A Guide for Climate Change Adaptation Planning

FOR NEW BRUNSWICK COMMUNITIES
REVISED VERSION

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Department of Environment and Local Government

New Nouveau Brunswick

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Glossary

Adaptation – In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects.

Adaptive capacity – The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.

Adaptation options – The array of strategies and measures that are available and appropriate for addressing adaptation. They include a wide range of actions that can be categorised as structural, institutional, ecological, or behavioural.

Climate – The average, or expected, weather and related atmospheric, land, and marine conditions for a particular location. In statistical terms, it is the mean and variability of relevant measures over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization.

Climate change – A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use.

Climate change resilience – The ability of a system (built, natural, social or economic) to anticipate, withstand, recover, adapt to and transform in response to a climate-related hazard.

Climate impact – The effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health status, ecosystems, economic, social, and cultural assets, services (including environmental), and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. Impacts are also referred to as consequences and outcomes. The impacts of climate change on geophysical systems, including floods, droughts, and sea level rise, are a subset of impacts called physical impacts.

Climate model – A qualitative or quantitative representation of the climate system based on the physical, chemical and biological properties of its components, their interactions and feedback processes and accounting for some of its known properties. Climate models are applied as a research tool to study and simulate the climate and for operational purposes, including monthly, seasonal and interannual climate predictions.

Climate prediction – A climate prediction or climate forecast is the result of an attempt to produce (starting from a particular state of the climate system) an estimate of the actual evolution of the climate in the future, for example, at seasonal, interannual or decadal time scales. Because the future

evolution of the climate system may be highly sensitive to initial conditions, has chaotic elements and is subject to natural variability, such predictions are usually probabilistic in nature.

Climate projection – Simulated response of the climate system to a scenario of future emissions or concentrations of greenhouse gases (GHGs) and aerosols and changes in land use, generally derived using climate models.

Climate related hazard – The potential occurrence of a natural or human-induced physical event or trend, or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, and environmental resources. In this Guide, the term hazard refers to climate-related physical events or trends or their physical impacts.

Climate scenario – A plausible and often simplified representation of the future climate, based on an internally consistent set of climatological relationships that has been constructed for explicit use in investigating the potential consequences of anthropogenic climate change, often serving as input to impact models.

Earth system model – A coupled atmosphere–ocean general circulation model in which a representation of the carbon cycle is included, allowing for interactive calculation of atmospheric CO_2 or compatible emissions. Additional components (for example, atmospheric chemistry) may be included. Coupled atmosphere–ocean general circulation models provide a comprehensive representation of the climate system, among the most comprehensive of the suite of climate models currently available.

Effects – The *Impact Assessment Act* provides that effects means, unless the context requires otherwise, changes to the environment or to health, social or economic conditions and the positive and negative consequences of these changes.

Global climate model – Complex computer simulation of the climate system usually including interacting simulations of the atmosphere, ocean, ice and land surface. The climate system can be represented by models of varying complexity. Climate models are developed and used at climate research institutions around the world to make projections of future climate, based on future scenarios of greenhouse gas and aerosol forcing. See also Earth System Model.

Likelihood (in quantifying climate change uncertainty) – The chance of a specific outcome occurring, where this might be estimated probabilistically. The likelihood of a result occurring is based on quantified measures of uncertainty expressed probabilistically (based on statistical analysis of observations or model results, or expert judgment). Likelihood is expressed quantitatively.

Likelihood (in risk analysis) – Is the chance of an event or an incident happening (that is, a Climate Hazard), whether defined, measured or determined by qualitative or quantitative means.

Natural* Infrastructure / *Nature-based solutions – Nature-based solutions (NBS) refer to nature-based measures that protect, repair and sustainably manage natural or human modified ecosystems, with the aim of maintaining or enhancing the services provided to human communities and benefits to biodiversity.

It is also referred as Natural Infrastructure (NI) to a specific segment of NBS that uses preserved, restored or enhanced ecosystem features and materials (e.g., water, native species of vegetation, and sand and stone) to meet targeted infrastructure outcomes, while providing a range of co-benefits to the environment, the economy, community health and well-being.

Risk – The potential for adverse consequences for human or ecological systems. In the context of climate change adaptation, risks can arise from potential impacts of climate change as well as human responses to climate change.

Risk assessment – The overall process of risk identification, risk analysis and risk evaluation.

Scenario (forcing scenario, emission scenario) – A plausible representation of the future based on a coherent and internally consistent set of assumptions. A forcing scenario is a possible future evolution of greenhouse gas concentrations and other anthropogenic forcings. An emission scenario describes a possible future evolution of emissions of greenhouse gases, and other climate drivers. They assist in climate change analysis, including climate modelling and the assessment of impacts, adaptation, and mitigation. The likelihood of any single emissions path described in a scenario is highly uncertain.

Sea-level rise – Change to the height of sea level, both globally and locally (relative sea level change) at seasonal, annual, or longer time scales due to (1) a change in ocean volume as a result of a change in the mass of water in the ocean (e.g., due to melt of glaciers and ice sheets), (2) changes in ocean volume as a result of changes in ocean water density (e.g., expansion under warmer conditions), (3) changes in the shape of the ocean basins and changes in the Earth's gravitational and rotational fields, and(4) local subsidence or uplift of the land.

Sensitivity – The degree to which a system is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea-level rise).

Storm surge – An abnormal rise in sea-level accompanying a hurricane or other intense storm, due to low atmospheric pressure and strong, on-shore winds. Storm surges, particularly at times of high tide, may lead to damaging waves and coastal flooding.

Subsidence – The motion of a surface (usually, the Earth's surface) as it shifts downward relative to a datum such as sea-level. Regional subsidence is a natural process in which land over a large area gradually decreases in elevation ("sinks") over time. It is a result of on-going readjustments to the earth's crust, following the retreat of glacial ice sheets.

Vulnerability – The degree to which a system is susceptible to, exposed to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

Purpose

As the effects of climate change in New Brunswick have become a growing concern, it is important that communities address these impacts to improve adaptation efforts and build climate resilience. New Brunswick's Climate Change Action Plan 2022-2027 outlines the Province's role in advancing climate change adaptation across various sectors.

Action 26. The Provincial Government will:

Collaborate with regional service commissions, local governments, and rural districts to ensure that:
a. Beginning April 1, 2024, progress on climate change adaptation plan development and implementation is reported annually;
b. Adaptation plans are updated and completed for 50 percent of all local governments and rural districts by 2025 and 100 percent by 2030; and
c. Beginning April 1, 2025, and each year thereafter, as adaptation plans are completed, implementation schedules are developed within one year so that communities can begin the delivery of priority adaptation measures.

The purpose of this action is help build our collective resilience to the impacts of climate change to encourage local governments and rural districts to work collaboratively through strategic adaptation planning to implementation of adaptation measures. As part of this action item 26, local governments and rural districts are leading their communities to be prepared and become climate resilient. By creating a Climate Change Adaptation Plan (CCAP):

- Communities key climate change vulnerabilities have been identified and prioritized.
- Communities are better equipped to address climate change vulnerabilities with priority adaptation measures identified in the CCAP.
- Communities are considering and integrating climate adaptation and resilience in planning and strategies.

The purpose of this guidebook is to assist local governments, elected officials and decision makers in adapting to the local impacts of climate change. The guidebook aims to increase the expertise and capacity of NGO's and consultants, who can provide services and expertise such as risk and vulnerability assessments, adaptation planning, identification of effective adaptation options, and proposing land-use planning approaches, etc., in an effort to increase adaptation and resilience to the impacts of climate change.

The guidebook provides information on:

- Initial considerations for preparing communities to become more resilient to climate change
- Historic and predicted climate conditions in New Brunswick
- Considerations on how to do vulnerability assessment and the tools used

- Setting priorities for identified vulnerabilities and incorporating appropriate adaptation measures.
- An outline of an adaptation plan and examples of adaptation plans
- Completing and implementing the adaptation plan

Layout of the Guide

The guidebook details the steps for the creation of an adaptation plan that addresses potential hazards, vulnerabilities and identifies a series of adaptation actions aimed at improving community adaptation and resilience.

It is presented in five Chapters (Chapter I through V) to allow easy access to various topics in the adaptation planning process. These chapters are presented in an order that follows an accepted adaptation planning process: moving from scoping and organizing through to adaptation plan development and implementation.

Chapter 1 Scoping and Organizing: Getting Started on Community Climate Change Adaptation Planning

This Chapter provides ideas and information on what is meant by climate change adaptation, why it is essential to work with partners, how to identify stakeholders, and how to capitalize on adaptation work already on-going in different areas of the community.

GENERAL INFORMATION AND QUESTIONS

What is adaptation to climate change?

Climate change adaptation describes how people and systems adjust to future climate conditions. Adaptation involves making adjustments in our decisions, activities, and thinking, due to observed or expected changes in climate. To reduce risks and take advantage of opportunities, we must understand the vulnerabilities and challenges posed by a changing climate and take steps to address them.

Why is adaptation planning important?

