Climate Change Adaptation Plan

For the Kanien’kehá꞉ka Mohawk Community
of Kanehsatà꞉ke

January 2024

Authors of this Plan

Developed by

Eugene Nicholas, Director of the Ratishontsanonhstats Kanehsatà:ke Environment Office, with special thanks to Colin Nicholas who produced all the maps in this report, as well as Gabrielle Lamouche and Mary Nicholas for their help and support all along the project.

Facilitated by

Coralie Gautier, with the support of Andréanne Ferland, Eugénie Morasse-Lapointe and Stéphanie Boulais of the First Nations of Quebec and Labrador Sustainable Development Institute (FNQLSDI).

With the support of

The Mohawk Council of Kanesatake. Many thanks for the collaboration and time devoted to interviews and discussions with area directors and band council chiefs.

About the Authors

Ratishontsanonhstats Kanehsatà:ke Environment Office

Founded in 2016, Ratishontsanonhstats Kanehsatà:ke Environment Office was created to develop and implement safety measures and environmental policies for the Mohawk Community of Kanehsatà:ke (MCK), in order to protect and ensure a healthy environment for future generations.

The Ratishontsanonhstats Kanehsatà:ke Environment Office's team consists of the Director, Eugene Nicholas, who also created the office; Assistant and Researcher, Mary Nicholas; Communications and Web Officer, Gabrielle Lamouche; and Day Coordinator, Colin Nicholas.

First Nations of Quebec and Labrador Sustainable Development Institute

Founded in 2000, the First Nations of Quebec and Labrador Sustainable Development Institute's (FNQLSDI) key mandate is to support the 43 First Nations communities in Quebec and Labrador in their application of the Sustainable Development Strategy of the First Nations of Quebec and Labrador.

The FNQLSDI supports First Nation communities in their activities involving the protection and management of territories, social development, economic viability and recognition of their rights. The FNQLSDI is active, first and foremost, in the areas of climate change, renewable energy, biodiversity, conservation, environmental and waste management, consultation, impact and benefit agreements, as well as strategic and comprehensive community planning.

The Climate Change and Renewable Energy team at the FNQLSDI includes Andréanne Ferland (Team Coordinator), Coralie Gautier (Climate Change Project Leader) and five other Climate Change Employees.

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Glossary

Adaptation: Any activity that reduces the negative effects of climate change or takes advantage of new opportunities in a changing climate.

Climate: All weather conditions in a given region, characterized by long-term statistics. Measures of climate include temperature, precipitation, and wind.

Climate change: Any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period of time (decades or longer). Climate change may result from natural factors and processes, as well as from human activities that change the atmosphere's composition and land surface.

Climate scenario: RCP8.5, known as the high carbon scenario, portrays a future where carbon dioxide emissions continue to increase at the current rate. This is the business-as-usual scenario.

Floods: Floods occur when drainage infrastructure (natural or artificial) no longer has the capacity to drain all the water it receives (i.e., during heavy rains), when water tables rise or when rivers overflow their banks (e.g., ice dams in rivers, spring floods, snowmelt with rain showers).

Forest fires: Unplanned fires that consume natural fuels on forested land.

Freeze-thaw cycles: A freeze-thaw cycle occurs when the temperature oscillates below 0°C and above 0°C over a given period. Cycles can be daily or seasonal. In a daily cycle, it is likely that some of the water at the surface is both liquid and icy on the same day.

Global warming: Average increase in the temperature of the atmosphere, which can contribute to changes in global climate patterns. Global warming has a variety of causes, both natural and human-made.

Greenhouse gas (GHG): Any gas that absorbs infrared radiation in the atmosphere; examples include carbon dioxide, methane, nitrous oxide, ozone, and water vapour.

Heat waves: Periods of high heat, above average seasonal temperatures, lasting several days.

Impacts: The effects of climate change hazards on human and natural ecosystems; more vulnerable communities will experience more pronounced impacts of climate change.

Natural hazard: Physical phenomena induced by climate change, including changes in temperature, precipitation, extreme events, and water resource quality and availability.

Resilience: The capacity of a community exposed to a hazard to cope with a hazard, including preparedness, planning, recovery and adaptive capacities. It is the opposite of vulnerability.

Violent storms: Storms accompanied by strong winds and wind-driven rain.

Vulnerability: The degree to which a community is susceptible to or unable to cope with exposure to a hazard.

Winter storms: Storms accompanied by one or more of the following: significant snowfall, extreme cold, freezing rain or ice.

Why Do We Need This Plan?

In the spring of 2017 and 2019, the community of Kanehsatà:ke experienced considerable flooding that caused countless damages to infrastructure. The community experienced considerable financial pressure, in addition to a great deal of emotional stress felt by community members. Following these events, the Ratishontsanonhstats Kanehsatà:ke Environment Office decided to develop and implement the project entitled Climate Change Adaptation Planning in the Kanien'kehá꞉ka Mohawk Community of Kanehsatà:ke, in partnership with the FNQLSDI.

In recent decades, Kanehsatà:ke has experienced significant changes in weather patterns and local climate. The main objective of this plan is to document the evolution of the local climate in order to better understand how it affects the inhabitants of Kanesatè:ke as well as the impacts caused on their land and within their community. It will allow for a thorough investigation of strategies to be implemented and support the community in its desire to mitigate future risks.

Another goal of this project is to mobilize Kanehsatà:ke members around climate change by allowing them to contribute to the first ever climate change adaptation plan. The project will also map flood risks using local and Indigenous knowledge, and build First Nations' capacity by recruiting, mentoring and training a local climate change coordinator.

The outline and content of this plan are based on the Kanehsatà:ke community's Ohen:ton Karihwatehkwen (Thanksgiving Address – Appendix 1).

To create this plan, an initial literature review was done on climate change impacts and future predictions for the community. Then interviews with community members, youths, elders, band council directors and chiefs were conducted to gather local knowledge on the impacts of climate change experienced by the community and the strategies that they wished to implement. Theses strategies are found at the end of each section of this plan with an evaluation of how much time and money it could cost to put them in place. All steps of this project were done in close collaboration between the Ratishontsanonhstats Kanehsatà:ke Environment Office and the FNQLSDI.

Acknowledgements

We are grateful to the members of the community who participated in the project's activities and workshops, and who shared their knowledge, vision and strategies for a better future. Niawenhkó:wa!

We also thank Crown-Indigenous Relations and Northern Affairs Canada's (CIRNAC) for their financial support through the First Nation Adapt Program that made this project possible.

People

History of the Community and the Land

Kanehsatà:ke is a Kanien'keha:ka Mohawk settlement situated on the shore of the Ottawa River, close to the Lake of Two Mountains and St. Lawrence River. Although the territory is defined as Indian Land by in Section 91(24) of the Constitutional Act, it has not been officially designated as a Reserve.[1] The name of the community means *on the crusty sand*, since it is based on a sandy hill.

Kanehsatà:ke, jointly holds land in Tiowéro:ton (Doncaster 17 Indian Reserve) with its sister community Kahnawà:ke. This represents 7000 hectares of land in the Laurentides region. However, Doncaster is known to be mainly used by Kahnawà:ke community members.[2]

The community members of Kanehsatà:ke are known as Kanehsata'kehró:non. Historically, Kanehsatà:ke was the easternmost nation of the Haudenosaunee (Six Nations Iroquois), which were predominantly based in what is now New York State, west of the Hudson River and in Pennsylvania, USA. Their hunting territory extended as far as the Ohio and Shenandoah valleys. Over time, some Mohawks moved closer to French colonists in what is now Quebec, Canada, and settled in mission villages. By the mid-1800s, the people of Kanehsatà:ke were formally recognized as one of the seven First Nations of Canada and were allies of the British.[3]

The original 1718 concession was almost a square in size, stretching 14 km by 13 km from Pointe-Aux-Anglais to Pointe-Calumet and including St-Benoit, St-Joseph, and most of Lake of Two Mountains. Since 1945, more lands have been officially added to the demarcated territory, as shown on the Evolution of Kanehsatà:ke Lands Territory map below. However, the unofficial history of these lands is that they were never meant to be "given away," since they never belonged to Canada.[2] In 1975, Kanehsatà:ke, Kahnawà:ke, and Akwesasne filed a comprehensive land claim that was rejected by the Canadian government. The government argued that the Mohawks could not claim Aboriginal title because they had not retained possession of the land since time immemorial, a point that is highly contested within the Nation.[4]

