

Adapting to Climate Change in New Brunswick: Nature-Based Solutions for New Brunswick and Other Maritime Communities

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The Earth's climate undergoes natural cycles of warming and cooling.¹ The Milankovitch Cycle is the process by which the Earth's elliptical orbit around the Sun changes. This results in the shift between the glacial and interglacial periods, which in turn influences our climate.² In Canada, for instance, ice has both advanced and atrophied throughout history. The last major glaciation event was the Wisconsin Glaciation, which ended approximately ten thousand years ago.³ We are currently living in an interglacial phase, the part of the cycle in which the Earth's average temperature rises. However, human activities are exacerbating the Earth's natural warming and causing a more significant rise in global temperature than would have otherwise occurred.⁴ In this paper, I will review possible adaptation strategies to prepare New Brunswick for the damaging effects of climate change.

I.1 GLOBAL CLIMATE CHANGE

The Intergovernmental Panel on Climate Change (IPCC) has demonstrated that the evidence for climate change is unequivocal. Its impacts are evident across the planet, affecting both human and nonhuman life. In recent decades, the atmosphere and oceans have warmed, the amount of snow and ice has diminished, the sea level has risen, and the concentration of greenhouse gases has increased.⁵ Each of the last three decades has been warmer than the last. The major contributing factor to the progression of the planet's warming is humanity's still-increasing greenhouse gas emissions. Furthermore, emissions from industrialised countries are roughly five times higher than nonindustrialised

countries.⁶ With increasing, global awareness of climate change, the United Nations established the Paris Agreement in December 2015. Since an increase of more than 2°C will result in irreversible damage to our planet, the Paris Agreement aims to accelerate the global response to climate change and keep the global temperature rise below 2°C.⁷ Although this a constructive initiative, the goal will be difficult to achieve due to the lack of global political will, in addition to the inevitable effects of past pollution.⁸ As things stand, our current greenhouse gas emissions are expected to raise global temperatures by 3.5°C by the end of this century.⁹

1.2 NEW BRUNSWICK AND CLIMATE CHANGE

The average temperature in Canada has increased by 1.7°C since the 1950s. As a result, Canadian communities are expected to experience increased risk of flooding, sea-level rise, topsoil erosion, and extreme weather events, such as heat waves and severe storms.¹⁰ Secondary impacts include infrastructure failures, agricultural loss, and property damage. In New Brunswick, anticipated impacts include longer seasons without frost, more significant coastal erosion and flooding, as well as more erratic weather patterns.¹¹ Furthermore, CO₂ emissions and greenhouse gases lower air quality, leading to health problems and an increased risk to public safety.¹²

A recent report from the Government of New Brunswick, *Transitioning to a Low Carbon Economy: New Brunswick's Climate Change Action Plan*, emphasises the importance of implementing a variety of adaptation approaches to mitigate emissions and prepare New Brunswick communities for the impact of climate change.¹³ Immediate action must be taken to reduce the impact of climate change and prevent further damage, for the cost of adaptation increases when action is delayed.¹⁴ There is no uniform approach to adapt to climate change, but there are a number of strategies that can be implemented to minimise its effects. Examples include increasing the use of renewable energy, restoring or conserving natural lands, and raising public awareness about sustainability. In the present paper, I explore nature-based solutions as one highly effective approach to dealing with climate change.

1.3 NATURE-BASED SOLUTIONS

Nature-based solutions use natural systems, mimic natural processes, and incorporate traditional knowledge to address the impacts of climate change.¹⁵ They can be customised depending on the type of hazard and its location. If implemented properly, they can lead to healthier environments and communities, improve local economies, and decrease the damaging effects of natural disasters, such as floods and erosion.¹⁶ Unlike anthropogenic solutions, nature-based solutions improve over time, thus providing long-term solutions for communities. New Brunswick has already implemented some adaptation strategies, such as flood mapping and improved drainage systems.¹⁷ However, the anticipated magnitude of climate change requires the involvement of nongovernmental organisations (NGOs) as well, such as Nature N.B. and members of the Maritime Natural Infrastructure Collaborative.¹⁸

The nature-based solutions I discuss in this report draw from successful projects, publications, and news reports across the country. These solutions could be adapted to communities across New Brunswick as well as the entire Maritime region. Solutions that I discuss include active transportation, adaptation planning, climate modelling, sea dykes, culverts, green infrastructure, living breakwaters, open space preservation, property buyouts, and the incorporation of traditional ecological knowledge into climate strategies. I discuss current and future opportunities for adaptation, operating under the assumption that the required funding and expertise will be made available for such measures.