Adapting to climate change is an important component of a community's resilience. A changing climate presents both risks and opportunities for New Brunswick's communities and resource sectors. Enhancing a community's resilience to climate change results in a new level of preparedness, minimizing damages and costs related to impacts such as flooding. It is important to involve all those individuals and stakeholders (for a list of who to involve, see **Table 1**) in the adaptation planning process who will be directly or indirectly affected by a changing climate.

How long will adaptation planning take?

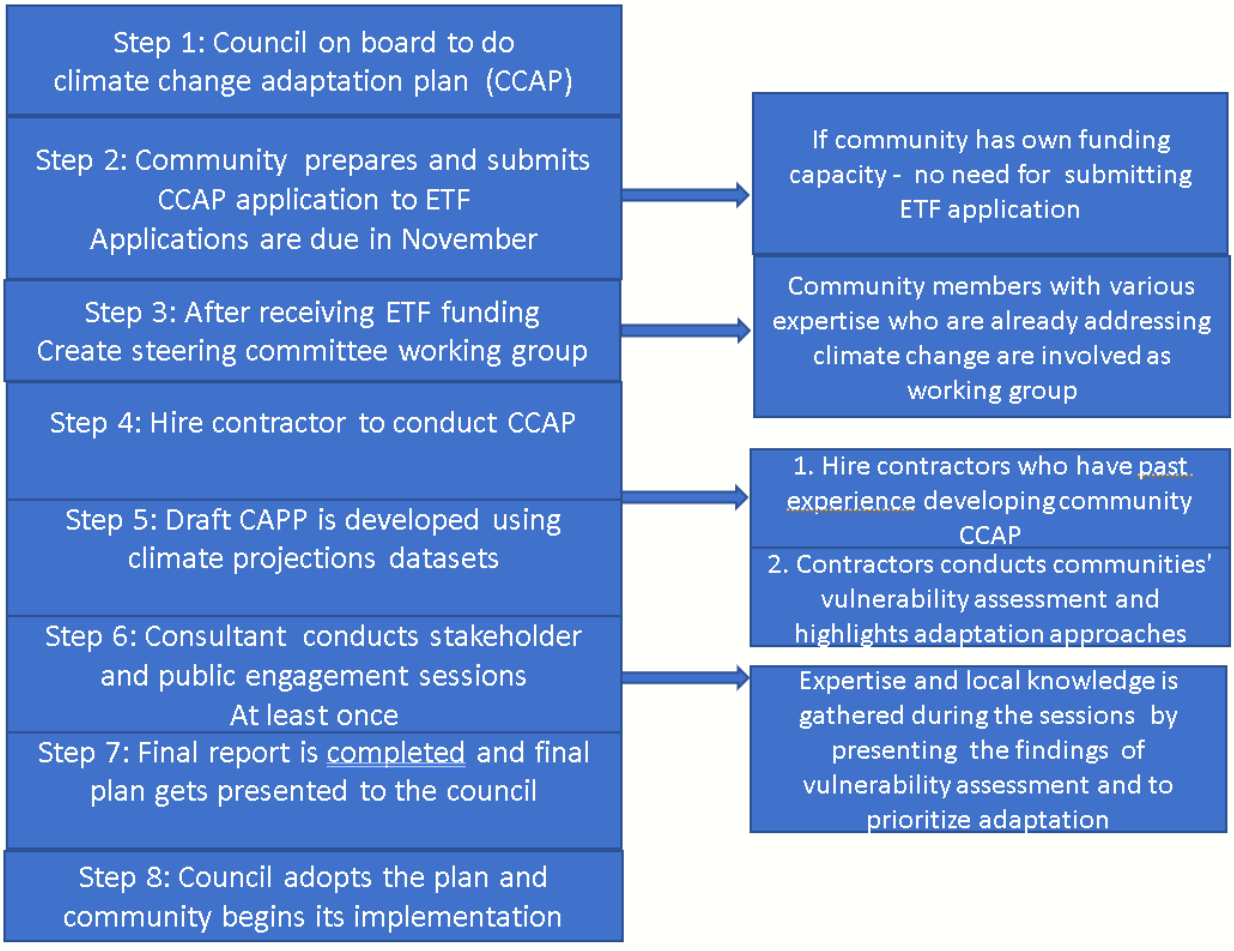
The goal of adaptation plan is to identify and provide pathways to reduce vulnerabilities and risks associated with climate change. For local governments, creating and implementing an adaptation plan will increase the resilience of the built and natural environments within their jurisdictions, making sound capital investments, managing infrastructure costs, ensuring service continuity, advancing public health and safety, and enhancing the community's capacity to adapt. Adaptation planning can include changes in policy, technology, behaviour, management, or regulation. Implementing an adaptation plan can take much longer than the typical five-year cycles of local government plans. Some actions can be easily implemented in a year or so, while others can take years to implement due to cost constraints, development of new land use policies and bylaws, etc.

PROPOSED STEPS IN DOING COMMUNITY ADAPTATION PLAN

The development and completion of a community adaptation plan is expected to take one year. **Figure 1** shows some major milestones for completing the community adaptation plan. At first, the local governments council must prioritize the development an adaptation plan. The council appoints one of the local government staff to coordinate the development of the adaptation plan. The staff member will lead the development and preparation of a project application.

If a local government wishes to apply for funding, a project application may be submitted to the Environmental Trust Fund (ETF) for the development of a CCAP. Information on how to apply for ETF funding, the timeline, eligible recipients, funding priority areas are detailed on this web page https://www2.gnb.ca/content/gnb/en/corporate/promo/environmental-trust-fund.html.

Figure 1: Proposed Steps in doing Community CCAP



CREATE STEERING COMMITTEE WORKING GROUP

The first step after receiving the funds is to find out if any groups or individuals are already taking action to address climate change via adaptation, emergency preparedness, flood control, storm-water

management, or public engagement around climate change issues in the community. These contacts may become partners that will work together, bringing specific expertise, knowledge, and capacities. **Table 1** contains a list of people to consider for Steering Committee Members.

The steering committee members have a lead role in the adaptation planning process including:

- Attending steering committee meetings
- Participating in stakeholder engagement
- Providing expertise and feedbacks on the final adaptation plan

Table 1. Potential contacts and partners to consider for Steering Committee Members.

Contact / Partners	Role
Emergency management officials	Deal with direct reaction to disaster events such as storms, as well as preparedness, and should have emergency plans in place. The provincial and local governments contact can be found here: **EMO - Municipal Emergency Preparedness (gnb.ca)**
Local police and fire departments	First responders in emergencies and disasters. They have practical experience and expertise that can contribute to one aspect of resilience; the ability to respond quickly to emergencies.
Councillors and municipal staff	Key decision-makers that will help move the plan forward. They will likely be involved in the implementation of the adaptation plan, any approvals needed (changes to bylaws/municipal plans and development requests) and can assist with prioritizing funding options on adaptation measures.
Town Manager or Chief Administrative Officer (CAO)	Municipal administrators are key in facilitating access to municipal council for approval to begin the adaptation process and organizing meetings with municipal staff who have valuable insight into a community's vulnerabilities.
Planning authorities	Municipal or the Regional Service Commission have a Municipal Plan or Rural Plan which sets out long-term goals for land uses; the plans set zones for specific uses, including uses in flood-prone areas. Some offices may have information on past flood events, erosion areas, population growth, development trends, demographics, etc.
Public works and Engineering staff	The officers would have information on storm-water management, culverts, pipes, sewage treatment facilities and road infrastructure, areas in the community sensitive to flooding, etc.
Managers of public and private infrastructure	Such as schools, nursing homes, hospitals, daycares, historical buildings/societies, etc.
Environmental non-governmental organizations/ /watershed groups	Several New Brunswick NGO's have developed expertise in guiding communities through the adaptation planning process from start to finish. These organizations have varying degrees of capacity, they assist or lead components of adaptation planning such as public engagement , research, help in educational tools development, and networking.
University & college educators and researchers	Academic institutions might have useful information, be willing to help gather necessary information, or help with community engagement and can help with developing tools and resources.

Land developers and real estate agents	Decisions to develop or not develop land areas can have a considerable impact on your community's resilienc. Developers can, for example, voluntarily implement adaptation options for subdivisions such as net-zero discharge, naturalized storm water basins, rain gardens, etc.
Informal community leaders	Key people in the community that are well connected, able to gauge a community's level of interest and identify other potential partners.
Indigenous Communities	Key partners, as they often have had first-hand experience dealing with climate change adaptation issues.
Provincial government departments	Local staff of provincial departments such as Transportation and Infrastructure, or Environment and Local Government (DELG), can often provide information on local infrastructure and vulnerabilities, as well as relevant government policies and legislation, and adaptation tools and resources.

Partners in the list above who are not included on the Steering Committee should be engaged as stakeholders by the consultant in the development of the adaptation plan.

HIRING AN ADAPTATION CONTRACTOR

It is vitally important that local governments recruit a contractor who have expertise and experience in working with communities to develop their adaptation plans.

