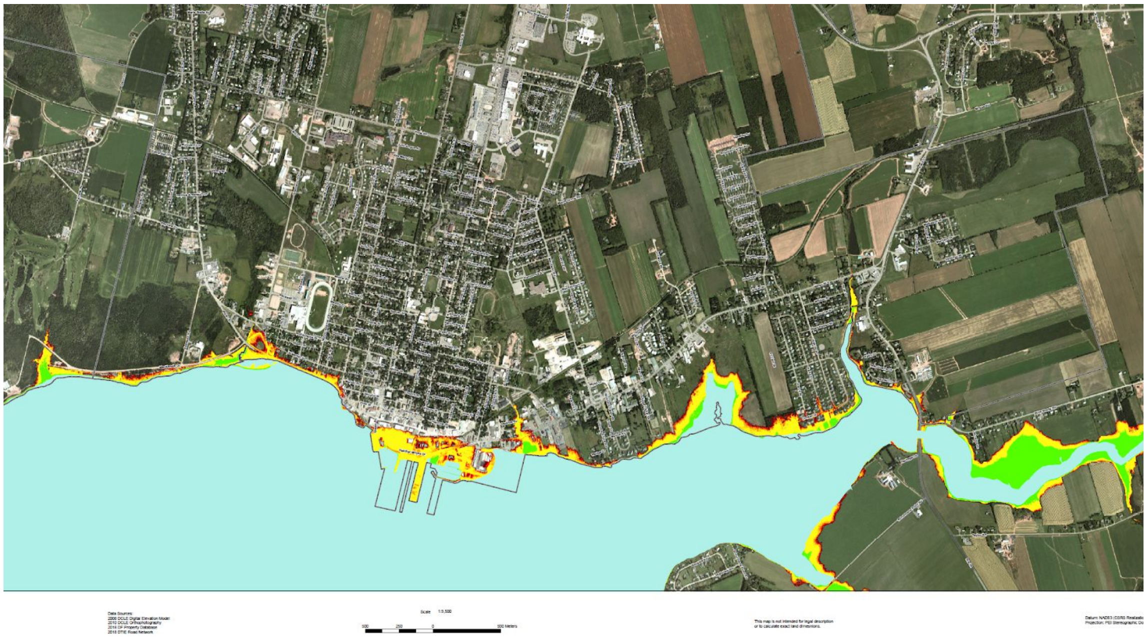
See Annex for detailed description of climate indicators, modeling methods, and projections.

2.4.1 Sea Level Rise and Storm Surge

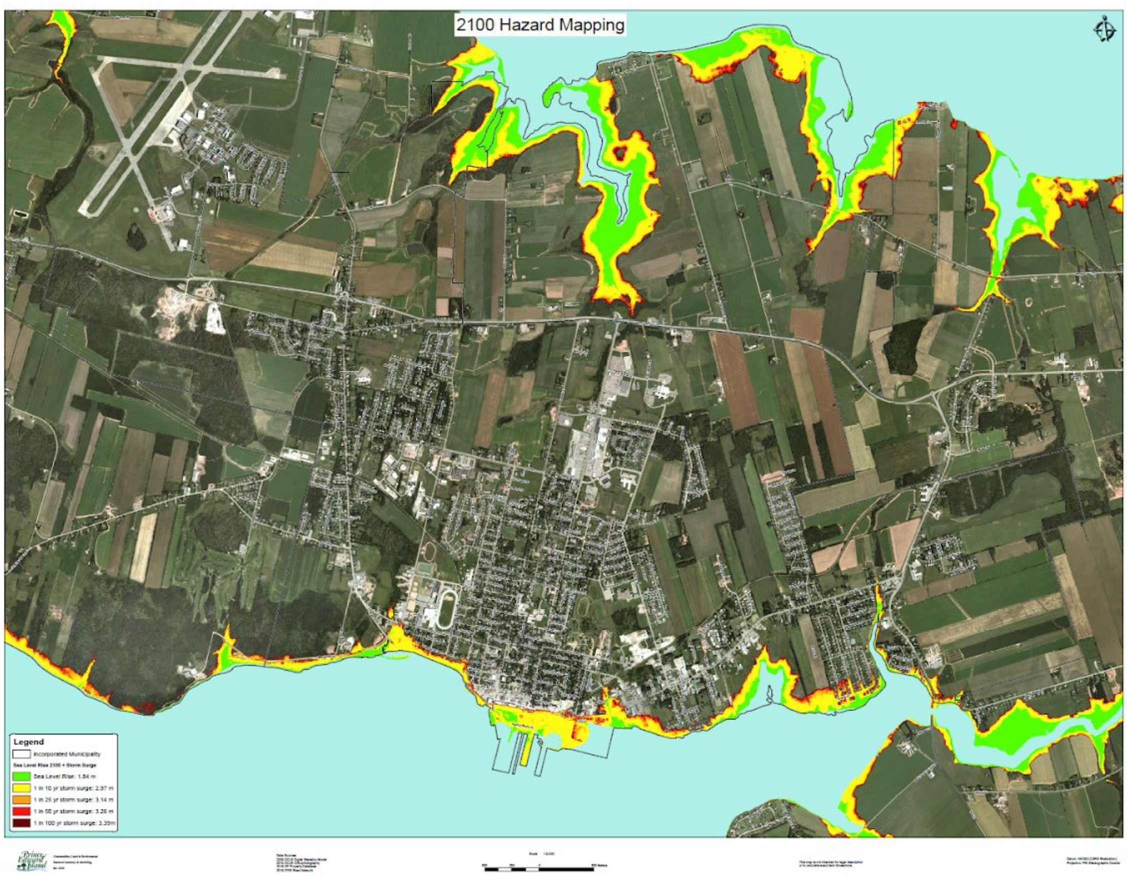
Sea level rise and storm surge can increase flood potential which can impact community infrastructure in coastal and low-lying areas, such as Summerside:

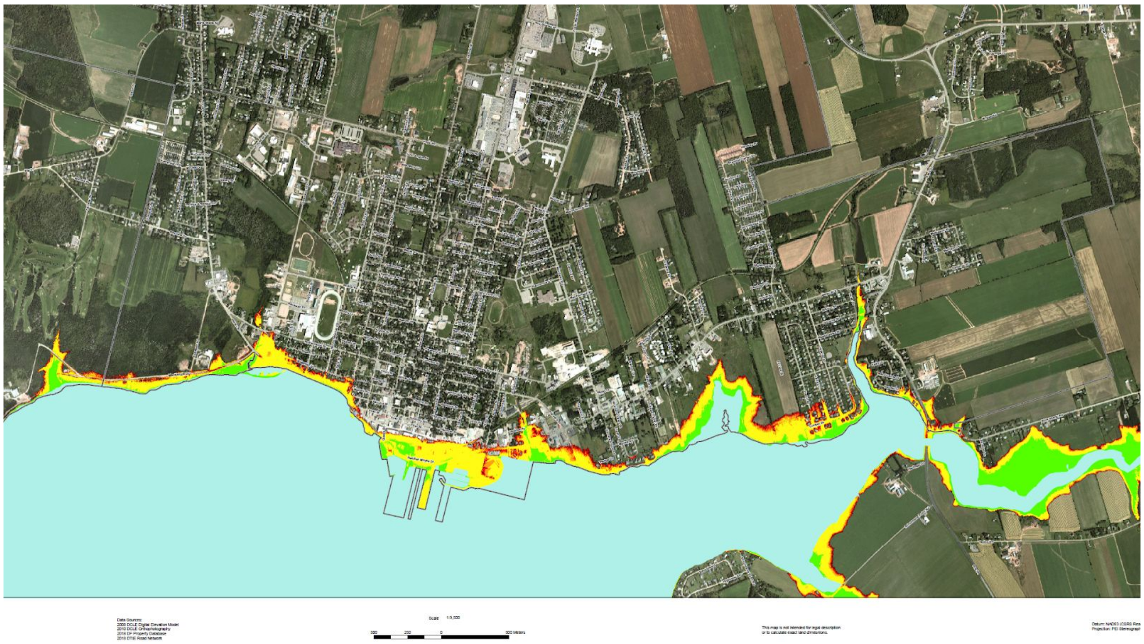
2050 Sea Level Rise and Storm Surge, Hazard Map





2100 Sea Level Rise and Storm Surge, Hazard Map

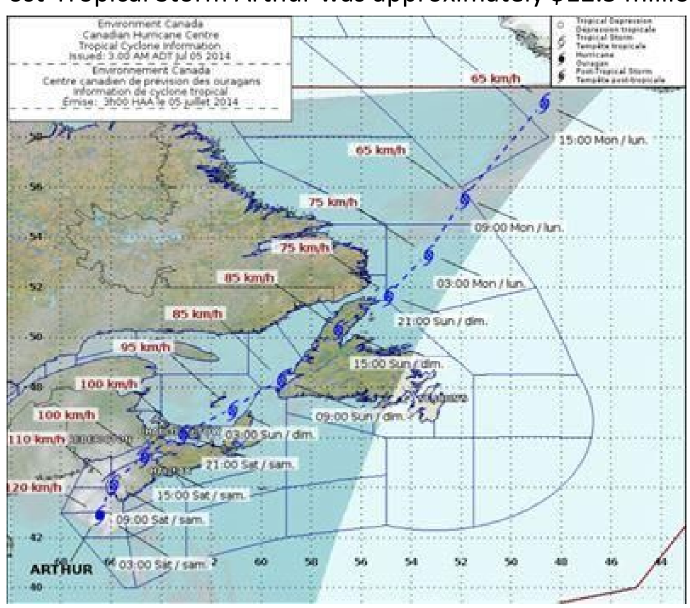




Source: Climate Change Secretariat, PEI

On occasion, strong wind and precipitation associated with post-tropical storms, can unleash significant overland flooding, stronger storm surges, breaches of dykes, bridges, causeways, roads and rail, and damage to property and infrastructure. A warmer climate is expected to result in warmer ocean-surface waters. These warmer waters will result in increased levels of humidity resulting in more intense and longer lasting hurricanes and Nor'Easters which may also push further north.

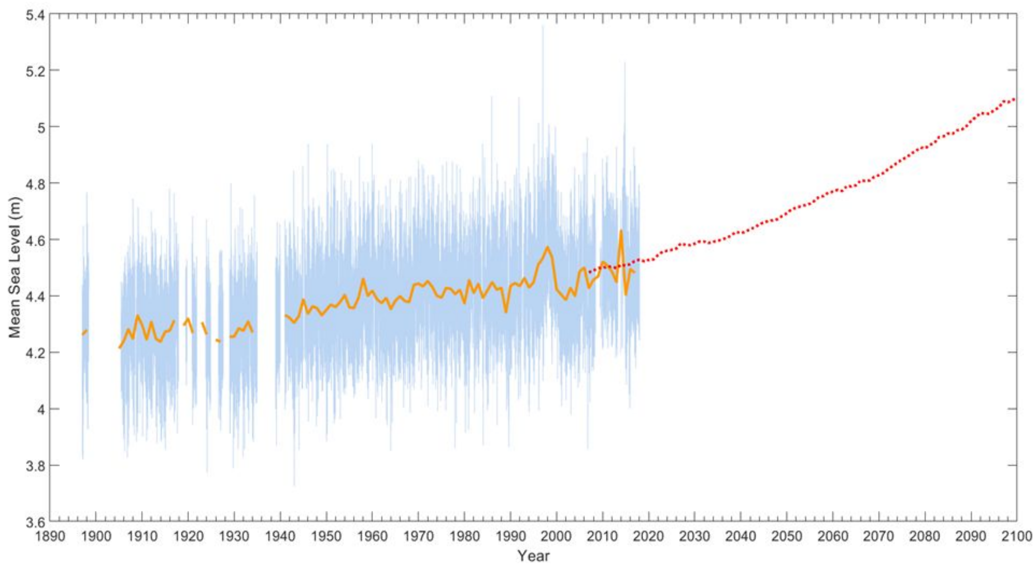
> On Saturday July 5th, 2014, Hurricane Arthur transformed into a potent Post-Tropical storm over the Maritime provinces, damaging homes, power infrastructure, roadways, etc. Total damage cost from Post-Tropical Storm Arthur was approximately $12.5 million.



Source: National Disaster Database

Due to the variety of flood-related risks in PEI which may increase with climate change, it is prudent for municipalities to understand local flood risks and develop risk reduction policies, actions/measures, etc., as part of future land use planning, asset management, infrastructure development, climate adaptation, emergency preparedness, etc.

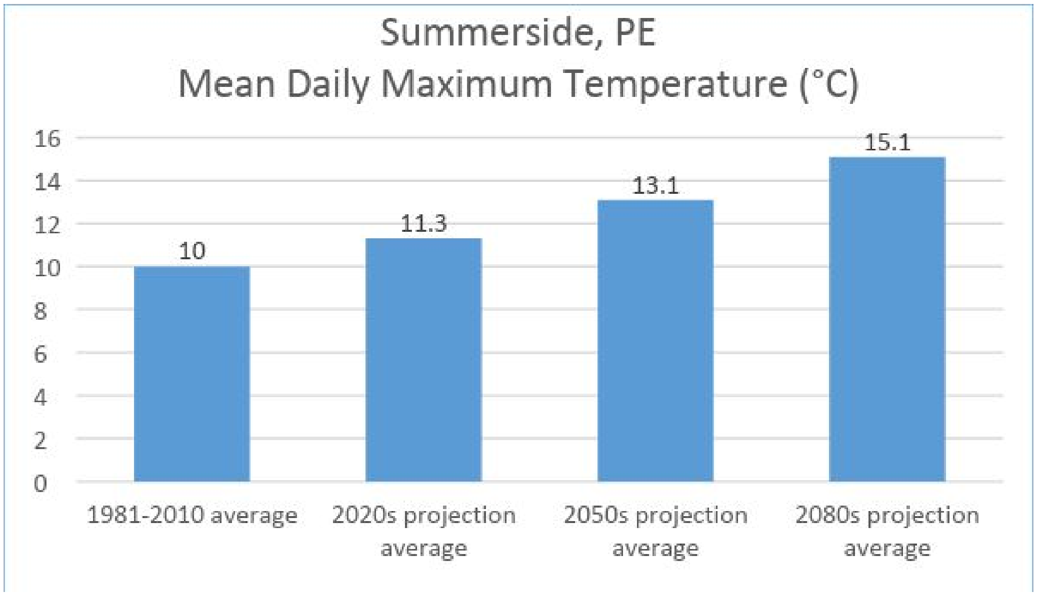
Here is an average Sea Level Rise Graph for PEI, based on IPCC 5th Assessment Report but it does not consider land subsistence or local geographic characteristics.