The people of Kanehsatà:ke are facing increasing challenges due to climate change, flooding, soil contamination, and a high birth rate. These factors have led to a decrease in available land, causing concern and stress for many community members who were interviewed.[5] Indeed, access and travel for subsistence activities such as fishing, hunting and trapping are less practised, in part because they have become more hazardous, due to the reduced freezing period caused by milder temperatures and more frequent winter thaws, which significantly disrupts the practice of these traditional activities.[6] These changing winter

[1] This status is unique in Canada, and those interested in learning more can refer to the Lands and Estates section on the Mohawk Council of Kanehsatà:ke (MCK) website. The Federal Government currently recognizes the territory's surface area as 9077 hectares.
[2] Lands, Estates and Membership Director, Kanehsatà:ke, July 2022.
[3] CCP, Kanehsatà:ke, 2021.
[4] Fayazi, Bisson, and Nicholas, 2020.
[5] Health Director, Kanehsatà:ke, July 2022.
[6] Alberti-Dufort *et al.,* 2022.

conditions mean that Mohawk hunters, trappers and fishers can no longer rely solely on their traditional knowledge of the weather and land.

Governance and Economic Development

Political governance is exercised by a customary process of electing five chiefs and one grand chief, with a four-year term of office. Until recently, many chiefs had governed for a long time. However, the most recent election in 2021 brought about a change in the Council, with the election of new candidates for the positions of chief and grand chief.[7]

The community's economic development is supported by some twenty private businesses, most of which belong to the retail sector, including convenience stores, gas stations, and arts and crafts stores. However, the number of cigarette stores that have opened to sell cannabis products has recently increased, despite their illegal status. Although federal services such as the local Band Council and Health Center are responsible for creating jobs in the community, most of these positions are administrative support staff or specialized care providers for community elders. The Kanehsatà:ke Health Center offers comprehensive health services with a physician and two registered nurses. Public security, fire safety, and garbage collection are entrusted to outside resources, such as the Quebec provincial police and the municipality of Oka for fire prevention.[8]

Education and Health

Some people in the community are fluent in English, Mohawk and French. Others speak only one or two of these languages to varying degrees. Kanehsatà:ke has two schools managed by the Band Council: Rotiwennakehte/Aronhiateka (elementary school) and Ratihente (high school). However, due to recurrent underfunding of the community's schools in the past, many young people attend Oka high school. This lack of support has had a detrimental effect on the preservation of traditional culture and language and has contributed to poverty and academic difficulties at home and at school.[9]

The community Health Center employs a doctor and several nurses, but most of them come from outside the Mohawk Nation, which can create a barrier and lack of trust on the part of community members. Moreover, it can be difficult to find qualified individuals willing to work in the community due to the unfavourable external image resulting from historical conflicts, such as the events of 1990, known as the Oka crisis or the Mohawk resistance at Kanehsatà:ke.[10]

Members of the Kanehsatà:ke community have a higher incidence of certain illnesses, such as cancer (prostate, lung, breast, etc.), diabetes, obesity, and cardiovascular disease, than the population of Oka. While some of the causes of these health issues are known, the origin of many cancers remains unknown, creating considerable stress within the community. It is suspected that these health problems may be linked

[7] Grand Chief, Kanehsatà:ke, July 2022.
[8] Lands, Estates and Membership Director, Kanehsatà:ke, July 2022.
[9] Health Director, Kanehsatà:ke, July 2022.
[10] Obomsawin, 1993. Film: *Kanehsatake : 270 ans de résistance.*

to groundwater and water contamination. These concerns were expressed by both the Health Center and community members.[11]

The loss of land and environmental contamination, as well as the increased risk of natural disasters, is a significant source of stress and anxiety for individuals and the community as a whole. Climate change is an important factor to address, as spring floods affect the community every year. In addition, the community's growth rate is high, and the space available for housing is limited due to spatial constraints such as the river and non-Mohawk lands. Access to mental health services, education, and resources can help build community resilience and well-being,[11] connection to the land and family ties, in addition to asserting community and Indigenous rights.

Culture and Traditional Knowledge

The community has a rich history of traditional activities, such as farming the three sisters (squash, corn and beans), practising arts and crafts, making baskets from ash trees, trapping small animals such as rabbits and lynx, fishing in the lake and river throughout the year, and gathering medicinal plants. In recent decades, however, these practices have declined, and community members now increasingly rely on modern medicine rather than traditional knowledge for their health. Despite this shift, there is hope for revitalization, as a new language and culture-based teaching program has recently been established, attracting participants of all ages. It is an important step towards preserving the community's cultural heritage and promoting the continuation of traditional practices for future generations.[12]

According to conversations with elders and members of the community (Figure 1), the local climate has undergone major changes over time. Winters have become less severe and colder, with increased humidity and more rain-on-snow episodes. The thinner ice on the river has caused problems for fishing and crossing to Hudson. Spring arrives less gradually than before and brings more freeze-thaw episodes, affecting both wild and cultivated plants. In addition, some animal populations have declined, while others, such as wild turkeys and white-tailed deer, have increased. Some invasive insects have also become more prevalent. Storms are more frequent and stronger, with an increased likelihood of tornadoes. While flooding is not a new phenomenon, its effects have been exacerbated by the increase in the number of people living in flood-prone areas.[13]

[11] Health Director, Kanehsatà:ke, July 2022.
[12] Culture Center Director, Kanehsatà:ke, April 2022.
[13] Community interviews, Kanehsatà:ke, Sept. 2022.