The contractor has a lead role in the adaptation planning process, including conducting the risk assessment and prioritizing adaptation measures. The contractor also plays an important role in the following operations:

- Facilitating discussions with stakeholders
- Facilitating public engagement
- Being a liaison between the community and the municipal government
- Coordinating an adaptation steering committee
- Managing the adaptation planning process
- Completing the project on time (within 1 year)

PLANNING FOR COMMUNITY OUTREACH, ENGAGEMENT AND EDUCATION

Transparency and engagement ensure that community members are included and understand the risks and opportunities associated with adapting to the changing climate.

At the beginning of the adaptation planning process, information sharing and knowledge-building about the impacts of climate change is important. The plan will be more successful if community members feel they have had meaningful input. By including community members, it connects the contractor to the community itself and gathers useful information, ensuring a variety of perspectives is considered.

Here are some ideas to get started with community outreach:

- Include community members and businesses that are impacted by extreme weather events.
- Hold open-houses to keep the public informed and invite guest speakers to discuss specific impacts to the community. For example, in a coastal community focus on sea level rise, storm surges and saltwater intrusion in drinking water wells. Inland communities will want to focus on flood risk along rivers due to ice jams and heavy rainfall events;. Note: Offer events at different times of the day, in the evening and on weekends to ensure local residents can participate.
- Hold focus groups with stakeholders or community discussions to identify and assess adaptation options, set priorities, and collect feedback or concerns that people may have.
- Reach out to the community at popular community events such as fairs and farmers markets. Provide articles or letters to local newspapers, sending mail-outs to households, develop brochures and posters, use social media, or set up a public web page outlining future plans and progress.
- Provide ideas on what people can do to be better prepared for climate change (i.e. prepare a 72 hour emergency kit, getting managing storm water with rain gardens, flood-proofing homes, etc.) as this will provide a positive background to further discussions.

ADOPTION AND IMPLEMENTATION OF ADAPTATION PLAN

The council adopts the adaptation plan when the contractor presents the final plan to the council. This plan becomes an official document for implementing and tracking adaptation planning in local governments. As part of Action 26, an online portal is being developed for reporting the progress and implementation of climate change adaptation by local governments. The climate change portal for reporting adaptation planning and implementation will be ready by March 2024.

Chapter II Changing Climate in New Brunswick

This Chapter provides background information, and climate change datasets and tools that can help identify the specific future climate impacts. This Chapter identifies potential events, and the hazards expected to result based on changing climate information.

WHAT WE HAVE BEEN EXPERIENCING

New Brunswick is already experiencing impacts as a result of a changing climate. These impacts are predicted to increase and become more severe in the future.

Changing Temperature

New Brunswick's average annual temperature has increased by 1.1 °C over the last thirty years. The increase in the annual temperature has impacted many aspects of our lives (energy use, tourism and recreation, and health). The changing temperature, for example, is impacting the likelihood of New Brunswick communities experiencing a white Christmas, growing seasons for traditional crops, and the productivity of heat-loving crops, such as corn, canola, and soybean (see **New Brunswick's Climate Change Indicators)**

Changing Precipitation

Some communities in New Brunswick are experiencing more extreme rainfall events. An extreme rainfall event occurs when 50 millimetres or more of rain falls over a 24-hour period. In recent years, many of these extreme precipitation events have caused flooding damage to many communities in New Brunswick.

Rising Sea Levels and Storm Surges

Coastal areas have seen a rise in sea levels over the past 100 years. In Saint John for example, sea level has risen by 24 centimeters since 1920. The melting of ice caps and glaciers, as well as the expansion of seawater due to heating, contribute to an increased and accelerated rise in sea levels. During the past few years, major storm surges have heavily damaged many coastal communities in New Brunswick. Storm surges are likely to worsen as sea levels continue to rise, and the risks for coastal communities are continuing to grow from the impacts of climate change.

Changing Coastal Erosion Rates

In New Brunswick, coastal erosion is increasing in severity from storm surge and sea level rise. The Northeast region is experiencing the highest erosion rates, followed by the coastline along the Northumberland Strait, Chaleur Bay, and then the Fundy Coast.

WHAT WE CAN EXPECT

New Brunswick is already experiencing the impacts of climate change, and it will get worse. We are experiencing warmer, wetter, stormier weather, and rising sea levels.

Warmer Temperatures

Global climate models project that by the year 2080, New Brunswick's mean annual temperature will increase by approximately 5°C (**see Figure 2).** A warmer climate will result in more days at increased temperatures and frost-free days, increasing the potential for new pests and invasive species to colonize New Brunswick and reducing opportunities for winter activities. The annual number of days with temperatures above 35°C is projected to increase, which may result in more heat waves and heat-related health issues, particularly for seniors and infants who are most vulnerable to higher temperatures (**see Figure 3**). An increase in hotter temperatures will encourage more frequent and severe forest fires, and cause earlier snowmelt and break up of ice, leading to an increased potential for ice jamming and flooding. This variability in climate is predicted to result in very costly damages for New Brunswick. However, this also means that farmers may be able to grow new varieties of crops that normally are grown further south than New Brunswick.

Figure 2: Historical average mean temperature (°C) (left), compared to the predicted mean temperatures in 2080 under the RCP 8.5 model (right).

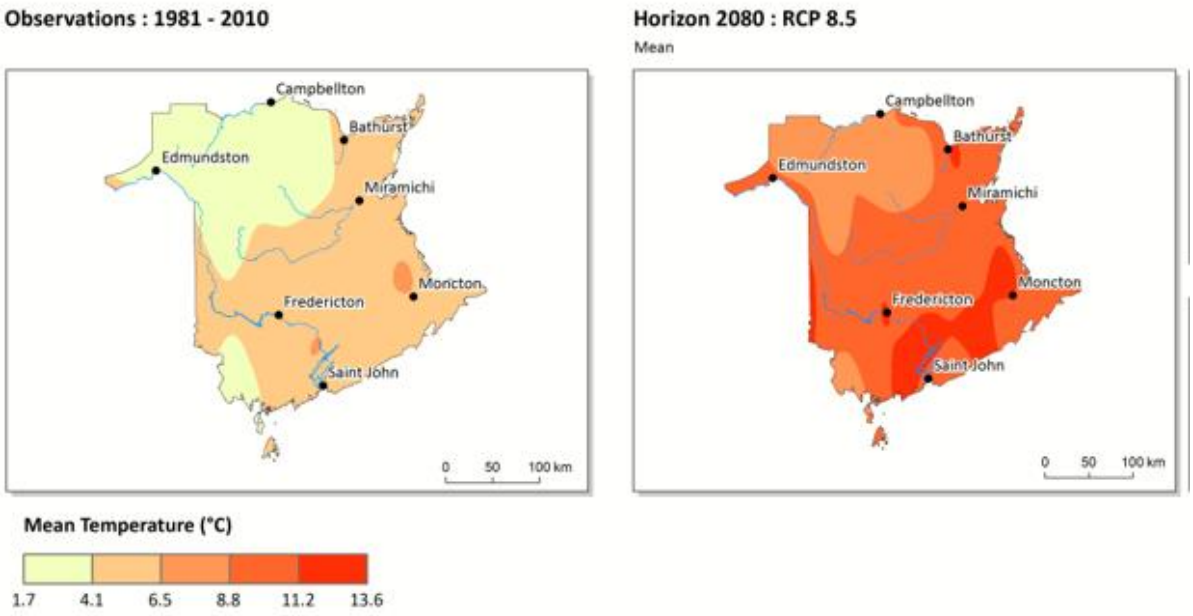
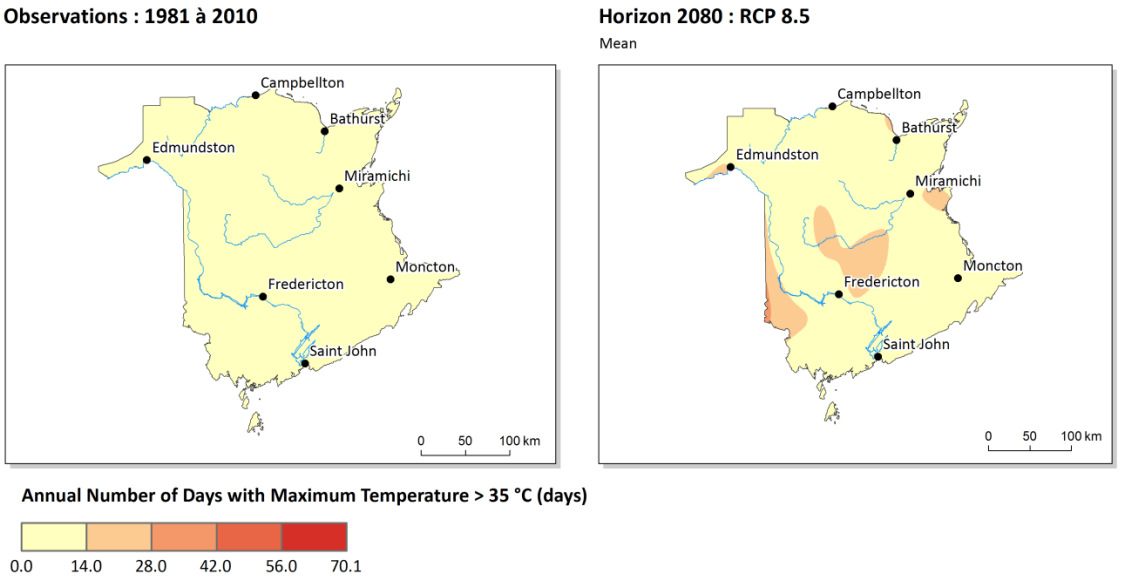


Figure 3: Historical annual number of days where the maximum temperature was above 35°C (left), compared to the predicted annual number of days with the maximum temperature surpassing 35°C in 2080 under the RCP 8.5 model (right).