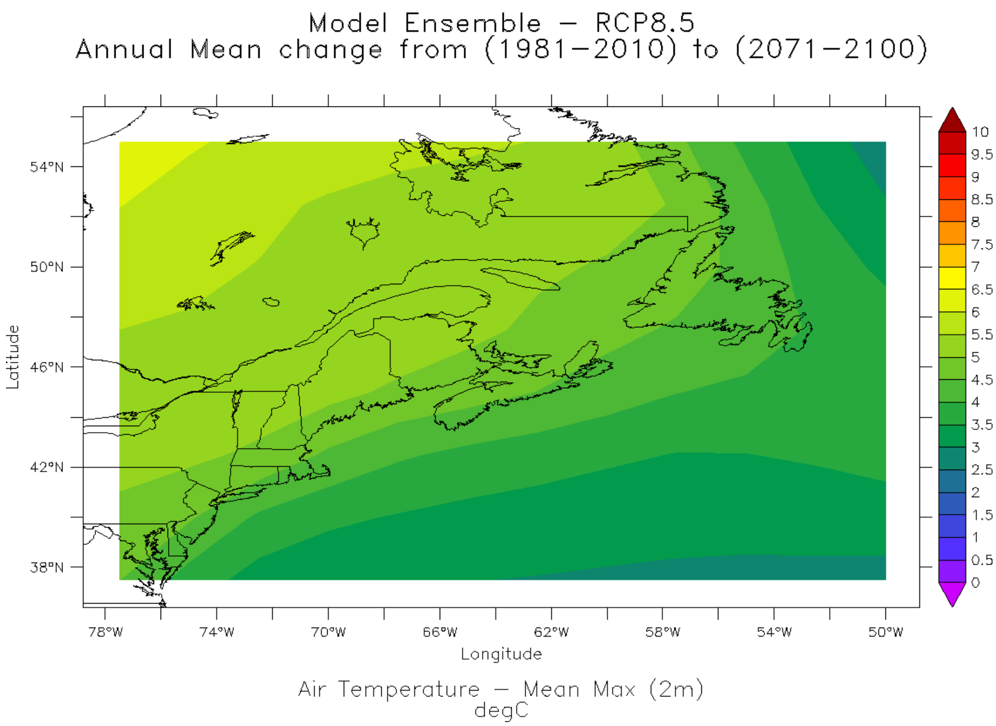


2.4.2 Temperature (Max, Min, Mean, Days above 30°C and under -24°C)

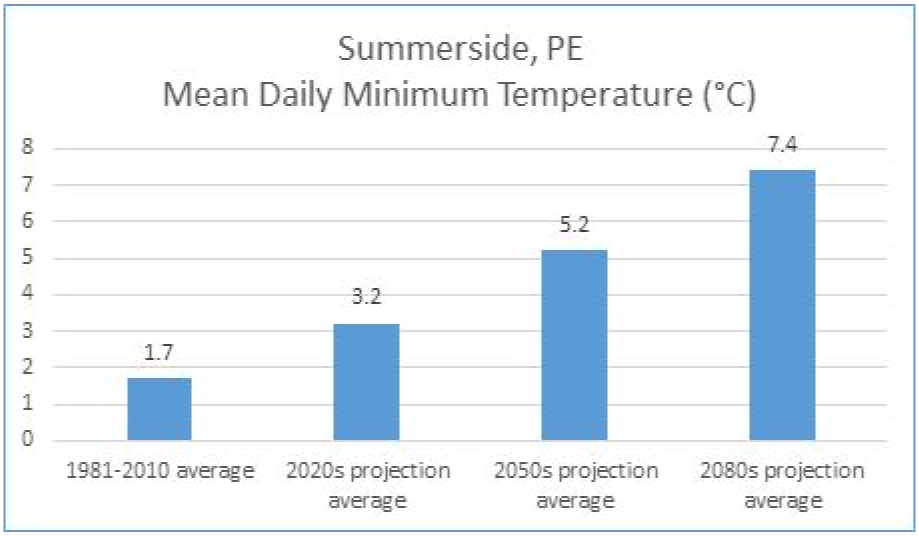
For temperature, climate variables are presented showing values and trends in maximum, minimum and mean temperature. As demonstrated in the Charts below, mean maximum and mean minimum temperatures are expected to increase by 5 degrees Celsius by 2100. As well, with climate change it is expected that there will be increase in the number of days above 30°C and heat waves during the summer, and may lead to more freeze-thaw events in the winter.