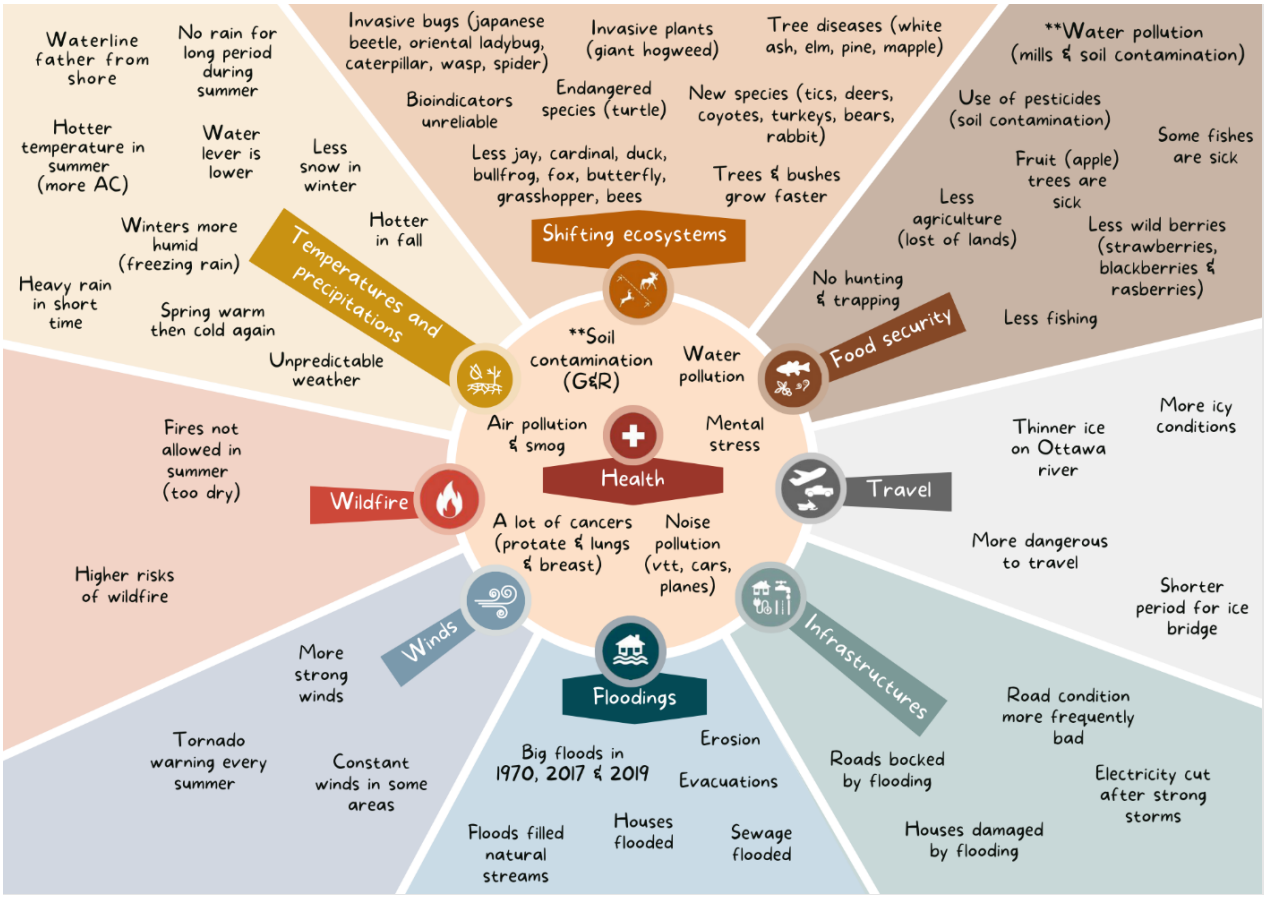
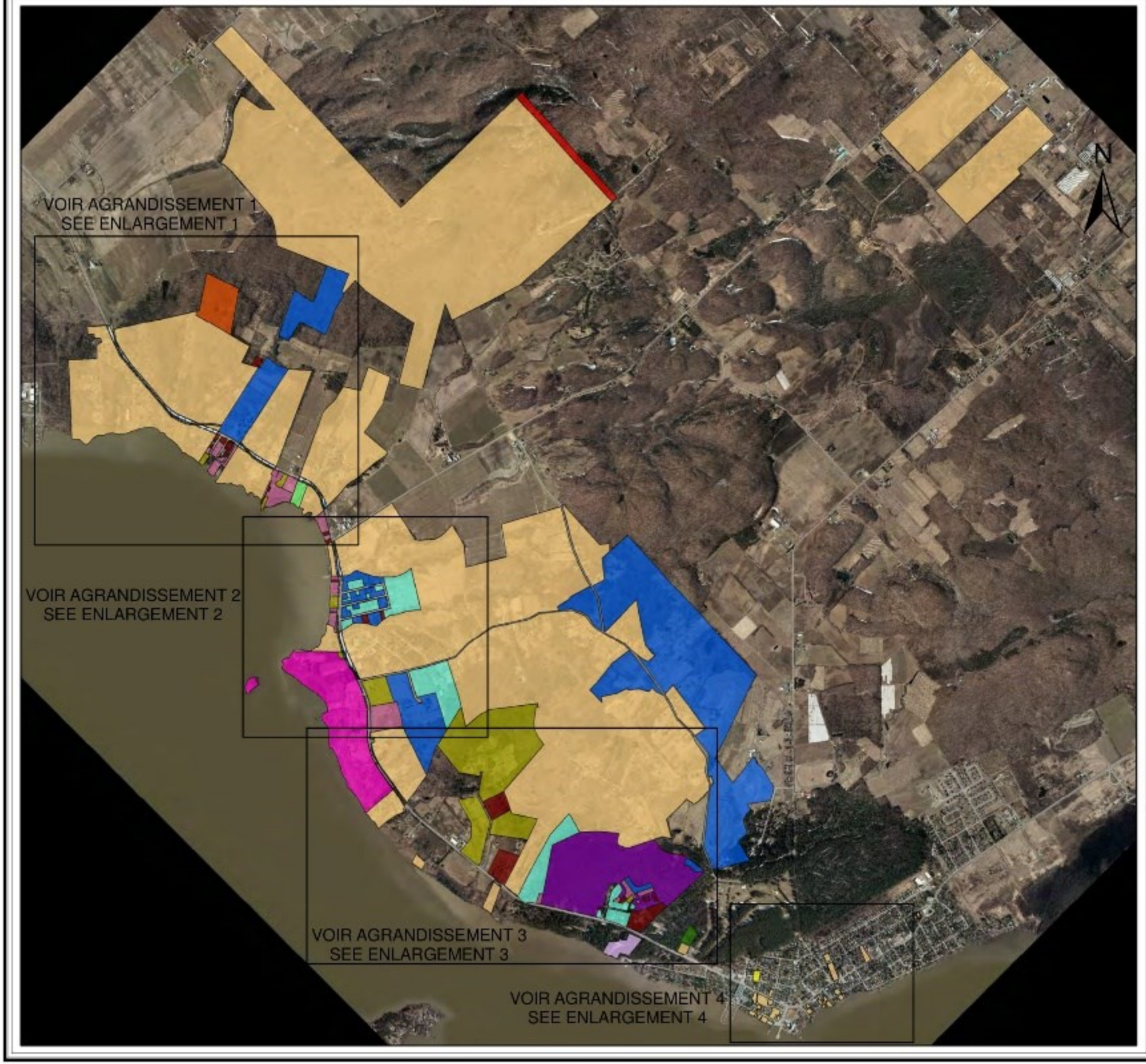


Figure 1. Impacts of Climate Change Observed by Community Members. Community interviews, Kanehsatà:ke, September 2022.

The magnitude of climate change and the speed at which it is expected to occur is set against a rapidly-evolving socioeconomic backdrop: rapid population growth and increased development are simultaneously putting pressure on their community and the ancestral territories that Mohawk Peoples have occupied since time immemorial. Taken together, these various impacts are likely to compromise their quality of life through risks to people's health, jobs, housing, infrastructure and natural resource development.[14] Consequently, the impacts of climate change are likely to result in a loss of cultural heritage for community members. More details on how climate change will impact the environment and people are presented in Appendix 2.

[14] Alberti-Dufort *et al.*, 2022.



Ressources naturelles Canada | Natural Resources Canada

CE PLAN NE PEUT SERVIR À DÉFINIR LES FRONTIÈRES

THIS PLAN IS NOT TO BE USED FOR DEFINNING BOUNDARIES

ÉVOLUTION DU TERRITOIRE DES TERRES DE KANESATAKE

EVOLUTION OF KANESATAKE LANDS TERRITORY

0 0,5 1 2 Kilometers

ÉCHELLE GRAPHIQUE - GRAPHIC SCALE

LÉGENDE - LEGEND

Ancien territoire de la réserve de Kanesatake	Old Kanesatake Reserve Territories	Réserve actuelle de Kanesatake	Current Reserve of Kanesatake
1945 - 1961		1925 -	1990 -
1973 - 1977		1944 -	1992 -
		1945 -	1993 -
		1958 -	1994 -
		1966 -	1995 -
		1972 -	1996 -
		1985 -	1997 -
		1986 -	2007 -

NOTES

- Le but de ce plan est d'illustrer l'évolution du territoire de la réserve indienne
- The purpose of this plan is to illustrate the evolution of the Indian Reserve territory

- Disponible auprès de Ressources naturelles Canada, Direction de l'arpenteur général
- Available from Natural Ressources Canada, Surveyor General Branch

SOURCES

- Données cadastrales numériques. 2014 Gouvernement du Canada avec la permission de Ressources Naturelles Canada,Direction de l'arpenteur général.
- Digital Cadastral Data Set. 2014 Gouvernement of Canada with permission from Natural Ressources Canada, Surveyor general branch.