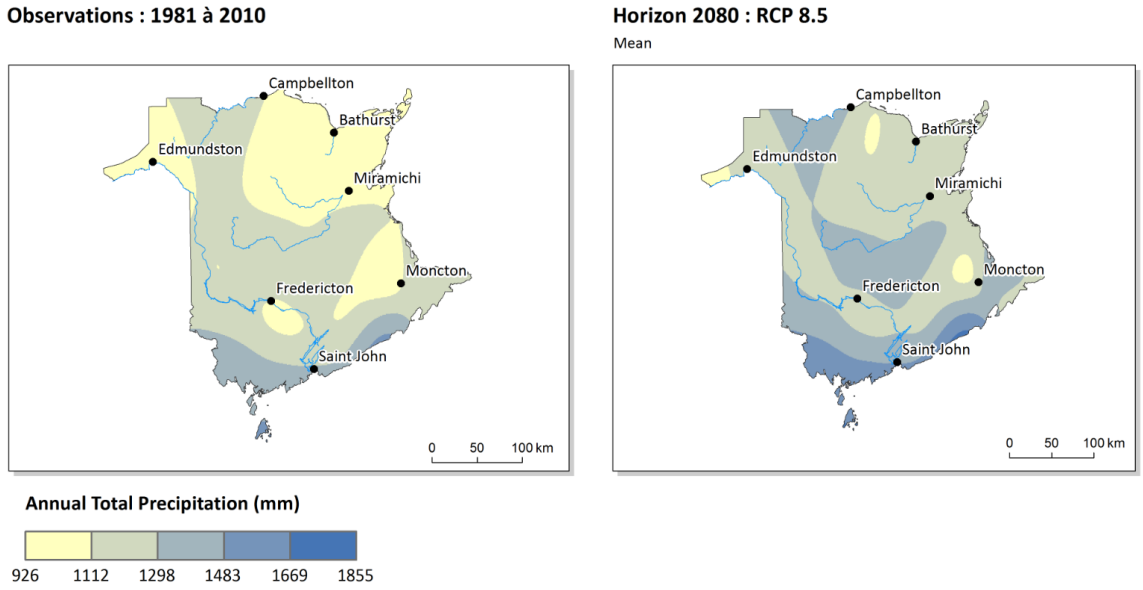


Source: Future Climate Scenarios Province of New Brunswick, Ouranos, 2016
See Adapt-Action (csrno.ca) or climatedata.ca for local climate change projection analysis.

Increase in Intense Precipitation Events

Climate change models project that New Brunswick will experience less frequent but more intense precipitation events, increasing the annual total precipitation throughout the province **(see Figure 4**). This expected increase in precipitation is projected to cause road washouts, more frequent flooding of low-lying areas, increased soil erosion, and water contamination due to events such as overflowing of municipal waste treatment systems. It is important to note that although overall precipitation is projected to increase, variability of such events can also lead to extended dry periods and even droughts. To account for climate change impacts to extreme rainfall, Climatedata.ca provides historical and climate change-scaled Intensity Duration Frequency (IDF) curves produced by Environment and Climate Change Canada for all IDF stations in Canada.

Figure 4: Historical annual total precipitation (mm) in New Brunswick (left), compared to the predicted annual total precipitation (mm) in 2080 under the RCP 8.5 model (right).



Source: Future Climate Scenarios Province of New Brunswick, Ouranos, 2016
See Adapt-Action (csrno.ca) or climatedata.ca for local climate change projection analysis.

Increase in Sea-Level Rise and Storm Surges Events

The coasts of New Brunswick have been shown to have significant sensitivity to sea-level rise and associated storm impacts. The updated study on Sea Level Rise Scenarios for the Coastal Sections of New Brunswick (Daigle 2020) presents projected sea level rise and flooding scenarios for coastal sections of New Brunswick. Projected sea level rise and flooding elevations can be used to ensure infrastructure are designed and build above the projected sea level rise elevation.

Coastal areas also face the risk of greater rates of erosion, well water contamination by saltwater intrusion, and permanent loss of low-lying coastal areas. The loss of coastal land through erosion poses greater risks to homes, roads, industries, and tourism sites.

TYPES OF HAZARDS AND ASSOCIATED IMPACTS FROM CLIMATE CHANGE

For illustrative purposes, **Figures 5 and 6** show a few examples of climate change hazards and their associated impacts. Communities will experience different types of hazards that could affect a wide range of sectors including agriculture, the economy, human health, habitat and biodiversity, etc.

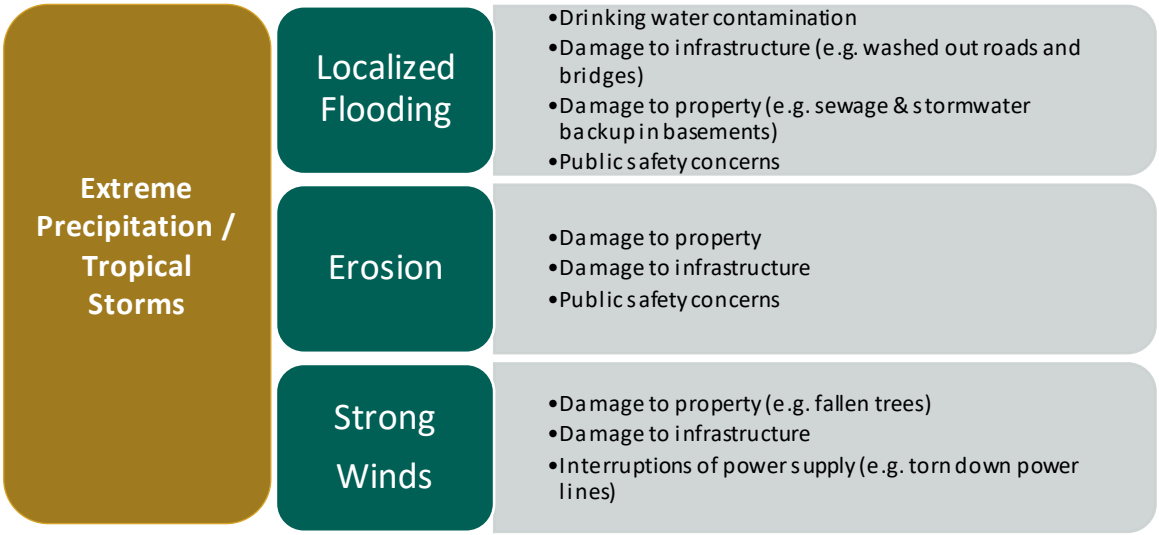


Figure 4: Extreme precipitation and tropical storm events and their associated impacts.

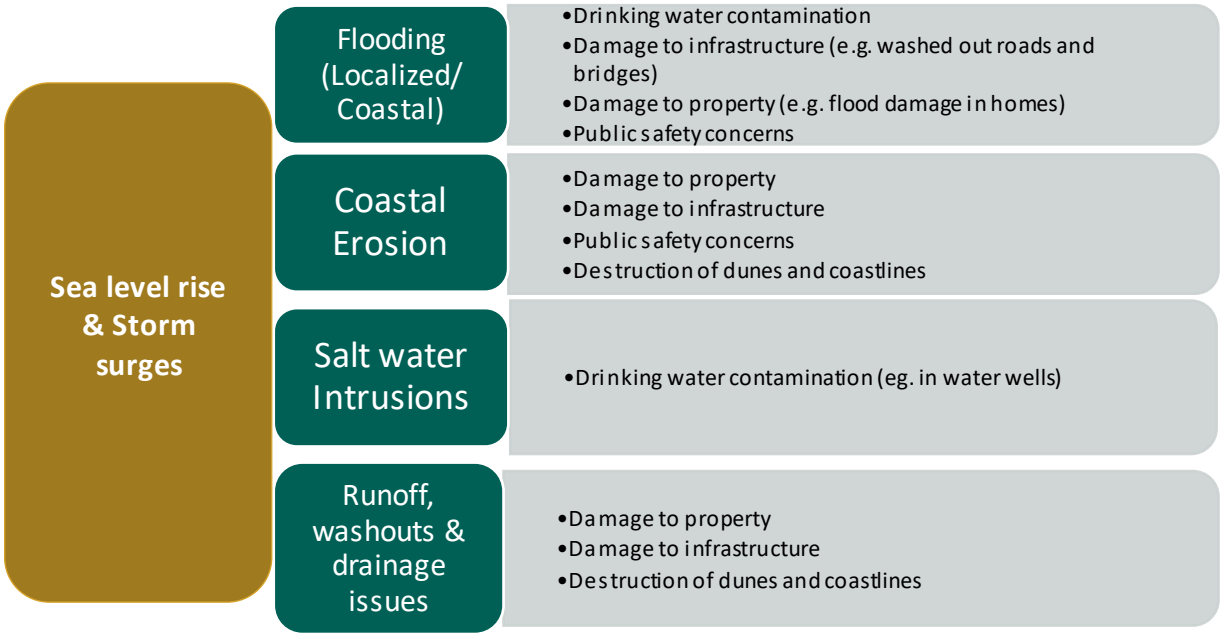


Figure 5: Sea level rise and storm surge events and their associated impacts.