2.1 CURRENT ADAPTATION STRATEGIES

2.1.1 *Active Transportation: Promoting Mitigation and Adaptation*

Active transportation is the use of one's bodily energy to travel, instead of relying on carbon-based transportation; this can include walking, biking, or rollerblading. Some cities in New Brunswick, such as Moncton and Fredericton, are expanding roads and sidewalks to facilitate active transportation.¹⁹ Encouraging active transportation improves air quality by reducing levels of CO₂ and other greenhouse gases that would otherwise be emitted.²⁰ It also provides more opportunities for regular physical activity, thus benefitting human health. Moreover, active transportation can be supplemented by public transportation, such as buses or subways, thus reducing CO₂ emissions further.²¹

2.1.2 *Adaptation Planning and Policies*

Local communities can reduce natural hazards by implementing adaptation planning and policies. To do so, the community must identify areas at risk and create strategies to reduce community vulnerability while being guided by future climate projections.²² There are many different components of planning approaches, including risk assessment, hazard mitigation, and post-disaster planning.²³ Such detailed, long-term planning is essential to create more resilient communities. In general, adaptation planning can also pressure the government to implement policies that protect natural habitats and reduce vulnerability. Government policies at all levels are often crucial to implement plans and manage nature-based solutions. The city of Bathurst is one example of a community that has implemented a planning approach. Established in 2017, Bathurst's *Climate Change Adaptation Plan* presents an assessment of projected climate change impacts as well as potential adaptation strategies.²⁴ In this plan, the community identified increasing sea-level rise and storm surge events as a primary, expected impact of climate change.²⁵ To reduce the risk of flooding, the City of Bathurst outlined a number of adaptation strategies, such as constructing or improving shoreline buffers and improving storm water management.²⁶

2.1.3 *Climate Modelling*

The Petitcodiac River goes through the Greater Moncton Area (GMA), which includes Riverview and Dieppe. The GMA also sits at the head of the Bay of Fundy. Given its geographical location, the GMA is at risk of flooding from tidal surges and extreme weather events. Infrastructure and wastewater management problems, as well as the resulting property damage, are expected to occur with continued sea level rise. To help prepare for these impacts, Moncton has used climate modelling.²⁷ Climate models are a (usually digital) representation of expected impact of climate change in a particular area.²⁸ Climate models can incorporate interactions in the atmosphere, oceans, and land. Additionally, climate models can help organisations work through complicated problems and test possible solutions. In the case of Moncton, climate models are focused on floodplain mapping to provide information on at-risk areas. Floodplain models allow the municipality to plan and develop policies, reinforce infrastructure, and monitor target areas.²⁹ Climate models can also capture land use, greenhouse gas emissions, and solar radiation.³⁰

2.1.4 *Sea Dyke*

The Tantramar Marshes, which link Nova Scotia and New Brunswick, create one of the most vulnerable coastal areas in terms of flooding. The dykes, large anthropogenic barriers that hold back the tides and prevent water from flooding farmlands, were originally constructed by the Acadians to expand available agricultural land. They are typically made with sand at the core, a watertight outer protective layer, and a drainage channel. The surface is protected with grasses or stones.³¹ However, dykes require regular maintenance. For instance, as sea levels rise, additional material must be added to the dykes in order to increase their height.³² This is a costly adaptation approach, but it is necessary, given grave risks to the region. Furthermore, if Tantramar's critical transportation corridor were to flood, the highway would shut down, stopping the route of billions of dollars in trade exports.³³ Parts of Sackville, New Brunswick would also be at risk of flooding, and Nova Scotia would likely become an island.³⁴ As sea levels rise, further strategies, such as living breakwaters and natural salt marsh restoration, may be required to delay major flooding in the Tantramar Marshes.

2.2 FUTURE ADAPTATION STRATEGIES

2.2.1 *Flood and Wildfire Friendly Culverts*

Friendly culverts are a form of infrastructure that allow more water to flow underneath a road than conventional culverts without disrupting traffic.³⁵ They are particularly sensitive and require correct, location-specific measurements to function properly. If a culvert is outdated or improperly designed, it can increase the velocity of water and flood adjacent areas.³⁶ An undersized culvert can be improved by identifying the vulnerable road crossing, prioritising problem areas, and upgrading the culvert based on assessments to improve functionality.³⁷ A well-designed culvert can reduce the risk of flooding by moving water more effectively through an area, thus mimicking a natural flood path and preventing any backup floodwater. They are also able to pass water through a system at a quick and efficient speed.³⁸ One incidental benefit of culverts is the resulting reconnection of waterways. Migratory fish species rely on waterways for reproduction, and increasing the number of fish-friendly waterways can improve the health and resilience of both fish and fisheries.³⁹ Though costs can vary, upgrading culverts is usually less expensive than replacing outdated ones. Culverts have been constructed all over

Canada. For example, Toronto has constructed over one hundred and fifty large culverts with diameters larger than three metres as well as countless smaller culverts.⁴⁰

2.2.2 Green Infrastructure

An increasingly common adaptation strategy across the world is green infrastructure. It incorporates natural elements into urban and rural infrastructures with the goal of creating more environmentally friendly communities.⁴¹ With more green space in communities, green infrastructure can contribute to environmental, social, and economic sustainability, along with overall aesthetic improvement.⁴² Examples of green infrastructure include bioswales, green roofs, and rain gardens.