Préparé le : 2014-08-26
Mise à jour: 2015-05-28

Canada

Mother Earth

Current Conditions

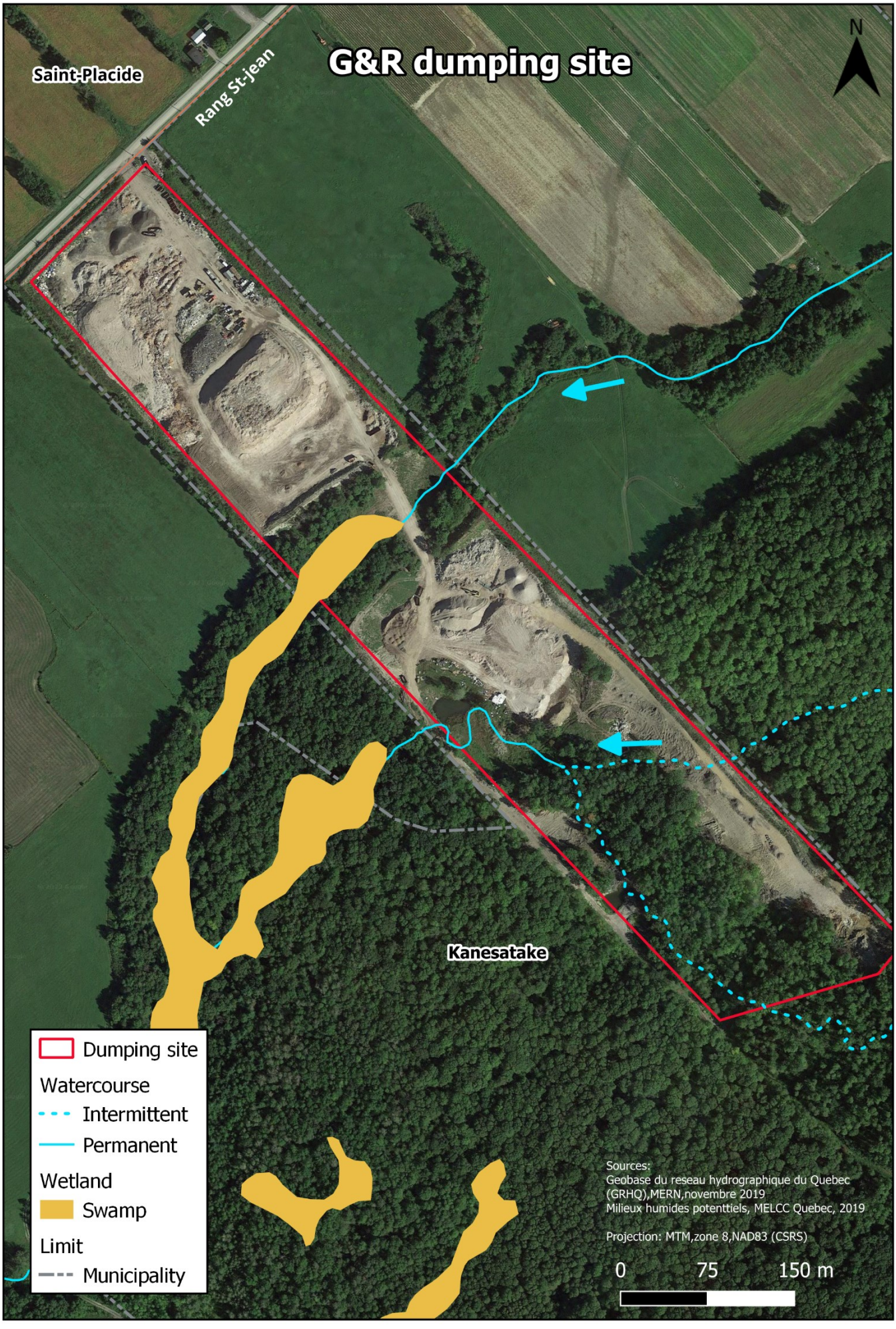
There is an important soil contamination problem resulting from the illegal dumping of construction materials and contaminated soil in the community. Soil contamination began several decades ago, when Highway 344 was built in the area, using contaminated residues from a nearby mine. Many areas in the community are contaminated. Furthermore, non-Indigenous people often come and bribe community members in an effort to illegally dump on their land, to avoid dealing with the contaminants legally or being fined.[15] Also, on the mountain near the community, there is a lot of garbage, such as gas tanks, which can contribute to forest fires.[16] Illegal dumping has created many problems for the land and community members. These contaminated areas give off a horrible smell (due to NO_2) and contribute to contaminating many fresh water sources through underground seepage.

Currently, the largest area is on the G&R recycling site (327,000 m³ of residual material dumped), located on top of the hill on Rang St-Jean, 3 km from the shore. This area was originally a recycling site but has been turned into a huge pile of waste, contaminated soil and construction materials resulting from illegal dumping. The next map (G&R Disposal Site map) shows the contaminated zone (in red), with watercourses (in blue) and swampy areas (in yellow), which are both vulnerable ecosystems on the contaminated site. According to the report by the consulting firm that studied the site in 2021, excessive levels of contaminants are found in soil, sediments, surface and groundwater, and air.[17] These contaminants include monocyclic aromatic hydrocarbons, petroleum hydrocarbons, polycyclic aromatic hydrocarbons, metals, sulfur and sulfates, phenolic compounds, microbiological parameters (coliforms and atypical bacteria) and dissolved gases.[17] As a result, contaminated land cannot be used by community members, contributing to food insecurity, overpopulation and decline in traditional activities on the land. Lastly, this soil and water contamination is partly responsible for many of the health problems suffered by community members.[18]

The Future in a Changing Climate

More frequent and intense storms, floods, and heavy rainfall events, as expected with climate change, can lead to the runoff of pollutants and contaminants from contaminated sites into the Ottawa River. Indeed, changes in precipitation patterns can affect the hydrology, which can impact the concentration and dispersion of pollutants in water bodies, potentially leading to higher contaminant concentrations. If no changes are made to remedy the situation, the air, soil and water pollution created from the G&R site will continue to contribute, on a small scale, to the deterioration of environmental quality and to climate change due to the greenhouse gases released into the atmosphere from the site.

[15] Health Director, Kanehsatà:ke, July 2022.
[16] Community interviews, February 2023.
[17] Golder Associates Ltd., 2021.
[18] Community interviews, Kanehsatà:ke, September 2022.


G&R dumping site
Saint-Placide
Rang St-jean
N
Kanesatake
Dumping site
Watercourse
Intermittent
Permanent
Wetland
Swamp
Limit
Municipality
Sources:
Geobase du reseau hydrographique du Quebec (GRHQ),MERN,novembre 2019
Milieux humides potenttiels, MELCC Quebec, 2019
Projection: MTM,zone 8,NAD83 (CSRS)
0
75
150 m

Adapting to the Impacts of Climate Change

The strategies proposed by Kanehsatà:ke community members, employees and elected chiefs are presented in Table 1 below.

Table 1. Strategies to Implement Against Climate Change – Mother Earth.

Objectives	Activities	Timeframe	Budget	Potential Partners
Fix the illegal dumping issues	Clean the G&R site Raise awareness of soil contamination & dumping Employ an environment officer for land surveillance	Mid-term Mid-term Short-term	$$$	Band Council, school
Improve the land policy to protect the territory	Establish rules for land management Get the approval of the Band Council & members	Short-term	$	Land & Estate Department
Reduce the use of pesticides	Engage discussion with farmers around the community Create regulations that are acceptable for both farmers & community members	Mid-term	$$	Farmers

Sun and Temperature

Current Conditions

Community members have noticed an increase in temperatures, especially during summer and winter months.[19] Heatwaves are more frequent in summer, which can be a problem for people with fragile health such as elders and young children. Many outdoor activities become dangerous or impossible when temperatures are very high. Persistent high temperatures increase the risk of drought, which can severely impact food production and health. High temperatures can also lead to an increase in the number of thunderstorms, which means greater risk of flash floods, lightning, hail and possibly even tornadoes.[20] In recent years, summers were cool enough not to use air conditioning. Nowadays, it's a must for many members during July and sometimes from May to August.[19]

UV rays are at higher levels, leading to a higher risk of skin cancer and creating hazardous issues for people with sun sensitivities, meaning they spend more time indoors. Increased temperatures have also led to a greater risk of heat deaths.

The Future in a Changing Climate

Rising temperatures are an undeniable consequence of climate change. Since 1950, temperatures have shown an upward trend and are projected to keep rising. Figure 2 shows the increase in average annual temperatures specific to Kanehsatà:ke over time, based on past data (historical period in gray) and model projections under a high emission scenario in the future (forecasted period in red).