Adapted from: Municipal Climate Change Action Plan Guidebook, Service Nova Scotia and Municipal Relations Canada-Nova Scotia Infrastructure Secretariat, Published November 2011

For resources on current and projected climate datasets, please see Appendix A.

Chapter III Assessing Climate Change Vulnerability

This Chapter presents a general overview of the steps involved in a vulnerability assessment which is conducted as part of a CCAP, highlights some of the adaptation approaches and tools commonly used to assess a community's vulnerability to climate change.

Vulnerability is defined as *"the degree to which a system is susceptible to, exposed to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity".*

As highlighted in Figure 1, the steps for conducting a vulnerability assessment would be conducted by the contractors who has been hired to do the community adaptation plan.

STEPS TO DO CLIMATE CHANGE VULNERABILITY ASSESSMENT

There are many different ways to assess vulnerability, depending on a community's capabilities and the scope of assessment. The primary purpose of any vulnerability assessment is to utilize climate change information to identify vulnerable areas, individuals, infrastructure, etc., within the community that will likely be impacted (or have been impacted in the past) by climate events (e.g., flooding, erosion, high winds, ice jams, etc.). The vulnerability assessment will help identify key areas where adaptation work is most needed, help prioritize vulnerabilities and address adaptation actions, thus reducing overall risks.

The following is a general overview of the common steps involved in conducting a climate change vulnerability assessment. The specific steps may vary slightly depending on the contractor's specific approach and tools used, but the overall intent of the vulnerability assessment remains the same.

Step 1: Understanding the climate hazards and potential impacts

Key questions to answer:

- What types of climate hazards are the most likely to impact the community and how?
- How likely are these hazards to occur, and how often?
- What are the expected impacts resulting from the hazards?

This step will help:

- Identify which types of climate hazards and associated impacts such as sea-level rise, storm surges, coastal erosion, flooding from extreme precipitation events, etc. that have most significantly impacted the community.
- Identify the causes, extent, and frequency of impacts that have occurred in the community.

Step 2: Identifying locations of climate impacts and vulnerable infrastructure

Key question to answer:

- Which areas of the community are vulnerable?
- Which areas of the community have been impacted in the past?
- What types of infrastructure are vulnerable to these impacts?
- Is there infrastructure in need of repair, replacement or upgrades that may be vulnerable to future climatic events?

This step will help:

- Identify where climate-related impacts have occurred in the past or may occur in the future.
- Identify where flooding may occur such as, low-lying areas, wet areas, wetlands, bottom sections of hillsides, ditches, watercourses and areas immediately adjoining them, shoreline locations composed of soft material such as beaches, dunes, exposed cliffs showing signs of erosion, and locations along the high water mark in coastal settings, etc.
- Identify where erosion may occur, such as areas exposed to high water flows or wave action. Look for barriers that might impede the flow of surface water, such as roads at the bottom of hillsides or culverts that drain a large area. Impervious surfaces such as asphalt and concrete allow surface water to move downstream or downhill with increased velocity, potentially damaging downstream locations.
- Identify which infrastructure has been impacted in the past or is at risk of impacts in the future.

Note:

- Try to gather as much location-specific information as possible as each community is unique and impacts will vary.
- It should be noted that some climate impacts are broad in scale and will not be confined to specific locations within a community (e.g. temperature-related impacts).

Step 3: Identifying individuals/social groups most vulnerable to climate impacts

Key question to answer:

- Who will be the most impacted in the community and how will they cope with these impacts? Consider the following:
    - Elders and youth
    - Single parent households
    - Special needs households
    - Lower literacy level households
    - Those living in an isolated location
    - Those living with low income
    - Other

This step will help:

- Identify vulnerable individuals and groups to ensure adequate measures are implemented to protect these vulnerable groups.

Step 4: Identifying economic consequences of climate impacts

This step will help:

- Identify locations where key economic activities take place in the community.
- Identify financial costs associated with climate impacts in the community.

Key question to answer:

- What are the businesses, services and industries that are most vulnerable within the community?
    - If it is determined that commercial, service, and industrial entities are located within known flood zones or in areas prone to erosion, then those parties should be included in this adaptation planning process to review options that will reduce the impacts to their places of business.

Step 5: Identifying environmental, social, cultural and health impacts caused by climate

Key question to answer:

- Which natural environments and habitats are sensitive to climatic impacts?
- What industries, businesses and facilities may contribute to environmental pollution or public safety issues as a result of a climate threat?
- Which major infrastructure responsible for the transportation of goods are impacted?
- What health impacts could result from extremely hot and cold weather conditions?

This step will help:

- Identify environmentally sensitive areas that could be impacted by a climate threat and businesses and infrastructure that may be impacted by a climate event and may cause damage to the natural environment, e.g. waste disposals sites, hazardous material storage sites such as gas stations.

Ensure the community's emergency shelter sites are properly equipped to accommodate residents during a catastrophic event and provide shelter, food, heat or air conditioning, and other essential services.

To summarize the above steps, climate change vulnerabilities should be considered within the following five areas:

1. **Infrastructure vulnerabilities**:

    - Water (i.e. wells, reservoirs, treatment, pump stations, water mains, service connections, hydrants);
    - Sewer (i.e. Sewer mains, manholes, service connections, pump stations, treatment facilities, outfalls);
    - Drainage (i.e. catch basins, manholes, culverts, storm mains, open channels/ditches, wetlands, detention ponds);

- Recreation (i.e. community buildings, parks, trails, equipment);
- Health/emergency services (i.e. hospitals, ambulances, fire halls, fire trucks, police stations);
- Transportation (i.e. bridges, roads, trails, sidewalks, lights, buses, rail, ferries);
- Solid Waste (i.e. recycling, landfill, trucks); and
- Electrical (i.e. transmission lines, transformers, generators, lighting, telecommunication).

2. **Public Safety and Emergency Preparedness vulnerabilities**:

- Emergency Measures Plan;
- Emergency shelters;
- Generators (i.e. public and privately-owned);
- Emergency food stocks;
- Alternate emergency transportation routes;
- Evacuation routes;
- Communication of emergency response (i.e. communication systems, cell towers, radio towers, etc.);
- Flood-risk areas identified; and
- Vulnerable populations and facilities (i.e. old age population, single parent household, family with special needs, people living in isolated locations, low-income areas, long-term care homes, etc.).

3. **Environmental vulnerabilities**:

- Ecosystems and sensitive habitats (i.e. species at risk, invasive species, wetlands, dunes, etc.);
- Potable water sources (i.e. lakes, aquifers, rivers, wells, etc.);
- Natural assets (i.e. forests, wetlands, natural shorelines, dunes, etc.);
- Water quality and water shortages (i.e. recreational use, blue-green algae, E. Coli, drought, etc.); and
- Air quality.

4. Social, Cultural, and Health vulnerabilities:

- Food systems (i.e. food security, accessibility, food assistance, etc.);
- Vulnerable populations (i.e. ageing population, single parent households, family with special needs, people in isolated locations, impoverished areas, people displaced or at imminent risk, new Canadians, etc.);
- Education (i.e. building awareness of climate change and its impacts within the community/region);
- Heat-related mortality (deaths) and morbidity (illness);
- Changes to agriculture and natural resources such as food-, vector-, and water-borne diseases; and
- Eco-anxiety (i.e. impacts on mental health, domestic abuse, and well-being).

5. **Economic vulnerabilities**:

- Key sectors (i.e. businesses, services, industries, natural resources, agriculture, tourism, etc.);

- Employment (i.e. key employers, workforce availability, unemployment rate, health constraints, etc.); and
- Fiscal impacts of damages (i.e. to assets, infrastructure, businesses, service interruptions, etc.).

APPROACHES TO VULNERABILITY ASSESSMENT

The following tools are available to use when conducting vulnerability assessments. **Table 2** outlines a number of vulnerability approaches and tools. These approaches can be used independently or in combination with others, depending on the vulnerabilities being faced in the communities .

Table 2: Adaptation Approaches to Vulnerability Assessments.