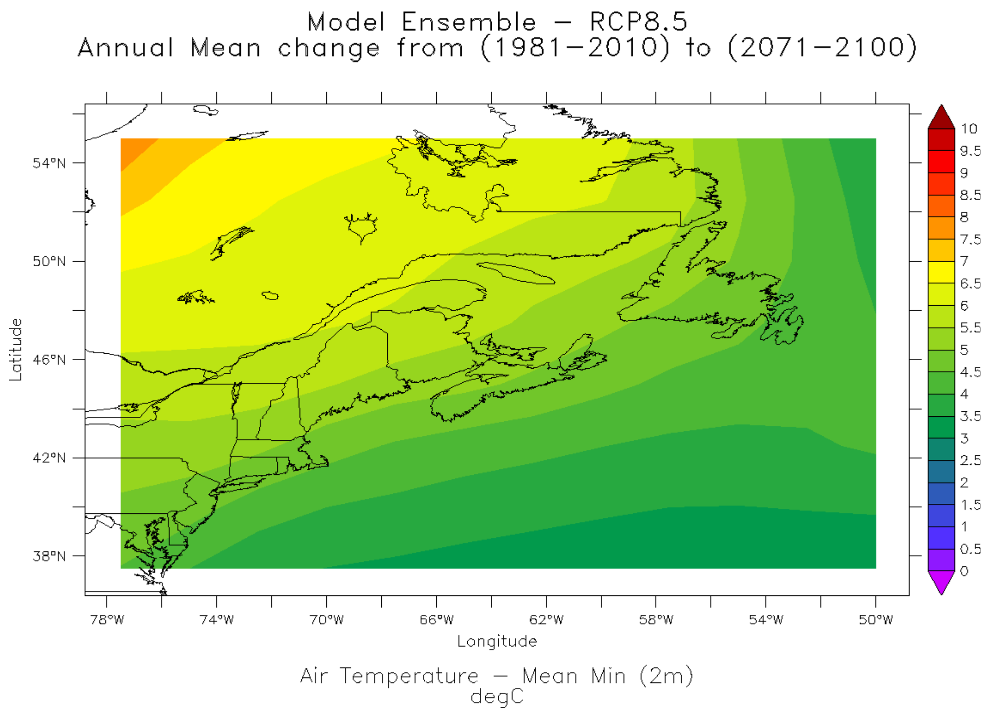
Maximum Temperature



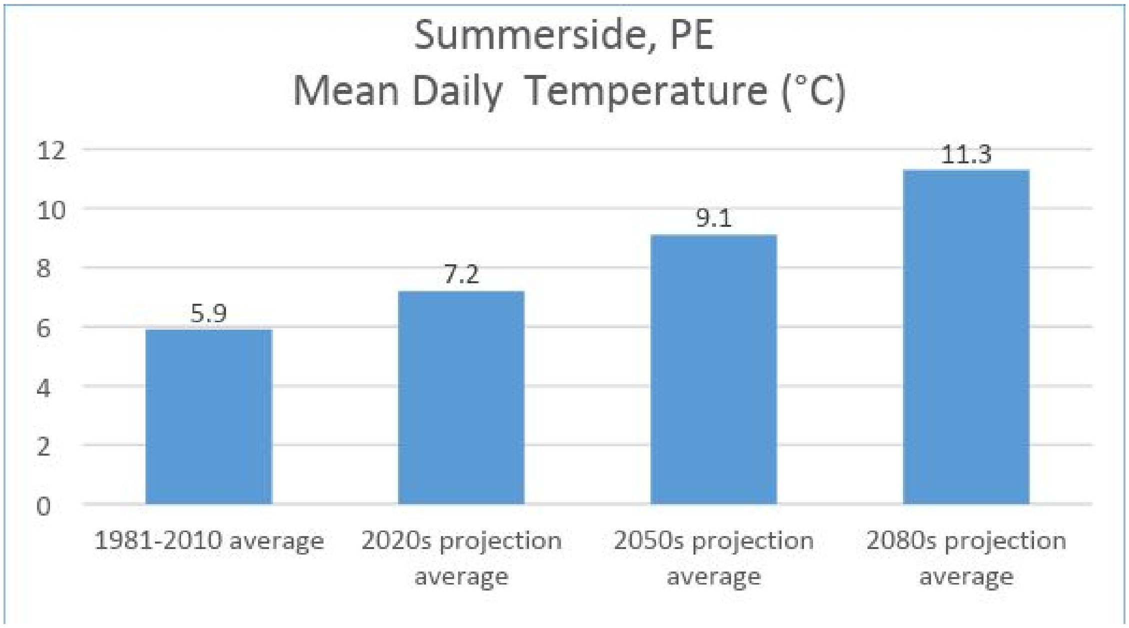


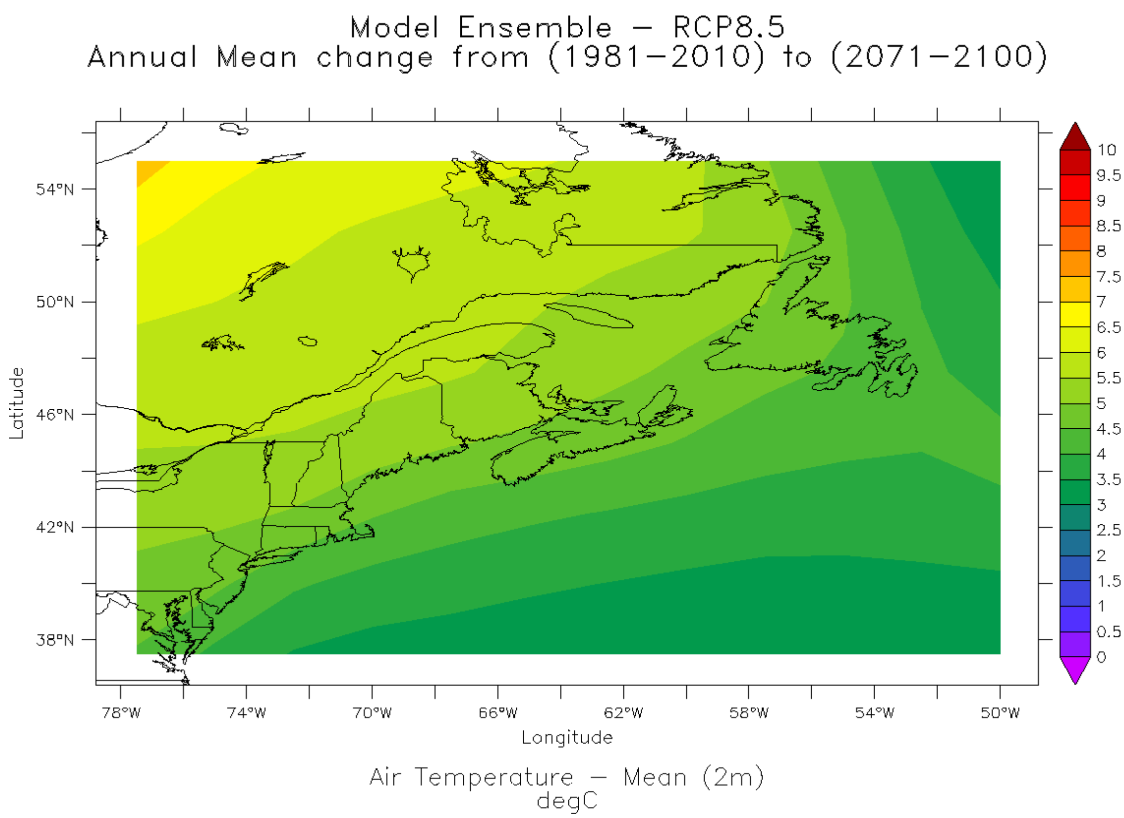
Minimum Temperature



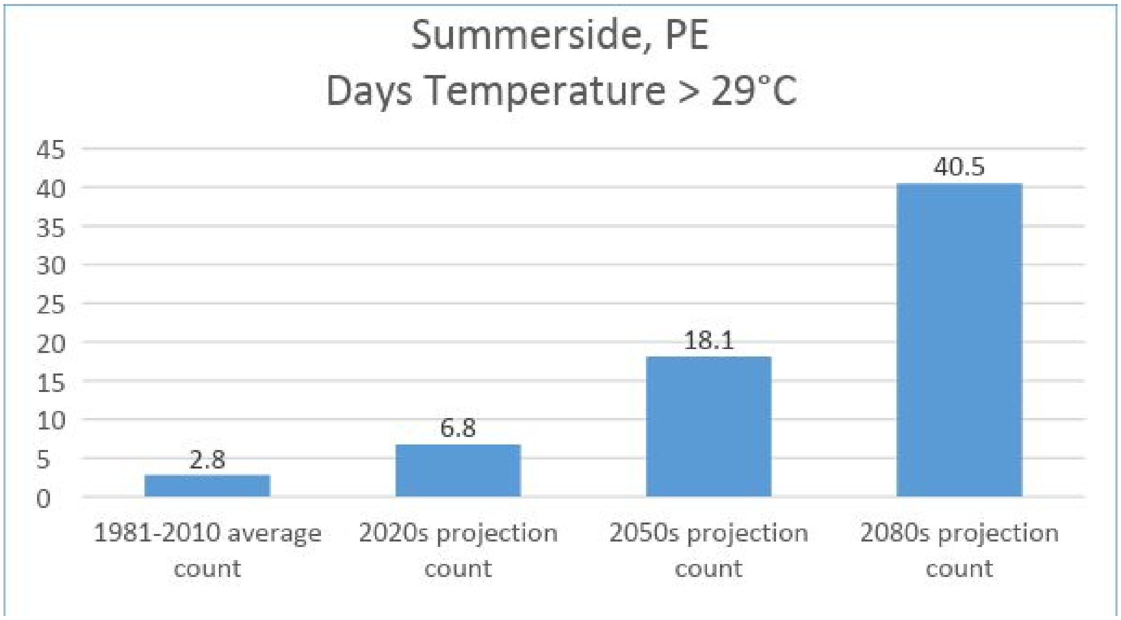


Mean Temperature

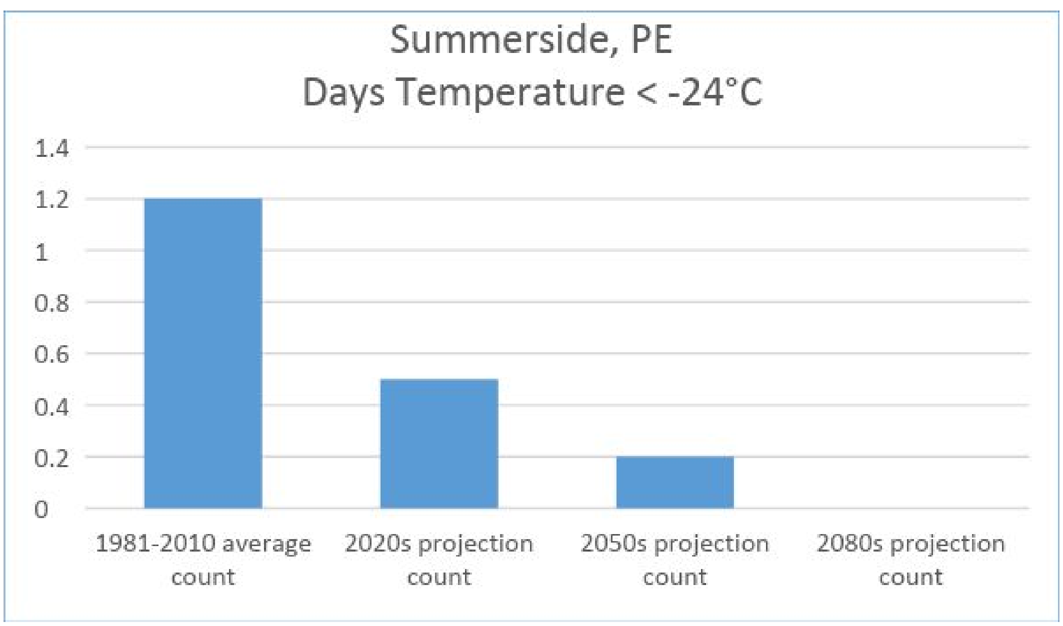




Hot Days

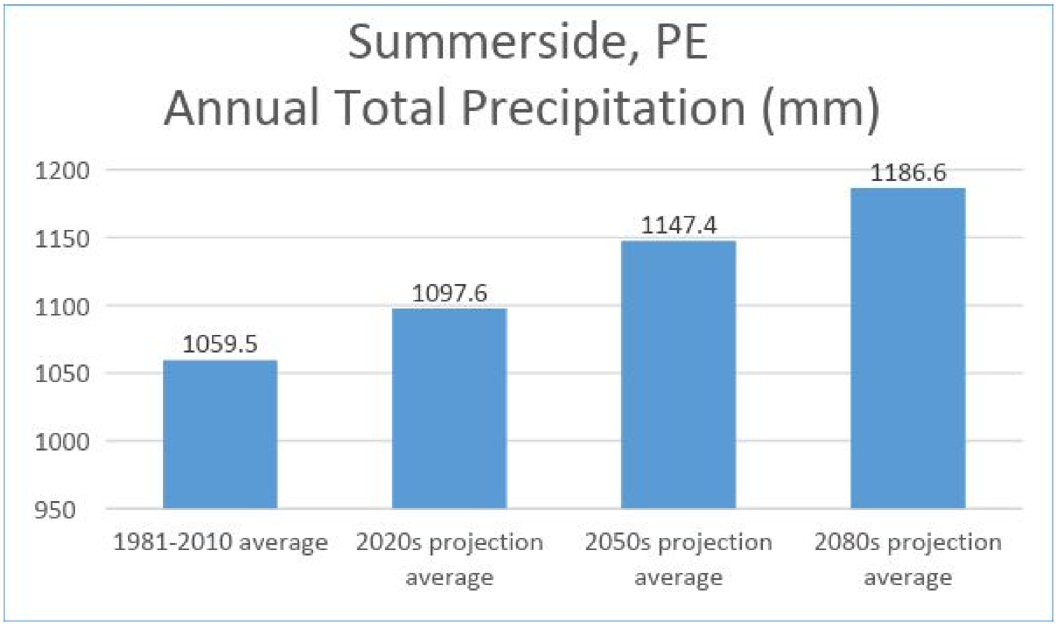


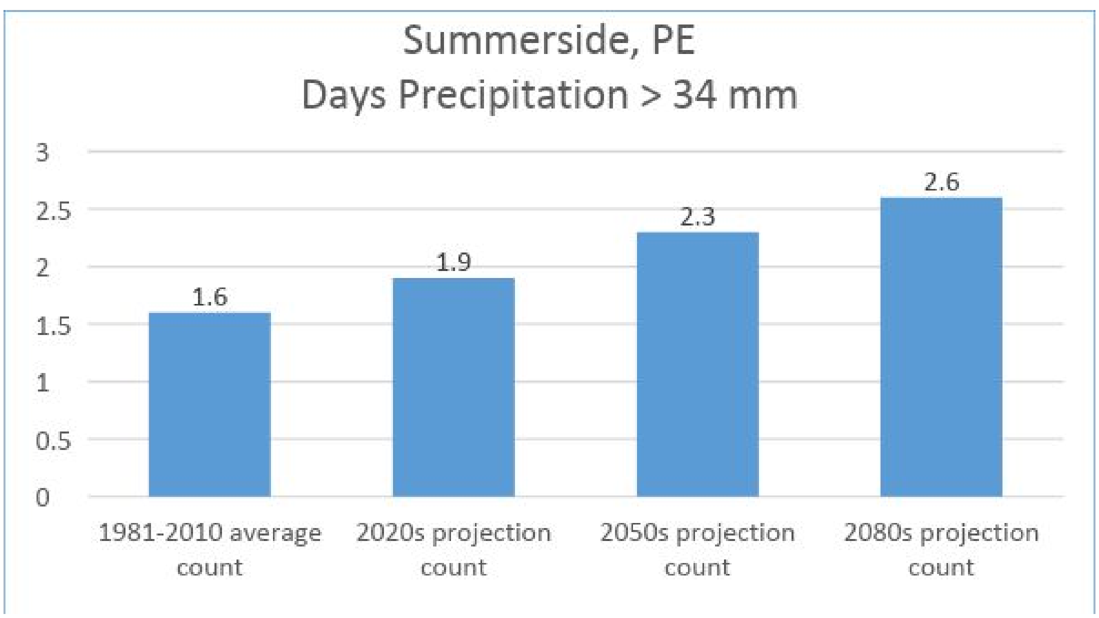
Cold Days

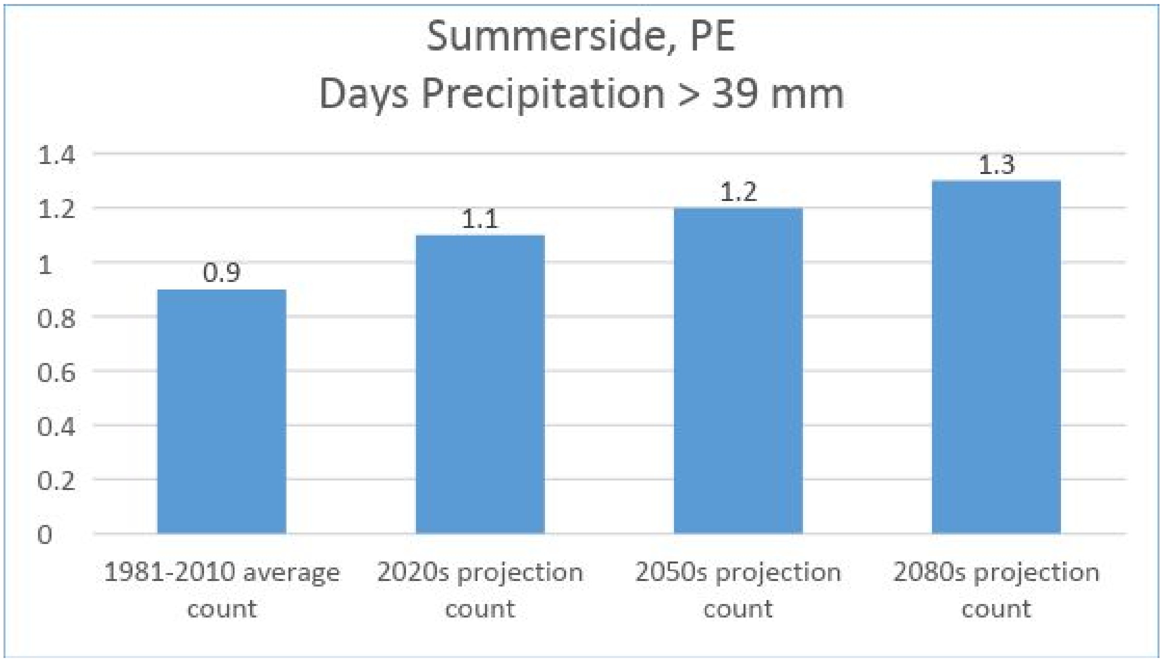


2.4.3 Precipitation

For precipitation, climate variables are presented showing values and trends in total and maximum precipitation. As the charts and maps below demonstrate, Summerside will experience an increase in total annual precipitation by about 127 mm. It should also be noted that climate change is expected to increase the severity and frequency of extreme rain events, with increased total accumulations over 24 to 48 hours. These events are difficult to model due to complex weather and climate factors but should be considered in future planning decisions.



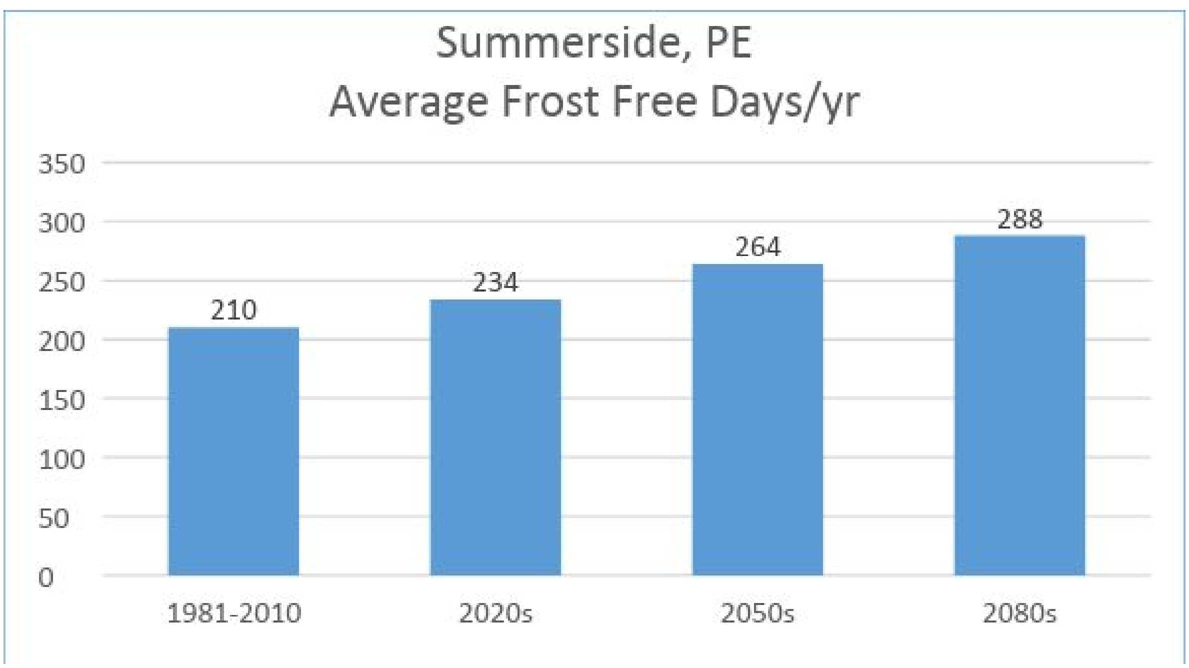




2.4.4 Frost Profile

For the Frost Profile, climate variables are presented showing the values and trends in total number of frost-free days. As the graph indicates below, the City of Summerside will experience an increase of 78 frost-free days by 2100, for a total of 288 frost-free days.

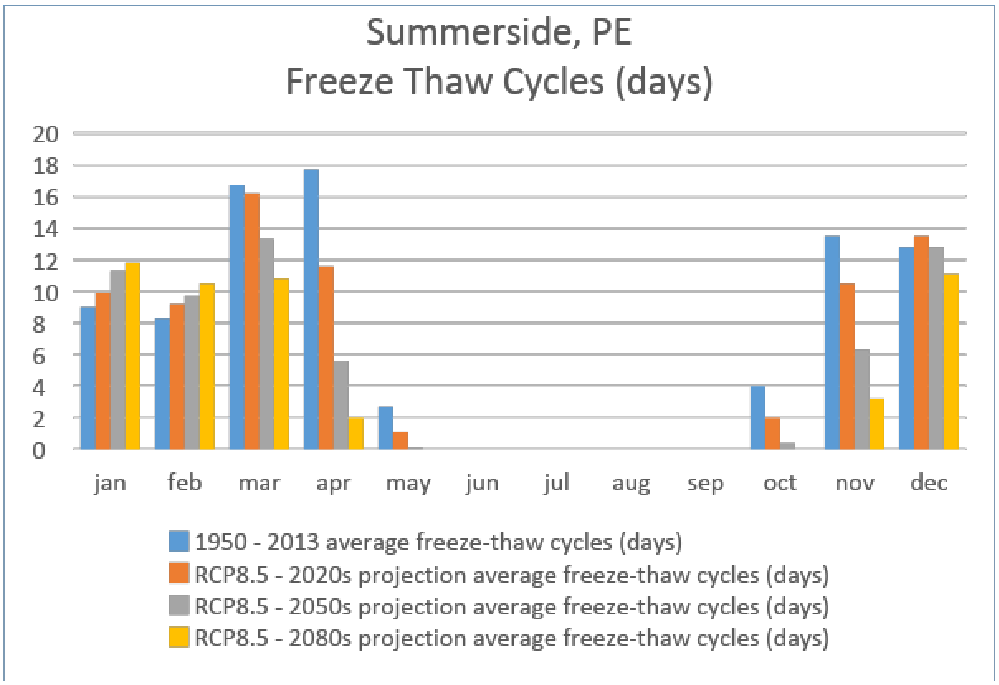
Frost-Free Days

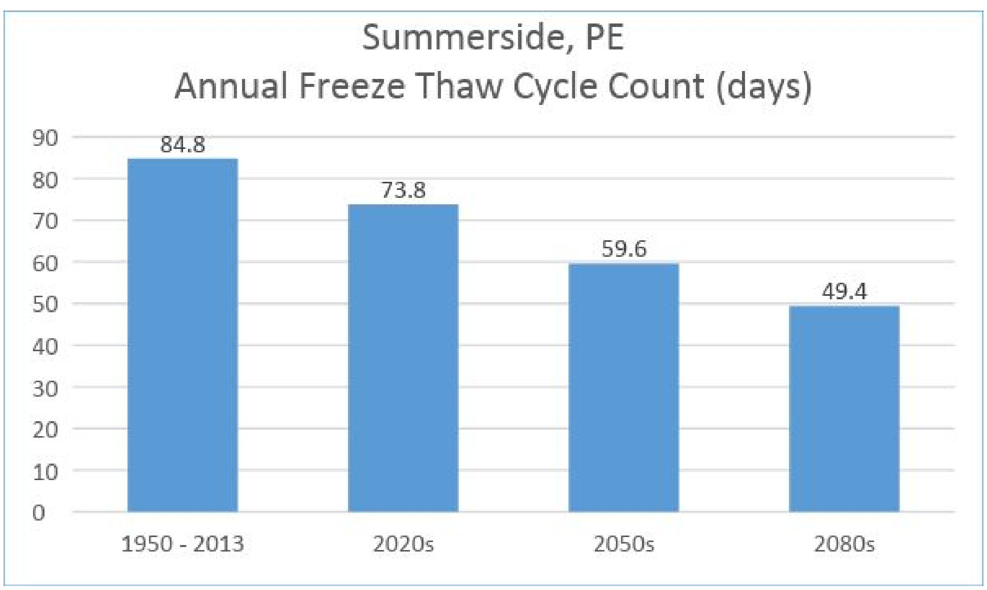


2.4.5 Freeze-Thaw Profile

For the Freeze-Thaw Profile, climate variables are presented showing the values and trends in total number of days with freeze-thaw cycles by month and annually. As the graphs demonstrate below, the City of Summerside will experience an 40% decrease in annual freeze-thaw cycles, but will experience more freeze-thaw cycles during January and February. This has important implications for adaptation in the winter time.