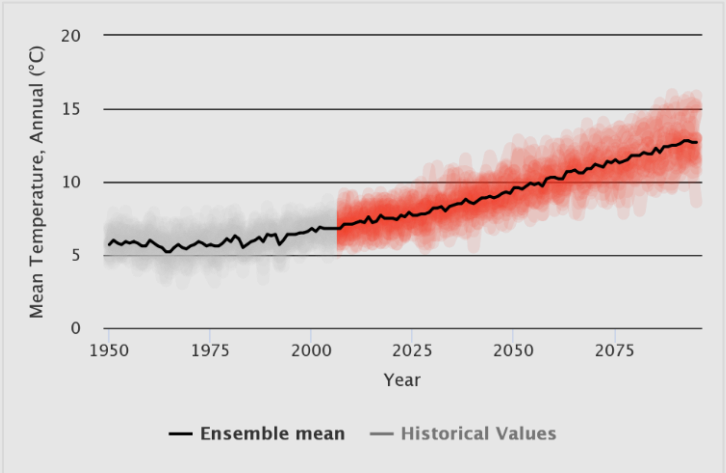


Figure 2. Past and Projected Annual Mean Temperature in Kanehsatà:ke Under a High Carbon Emission (FCR 8.5) Scenario.[20]

[19] Community interviews, Kanehsatà:ke, September 2022.
[20] Prairie Climate Centre, 2019a.

Table 2 below shows that annual temperatures in Kanehsatà:ke could increase by 2°C in the immediate future (2021–2050) and by 4°C in the near future (2051–2080) when compared to the reference period of 1976–2005. In terms of heat extremes, climate models also predict a sharp increase in the maximum temperature of the hottest day of the year, the duration of heat waves and the frequency of tropical nights (>20°C).[21]

Table 2. Future Temperature Predictions for Kanehsatà:ke Basted on a High Carbon Emission (RCP8.5) Scenario.[22]

Variable	Reference Period (1976–2005)	Immediate Future (2021–2050)		Near Future (2051–2080)	
	Real mean value	Projected mean value	Change %	Projected mean value	Change %
Mean temperature (annual)	6.2°C	8.4°C	↑ 35%	10.7°C	↑ 73%
Mean temperature (winter)	-8.6°C	-6.0°C	↑ 30%	-3.4°C	↑ 60%
Mean temperature (spring)	5.4°C	7.1°C	↑ 31%	9.1°C	↑ 69%
Mean temperature (summer)	19.5°C	21.5°C	↑ 10%	23.7°C	↑ 22%
Mean temperature (fall)	8.4°C	10.8°C	↑ 29%	12.9°C	↑ 54%
Tropical nights	5 nights	15 nights	↑ 200%	34 nights	↑ 580%
Very hot days (>30°C)	10 days	27 days	↑ 170%	53 days	↑ 430%
Number of heat waves	1.2	3.7	↑ 208%	6.0	↑ 400%
Coolest minimum temperature	-29.9°C	-26.0°C	↑ 13%	-21.4°C	↑ 28%
Winter days (<-15 °C)	41.4 days	25.6 days	↓ 37%	12.0 days	↓ 65%

Extreme heat has many negative effects on health, especially over extended periods, as it promotes smog formation and degrades air quality. Above certain thresholds, these temperatures can also cause health problems (heat stroke, dehydration), and are linked to higher mortality, when very high temperatures persist for several consecutive days and nights. The most vulnerable people are the elderly and children, especially those with pre-existing health conditions, such as mental health problems.[23]

[21] Ouranos, 2015.
[22] Prairie Climate Centre, 2019a.
[23] Alberti-Dufort *et al.*, 2022.

Adapting to the Impacts of Climate Change

Strategies from Kanehsatà:ke community members, employees and elected chiefs are presented in Table 3 below.

Table 3. Strategies to Implement Against Climate Change – Sun and Temperature.

Objectives	Activities	Timeframe	Budget	Potential Partners
Raise awareness about climate change impacts and adaptations	Talk with people during community meetings Make flyers to distribute to houses Use the new community center during heat waves	Short-term	$	Health Center, Band Council

Water

Current Conditions

Water is extremely important to the community. It represents life for all plants, animals and people. Nevertheless, numerous problems linked to water quality and accessibility are currently causing stress for community members.

Summer and winter precipitation

During the summer, rainfall is more often very heavy and short-lived, then absent for a long period, which can lead to droughts. During hot summers, the waterline of the Ottawa River recedes from the shore.[24] Heavy rain in a short period of time can lead to landslides. Although no serious landslides have happened yet on community land, some areas are prone to them (see the Baie des Indiens and Pointe d'Oka maps[25] below), due to slope inclination and soil type. Hence, future development should take these risks into consideration.

These days, winters are shorter, milder, wetter, and less snowy than in the past. Community members recall that in the 1960s and 1970s, snowbanks could reach up to 6 feet in height, which is no longer common today.[24] Rain and freezing rain are now common winter phenomena. The freezing rainstorm that hit the southern part of the province and Kanehsatà:ke in January 1998 was a natural disaster that caused extensive damage in the region. The storm lasted several days, covering the area with a thick layer of ice. Under the weight of the ice, trees snapped, and power lines collapsed, depriving the population of electricity for several weeks. The storm also caused multiple fatalities and injuries due to falling ice and trees. The storm was a stark reminder of the power and unpredictability of nature, and the importance of preparedness and resilience in the face of natural disasters.

Milder winters and freeze-thaw cycles can have major impacts on infrastructure. Water expands when it freezes, so the freezing, melting and refreezing of water can—over time—cause significant damage to roadways, sidewalks, and other outdoor structures. Potholes that form during the spring, or midwinter melts, are good examples of the damage caused by this process.[26] Milder winters can also affect ability to travel (skidoo or snowshoe) since the ice on rivers is thinner, like on the Ottawa River, and can cause accidents or death to those trying to cross it.

[24] Community interviews, Kanehsatà:ke, September 2022.

[25] Ministère des Transports du Québec, 2012.

[26] Prairie Climate Centre, 2019a.

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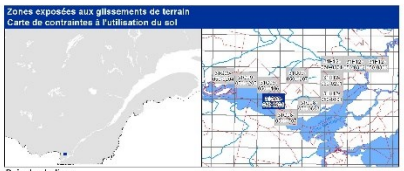
Baie des Indiens

31G08-050-0806



Baie des Indiens

Zones de contraintes relatives aux glissements faiblement ou non rétrogressifs

Zones de contraintes relatives aux glissements fortement rétrogressifs

Avis à l'utilisateur

Métadonnées

Sources

Réalisation

Transports Québec

31G08-050-0707

Pointe d'Oka

31G08-050-0707

Pointe d'Oka

Zones de contraintes relatives aux glissements faiblement ou non rétrogressifs

Zones de contraintes relatives aux glissements fortement rétrogressifs

Avis à l'utilisateur

Métadonnées

Sources

Réalisation

Rivers and flooding

In the Ottawa River watershed, the convergence of melting snow from the winter season and heavy rainfall during April and May leads to prolonged high flow in the rivers throughout the spring. This extended period of higher water levels is attributed to the continuous contribution of water from each tributary within the watershed, gradually increasing as temperatures rise from the southern to the northern regions over several days and weeks.[27]

Community members have noticed a considerable decrease in the water level of the Ottawa River in recent summers,[28] likely attributed to the rising temperatures experienced in the region. Indeed, at the end of summer, typically in late August to early September, the Ottawa River experiences low water conditions as a result of seasonal factors. This period of low water marks the lowest water levels, reflecting the natural fluctuations in the river's flow.[27] This decline in water level can lead to a variety of consequences, including potential impacts on water quality, flow patterns, and the overall habitat of numerous aquatic species. However, it is noteworthy that during the spring season, particularly during ice breakup or heavy rainfall events, the river sees a significant rise in water levels. For community members residing along the shoreline, these heightened water levels have occasionally reached problematic levels, posing challenges and concerns for those directly affected.