Approach	Purpose	Who to engage	Example Tools
Community-based	By engaging community members to think about their community's resilience, especially in terms of their public safety. Focuses on identifying the risks and impacts of climate change, and prioritizing actions.	A community champion and adaptation committee, municipal councillors/staff, NGOs, private enterprises, and engaged citizens.	7 Steps to Assess Climate Change Vulnerability in Your Community - Introduction | Atlantic Climate Adaptation Solutions Association (atlanticadaptation.ca)
	Municipal officials and staff can begin discussions on municipal infrastructure, how it is planned, constructed and maintained. This opening dialogue is followed by how the community is being affected by changes in local weather patterns. The discussion culminates in what can be done to manage and protect municipal infrastructure in order to minimize the vulnerability of the community to the impacts of climate change.		Managing Municipal Infrastructure in a Changing Climate (http://turnbackthetide.ca/tools-and-resources/pdf/managing_municipal_infrastructure.pdf
	Responding to the impacts of climate change, developing and implementing an adaptation plan that protects the people, property, and prosperity of the community will be the end goal of a vulnerability assessment.		Small and Rural Communities Climate Action Guidebook | ICLEI Canada

Engineering & Public Works	By working with engineers, communities can help to repair, replace and design municipal infrastructure that will withstand a changing climate. This approach provides engineering solutions that will help create more resilient communities.	Engineers	Engineers Canada, Public Infrastructure Engineering Vulnerability Committee PIEVCAnalysis for a list of case studies.
Land-use Planning based	In order to increase a community's resilience, land-use planning can be used to help identify areas most vulnerable, help develop bylaws and zoning guidelines when a planning process is underway. By using land use planners, communities can be designed in a way that will decrease their risk to climate hazards.	Land-use planners, municipal staff	Provides the capacity and a process (legal requirement) to make changes to how the community develops Canadian Institute of Planners: (http://cip-icu.ca/Resources/Resource-Library/Climate-Change#)
Emergency Measures Organizations (local)	When developing emergency planning procedures, it will help identify vulnerabilities within a community, since EMOs are the first to respond to extreme climate events. This will help to reduce severity of impacts and the need for emergency response and recovery.	EMO coordinators	Municipal Emergency Response Plan for New Brunswickers nb-emo_booklet-e.pdf (gnb.ca)

USE OF MAPS IN VULNERABILITY ASSESSMENT

About Maps

Maps play a critical role in a climate change vulnerability assessment, as they help stakeholders visualize areas that are vulnerable to potential climate impacts within a community. Maps can accurately show the location where an impact can or is projected to occur and can illustrate risks such as floods or coastal erosion.

Maps that show where flooding may occur are known as flood hazard maps, showing elevation data indicating high and low points in the landscape, combined with predictions about how much water will be present during a flood event. The maps show the extent and depth of flooding at a particular location, and provide anticipated frequency for coastal areas. On top of this base-layer, various types of information or data can be added or "layered" to show risks to public infrastructure such as roads, houses, bridges, nursing homes, etc.

The New Brunswick Flood Hazard Maps is a tool that allows users to explore maps covering New Brunswick's coastline as well as many rivers that are prone to flooding. The tool also incorporates projections regarding the impacts of climate change.

While maps can be invaluable in visually representing vulnerabilities that have a geographic dimension, a community can also do work in the absence of maps. This is especially the case in areas where impacts have already been felt, floods have occurred, and there is a clear risk identified through historical events. In those cases, a community can work by gathering information and data on the location of vulnerable areas and who the vulnerable community members are in the region.

What is a Digital Elevation Model (DEM)?

Digital Elevation Models are data files that contain the elevation of the terrain over a specified area, usually at a fixed grid interval over the surface of the earth. The intervals between each of the grid points will always be referenced to some geographical coordinate system. A digital elevation model can be used to create topographic maps with a high degree of accuracy, which is very important for many of today's planning and engineering projects (e.g., designing new roads, power transmission line routing, identifying flood prone areas, calculating coastal erosion rates, locating new public infrastructure, etc.).

What is Light Detection and Ranging (LiDAR)?

A technique called LiDAR (Light Detection and Ranging) is used to collect highly accurate points on the landscapes which are used to create the digital elevation model. LiDAR is an optical remote sensing technology which measures properties of scattered light to determine the elevation of the land. Airborne LiDAR scanning is a rapid, highly accurate and efficient method of capturing 3D elevation data. LIDAR surveys have become the de facto standard for terrain mapping.

The provincial DEM and LiDAR data can be used to create maps that can show flood zones, vulnerable areas, or areas flooded when high precipitation events occur. They can be used in municipal plans and regional plans to show historical flooding, identify flood risk areas, and overlay zoning.

Using LiDAR Derived Maps for Vulnerability Assessments

LiDAR is preferred as base data because it is highly accurate, but it is also costly to obtain. GeoNB LIDAR data have data available for all regions of New Brunswick in 1km x 1km grid tiles. LiDAR data can be used to create baseline elevation mapping for conducting risk analysis.

For resources on vulnerability approaches, please see Appendix A.

Chapter IV Identifying Adaptation, Priorities, Options and Actions

This chapter provides guidance on prioritizing vulnerabilities, developing priority actions and setting timelines.

Through the vulnerability assessment completed in Chapter III, the information gathered provides a considerable list of vulnerable areas, facilities and infrastructure, individuals and groups, economic consequences and environmental, social, cultural and health impacts on the community's sectors. The next step is to prioritize the vulnerabilities and identify adaptation options for those vulnerabilities.

STEPS TO PRIORITIZE VULNERABILITIES, IDENTIFY ADAPTATION OPTIONS AND ACTONS

Step 1: Identify high priority vulnerabilities.

Identified vulnerabilities should be prioritized from highest to lowest risk, with each vulnerability assigned a corresponding adaptation measure and implementation strategy. Adaptation approaches should consider the capacity of the community or region to undertake these measures and ensure implementation.

When prioritizing adaptation approaches, the following have the highest ranking for adaptation efforts:

- Public safety (ensuring safety of people in a community/region).
- The protection and continued delivery of safe drinking water and all vital public services and utilities such as electricity, wastewater management, transportation, emergency response, health care services, and telecommunications; and
- The protection of key structures for emergency exits and detours, buildings, and infrastructure that support the community, its economy, residents, and environment.

It is also important to consider the degree of urgency by identifying hazards that are immediate versus those that are more long-term and can be dealt with gradually over time.

Step 2: Identify adaptation options for priority vulnerabilities

This step involves identifying which options are available to address the community's vulnerabilities. The feasibility of implementing various options is considered, with the costs compared to the benefits of the option chosen, potential funding sources, the time needed for implementation, human resources required, and whether this is a new approach or something that has been used successfully in the past (e.g. based on case studies from other communities).

Step 3: Identify actions to support options

Once the priorities are established (Step 1) and the options and their feasibility are identified (Step 2), develop a list of actions needed to be undertaken.

Ensure all actions are focused, and that they clearly identify the lead (individual or group) responsible for its implementation. It is also important to include a timeline based on the degree of urgency, and difficulty (short-term: 1-2 years, a medium term: 3-4 years, and a long-term rating within the next 5 years).

To ensure that the actions are implemented, identify monitoring and review measures. It should also be noted that in some cases, further studies such as feasibility, cost-benefit analyses, or additional public consultation are needed before action can take place. Actions can be tabulated in a format that allows for easy reading, and easy monitoring and review (see **Table 3** as an example):

Engineering approaches, natural infrastructure, and the creation of naturalized infrastructure can all be considered as potential solutions to a community's vulnerabilities. Natural infrastructure such as dunes, beaches, and wetlands are often well-suited to provide protection from climate impacts as they have been naturally occurring on the landscape for centuries and have developed a resiliency to climate impacts. Natural infrastructure is also most aesthetic, complimenting an area's natural beauty and providing value-added benefits such as attracting tourism and help in generating local economies that contribute to community sustainability.

Table 3: **Vulnerability Priority and Adaptation Option/Action**

Priority vulnerability	**Adaptation Option/Action**	**Timeframe: Short-term (1 -2 years) Medium (3-4 years) Long-term (5 years)**	**Estimated cost**	**Level of difficulty (1, easy; 2 doable but difficult; 3 - very difficult)**	**Lead**
Flooding along road XYZ	Install larger culvert	Medium	$ amount associated	1	Engineering & Public Works Department

Sourced from Moncton's Climate Change Adaptation and Flood Management Strategy

II Examples of Adaptation Options for High Priority Issues

Presented below are some examples of adaptation options for the more common climate change impacts that New Brunswick communities can expect.

<u>Coastal & Inland Flooding and Erosion</u>

New Brunswick has a long history of flooding and erosion events of varying severity. Flooding can be caused by heavy and prolonged precipitation events, winter rainfall events that cause flooding when the ground is frozen, or ice jams. Inland erosion can result during precipitation events when water is

moving overland at higher-than-normal speeds or the volume of water is significant.

Coastal flooding occurs as a result of large precipitation events with strong winds, and specifically when high tides coincide with storm surges. These events are regular in New Brunswick, and with added sea-level rise and regional subsidence, this has increased the likelihood and severity of flooding. Erosion can result when coastal waters are pushed landward by severe winds, high tides, storm surges or waves, impacting the immediate shoreline or causing damage to areas further inland during intense storm events.