Freeze-Thaw Profile

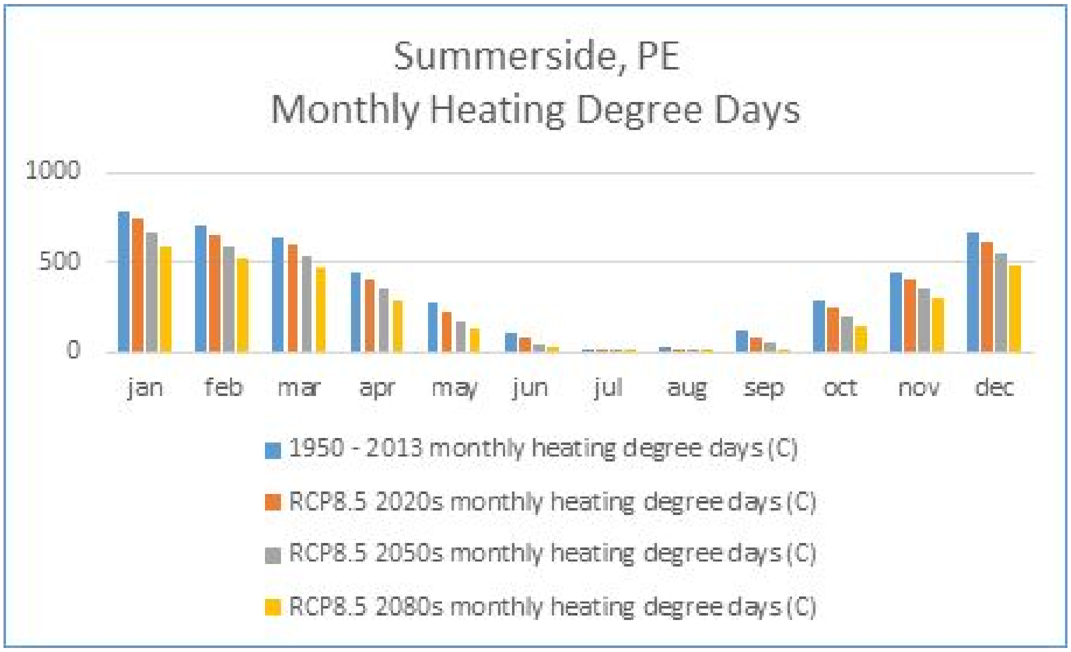


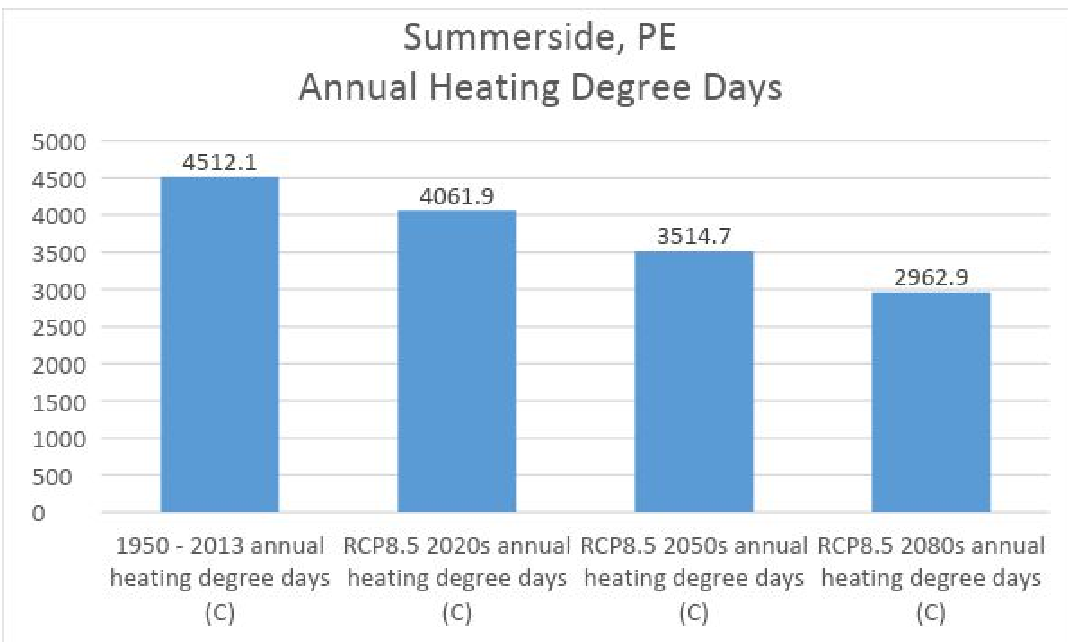


2.4.6 Heating / Cooling Degree Days

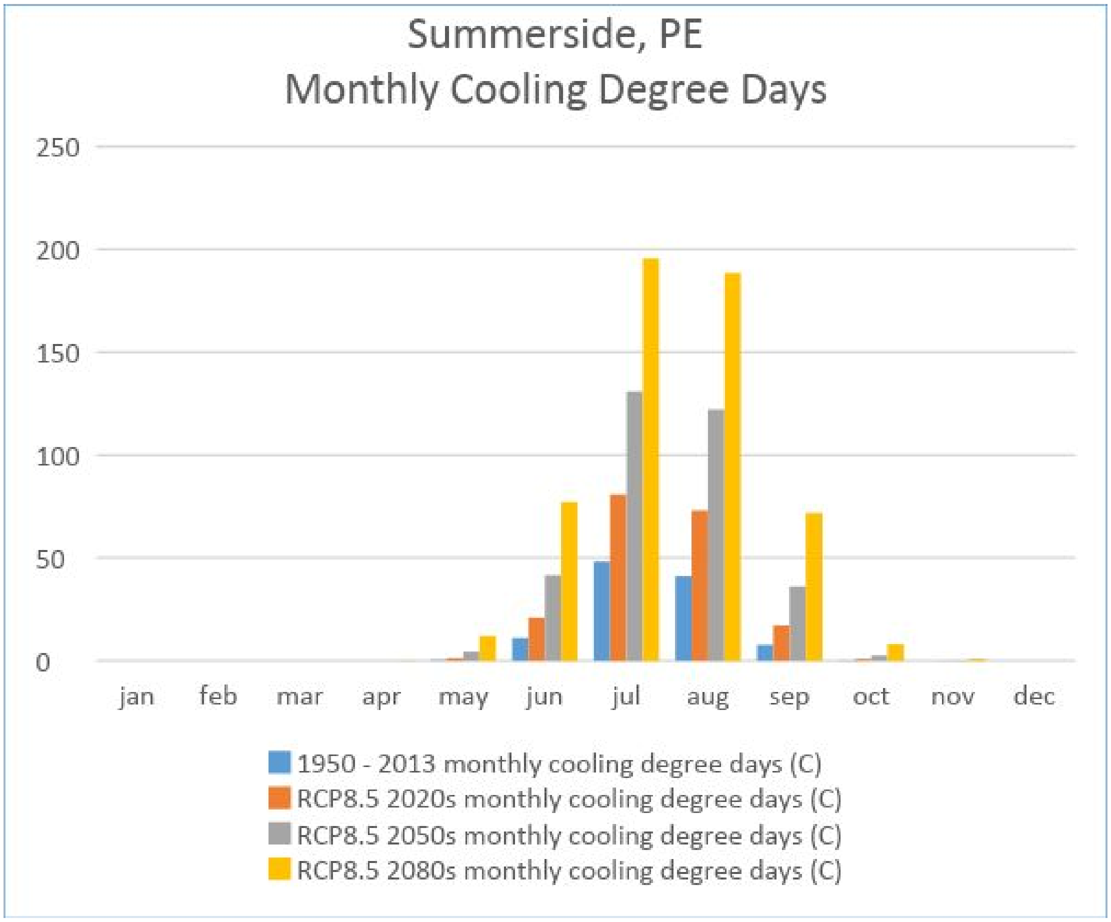
For the Heating / Cooling Degree Days Profile, climate variables are presented showing the values and trends in total number of heating days and cooling days by month, and for each projection period. As the charts demonstrate below, Summerside will experience a decrease in the number of heating degree days, and an increase in the number of cooling degree days. This has important implications for agriculture, electricity production, and provision of shelters for heating/cooling vulnerable populations during prolonged outages.