Presently, many community members reside in close proximity to water bodies as a result of land transactions where non-Indigenous residents have sold lands back to the Mohawks. However, locations near the shore expose them to elevated risks of flooding and shore erosion. Recent events in 2017 and 2019 demonstrated the community's vulnerability to flooding (see flooded areas from the 2017 & 2019 flooding map below), influenced by various contributing factors as discussed in a recent article:

> "The winter of 2017 was the fourth warmest since 1948 and the accumulation of snow and rain was the second and third highest, respectively, in over 50 years. The accumulation of higher-than-normal precipitation and quicker melting process of the snow cover caused severe floods in April and May 2017. Moreover, the manager of the Carillon dam, located upstream of the community, did not notify the MCK that they would open the floodgates of the dam, which contributes to increase the flooded areas in the community. In 2019, a deep and rapidly melting snowpack and many days of intensive rain again caused unprecedented flooding that in some areas beat previous records set during 2017."[29]

Despite the challenges faced during the floods in 2017 and 2019, the community came together to support each other by piling up sandbags and evacuating those in affected areas. However, it was highlighted that a quicker and more effective response could have been achieved if the community had an emergency plan in place, as well as dedicated teams and funding for a local police force and fire station.[29] By having these measures in place, the community would be better equipped to respond to future crises and ensure the safety and well-being of its members.

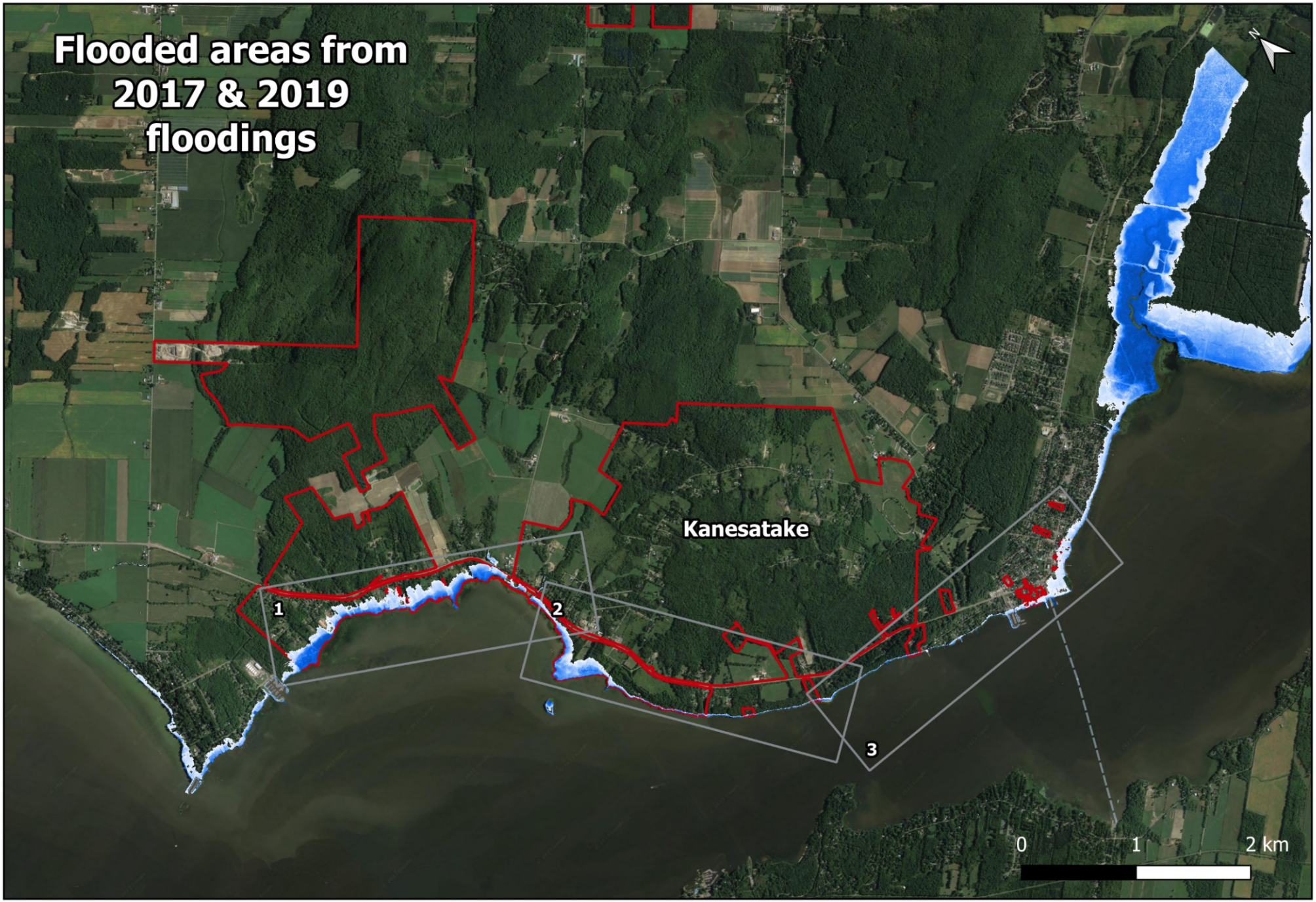
[27] Ottawa Riverkeeper, 2023b.
[28] High school workshop, Kanehsatà:ke, February 2023.
[29] Fayazi, Bisson & Nicholas, 2020.

Following the devastating 2017 flood, many members faced the challenge of temporary relocation. Some were forced to reside in trailers near their damaged homes, and unfortunately, they were still without a permanent residence when the subsequent flood struck in 2019. Due to the limited availability of Mohawk lands, relocation farther from the shore was not a viable option for many families. Consequently, they had no choice but to remain in their compromised dwellings, where sewage contamination and the potential growth and spread of mold posed additional concerns.

The aftermath of these floods has rendered house and flood insurance practically unattainable for community members. Firstly, due to the majority of lands being situated in the floodplain where future floods are a high probability. Secondly, Kanehsatà:ke is classified as a red (dangerous) zone by insurances, due to the Oka crisis in 1990. Lastly, since the land and houses predominantly belong to the government, they are considered non-seizable, which further complicates insurance accessibility.[30] These circumstances underscore the urgent need for comprehensive strategies to address housing and insurance challenges faced by the community.

The extent and severity of the flooding that occurred in 2017 and 2019 are depicted on the maps below. The first map provides an overview of the entire community, showcasing the areas with the highest waterline experienced during those events. The second and third maps provide closer views of three specific regions within the community's territory: the bay shore (zone 1), the forest shore (zone 2), and the Oka shore (zone 3). In the legend of the map, the depth of the flooding is indicated in blue shade, ranging from 0 metres to 3.1 metres in certain locations during the 2019 floods. Notably, the bay area experienced the greatest impact, with floodwaters reaching a height of 3 metres and extending up to 100 metres from the shore. These maps are an important tool to visualize and identify areas and infrastructure affected by serious flood events.

[30] Fayazi, Bisson, & Nicholas, 2020.


Flooded areas from 2017 & 2019 floodings
Kanesatake
1
2
3
N
0
1
2 km

Flooding

Flooded areas (m)