For Residences:

- Ensure house entrances are above flood levels.
- Ensure sewage backflow valves are installed to avoid sewage backup.
- Build above the flood elevation, outside mapped flood hazard areas, and away from all sensitive areas to erosion. Consult New Brunswick Flood Hazard Maps to know which location is at risk of flooding.
- Use sump pumps in flood-prone homes.
- Build a rain garden or capture rainwater in barrels for slow release to avoid adding to storm-water runoff during heavy rain events.
- Remove equipment and living space from basements to avoid damages.
- Prepare an alternative water supply to avoid well water becoming contaminated with saltwater during a flood event.
- To help prevent flooding ensure proper grading effectively diverts overland runoff away from residences.

For Infrastructure:

- Avoid placing infrastructure in areas at risk of flooding or erosion. Consult New Brunswick flood hazard mapping available on GeoNB and flood zone mapping at planning offices at regional service commission.
- Raise existing roads prone to flooding or relocate roads that are vulnerable to erosion.
- Plan for wider setbacks from streams and wet areas (Note: A Watercourse and Wetland Alteration Permit is required prior to fill placement or other disturbance within 30 meters of a wetland or watercourse).
- Direct surface water to buffered areas, rain gardens, or install proper drainage such as gravel beds, prior to its flow over un-vegetated or unstable slopes to help slow the flow of water.
- Implement storm water management provisions such as naturalized storm water basins, parking areas without curbs and gutters that direct runoff into efficient drainage areas that release water gradually to reduce localized flooding.
- Reduce impermeability of some surfaces to minimize the amount of water entering the storm-water management system (e.g., using pervious pavement designs in parking lots).
- Design infrastructure with future climate predictions in mind (e.g., accounting for increased precipitation by installing larger culverts, and more trenches to divert water away from problem areas).

- Ensure that other municipal infrastructure such as mechanical and electrical equipment, lift stations, underground piping/wiring, and above ground electric installations are located above projected flood levels.
- Timely maintenance of any infrastructure designed to protect against storm water management and erosion is critical.
- Beaches and dunes are critical natural components that protect inland areas from flooding and erosion, so communities should safeguard against sand removal from beaches and discourage motorized vehicle traffic on dunes.
- Ensure that sewage lagoons are not exposed to risks of erosion, are located above predicted water elevations, sea-levels, and storm surge elevations. Where lagoons are located behind dykes ensure that those dykes are also built up and protected against erosion.
- Consider creating natural barriers, green buffers along watercourses, wetlands, and shorelines. This offers increased protection from storm surges, erosion, and flooding to those developing adjacent to these buffers.

For Zoning, Permitting and Bylaws

- Bylaws can be used as tools a municipality can use to implement certain restrictions in specific zones (ex. Bylaws can establish the minimum elevation of a house in a coastal or inland flood hazard area).
- Discourage development in areas that are vulnerable to unstable slopes, close to cliff edges, or below unstable cliffs.
- Locate new infrastructure at an elevation above predicted maximum flood levels, and safe access should be available during a flood event.
- Incorporate an analysis of coastal vulnerability, flood risk assessments and maps of flood hazard areas into community planning exercises and decision-making process (ex. Prohibiting construction in flood hazard regions).
- Re-zone flood hazard areas to limit the types of permitted development or instituting stricter building setbacks, for example.
- Implement a net-zero run-off policy for new developments so that new development does not result in increased storm water run-off.
- Consider enacting protection protocols in municipal by-laws that do not permit impacts to dunes, wetlands and sections of shoreline that help to protect communities from wind and wave action.
- Consult the New Brunswick Flood Hazard Maps and GEONB map server (Applications - GeoNB (snb.ca) to view known flood risk zones in several areas across NB, as well as mapped wetlands and watercourses and their buffers where wet areas and areas most prone to flooding could exist.
- Consult other regional examples of bylaws, policies and best management practices that have worked well to prevent of minimize the effects of climate change impacts.

Displacement/Relocation

Relocation may be necessary for areas at risk of inland flooding and erosion. Though relocation can be a long process, it can be the most cost effective and realistic solution, rather than building intensive infrastructure such as sea walls or expensive pumps.

Monitoring

It is encouraged that communities continue to monitor environmental variables in order to predict future impacts and take preventative measures (e.g. monitoring precipitation in areas that have a history of slope failure).

Education

Education is an important way to build awareness and encourage caution in areas that are vulnerable to erosion and flooding. By providing the public with useful and informative resources, it can reduce vulnerability to hazards.

Emergency Measures

- Having an up-to-date emergency plan to prepare for extreme weather events.
- Ensure response centres are included in emergency plans in order to provide food and shelter to evacuees in an emergency situation. A planning exercise should identify the location of the response centre by taking into consideration safety and accessibility, secure power generation, and a site that can be permanently stocked with provisions.
- Conduct a thorough due diligence and planning exercise for proposed new commercial development to ensure they are kept out of known flood zones and areas prone or predicted to be at risk of erosion, that access and evacuation points are secure during extreme events to ensure continuation of business activities, and providing proponents and developers with required storm water management approaches and requirements.

III Financing the Work

There are several different funding sources that can be accessed to help fund the various components of adaptation planning and implementation:

NB Environmental Trust Fund (ETF)

ETF funding is meant for action-oriented projects such as those regarding adaptation planning, and for projects focused on public engagement. The fund has also supported research and development of broader tools that help communities in the adaptation process. Before submitting a project, it is important to contact the Department of Environment's Climate Change Secretariat to discuss project ideas.

Canada Community-Building Fund

This fund provides project funding to New Brunswick municipalities for environmentally sustainable infrastructure. Municipalities can apply and allocate funds received to adapting municipal infrastructure to climate change.

Investing in Canada Plan

A federal-provincial fund that targets municipal and rural infrastructure that aims to create long-term economic growth, support a low carbon, green economy and build inclusive communities.

Green Municipal Fund

The Fund supports partnerships and leveraging of both public and private sector funding to reach higher standards of air, water, and soil quality and climate protection and is managed by the

Federation of Canadian Municipalities. Funds are available to develop sustainability plans (could include adaptation plans), conduct studies, and implement some capital projects.

Other Funding

Non-profit organizations have access to a number of funding sources. Those include the ETF mentioned above around community engagement projects. The Wildlife Trust Fund has been used to fund projects around stream buffer restoration. The Eco Action Community Funding Program from Environment Canada has been used for tree planting projects.

Other potential sources:

- Environmental Funding Program:
- Natural Infrastructure fund
- RBC Blue Water Project
- TD Friends of the Environment Foundation
- Shell Canada Environmental Fund

For more information on adaptation and resilience resources and tools, please see Appendix A.

Chapter V Content of Adaptation Plan and Examples of Local Plans

This chapter is to help communities develop an adaptation plan, a written document that addresses their vulnerabilities and sets out a series of adaptation actions to reduce their vulnerability. An adaptation plan may be a comprehensive document that addresses all potential climate change impacts and vulnerabilities within a community. It may also be focused on a single high priority climate impact, such as flooding.

Adaptation is a long-term process, and thus these plans or strategies need to be considered as living documents and be updated every five years as new scientific information on climate change projections datasets becomes available. Many communities in New Brunswick have completed their adaptation plans. These plans can be referenced early adopters and used as models for communities in the beginning stages of adaptation planning.

CONTENT OF AN ANDAPTATION PLAN

The previous Chapters II, III and IV form the structure and content of what should be included in an Adaptation Plan. The following sections should be considered for the remaining content of an Adaptation Plan.

Background and Context

This section of the Adaptation Plan will identify the context of the local community or region. Many residents may not know some specific facts about their community, and this section will provide background information upon which the assessment and actions will be based. It may contain sections on:

- Community structure (residential, industrial, institutional, business),
- Information from Statistics Canada (demographics, types of dwellings and collectives, etc.),
- Information on economic development priorities, environmental setting, etc.

Climate Impacts and Issues (see Chapter II)

This section of the plan identifies the climate impacts currently being experienced and those expected in future in the community. It will contain:

- Present and future climate impacts and whether these impacts are likely to increase in severity/frequency.

Present climate impacts that are currently the most critical in the community (**See Figures 5 and 6** for examples of hazards and associated impacts).

Climate Change Vulnerability Assessment (see Chapter III)

This section of the plan summarizes the vulnerabilities of the community, by using maps, engineering and ecosystem assessments, historical information, results from interviews with community members, and focus groups. The section is especially valuable since it will include potential economic impacts (e.g. damage to infrastructure, damage to ecosystems, or release of contaminants), and social, cultural and health impacts (impacts to homeowners, landowners, business owners, other members of the community, as well as those who are the most vulnerable in the community).

Adaptation Priorities, Options, and Actions (see Chapter IV)

This section focuses on a set of strategies and actions that have been developed to address all identified climate impacts. If the vulnerability assessment is broad (i.e., includes many stakeholders and vulnerable areas), it is important that actions are developed with the participation of all stakeholders, and that they are part of the prioritization process. It is also important to note that the most urgent actions will not always be the most easy to accomplish. Short-term, medium-term and long-term goals can be established in this section and will form the basis of progress reporting. This step should identify high-priority, medium-priority, and low-priority actions to help prioritize the adaptation options required to deal with identified vulnerabilities.