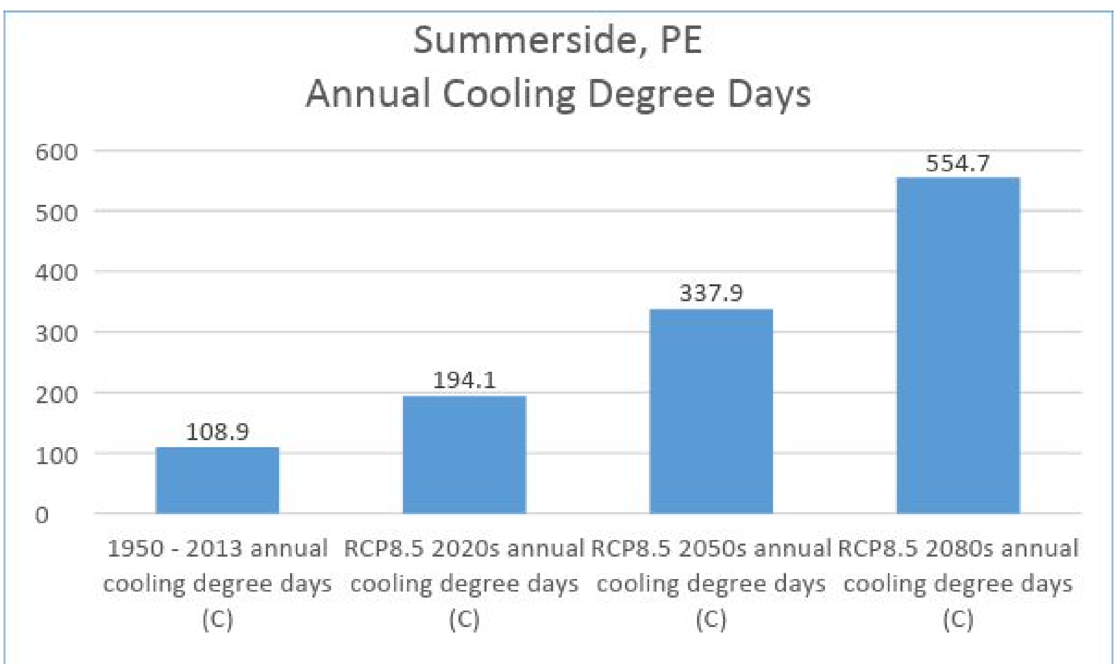
Heating Degree Days





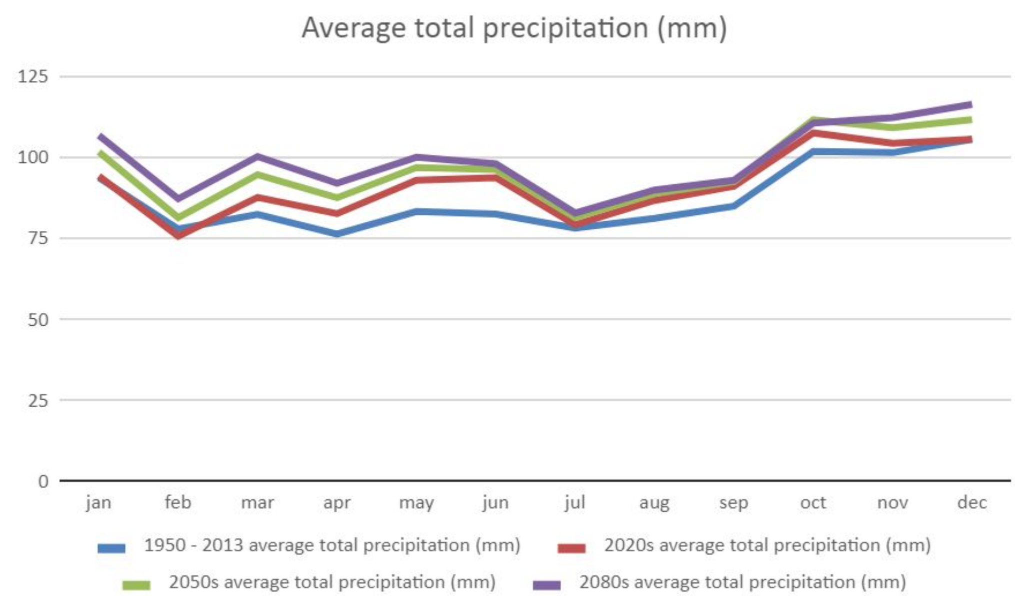
Cooling Degree Days

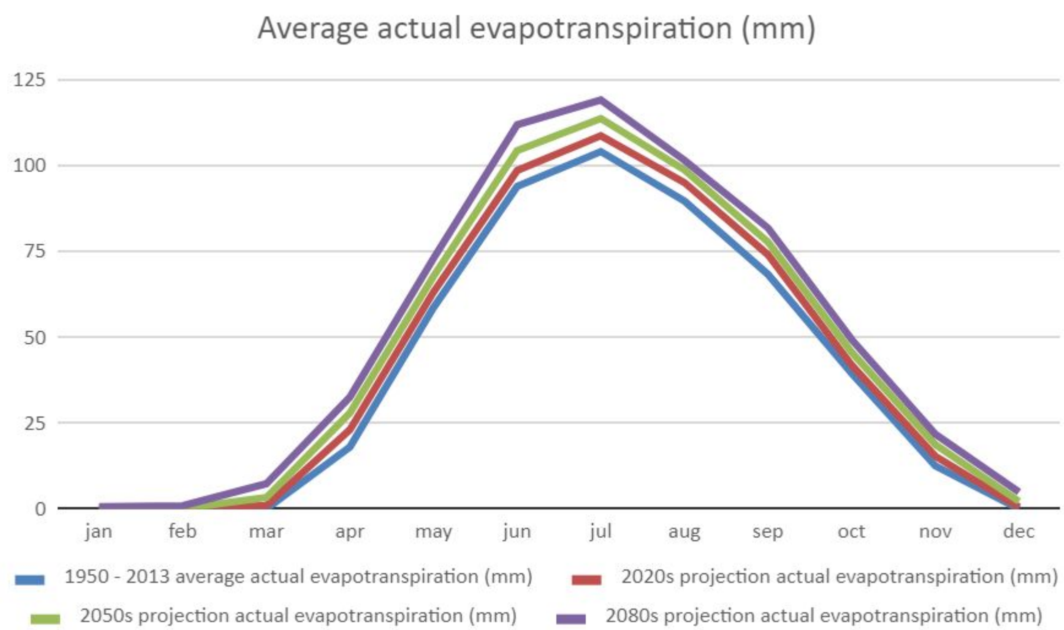


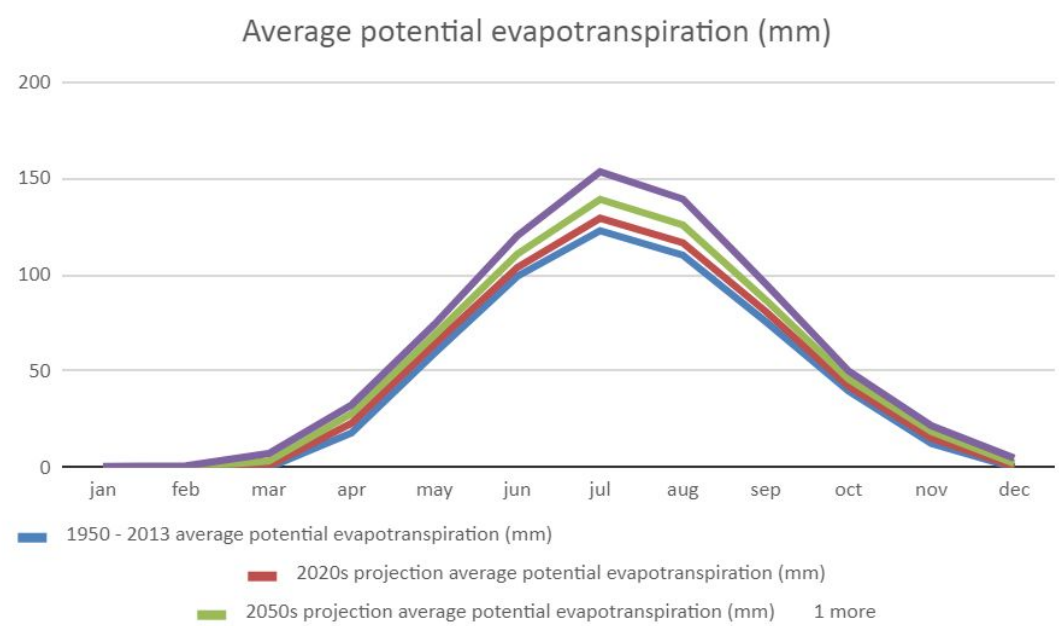


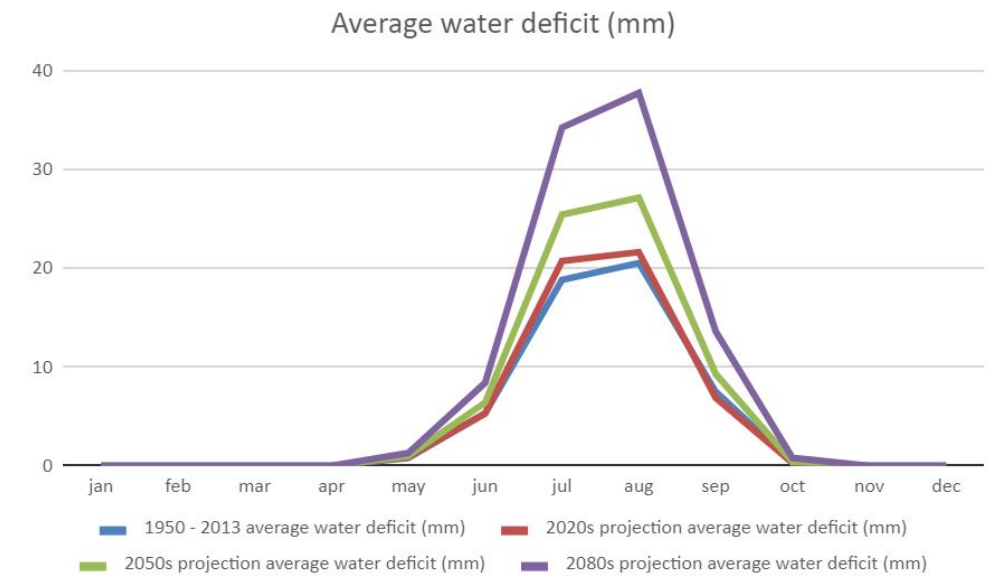
2.4.7 Water Balance

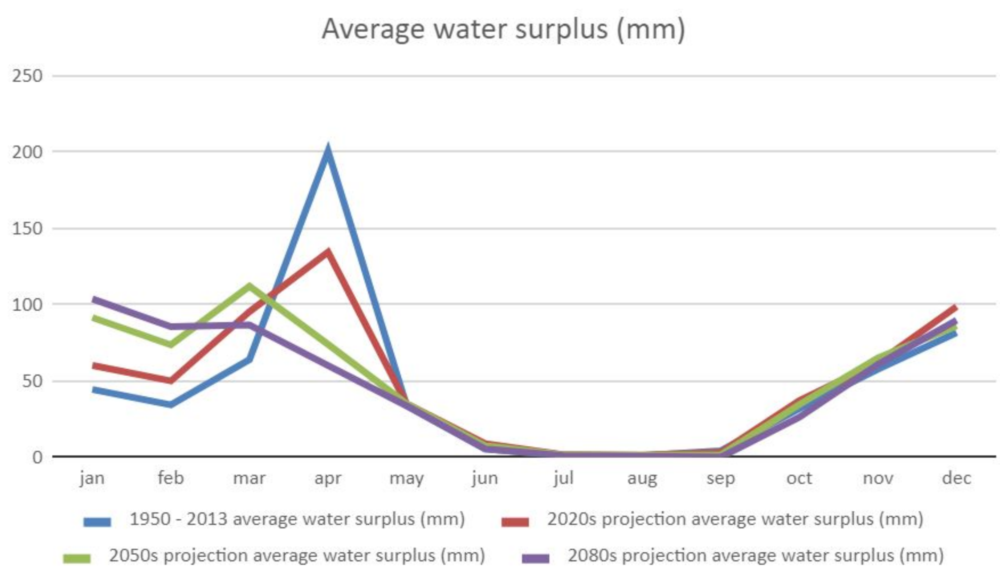
For the Water Balance Profile, climate variables are presented showing the values and trends in historical and future water balance, including total precipitation and evapotranspiration. As the graph below indicates, the City of Summerside will experience an increase in water balance over the winter months, and a decrease in the water balance in the summer months. This can have implications in the summer for agriculture (drought), potable water supply, electricity production (less hydro), forest fires (dryer summer conditions), and changes in flora and fauna, as well as increase local flood risk and require stormwater attenuation during winter and early spring.




Average actual evapotranspiration (mm)
125
100
75
50
25
0
jan
feb
mar
apr
may
jun
jul
aug
sep
oct
nov
dec
1950 - 2013 average actual evapotranspiration (mm)
2020s projection actual evapotranspiration (mm)
2050s projection actual evapotranspiration (mm)
2080s projection actual evapotranspiration (mm)


Average potential evapotranspiration (mm)
200
150
100
50
0
jan
feb
mar
apr
may
jun
jul
aug
sep
oct
nov
dec
1950 - 2013 average potential evapotranspiration (mm)
2020s projection average potential evapotranspiration (mm)
2050s projection average potential evapotranspiration (mm)
1 more





- **Historical water surplus: 558.85mm**
- **Historical water deficit: 53.11mm**
- **Projected RCP 8.5 2020s water surplus: 586.62mm**
- **Projected RCP 8.5 2020s water deficit: 55.67mm**
- **Projected RCP 8.5 2050s water surplus: 582.45mm**
- **Projected RCP 8.5 2050s water deficit: 69.61mm**
- **Projected RCP 8.5 2080s water surplus: 552.72mm**
- **Projected RCP 8.5 2080s water deficit: 95.92mm**

2.4.8 Summary Table of All Climate Variables

	1981-2010 Average	2020s Projection Average	2050s Projection Average	2080s Projection Average
Average Frost-Free Days/yr	210	234	264	288
Annual Freeze-Thaw Cycle Count (days)	84.8	73.8	59.6	84.8
TMAX(°C) - Spring	7.5	8.6	10.4	12.3
TMIN(°C) - Spring	-0.9	0.4	2.3	4.3
TMEAN(°C) - Spring	3.3	4.5	6.3	8.3
TMAX-(°C) - Summer	22.1	23.4	25.2	27.4
TMIN(°C) - Summer	12.7	13.9	15.7	17.8
TMEAN(°C) - Summer	17.4	18.7	20.5	22.6
TMAX(°C) - Fall	12.5	13.8	15.5	17.5
TMIN(°C) - Fall	4.8	6	7.7	9.8
TMEAN(°C) - Fall	8.7	9.9	11.7	13.7
TMAX(°C) - Winter	-1.9	-0.4	1.4	3.5
TMIN(°C) - Winter	-9.9	-7.8	-5.2	-2.5
TMEAN(°C) - Winter	-5.9	-4.2	-1.9	0.4
TMAX >29(°C)	2.8	6.8	18.1	40.5
TMIN<-24(°C)	1.2	0.5	0.2	0
Cooling Degree Days	108.9	194.1	337.9	554.7
Heating Degree Days	4512.1	4061.9	3514.7	2962.9
Annual Precipitation (mm)	1059.5	1097.6	1147.4	1186.6
Annual # of days with Precipitation >34mm	1.6	1.9	2.3	2.6
Annual # of days with Precipitation >39mm	0.9	1.1	1.2	1.3

See Annex for data sources and methodology.

3.0 Pre-Survey Results (Municipality)

3.1 Introduction:

The purpose of the pre-survey was to determine where the municipality sees its strengths and potential areas for improvement, across a variety of energy-dependent services in their communities. Each municipal lead (staff) completed the survey before the first workshop. The results of the survey provided context during the first workshop. Results were shared with all participants which led to interactive knowledge sharing and additional information gathering. The participants' inputs are captured below.

3.2 Summary of Results:

3.2.1 Level of Awareness **of climate change in the community**: low to moderate

3.2.2 Resilience is: Ability to meet expected and unexpected challenges without negative impacts to residents and the services they expect and need.

3.2.3 Key Drivers:

a) **Reduce or avoid cost** (i.e., economic sustainability);
b) **Reduce local vulnerabilities** (i.e., lower risk to public health and safety, infrastructure etc.);
c) **Reduce impact** of extreme weather/climate change.

3.2.4 Strengths and Areas for Improvement:

Area	Strength	May Need Improvement
Vegetation Wildlife	Summerside has local tree trimming, and NB Power also works to ensure reliability of electrical systems (preventing trees from falling on power lines). Summerside encourages bio-retention measures to reduce stormwater runoff and flooding, but it is unclear how. The City protects natural buffers. The Province is responsible for forest fire management.	It is unclear how many public facilities, homes and businesses are adjacent to forests.

Planning	Resilience is the responsibility of the Emergency Management Committee. The City Council knows their roles and responsibilities and keeps learning. The EM Plan was updated in 2018 but has not been exercised in a while. The City participates in provincial exercises, such as an exercise in Port a few years ago to improve preparedness at the port, which was done by EMO, with City and EMS. The City is working on an asset management framework and training, and draft policy, aiming to consider climate change risk in their decisions. The City is updating the contact tree, inventory of resources and equipment. The last inventory was made in 2010. Alliances exist, for example, with the Red Cross, which provides fire service for surrounding area. The new Council is meeting to go over the EM Plan, with CAO.	Summerside does not have the copies of the EM plans for local schools, hospitals and nursing homes. There is no climate adaptation plan. There is no asset management plan in place.
Communications	Summerside is proactive using social media and electronic communications to send out information.	Communication towers have back-up power but are at risk of fuel shortages. Generators only provided about 12 hours and remain vulnerable if supply of fuel is interrupted for longer.

	The City is proactive when engaging / establishing communication with industry. At least one radio station has back-up plan. The City can provide equipment to HAM radio operators.	
Energy Infrastructure	The City has back-up for City Hall / EMO and Public Works. The City has 6 stationary back-up generators and has identified alternate sources of fuel. Key municipal facilities and lift stations are ready for back-up power. The City has provisions to keep fueling stations open during prolonged interruptions. Sea level and storm surge assessments have been partially completed for electrical utility infrastructure. Electric Utility maintains a list of oxygen users as vulnerable persons but it's up to customers to self-identify. Hospitals are ready (provincial responsibility) and schools are ready for back-up power. EM Shelters have back-up power.	There are emergency shelters (or heating and cooling centers) without back-up power. It is unclear if there is back-up power at nursing homes, animal shelters, and bank. It is unclear if the flood risk (1 in 100 year events) to electrical/utility infrastructure has been assessed.

	A radio station based in Charlottetown has back-up plan.	
Water and Sewage	There are no known neighboring land uses that contribute to the community's flooding risk. The City has a distributed water system (potable). The City has separated storm water and sewer systems. The City has back-up power for water and wastewater treatment and lift stations. Two wellfields (St Eleanor's and Wilmot) have backup power, the 6 individual wells throughout the City do not. The City also has a lagoon, above 1 in 100 year flood events.	There are no retention ponds/planned flood space There are some individual and shared wells, that are vulnerable to outages. Not clear if Summerside notifies permit applicants of floodplains Storm sewers can't handle 1 in 100 year storm events, but can handle 1 in 10 year rain events. All local storm sewers can handle 1 in 10, major intersections only at 1 in 100. Doubling of water to sewage during heavy rainfall due to inflow. There is a ⅔ capacity during rainfall events.
Transportation	The City has a few main transportation corridors to enter/exit the community, unclear if they are frequently blocked due to weather or other conditions. The City has bus transit (gas/diesel powered), a potential resilience asset.	There are neighborhoods / homes and businesses, with only one access road. The City has EVs, but no charging stations would have back-up The Confederation Bridge experiences short closures throughout the year due to high winds and may experience two extended closures a year due to extreme weather conditions. If the bridge was to have a major problem, road access could be off for prolonged periods, interrupting supplies such as food, propane, fuel. If major structural issues, could be closed for up to 3 years. The city is exploring the option to develop container traffic through the Summerside port. No current capacity for container traffic, just bulk.

		The closure of the bridge is more than 4 times a year. There is no back-up power at Port.
Food	Food is delivered by truck into the community. The community has a small community garden. The community has a greenhouse.	Food supply (trucks) is affected by bridge closures around 4 times a year. It is unclear if local gardens or greenhouses have back-up power. Local grocers do not have back-up power. Like many communities, it is unknown how many days the City has food for if there are interruptions to supply.

4.0 Workshop 1 Results

4.1 Introduction

Goal: to engage municipal staff, utilities, and community stakeholders to discuss local climate risks and vulnerabilities, and identify areas for improvement, with the help of QUEST facilitator and several table-top exercises / tools. The day included presentations, interactive discussion, table-top exercises, and knowledge sharing among diverse stakeholders. Results from the workshop are summarized below. A list of participants is included in the Annex.

4.2 Summary of Presentations:

Presentations were delivered by QUEST facilitators as well as the PEI Emergency Measures Organization and PEI Department of Communities, Land and Environment. The presentations were delivered throughout the morning session, to provide context for climate change adaptation and resilience building at the community scale.