3.1

0

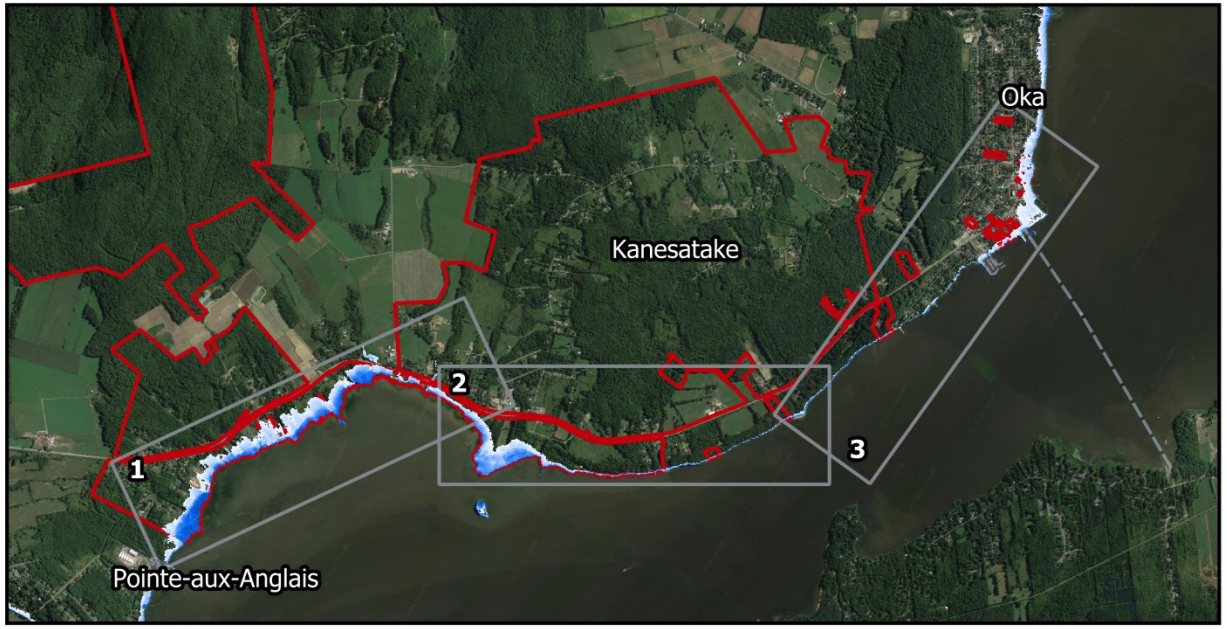
Limit

Kanesatake

Road

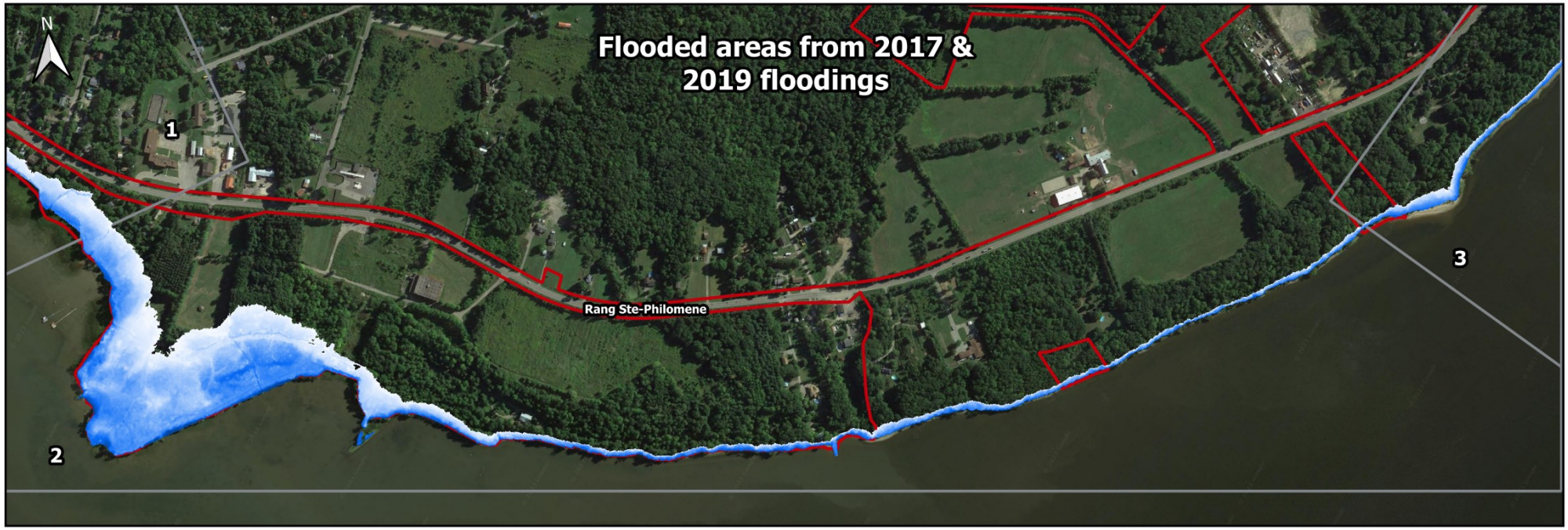
Ferry

Flooded areas from the 2017 & 2019 floodings



Sources:
Basemap Imagery QGIS
Adresses Quebec, MERN Quebec, aout 2022
Geobase du reseau hydrographique du Quebec (GRHQ, MERN Quebec, novembre 2019
BDGA, 1:1000 000, MERN Quebec, 2019
CanVec, 1:1000 000, RNCan, 2019

Projection: MTM, zone 8, NAD83 (CSRS)


N
Flooded areas from 2017 &
2019 floodings
1
2
3
Rang Ste-Philomene


N
2
3
Rue St-Michel
0
100
200 m

Drinking water

The fear and hesitation among community members to use or drink water from their wells (see Location of Wells and Septic Systems in the Community map, page 57) persist, even when water tests indicate the water is safe. While Health Canada conducts regular testing of some wells for standard contaminants, this may not be sufficient.[31] The ongoing issue of dumping and soil contamination in the area, as discussed in the Mother Earth section, raises concerns about the adequacy of the testing measures. It is crucial to address these challenges comprehensively to restore confidence in the safety and quality of the water supply for the community.

Water quality surveillance is essential to ensuring safe and clean water for the community of Kanehsatà:ke. The Health Center is responsible for water quality surveillance in the community's wells. This involves taking water samples from residents and public/semi-public buildings for testing. For private homes, two different tests are conducted annually, one for bacteria and one physicochemical test every five years. Michelle also conducts weekly monitoring of the three buildings connected to the water supply of the neighboring town of Oka, checking for chlorine levels, turbidity, and bacteria. The physicochemical testing conducted every five years evaluates parameters such as arsenic, manganese, barium, nitrates-nitrites, chlorides, sodium, iron, sulfates, fluorides, and hardness, to ensure that none of these parameters exceed the maximum concentration limits recommended by the Canadian Drinking Water Quality guidelines.

Due to concerns about potential disruptions in the relationship between the community and the village of Oka, many community members express a strong desire for an independent aqueduct exclusively serving community members. The fear of being cut off from the water supply during periods of strained relations, as highlighted by the Grand Chief,[32] has amplified the urgency for a self-sustaining water system. Establishing an independent aqueduct would provide the community with a reliable and secure water source, alleviating their apprehensions and ensuring their water needs are met irrespective of external factors.

The Future in a Changing Climate

Precipitation

Climate change is anticipated to bring notable changes in precipitation patterns, particularly during winter and spring seasons (Table 4). These changes are expected to include increased precipitation levels accompanied by more frequent winter thaws and extreme rainfall events. Consequently, these alterations will directly impact the hydrological characteristics of rivers, leading to elevated winter flows and earlier spring floods.[33]

Climate models also predict that, despite the increase in precipitation, the snow cover will be more vulnerable due to warmer winter temperatures. The immediate future (2021–2050) is projected to witness

[31] Environment Director, Kanehsatà:ke, November 2022.
[32] Grand Chief of Kanehsatà:ke, February 2023.
[33] Warren, Lulham & Lemmen, 2021.

a significant decline in snow accumulation across the territory.[34] While quantifying the precise proportion of winter precipitation that will manifest as rain or snow remains challenging with current data and models, an overall increase in total winter precipitation can be expected.[34]

The table below summarizes the changes in precipitation that are likely to occur in the short- and long-term if GHG emissions continue to rise.