Bioswales are sloped, vegetated channels designed to collect storm water runoff from large, impervious areas, such as roads or parking lots.⁴³ As a result, bioswales reduce the risk of inland flooding by retarding water flow within the swale. They are typically constituted of grasses and low-maintenance plants. Another benefit of bioswales is that they remove pollutants in the water, such as nitrates and phosphates, through filtration by the vegetation.⁴⁴ They can be planted in a region of any size, for they can be customised by location with the use of native plants. Bioswales are particularly well suited to highways and roads. For example, Calgary has encouraged the development of bioswales to treat storm water runoff since 2007.⁴⁵ Today, Calgary has over one thousand acres of bioswales spread over the city.⁴⁶

Green roofs are established to improve air quality, absorb and store rainfall, and reduce the effects of urban heat islands. These roofs are partially or completely covered with vegetation, making use of the expansive roof area of towns and cities. They are typically made of a waterproof membrane, a drainage layer, and plant material. Furthermore, green roofs can increase urban biodiversity by providing a habitat for wildlife.⁴⁷ Since they add to the aesthetic of an area, green roofs are often constructed in downtown metropolitan areas.⁴⁸ Additionally, other forms of green infrastructure, such as green walls, green streets, and green parking lots, serve the same purpose. Today, green roofs have been established across the Maritime provinces. Halifax has become a leader in implementing green roofs, including at St. Mary's University, Nova Scotia Community College, Citadel High School, and the Halifax Seaport Farmers Market. These green roofs have been implemented for

research and environmental purposes.⁴⁹

Rain gardens, a third type of green infrastructure, are landscape features designed to collect storm water.⁵⁰ Rain gardens are different than standard gardens: they offer increased water filtration, are deliberately placed downstream to maximise storm-water catch, and are primarily composed of native plants.⁵¹ It is important to use native plants, for they are already adapted to local rainfall patterns. Rain gardens reduce the risk of inland flooding, erosion, and other complications from lack of drainage. In addition, they can provide a habitat for insects and small birds.⁵² Rain garden projects are being coordinated by a variety of NGOs and local governments throughout Canada. Due to the community's initiative, the City of Toronto and the Greater Toronto Area have increased the amount of rain gardens over the past decade. Many Toronto residents are constructing their own rain gardens at home and around their communities. Because of their aesthetic appeal as well as economic and environmental benefits, rain gardens have become increasingly popular.

2.2.3 Living Breakwater

Living breakwaters are a nature-based solution that can be implemented in the case of coastal erosion and coastal flooding. Living breakwaters are offshore barriers, which mitigate the force of incoming tides.⁵³ As the name suggests, living breakwaters protect the coastline from erosion and flooding using the natural components of the habitat, especially its vegetation. The natural growth of living breakwaters allows them to strengthen over time, and they can be used in coastal areas of any size.

There are different types of living breakwaters, including oyster reefs and reef balls. Oyster reefs are naturally occurring ecosystems that are often found near salt marshes.⁵⁴ Like all living breakwaters, oyster reefs limit wave energy from tide cycles and storm surges, thereby reducing rates of coastal erosion onshore. Engineered oyster reefs are made of elements of the natural habitat. They are created to facilitate the development of a stabilised habitat that oysters will colonise, which in turn creates new oyster reefs. Whether they are naturally occurring or engineered, oyster reefs protect the coastline from erosion and flooding.⁵⁵ Along with buffering, oyster reefs provide a variety of benefits to the overall environment. For example, they are a habitat for benthic invertebrate colonies, and they support an increasingly complex ecosystem.⁵⁶ Additionally, the water filtering capacity of oysters allows for the

filtration of pollutants from the water, such as sediment and nitrogen, thus improving water quality.⁵⁷ In Canada, there are oyster reefs along the Atlantic coast, including PEI and the Bay of Fundy.