QUEST provided an overview of the project, goals of the workshop, and pre-survey results. PEI Department of Communities, Land and Environment (Climate Change Secretariat) provided an overview of climate change indicators and predicted impacts. PEI Emergency Measures Organization provided a presentation on resilience in emergency and disaster management.

Participants engaged in discussion / Q&A, following each presentation. In summary, participants were aware of climate change but learned more about future impacts and their potential severity. They also noted a need to maintain this type of collaboration across departments and groups involved in climate adaptation and resilience.

4.3 Results of Exercises:

4.3.1 The 10 Essentials Exercise

The 10 Essentials for Disaster Risk Reduction (also known as Making Cities Resilient), was developed by UN ISDR (International Strategy for Disaster Reduction) and has been endorsed by the Government of Canada. It provides a high-level framework to determine strengths and weaknesses in a community, to be able to better target efforts at improving resilience. The framework was tailored for use as a table-top exercise.

Goal:

Enable participants to determine whether the community is strong and where improvements may be needed.

Overview:

Participants discussed each Essential at their tables and answered questions for each Essential, and then assigned a score. Scoring:

1 = In Place, Functioning Well;
2 = Something in Place, Can be Improved;
3 = Nothing in Place;
4 = Not sure / need more information.

After 45 minutes of discussion, a participant at each table shared three highlights from their tabletop discussion, with the rest of the group:

A. Where is the community strongest;
B. Where is it doing well but needs improvement;
C. Where is nothing in place and needs attention;

Each table submitted their workbook to QUEST. The scores and responses are summarized below:

Summary of Results:

1. **Put in place Organisation and Coordination, clarify everyone's roles and responsibilities:**
   Score: The average score of all groups is **2** = indicating there is something in place but it can be improved
   Comments:
   - Local organizations are well equipped with capacities (knowledge, experience, and official mandate) for disaster risk reduction and climate change adaptation, with room for improvement.
   - It is unclear if partnerships exist between the municipality, private sector, energy utilities, and other local authorities to reduce risk.

2. **Assign budget for Disaster Risk Reduction:**
   Score: The average score of all groups is **2.25** = indicating there is something in place but there is need for improvement
   Comments:
   - It is unknown if the local government has access to adequate financial resources to carry out risk reduction activities.
   - There are no local economic incentives established to invest in disaster risk reduction for households and businesses (e.g., reduce insurance premiums for households, tax holidays for businesses).
   - It is unknown if local business associations support efforts of small enterprises for business continuity during and after disasters.

3. **Update Hazard/risk assessment to inform plans:**
   Score: The average score of all groups is **2.2 =** indicating there is something in place but there is need for improvement.
   Comments:
   - The City is somewhat considering future climate change projections/impacts when making infrastructure and land use planning decisions; specifically, infrastructure retrofits, replacements, stormwater and electric.
   - The City considers some impacts of hazards on municipal services from the viewpoint of maintaining reliable energy. The utility is owned by the municipality which allows for clear communication regarding planning.

- The local government communicates some information to the community regarding local hazard trends and risk reduction measures, including early warnings of likely hazard impact. The City is currently engaging in capacity planning/research for the electric utility to become more self-reliant. There is a strength for communication via social media.
- Local government risk assessments are not linked to risk assessments from neighbouring local authorities and provincial government risk management plans.
- Disaster risk assessments are somewhat incorporated into relevant local development planning.

4. **Invest in and maintain infrastructure to cope with climate change:**
   Score: The average score of all groups is **2.25 =** indicating there is something in place but there is need for improvement
   Comments:
   - Regulations for housing and development infrastructure somewhat take current and projected flood risk into account.
   - There are some measures taken to protect critical public facilities from damage during disasters.

5. **Assessing safety of schools and health facilities:**
   Score: The average score of all groups is **2** = indicating there is something in place but it can be improved
   Comments:
   - Some local schools, hospitals, and health facilities have received special attention for "all-hazard" risk assessments for the province.
   - Hospitals and health facilities have some systems in place to remain safe from disasters and remain operational during emergencies. Main schools have no or few systems in place to remain safe from disasters and remain operational during emergencies.
   - There are some programs in place to assess schools, hospitals and health facilities for maintenance, compliance with building codes, general safety and weather-related risks.

6. **Apply risk compliant building regulations and land use planning principles:**
   Score: The average score of all groups is **1.75 =** indicating there is something in place and it can be improved
   Comments:
   - Improvements can be made in terms of enforcing risk-sensitive land use regulations, building codes, and health and safety codes across all development zones and building types.
   - Improvements could be made to existing regulations to better support disaster risk reduction. The building code used is the National Building Code. The City does not have land use plans or flood info. They do have storm drainage plans.

7. **Ensure education programmes and training in place:**
   Score: The average score of all groups is **2.33 =** indicating there is something in place but there is need for improvement

Comments:

- The local government provides some training in risk reduction for local officials and community leaders.
- It is unknown if local schools and colleges include courses, education or training in disaster risk reduction as part of the educational curriculum.
- Though some residents may be aware, in general residents are not adequately aware of evacuation plans and drills for evacuations. Communication between the City and the public about emergency preparedness is lacking.

8. **Protect ecosystems and natural buffers to mitigate floods, storm surges and other hazards:**
   Score: The average score of all groups is **1.5** = indicating things are functioning well and some improvements may be made
   Comments:
   - The local government supports the restoration, protection and sustainable management of ecosystem services.
   - There is some participation from the private sector and civil society in the implementation of environmental and ecosystems management plans, but participation could be improved.

9. **Develop EM capacity / early warning**:
   Score: The average score of all groups is **1.94 =** indicating there is something in place but it can be improved
   Comments:
   - Early warning centres are established but could be improved.
   - The community has an Emergency Operations Centre and an emergency communication system that could be improved.
   - Training drills and exercises are carried out somewhat regularly.
   - It is unclear if there are stockpiles of emergency relief supplies, emergency shelters, evacuations routes identified, a contingency plan or a community disaster preparedness plan for all major hazards.

10. **Place needs of survivors at centre of re-build, Build back better:**
    Score: The average score of all groups is **2.5** = indicating there is very little in place and there is need for improvement
    Comments:
    - It is unclear if local government has access to resources and expertise to assist victims of psycho-social impacts of disasters is lacking or non-existent. Assistance from provincial government and support from local clergy were identified as potential resources.
    - Disaster risk reduction measures are not well integrated into post-disaster recovery and rehabilitation activities.

What we heard: (during plenary)

i. **Where is the community strongest:**

Essential 8: Ecosystem services, private sector/civil society. Shore protection in Summerside is well managed on the south side. Little damage from storms in past years, duck pounds to deal with flow, revitalized ice pond, infrastructure for storm drainage to allow for high end drainage, worked with Bedeque Bay and Environmental Management Association.
Essential 6: Strong risk-sensitive regulations - familiarity with roles and responsibilities.
Essential 9: Emergency operations centre and emergency communication system.
Essential 1: Organization and coordination.
Essential 5: Hospital and health facilities.
Other:

- Risk compliant building regulations, indirectly through land use planning and national building inspection

ii. **Where it may need improvement:**
Essential 10: Resources to address psycho-social impact, build back better.
Essential 7: Education Programs.
Essential 4: Protection from flood risk.
Essential 2: Economic incentives, funding.

Other:

- Educational programs done ad-hoc with no concentrated effort
- No information when (we) went through the education system
- No budget identified specifically for adaptation, and no programs available for homeowners / businesses to invest in adaptation measures. Providing financial incentives for homeowners is not the role of municipal government.
- Coordination of hazards and vulnerabilities to other levels
- Haven't incorporated provincial hazard management into EMO

4.3.2 Map Exercise

Goal:

Provide participants with a hands-on resilience-building mapping experience to enable them to share knowledge, discuss resiliency in a local context, apply basic techniques for identifying risks and vulnerabilities in a spatial context, as well as planning local adaptation and resilience measures.

Overview:

Participants discussed the probability (**P**) and consequence (**C**) of various types of climate hazards, drew and denoted hazards, risks and opportunities to improve resiliency on a large map on the table in front of them. Dot stickers, markers, colour/design code legend enabled participants to denote these opportunities and discuss various aspects / viewpoints.

Summary of Results:

i. Key Hazards of Concern

# of tables selecting high, medium or low risk:

Risk Level:	*HIGH*		*MEDIUM*		*LOW*		
	P	**C**	**P**	**C**	**P**	**C**	**Result**
1. Atmospheric hazards	1	1	1	1			Medium to high probability and medium to high consequence
2. Hydrological hazards			2	1		1	Medium probability and medium to low consequence, of rainfall related flood events, but higher risk and consequence from sea level rise
3. Power and Water Outages, Fuel Shortages	1			1	1	1	Diverse views on probability and medium to low consequence
4. Contamination and Pollution			1	1	1	1	Medium to low probability and medium to low consequence
5. Forest Fires					2	2	Low probability and low consequence
6. Earthquakes					2	2	Low probability and low consequence
7. Food Shortages		1			2	1	Consensus on low probability, diverse views on consequence
8. Geological hazards (e.g. erosion, landslides, land subsidence)					2	2	Low probability and low consequence
9. Dam Failure and Structural Collapse					2	2	Low probability and low consequence
10. Other hazards e.g. Hazardous Material Spills		1			2	1	Consensus on low probability, diverse views on consequence

This activity indicated highest probability and consequence from atmospheric, hydrological, power outage, and contamination hazards. These were added to the table-top map using yellow stickers. (see map images further below)

The results in the previous table can also be visualized as follows, in order to prioritize areas for climate adaptation and resilience building.

Probability			
High			**Hydrological**
Medium		**Atmospheric** **Power Outage** **Contamination**	
Low	**Forest Fire** **Earthquakes** **Geological Hazards (e.g. erosion, landslide)** **Structural Failure**	**Food Shortage** **Hazardous Materials Spills**	
	Low	**Medium** **Consequence**	**High**

ii. **Vulnerabilities**

Using a red marker and stickers, the participants identified potential local vulnerabilities. **These are listed here:**

a) Electric Utility Substation;
b) Lift stations;
c) Port of Summerside;
d) PEI Ocean View Resort & Golf;
e) Lefurgey Cultural Centre;
f) Jenkins Avenue Business Area;
g) Wastewater treatment plant;
h) Wind turbine #4;
i) Holland College/Marine Centre;
j) Lefurgey subdivision;
k) Water St – road;

l) Fuel storage at substation;
m) ADL – natural gas;
n) Prince County Hospital;
o) SPA (isolated - one way/one out);
p) John Deere;
q) Slemon Park;
r) Island Petroleum (fuel storage).

iii. Strengths/Assets

Using Green Stickers, the participants identified local assets that serve as strengths in terms of resilience. **These are listed here:**

a) Credit Union Place;
b) Fire Department Station 2;
c) Prince County Hospital;
d) Three Oaks Senior High School;
e) Water Reservoirs;
f) Well fields;
g) Lift station/back up power;
h) Lagoon treatment;
i) Airport;
j) Curran and Briggs Heavy Machinery;
k) Wind Farm;
l) CUP – shelters;
m) Fire stations – shelter;
n) ADL – food warehouse;
o) Grocery retail – food;
p) Advance Rentals (Retail tools and equipment);
q) Municipal Public Works;
r) Community Centres.

iv. Alternate Sources of Power/Heat

Using Yellow, Red, and Green star-shaped stickers, participants identified ***potential*** sources of renewable heat and power for back-up, for use in key facilities to improve their resilience. **These are listed here:**

a) Wind Farm;
b) Solar CUP;
c) CUP – Waste Heat Recovery;
d) Geothermal;
e) Biomass, PCH;
f) New solar farm;
g) Holman renewable heat;
h) Solar at port;
i) Well field solar;

j) HST Centre – proposed;
k) Prince County Hospital – proposed.

In some communities there is the opportunity for District Energy (blue circle):
Potential for district heat identified nearby the wastewater treatment plant.

v. Possible Improvements

Using a purple marker, participants identified areas where resilience improvements / adaptation needs to take place. **These are listed here:**

a) Jenkins Avenue;
b) New generation assets;
c) Lift station upgrade;
d) Secondary egress/access;
e) Fuel storage (decrease volume, increased protection, security/safety);
f) Elevation sea wall;
g) Increasing size and capacity of culvert.

vi. Bio-Retention and Green Infrastructure improvements

Using a green marker, participants identified areas to add green infrastructure.

a) Farmland east of Prince County Hospital;
b) Area north of Mackenzie Drive.

vii. Zones to discourage development, or apply minimum build requirements

Using a red marker, participants identified areas to discourage development.
These are listed here:

a) Area west of St Clair St and east of Heritage Trailer Park;
b) Farmland bordered by Confederation Trail, Greenwood Drive and South Drive;
c) Wellfields;
d) Low-lying areas adjacent to waterways.

viii. Zones to encourage development or 'Build back better':

Using a green marker, participants identified areas to encourage development and build back better. **These are listed here:**

a) Farmland east of MacEwen Road.

ix. Transportation improvements

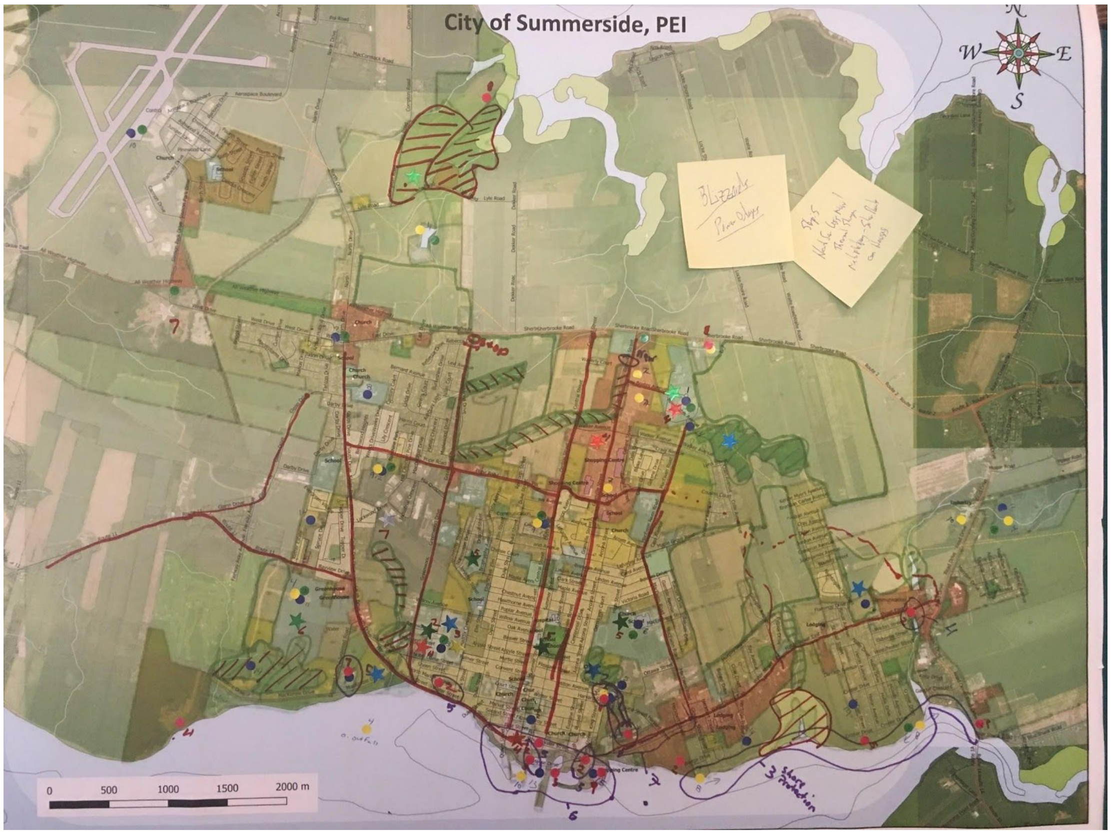
Using a red marker, participants identified existing primary and alternate emergency routes, to the East and West of the City.

x. Community Engagement and Muster Points

Using Blue stars, participants identified potential muster points and places to engage the community to build awareness. **These are listed here:**

a) Credit Union Place.

xi. Map Images




Blizzards
Power Outages
500
1000
1500
2000 m
Shore Protection


of Summerside, PEI
Atmospheric
#1
Food Shortages
#7
N
W
E
S
No Rain
0
500
1000
1500
2000 m

Disclaimer: This exercise was originally developed by Spatial Quest, to support NB Municipalities to understand local hazards, risks, vulnerabilities, strengths, and opportunities for improving resilience or climate adaptation, in a spatial context. Adapted or use by QUEST, for the Municipalities and Utilities Partnering for Resilience project. Maps were produced with best available data at the time. Decisions based on map information should be taken into context - and QUEST will not take responsibility for any damages caused by decisions made based on these maps.