Implementation and Monitoring Adaptation Actions

Once implementation begins, it is important to track adaptation planning progress. Tracking progress will also be helpful in order to make any necessary improvements and adjustments based on on-going experience with implementation. Make sure monitoring measures are in place, which could simply include a bi-annual meeting with stakeholders to report on actions taken.

Examples of Community Adaptation Plans

Many coastal and inland communities in New Brunswick have completed their climate change adaptation plan. This list with Municipalities with Climate Change Adaptation Plan provides final reports of adaptation plans from across New Brunswick that demonstrate how communities are adapting to climate change.

Appendix A

CLIMATE CHANGE ADAPTATION RESOURCES AND TOOLS

Climate Change Data and Maps (Historical and Projected)

Future Climate Scenarios for the Province of New Brunswick
Projected climate scenarios for 29 climate indices for the 2020s, 2050s, and 2080s-time horizons for New Brunswick. These projected climate datasets are locally analysed to help inform and understand the impacts of climate change on specific project areas. Climate Mapping Tools, linked below, support this material.
Climate Mapping Tools for the Province of New Brunswick
New Brunswick climate datasets and maps, supporting the Future Climate Scenarios for the Province of New Brunswick report above, can be downloaded here.
Sea Level Rise and Flooding Estimates for New Brunswick
The study presents projected sea level rise and flooding scenarios for coastal sections of New Brunswick. Projected sea level rise and flooding elevations can be used to ensure infrastructure are designed and built above the projected sea level rise elevation.
Canada's Changing Climate Report
Provides national perspective on how climate change impacts our communities, environment, and economy; get insights into Canada's key vulnerabilities and knowledge gaps as well as new and innovative approaches to adapt in your own context.
ClimateData.ca
ClimateData.ca enables Canadians to access, visualize, and analyze climate data, and provides related information and tools to support adaptation planning and decision-making. The climate datasets can be used for understanding the impacts of climate change across the Canadian region.
Climate Atlas of Canada
The Climate Atlas of Canada combines climate science, mapping, and storytelling to bring the global issue of climate change closer to home for Canadians.
IPCC Climate Change 2021: The Physical Science Basis
The Sixth Assessment Report is the most up-to-date physical understanding of the climate system and climate change, bringing together the latest advances in climate science, and combining multiple lines of evidence from paleoclimate, observations, process understanding, and global and regional climate simulations.
IPCC Climate Change 2022: Impacts, Adaptation and Vulnerability Report
The report details the impacts that climate change is having on human societies and ecosystems. These impacts are wide-ranging, and the report provides a global breakdown, by region, of the effects that climate change is having on water scarcity, food production, human health and wellbeing, cities, settlements and infrastructure, and ecosystem structure, range and timing.

Climate Services Centres and Climate Change Websites

CLIMAtlantic
Provides climate change data, information, and services to support adaptation to climate change in Atlantic Canada. *CLIMAtlantic* is part of the national network of Environment and Climate Change Canada's regional climate-expert organizations.
Canadian Centre for Climate Services
Provides access to multi-disciplinary resources on climate change datasets and adaptation resources.

Climate Change Analysis Tools

New Brunswick's Climate Change Indicators
Provides information on how New Brunswick's climate is changing.
IDF Curves and Climate Change
Guidance provided by ECCC for estimating future changes to extreme rainfall magnitudes using historical IDF curves.
Intensity Duration Frequency (IDF) Climate Change Tool
A web-based intensity-duration frequency tool to update and adapt local extreme rainfall statistics to climate change.

Flooding Applications and Reports for New Brunswick

Flooding in New Brunswick
Provides information on flooding in New Brunswick, i.e. New flood hazard mapping tool, flood history database, flooding applications, flood events and a changing climate etc. and can be used to be aware of any potential flooding of the land.
GeoNB LiDAR Data
Provides LiDAR data for all regions of New Brunswick. LiDAR data is available in 1km x 1km grid tiles. LiDAR data can be used to create baseline elevation mapping for conducting risk analysis.
GeoNB New Brunswick Coastal Erosion Database (NBCEDB)
Provides erosion data trends in coastline and shoreline displacement. This information can be used to identify the historical information rate of erosion at numerous locations and characterize the vulnerability of a region to coastal erosion and flooding.
GeoNB Flood Information Viewer
Provides information of past major flooding events (2018, 2008) and can be used to best inform decision on land-use planning and consideration of adaptation measures.
GeoNB WAWA Reference Map
New Brunswick wetland mapping that identifies locations of provincially significant wetlands for informing decisions on wetland regulations, land-use planning and climate change impact decisions.
Sea Level Rise and Flooding Estimates for New Brunswick
The study presents projected sea level rise and flooding scenarios for coastal sections of New Brunswick. Projected sea level rise and flooding elevations can be used to ensure infrastructure are designed and built above the projected sea level rise elevation.

Regional Wave Run-Up Study for the Province of New Brunswick

The study identifies estimates for extreme wave conditions and wave run up heights in combination with 2100 extreme water levels for the coastal sections of New Brunswick. The information can be used for the design and build of infrastructure to increase resiliency to the impacts of strong waves.

Climate Change Risk and Vulnerability Assessment Frameworks

Good Practices in Climate Change Risk Assessment

This document provides a snapshot of the Canadian Council of Ministers of the Environment's (CCME) Guidance on Good Practices in Climate Change Risk Assessment.

ISO 31000 Risk Management Framework

Explains in detail the climate change risk process and helps guide proponents to a more complete and quantifiable understanding of the climate change risks potentially impacting their project. This in-depth process would be considered sufficient if used by the project proponent to analyze climate change risks at this point. Following a similar ISO 31000 certified Risk Assessment Framework, centered on climate change risk, would be considered acceptable as well.

Adaptation to climate change — Guidelines on vulnerability, impacts and risk assessment

Guidelines for assessing the risks related to the potential impacts of climate change. Describes how to understand vulnerability and how to develop and implement a sound risk assessment in the context of climate change. Can be used for assessing both present and future climate change risks. Risk assessment provides a basis for climate change adaptation planning, implementation, and monitoring and evaluation for any organization, regardless of size, type and nature.

Infrastructure Canada's Climate Lens

The guide is used in assisting infrastructure owner and operators in assessing the greenhouse gas emissions and climate resilience of proposed infrastructure projects.

Public Infrastructure Engineering Vulnerability Committee (PIEVC) Protocol

The Protocol systematically reviews historical climate information and projects the nature, severity and probability of future climate changes and events. It also establishes the adaptive capacity of an individual infrastructure as determined by its design, operation, and maintenance.

Adaptation Measures/Approaches/Solutions

Coastal Adaptation Toolkit | Climatlantic

The toolkit will help communities that are experiencing coastal issues related to erosion and/or short- and long-term flooding impacts to plan for the effects of climate change. The toolkit will help community decision-makers as well as coastal property owners be aware of their coastal environment, the different adaptation options available to them, and the applicability of the options under different scenarios.

Wildfire Resilience

This checklist is compiled by FireSmart Canada, the Canadian Home Builders' Association, University of Alberta and the Intact Centre to encourage the use of wildfire resilience best practices in new home construction, renovations and landscaping to reduce the risk of wildfire property damage in wildland urban interface areas of Canada.

Extreme Heat

This guide presents a series of practical actions that Canadians can undertake to reduce extreme heat risks. They fall into three categories: Changing behaviour (non-structural), working with nature (green infrastructure), and improving buildings and public infrastructure (grey infrastructure).

Protecting Coastal Communities

This report outlines the range of practical measures that can be used to protect coastal communities on Canada's East and West coasts from flooding and erosion. Coastal protection measures include (1) Grey Infrastructure (hard, engineered coastal protection measures); and (2) Nature-Based Solutions (measures that depend on, or mimic, natural systems to manage flood and erosion risk).

Limiting Flood Risk in Canadian Cities

This report examined the preparedness of 16 major Canadian cites to minimize the negative consequences of current and future floods. It is the intent of this report to provide an informed perspective that will contribute to the alleviation of current and future flood and climate-related risks in Canada.

Natural Infrastructure and Nature-based Solutions (NBS)

Given the growing interest in using NBS to help governments meet emerging infrastructure challenges from changing climatic conditions, this Framework was developed to support decision-makers and practitioners. It aims to outline the wide range of NI and related NBS.

Natural and Nature-Based Climate Change Adaptation CoP

A platform for peer-to-peer learning, information exchange and sharing of best practices for natural and nature-based climate change adaptation approaches.

Floodproofing

The purpose of this booklet is to help reduce flood risk for existing buildings in locations that may be affected by flooding.

Adaptation | Climatlantic

The list focusses on adaptation measures on different sectors such as agriculture, coastal communities, Infrastructure, nature-based solutions, land and forests, health and well-being, ocean and marine, and tourism.