Reef balls are a relatively new initiative in shoreline protection. Invented in 1994, reef balls are artificial reefs that can create new aquatic habitats and provide shoreline protection.⁵⁸ They come in a variety of sizes, ranging from the size of a basketball to that of a car, allowing for individual projects to be flexible and customisable.⁵⁹ All reef balls are made with a pH neutral concrete that allows for coral and algal settlement. They are designed to mimic natural reefs and are used in many restoration projects.⁶⁰ Fully established reef balls act as a buffer between land and water, thus decreasing the risks of coastal flooding and erosion. Reef balls also help create or restore marine habitats by providing shelter for marine species.⁶¹ In Atlantic Canada, reef balls have been implemented in the Halifax Harbour. Since 2012, the Clean Foundation has constructed approximately four hundred reef balls with the goal of creating an artificial ecosystem.⁶²

2.2.4 Open Space Preservation

Open space preservation consists in purchasing undeveloped land for adaptation purposes, such as flood risk reduction, and for the preservation of aesthetic and ecological qualities.⁶³ Within a rural or urban community, open space or undeveloped land can take the form of forests, farmland, wetland, streams, or rivers.⁶⁴ Undeveloped land is shrinking as communities continue to expand outward. Many undeveloped areas are being converted into houses, commercial buildings, and roads. Governments, land acquisition organisations, and private landowners can all advance land preservation.⁶⁵ Conserving open land protects valuable habitats, increases adjacent property values, and removes land that is vulnerable to the effects of climate change from the market. It also provides many socioeconomic benefits, such as recreation opportunities, improved public health, and ecotourism.⁶⁶ Private landowners can donate land through the Ecological Gifts Program and any organisations that deal with land acquisition, such as the Nature Conservancy of Canada and the Nature Trust of New Brunswick. Guelph, Ontario, which has over one thousand hectares of established parks and open spaces, has implemented open space preservation. Their natural features also include seventy kilometres of public walking trails.⁶⁷

2.2.5 *Property Buyout*

Coastal communities are especially vulnerable to climate change.⁶⁸ Property buyout—the purchase of susceptible properties—reduces the impacts of flooding by moving vulnerable communities or infrastructure from areas that are likely to flood.⁶⁹ As a result, it reduces the chance of damage and injury in future flooding events. The scale and timeframe for buyouts are flexible, but planning for communities to move has many variables. The scale of buyouts can range from a few properties to a whole residential area. Property buyouts are beneficial because they allow for the possibility of implementing new, natural adaptation strategies and reducing the overall risk and vulnerability of a community.⁷⁰ Buyout programs are often criticised because they are usually pursued *after* a natural disaster has occurred. Therefore, local governments must work efficiently to build relationships with land owners and take necessary preventative measures *before* a natural disaster occurs.⁷¹ In Canada, property buyouts are not the most common form of adaptation. There have been a few property buyouts in Alberta, such as those due to flooding in Calgary and wildfires in Fort McMurray.⁷²

2.2.6 *Traditional Ecological Knowledge*

One important aspect of environmental planning and adaptation that should be recognised and utilised is traditional ecological knowledge. Traditional ecological knowledge refers to the knowledge, innovations, and practices of Indigenous communities to live in and adapt to their environment.⁷³ Indigenous peoples are the original cultivators of these lands, and they have accumulated generations of knowledge about the land and environment. Many strategies developed by Indigenous peoples to adapt to climate change can be widely implemented. These include fire management techniques, farming and agriculture techniques, the sustainable management of marine resources, and medicinal plant uses. Collaborations on research studies between scientists and Indigenous communities can provide a richer understanding of our ecosystems, the changing climate, and, by extension, ways of addressing the problem.⁷⁴

One major advantage of traditional ecological knowledge is that it is specific to a location, thus providing more insight into the nature of various environmental changes. Many scholars in Canada have collaborated with Indigenous communities and incorporated traditional ecological knowledge into their research. Most of these studies involve

conservation or natural resource planning. Examples include the Ethno Botany Project in British Columbia, the Forest Management Pilot Program in Alberta, and the Traditional Land Use Occupancy Study in Alberta.⁷⁵

3.1 CONCLUSION

Nature-based solutions help mitigate the effects of climate change, enhance natural ecosystems for wildlife, and improve our collective well-being. Furthermore, they can be incorporated into any environment.⁷⁶ The implementation of nature-based solutions is a complex process that requires time, collaboration, and funding. The first step involves identifying vulnerabilities and hazards in the community and, after necessary preliminary work, implementing effective plans to deal with them. Strategies involve climate change adaptation planning, consultation with experts and the community, and establishing monitoring and modelling programs. The second step is to increase the level of awareness through education. This can take the form of information panels, public documents, or business workshops. Presenting the issue of climate change to the public, and outlining ways in which to address it, encourages communities to organise and advocate for change. Once communities have a better understanding of the risks, they can better prepare for climate change. Ultimately, nature-based solutions may help address the impact of climate change on several fronts.

NOTES

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