4.3.3 Action Planning Exercise

Goal:

Provide participants with an opportunity to discuss the most significant findings of the day, and each present their ideas for key areas for improvement, related needs, and potential actions.

Overview:

Participants were asked a series of questions. For each question, they wrote their answers on a sticky-note. These sticky-notes were arranged onto panels by theme. The responses are summarized here:

Summary of Results:

i. **What is the greatest need / goal for Summerside?**

- New Electrical generator; Back-up power – stand alone and mobile (diversity). We are ill prepared for an extended electric power outage;
- Plan for secure resilient energy for the community, as it supports all other aspects; Develop a plan to address the numerous challenges and continue to update the plan;
- Strategic long-term development planning & Critical Infrastructure investment to include multi-agency stakeholder inputs;
- More attention to EMO planning / exercises with climate change component added;
- Action plan for EMO to identify strengths and weaknesses – SWOT
- analysis;
- Communication planning, education, to become more aware of the facts and realities of concern regarding infrastructure resilience, and steps that need to be taken.

ii. **What is needed?**

- Create a Working Group to inform / advise on planning. Engagement of stakeholders to provide input;
- Revise the curriculums in the schools to help education;
- Community engagement, inform, educate make them aware. Public workshops to engage community;
- Look at different power options, more wind, solar, battery - increase generating capacity;
- Information to the Community to understand the risks / need;
- More training for EMO and community leaders, establish more regular EMO planning type meetings, mandate training, be a part of the conversation more than just a few times a year;
- Long-term energy plan needs to be sized for all future needs and built-in resilience, ensuring all aspects/functions of the community are met;
- Help with the mitigation to identify the key concerns raised today and develop the budget requirements.

iii. Who Leads It?

- Everyone, but, I think it is a Federal and provincial responsibility to create a framework to help municipalities implementing plans and measures. We are all pretty busy, it's a shame that every municipality is reinventing the wheel;
- Municipal and provincial EMO in partnership;
- Partnership between the City and EMO and when relevant the owners of property to prioritize steps to needed to resolve the issue / efforts to be undertaken;
- Municipalities have the least resources of all three orders of government (Federal, Provincial, Municipal) – need to integrate better;
- Task force, no current task force for adaptation. Create a task force, acquire resources, build council and community support;
- We need the engineers to provide the technical background and needs, but we need 'wordsmiths' to articulate that problem in simple understandable terms;
- Electric utility personnel should be the lead with support from government. Resource allocations given by decision makers (authority of Council);
- The City can meet with professors of schools and institutions, to make them aware of the importance of education in addressing climate change / adapting and becoming more resilient as a community.

iv. Based on today, what will you do personally, or in your branch of work?

- Change the language from integrate to leverage;
- Add climate change resiliency debrief to the next EMO meeting agenda;
- Add climate change component in applicable land use planning/policy;
- Review QUEST report and follow recommendations (which are easily implemented) for energy;
- Begin immediately to develop a plan to address areas where urgent action is necessary;
- Participate in the green programs (e.g., Federal) to get clean energy;
- Continue to support sound economic decisions. Challenge is financial resources, time to leverage current resources;
- Be determined, be confident, be factual, be educational, be knowledgeable;
- Be accessible and available, be a part of the solution.

v. General Notes:

- We can't integrate all the time, we need a bigger pie rather than continuing to slice it;
- Capacity doesn't change which means we are improving one aspect at the expense of another;
- In federal applications it is always a sole focus on capital rather than operation;
- Society has changed to become more reliant on infrastructure for security;
- Sometimes you need legislation over enticements to get results;
- If the Province needs assistance, is there a pecking order in who you contact? / At what point during an emergency should a municipality reach out for help beyond the

Municipality? Answer: When the capacity is exceeded. EMO will “lean forwards” when they hear of an event and remind a municipality that there is help available;

- What is the acronym DFAA - Answer: Disaster Financial Assistance Agency;
- How long does the DFAA process take - Answer: long;
- Are DFAA claims ever denied? Answer: yes, on an item by item basis, if the item is not eligible, must be insurable and through municipal operations (e.g. not a separate development agency);
- Does the EMO ever disagree on the status of an emergency? Answer: Municipalities have the authority to declare an emergency, what is “needed” for that municipality may be disagreed upon but not the emergency themselves.

5.0 RDRP Hazard, Risk, Resilience

Following the 1st workshop, QUEST's team used the Disaster Resilience Portal of JIBC to dive deeper into climate risk and resilience assessment for each hazard type identified above as high risk/consequence. For each hazard type, the team examined aspects of risk, strengths of the community, and any gaps identified, using a detailed set of questions. This analysis uncovered areas of high risk and low resilience, which are summarized in the table below. Note - even though the community may be highly resilient to certain hazards, there may still be specific opportunities for improvement.

Category	Hazard	Low risk	Mid Risk	High Risk	Low Resilience	Mid Resilience	High Resilience
Atmospheric	Blizzards		✔				✔
	Snow Storms			✔			✔
	Heat Waves			✔		✔	
	Hurricanes			✔	✔		
	Ice Storms			✔	✔		
	Sea Storms and Surges			✔	✔		
	Wind Storms		✔			✔	
	Hail Storms		✔				✔
Hydrological	Sea Level Rise			✔		✔	
	Flash Flood	✔				✔	
	Ice Jam	✔				✔	
	Local Flood		✔				✔
	Rain Storm	✔				✔	
	Snowmelt flood		✔			✔	
Contamination / Spills	Gas leaks and explosions	✔					✔

	Oil leaks	✔					✔
	Other explosions	✔					✔
	Hazardous material spills (on site, on land, road, rail and marine)		✔				✔
Power, Water, and Food Shortages	Power Outages		✔			✔	
	Water Outages		✔				✔
	Food Shortages		✔			✔	
Fires	Brush, Bush and Grass Fires	✔				✔	
	Forest Fires / Wildfires	✔				✔	
	Wildland / Urban Interface fires	✔				✔	

Detailed aspects of risk and community resilience/weaknesses, for each hazard type, are included in a separate annex.

6.0 Summary of Results

Summary Key Hazards

Based on the climate projections and community discussion above, we found consensus on medium probability and consequence from atmospheric, hydrological, power outages, food shortage and contamination/material spills. The level of risk for each hazard sub-type was further assessed using RDRP tools - these detailed aspects of risk and community resilience/weaknesses, for each hazard type, are included in a separate annex.

- **Atmospheric hazards** of particular concern include: increasing frequency of ice storms; as well as sea storms and surges, snow storms and wind storms. In addition, the number of hot days (above 30 degrees Celsius) is expected to increase more than 4 times less relief at night, and an increase in winter temperatures leading to more freeze-thaw cycles.

- **Hydrological hazards** of particular concern include: coastal flooding, sea level rise, and other forms of flooding (e.g., rainstorm) from increased precipitation, especially in winter and spring.

- **Power outages** are a concern. The Community lacks adequate resources (e.g.. generators, back-up power) in the case of an extended electric power outage.

- **Food security** is a concern. Food is transported to Summerside by truck via the Confederation Bridge. The bridge is susceptible to closure due to weather events. This introduces risk of food insecurity.

- **Contamination/material spills** were a concern due to the active port in Summerside. There is risk if ships are transporting hazardous materials to the City.

Summary of Key Strengths / Things in Place

Based on the information contained in this report, below is a summary in bullet form of the key areas of strength in the community. This includes all the inputs gathered through the pre-survey, climate projections, table-top exercises (10 essentials, mapping, and action planning), as well as the RDRP. More detailed aspects of risk and community strengths/weaknesses, for each hazard type, are included in a separate annex.

Vegetation

- The City encourages bio-retention measures to reduce stormwater runoff and flooding.
- The City protects natural buffers.
- There is a local tree trimming program.
- The Province is responsible for forest fire management.
- The local government supports the restoration, protection and sustainable management of ecosystem services.

- There is some participation from the private sector and civil society in the implementation of environmental and ecosystems management plans.

Planning, Organization and Coordination

- City Council knows their roles and responsibilities.
- Summerside has an EM Plan. It was updated in 2018.
- The City is updating the contact tree, inventory of resources and equipment.
- The City has an alliance with the Red Cross.
- The City participates in provincial exercises..
- The new Council is meeting to go over the EM Plan, with CAO.
- The City is working on an asset management framework and training, and draft policy, aiming to consider climate change risk in their decisions.
- Local organizations are well equipped with capacities (knowledge, experience, and official mandate) for disaster risk reduction and climate change adaptation
- The City is somewhat considering future climate change projections/impacts when making infrastructure and land use planning decisions; specifically, infrastructure retrofits, replacements, stormwater and electric.
- The City considers some impacts of hazards on municipal services from the viewpoint of maintaining reliable energy. The utility is owned by the municipality which allows for clear communication regarding planning.
- The City is updating the contact tree, inventory of resources and equipment. The last inventory was made in 2010.
- Regulations for housing and development infrastructure somewhat take current and projected flood risk into account.
- There are some measures taken to protect critical public facilities from damage during disasters.
- Some local schools, hospitals, and health facilities have received special attention for "all-hazard" risk assessments for the province.
- Hospitals and health facilities have some systems in place to remain safe from disasters and remain operational during emergencies. Main schools have no or few systems in place to remain safe from disasters and remain operational during emergencies.
- There are some programs in place to assess schools, hospitals and health facilities for maintenance, compliance with building codes, general safety and weather-related risks.
- The local government provides some training in risk reduction for local officials and community leaders.
- Early warning centres are established The community has an Emergency Operations Centre.
- Training drills and exercises are carried out somewhat regularly.

Communications and Awareness

- The City uses social media and electronic communications.
- The EM Plan is being reviewed by Council and the EMO.

- At least one radio station in Summerside has a backup plan.
- The City can provide equipment to HAM radio operators.
- The local government communicates some information to the community regarding local hazard trends and risk reduction measures, including early warnings of likely hazard impact. The City is currently engaging in capacity planning/research for the electric utility to become more self-reliant. There is a strength for communication via social media.

Energy Infrastructure

- The City has backup power for City Hall/EMO and Public Works.
- The City has 6 stationary backup generators and has identified alternate sources of fuel.
- Key municipal facilities and lift stations are ready for backup power.
- There are provisions in place to keep fueling stations open during prolonged interruptions.
- Sea level and storm surge assessments have been partially completed for electrical utility infrastructure.
- Electric Utility maintains a list of oxygen users.
- Hospitals, schools, and some EM shelters are ready for backup power.

Water and Sewage

- Summerside has a distributed potable water system.
- Summerside has separated storm water and sewer systems.
- There is backup power for water and wastewater treatment, lift stations, two wellfields
- There is a lagoon that is above 1 in 100 year flood events.
- There are no known neighboring land uses that contribute to the community's flooding risk.

Transportation

- There are a several transportation corridors to enter and exit the community.
- Summerside has gas/diesel powered bus transit .

Food

- Food is delivered by truck into the community.
- Summerside has a small community garden and a greenhouse.

Summary of Areas for Improvement

Based on the information contained in this report, below is a summary in bullet form of the areas where things may be improved, are missing or needed. This includes all the inputs gathered through the pre-survey, climate projections, table-top exercises (10 essentials, mapping, and action planning), as well as RDRP. More detailed aspects of risk and community strengths/weaknesses, for each hazard type, are included in a separate annex. Recommendations will be made based on these findings at a second workshop in 2019 - Participants will then discuss actions/strategies suitable to the community and determine priorities:

Vegetation

- It is unknown how many public facilities, homes and businesses are adjacent to forests.
- There is some participation from the private sector and civil society in the implementation of environmental and ecosystems management plans, but participation could be improved.

Planning, Organization and Coordination

- Summerside does not have the copies of the EM plans for local schools, hospitals and nursing homes.
- Local government risk assessments are not linked to risk assessments from neighbouring local authorities and provincial government risk management plans.
- Disaster risk assessments are somewhat incorporated into relevant local development planning.
- Improvements can be made in terms of enforcing risk-sensitive land use regulations, building codes, and health and safety codes across all development zones and building types.
- Improvements could be made to existing regulations to better support disaster risk reduction.
- It is unknown if local schools and colleges include courses, education or training in disaster risk reduction as part of the educational curriculum.
- Though some residents may be aware, in general residents are not adequately aware of evacuation plans and drills for evacuations. Communication between the City and the public about emergency preparedness is lacking.
- It is unclear if there are stockpiles of emergency relief supplies, emergency shelters, evacuation routes identified, a contingency plan or a community disaster preparedness plan for all major hazards.
- It is unclear if local government has access to resources and expertise to assist victims of psycho-social impacts of disasters is lacking or non-existent. Assistance from provincial government and support from local clergy were identified as potential resources.
- Disaster risk reduction measures are not well integrated into post-disaster recovery and rehabilitation activities.

Communications and Awareness

- Communication towers have backup power but are at risk of fuel shortages. Generators remain vulnerable if supply of fuel is interrupted.

Energy

- There are emergency shelters without backup power.
- It is unknown if nursing homes, animal shelters, and banks have backup power.
- It is unknown if the flood risk (1 in 100 year events) to electrical/utility infrastructure has been assessed.

Water and Sewage

- Summerside does not have retention ponds.
- The city has individual and shared wells that are vulnerable to outages.
- It is unknown if Summerside notifies permit applicants of floodplains.
- All local storm sewers can handle 1 in 10 year events but only major intersections can handle 1 in 100 year events.
- Doubling of water to sewage during heavy rainfall due to inflow. There is a ⅔ capacity during rainfall events.
- 6 individual wells throughout the City do not have back-up power.

Transportation

- There are neighborhoods/homes and businesses, with only one access road.
- Summerside has EVs, but no charging stations have backup.
- If the Confederation Bridge is closed for a prolonged period, supplies such as food, propane, fuel would be interrupted.
- Summerside is exploring the option of developing container traffic through Summerside Port.
- The Port does not have backup power.

Food

- Food supply is affected by bridge closures around 4 times a year.
- It is unknown if local gardens or greenhouses have backup power.
- Local grocers do not have backup power.
    - It is unknown how many days Summerside has food if there are interruptions to supply.

7.0 Conclusion

This report concludes that the **City of Summerside** is doing well in several areas and has identified key areas for improvement, in order to adapt to expected climate change impacts.

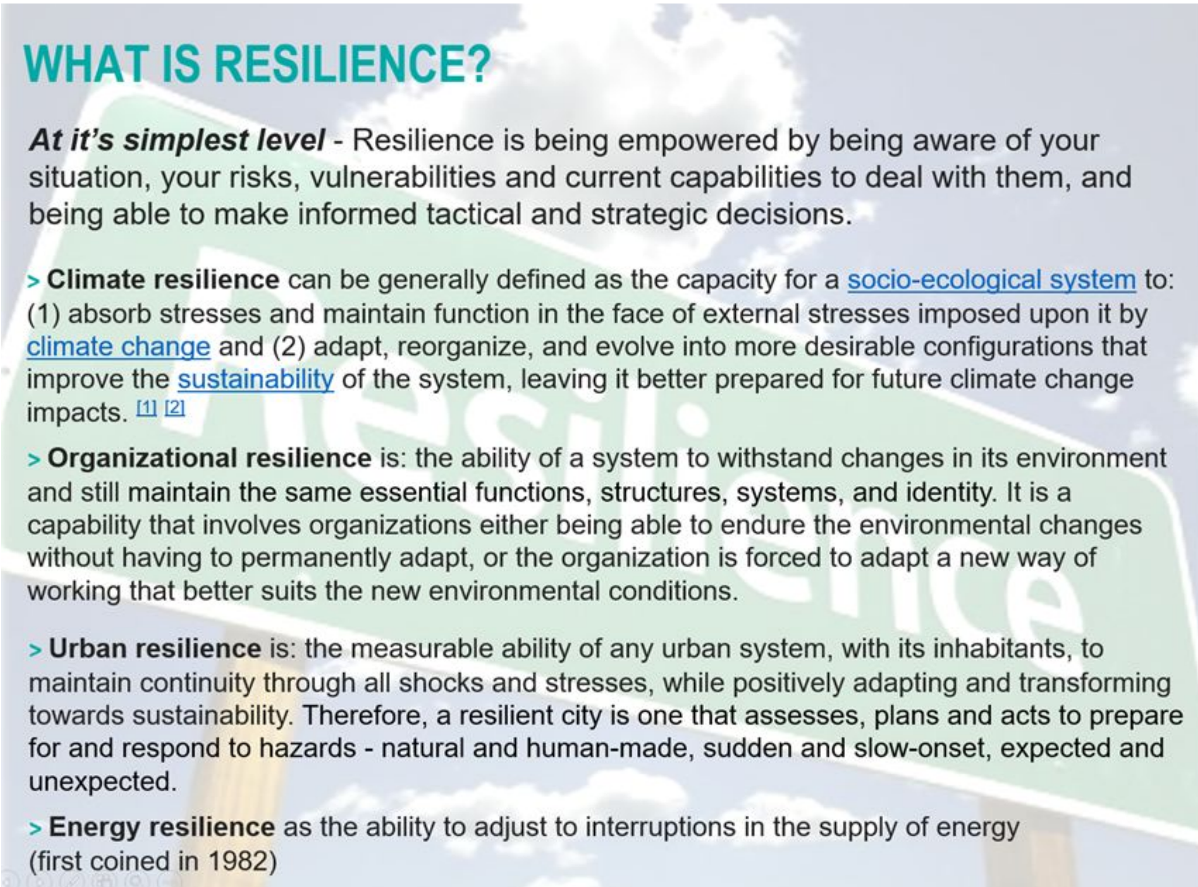
The results of this Climate Risk and Resilience Assessment will be used by QUEST to generate recommendations tailored for the City of Summerside and the results will be presented at the second workshop in 2019.

These results can be used by the community while planning future initiatives to improve resilience and adapt to climate change.

Based on feedback received, the process of engaging municipal staff, energy utilities, and other community stakeholders went very well and helped to inform this initial qualitative assessment . A detailed engineering assessment is outside the scope of this project and many still be required.

8.0 Annexes

Definitions of Resilience



source: Wikipedia

Climate Data Introduction

Below are the historical and future trends of relevant temperature, precipitation and complex climate variables. This climate analytics information will be used by QUEST project team members as input to the risk and resilience assessment phase of the project and as part of the final project report. Supporting climate data spreadsheets are provided separately.

Historical and projected climate data and maps for this report were extracted from the Climate Change Hazards Information Portal (CCHIP). The climate data for each community was extracted into spreadsheets and relevant data was used to develop the climate data summaries for each community.

CCHIP provides customized climate and climate change outputs based on geographical area, sector, theme and timeframe of interest. The portal draws on data from thousands of locations and multiple sources to provide information such as: temperature and precipitation normals and extremes; trends and frequencies of temperature and precipitation at relevant thresholds; key statistics on other extreme weather (e.g., lightning, windstorms, and tornadoes); and climate change projections from international and domestic government sources

The Climate Change weather station data from each location or closest to it and the nearest gridded climate data set from the NRCan and ECCC generated CANGRID dataset were used. The following applies to projected climate data:

- Projection periods include the 2020s (2011 – 2040), 2050s (2041 – 2070), and 2080s (2071 – 2100);
- Projections use a baseline period of 30 years, from 1981 – 2010;
- Projections use the suite of CMIP5 climate models from modeling centres around the globe; and
- Projected variables use up to 40 models to generate future values, with the specific number of models dependent on the variable and future scenario specified.

Using the suite of models allows for the calculation of percentiles around the multi-model mean, giving an estimate of model uncertainty.

Historical Climate Data

Data Coverage

CCHIP uses historical data from Environment and Climate Change Canada (ECCC) and Natural Resources Canada (gridded data). Daily data are available for analysis, but full availability varies among stations depending upon what was originally collected.

The ECCC Climate Data Archive for its historical data (hundreds of stations over various periods of record) was used. The data provided by ECCC is provided 'as-is' and is vetted by that organization. Errors or omissions in the ECCC dataset may therefore also be present in the dataset, although effort has been made to recheck values in the database.

Additionally, high-resolution (10km by 10km) peer-reviewed and vetted gridded observed data that cover the entire Canadian landmass (particularly useful in areas with poor ECCC station coverage) is provided. The gridded dataset is known as CANGRD and was developed in a collaboration between Natural Resources Canada and ECCC.

General Background

Official Intergovernmental Panel on Climate Change (IPCC) assessments predominantly rely on international research centres to contribute Global Climate Model (GCM) projection information. CCHIP uses GCM projection data from the same set of models. The most recent assemblage of GCM projections was provided for the IPCC 5th assessment of 2013 (AR5). In this assessment, 40 GCMs were used with multiple runs per model, resulting in approximately 75 projection estimates from which to calculate possible future conditions. Maximum, minimum and mean temperature are standard output variables from these GCMs, as is precipitation.

With increased computing power, a greater number of atmospheric phenomena have been incorporated into GCMs, and the models' spatial and temporal resolutions have improved. There has also been a large increase in the availability of model outputs and the ability to produce projections of future climate based upon an 'ensemble' of many models. These two factors give us a generally greater level of confidence in the projected values of climate parameters. CCHIP uses all available AR5 model runs (many models have more than a single projection available), and these are used together with baseline climate observations to generate measures of future conditions (described in the 'methodology' section of this document). The use of multiple models to generate a 'best estimate' of climate change is preferred over a single model outcome. Research has indicated that the use of multi-model ensembles is preferable to the selection of a single or few individual models since each model can contain inherent biases and weaknesses.

Uncertainty

The use of many model estimates allows for the calculation of central tendencies as well as the range of future values. Based on the 'spread' of these models, different characterizations of uncertainty can be provided. Simply put: a variable which shows less spread among many models is more reliable than a variable which has a very large range of projected outcomes. This is critical in the consideration of uncertainty. Charts below with model projections, plots and tables of the full range of all model run projections. The top horizontal bar is the highest model value, the bottom horizontal bar is the lowest model value, the box represents the range of 50% of the models with the top being the 75th percentile value, the bottom being the 25th percentile value.

Assumptions Regarding Rate of Warming

A new initiative in the IPCC AR5 was the introduction of RCPs (Representative Concentration Pathways). They represent a range of possible projection outcomes which depend upon different emission rate assumptions which generate different degrees of atmospheric warming. The lowest RCP 2.6, represents an increase of 2.6 W/m2 to the system, while the highest RCP 8.5 represents an increase of 8.5 W/m2 of energy. This range encompasses the best estimate of what is possible under a small perturbation situation (2.6) and under a large increase in warming (8.5). Both the 4.5 (moderate) and 8.5 (high) projected change are presented as future emission pathways and the resulting projections are based on these two alternatives. It is unknown which of the RCPs will apply in the future. However, it is important to note that historically, the GHG emissions have followed the highest (8.5) pathway. In the absence of a meaningful global agreement on GHG reduction, this trend is expected to continue which would support this pathway going forward.

RCP levels illustration

Projection Methodology

The 'Delta Approach'

The Delta Approach is one of several methods which can be used to obtain downscaled projections of future climate. It is perhaps the simplest approach, the easiest to understand, and has been widely used for impacts and adaptation studies. Is has also been shown to compare well with the accuracy of other approaches. When this method is coupled with the use of many models to generate projections, it generally provides more useful information than when a single or small set of models are used, regardless of their spatial or temporal resolution.

In the past, model data were difficult to obtain and process, making it challenging to use the delta approach together with a large ensemble of models. Modern data storage capacity and computing power allow the delta approach to be applied using outputs from all 40 GCMs and all model runs used in the IPCC AR-5.

The following 5 steps summarize the process for providing future estimates of climate variables:

1. Obtain for each parameter a baseline climate condition (or 'average' climate) for the user-specified station or CANGRD cell. Currently, the conditions for the most recent 1981-2010 period are used to define the baseline period of record.

2. Using the ensemble of all available CMIP5 models ('CMIP5 ensemble'), obtain the model average climate for the same historical period. For many of the 39 GCMs included, outputs are considered for multiple model runs when they were available. For our ensemble procedure, we first average all runs per model to obtain a model average value, then the individual model values are averaged to obtain the CMIP5 ensemble average.

   Before obtaining the average of all models, however, the model outputs are regridded according to a common resolution, since different modeling centres use different grid alignments and dimensions. This regridding uses a scale representative of the resolution of the GCMs, in this case approximately 200 by 200 km, matching the grid dimensions of the popular NCAR reanalysis. This is done using a process of linear interpolation to obtain the regridded datasets.

3. The CMIP5 ensemble future climate is obtained for the chosen station location or CANGRID cell for each of the required future periods. The model averaging procedure to obtain the ensemble average follows the same procedure as outlined in item (2) above. In this case, for three 30-year future periods starting in the year 2011 and ending in the year 2100. This provides average future conditions as projected by all GCMs for the: 2020s (2011 to 2040), 2050s (2041 to 2070), and 2080s (2071 to 2100).

4. The difference (or 'delta') between the CMIP5 baseline and CMIP5 future periods are then obtained, representing the change in the specified climate condition (the 'climate change signal'). Three climate deltas are produced, one each between the baseline (1981-2010) and the 2020s, 2050s, and 2080s respectively.

5. The final step is to apply this delta value to the station or gridded baseline period value. This has the effect of correcting for any difference (or bias) between the true measured baseline climate and the CMIP5 baseline climate. After applying the delta to the baseline, we have a projected climate average for each of the future periods, along with some information on the 'spread' of the model projections. We can approximate uncertainty by considering the spread of the projections, with smaller ranges suggesting more confidence in the projected value(s) than a wide projection range.

Climate Statistics

Frost Profile

The probability of frost profile is the daily probability of the occurrence of frost, i.e. when minimum temperature is less than 0°C, averaged over the 30-year period. It is expressed as the percentage of the number of days during the period when minimum temperature is less than 0°C and for plotting purposes, a five-day running mean has been applied to the data. An indication of the length of the freeze-free season is also given, i.e. the number of days during the year when the daily mean temperature is greater than 0°C.

Cooling and Heating, Growing Degree Days

Degree days are the accumulated departures of temperature above or below a particular threshold value, with these values selected to be of relevance to particular sectors, e.g. energy and agriculture. For example, a threshold temperature of 18°C is used as an indication of space heating or cooling requirements. For space heating, if the mean temperature is below 18°C then the departure from this threshold value is calculated and summed for all days on which the mean temperature is below the threshold value. For space cooling, the temperature departures are accumulated if the mean temperature on a particular day is above the 18°C threshold value.

Freeze-Thaw Cycle (Monthly)

Freeze-thaw cycles represent the average number of days per period indicated when the daily maximum temperature equals or exceeds 0°C AND the daily minimum temperature is less than 0°C. The freeze-thaw cycle and its associated effects on water/ice formation can have significant effects on built environment deterioration.

Accumulated Precipitation

The accumulated precipitation profile (in mm) indicates the progression of precipitation over a calendar year. Snow is converted to mm of water equivalent. The mean accumulation, maximum and minimum years for the period are shown as coloured lines. In addition, as an indication of extremes, diamonds indicate the progression of precipitation if either the maximum or minimum values of each month are summed for the period in question.

Water Balance

Monthly total precipitation, averaged over the 30-year period, is the rainfall amount plus the measured snowfall water equivalent. Actual and potential evapotranspiration values are also indicated. These have been derived an empirical method that computes changes in water storage as a function of monthly mean temperature, total precipitation, latitude (for day length) and soil texture (for water holding capacity).

Water deficit and surplus are calculated from the potential and actual evapotranspiration values. Water deficit is the amount by which the available moisture fails to meet the demand for water and is computed by subtracting the potential evapotranspiration from the actual evapotranspiration for the period in question. Water surplus is the excess remaining after the evaporation needs of the soil have been met (i.e. when actual evapotranspiration equals potential evapotranspiration) and soil storage has been returned to the water holding capacity level.

List of Workshop Participants

a. Gerald Giroux, City of Summerside;
b. Sami Ullah, City of Summerside;
c. Maurice Gallant, City of Summerside;
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e. Aaron MacDonald, City of Summerside;
f. Thayne Jenkins, City of Summerside;
g. Arnold Croken, Port of Summerside;
h. Basil Stewart, City of Summerside;
i. Greg Gaudet, City of Summerside;
j. Bob Ashley, CAO, City of Summerside;
k. Councillor Brian McFeely, City of Summerside;
l. Peter Nishimura, PEI CC Secretariat;
m. Tanya Mullally, PEI EMO;
n. Eddie Oldfield, QUEST;

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