Table 4. Future Precipitation Prediction for Kanehsatà:ke Based on a High Carbon Emission (RCP8.5) Scenario.[35]

Variable	Reference Period (1976–2005)	Immediate Future (2021–2050)		Near Future (2051–2080)	
	Real mean value	Projected mean value	Change %	Projected mean value	Change %
Annual **p**recipitation	967 mm	1032 mm	↑ 7%	1071 mm	↑ 11%
Winter **p**recipitation	220 mm	245 mm	↑ 11%	264 mm	↑ 20%
Spring **p**recipitation	223 mm	245 mm	↑ 10%	262 mm	↑ 17%
Summer **p**recipitation	265 mm	274 mm	↑ 3%	268 mm	↑ 1%
Fall **p**recipitation	260 mm	269 mm	↑ 3%	275 mm	↑ 6%
Heavy **p**recipitation (>20mm)	7.0 days	8.5 days	↑ 21%	9.7 days	↑ 39%
Max **p**recipitation in 1 day	42 mm	45 mm	↑ 7%	48 mm	↑ 14%
Max **p**recipitation in 5 days	65 mm	71 mm	↑ 9%	75 mm	↑ 15%

Flooding

Climate models unanimously project considerable increases in heavy and maximum precipitation indicators (Table 4) towards the end of the century, which could lead to localized flooding and drainage system overload.[36] The risk of flooding is highly influenced by both meteorological and climatic factors as well as land characteristics such as geomorphology, land use, and anthropic development.[37]

As seen in 2017 and 2019, the community's shoreline is vulnerable to flooding and will be at greater risk in the future. As climate change progresses, it will alter the net water supplies of the Ottawa River, leading to increased flood risk, particularly in early spring.[38] In parallel, an increase in the frequency of low-water events during late summer and fall is anticipated.[39]

[34] Ouranos, 2015.
[35] Prairie Climate Centre, 2019a.
[36] Ouranos, 2019.
[37] MSSS, 2017.
[38] Ouranos, 2021.
[39] Alberti-Dufort *et al.*, 2022.

Adapting to the Impacts of Climate Change

Strategies from Kanehsatà:ke community members, employees and elected chiefs are presented in Table 5 below.

Table 5. Strategies to Implement Against Climate Change – Water.

Objectives	Activities	Timeframe	Budget	Potential Partners
Be prepared to face natural hazards	Create an emergency committee Update the emergency plan for the community Improve communications during natural hazards with efficient communication (alert system)	Short-term	$$	1 person of each sector of the Band Council
Access to flood risk map with daily data	Use web tools that to predict flooding and follow the water level: Info-Crue [https://www.cehq.gouv.qc.ca/atlas-hydroclimatique/stations-hydrometriques/index.htm] CMM [https://www.cruesgrandmontreal.ca/?utm_source=Liste+de+la+CMM&utm_campaign=9a7b3ae7ab-EMAIL_CAMPAIGN_2020_06_10_06_10_COPY_01&utm_medium=email&utm_term=0_92c89e22c4-9a7b3ae7ab-172658767]	Mid-term	$	Environment Office
Install natural infrastructure on the shoreline to protect against future flooding	Employ an engineering firm to conduct a feasibility study Get community approval of the chosen measures Seek funding to support adaptation measures Implement the infrastructure chosen Monitor the effectiveness of the adaptation measures and make adjustments as needed Rehabilitate some natural streams that have been filled up	Mid-term	$$$	Engineering firm
Adapt buildings to flood risks	Develop a plan to adapt houses at risk of flooding. This could include measures such as elevating a house,	Mid-term	$$$	Engineering firm

	installing flood barriers, and improving drainage systems Move houses that can't be adapted, with members approval			
Collaborate with water organizations	Work with the local water protection or watershed organization of the Ottawa River Engage meaningful partnership with Hydro-Quebec regarding the Carillon dam Use plants on the Ottawa river to remediate against water pollution	Mid-term	$	Ottawa Riverkeeper Hydro-Quebec
Make the river safer for all kind of activities	Monitor ice thickness on the river every week Inform community members of the status of the ice on the river	Short-term	$	

Fish

Current Conditions

The Ottawa River that runs alongside the community is home to a diverse range of fish species, more than 40 different species just along the community (Table 6).[40] Historically, some of these fish species were an important food source. However, at present, many of these species are facing considerable conservation challenges and nine are included in the list of Species at Risk (Table 6).[41] Additionally, there are other species that are currently not listed but could potentially be included in the future if their populations continue to decline.

According to both youth and elders, there has been a significant shift in the consumption patterns of fish from the Ottawa River. Many years ago, community members ceased eating the fish they caught due to widespread observations of diseased fish and abnormal physical characteristics. These concerning findings led to a decline in traditional fishing activities throughout the year. However, in recent times, a few individuals and families have started to reintroduce fishing into their practices. Despite this resurgence, the fear of consuming contaminated or unhealthy fish remains a prominent concern among community members. Nevertheless, some have decided to consume yellow perch and walleye specifically caught during winter fishing excursions.[42] Additionally, the thickness of the Ottawa River's winter ice has noticeably decreased compared to previous years, resulting in fewer opportunities for ice fishing. This change has once again impacted the cultural traditions and practices surrounding fishing for community members.

Key improvements in water quality have been observed since the 1970s, resulting in clearer and less contaminated water in the river. However, despite these advancements, there is still pollution from various sources like microplastic pollution in the open water and the sediments of the river[43] and antifreeze used to prevent fishing holes from freezing during winter fishing on the river.[42] The improper disposal of antifreeze introduces toxic substances into the river, directly impacting the well-being of the fish population and the aquatic ecosystem.

In the past, there was a pulp and paper plant upstream of the community that contributed to the deterioration of the water quality in the Ottawa River. Monitoring of water quality in the river is primarily carried out by various industries and municipalities, including pulp mills, Chalk River Laboratories, and wastewater treatment plants.[40] However, accessing this information can be challenging, as it is often not readily available to the public. It is important to note that the data collected by industry entities primarily serves the purpose of ensuring compliance with environmental regulations and guidelines, rather than specifically addressing water quality trends in the Ottawa River over time. Efforts should be made to promote transparency and accessibility of water quality information to foster greater public awareness and involvement in protecting the health and integrity of the Ottawa River.

[40] Ottawa Riverkeeper, 2023a.
[41] COSEWIC, 2023.
[42] Community interviews, Kanehsatà:ke, September 2022.
[43] Vermaire *et al.,* 2017.

Table 6. Fish Species in the Ottawa River Near Kanehsatà:ke.[44]

Fish Species (English name)	Fish Species (Scientific name)	Status of the Species (Quebec)	Status of the Species (Canada)
American Eel**	*Anguilla rostrata*	Likely to be designated	Threatened
Atlantic salmon**	*Salmo salar*	-	Special concern
American shad**	*Alosa sapidissima*	Vulnerable	-
Banded killifish	*Fundulus diaphanus*	-	-
Black crappie	*Pomoxis nigromaculatus*	-	-
Bluegill	*Lepomis macrochirus*	-	-
Bluntnose minnow	*Pimephales notatus*	-	-
Bowfin	*Amia calva*	-	-
Bridle shiner**	*Notropis bifrenatus*	Vulnerable	Special concern
Brook silverside	*Labidesthes sicculus*	-	-
Brook stickleback	*Culaea inconstans*	-	-
Brown bullhead	*Ameiurus nebulosus*	-	-
Burbot	*Lota*	-	-
Central mudminnow	*Umbra limi*	-	-
Channel catfish	*Ictalurus punctatus*	-	-
Channel darter**	*Percina copelandi*	Vulnerable	Special concern
Common white sucker	*Catostomus commersoni*	-	-
Copper redhorse**	*Moxostoma hubbsi*	Vulnerable	Endangered
Creek chub	*Semotilus atromaculatus*	-	-
Eastern sand darter**	*Ammocrypta pellucida*	Threatened	Special concern
Freshwater drum	*Aplodinotus grunniens*	-	-
Golden shiner	*Notemigonus crysoleucas*	-	-
Greater redhorse	*Moxostoma valenciennesi*	-	-
Iowa darter	*Etheostoma exile*	-	-
Johnny darter	*Etheostoma nigrum*	-	-
Lake sturgeon	*Acipenser fulvescens*	-	-
Largemouth bass	*Micropterus salmoides*	-	-
Longnose gar	*Lepisosteus oculatus*	-	-
Mooneye	*Hiodon tergisus*	-	-
Muskellunge	*Esox masquinongy*	-	-
Northern brook lamprey**	*Ichthyomyzon fossor*	Threatened	Special concern
Northern pike	*Esox lucius*	-	-
Pumpkinseed	*Lepomis gibbosus*	-	-
Quillback	*Carpiodes cyprinus*	-	-
River redhorse**	*Moxostoma carinatum*	Vulnerable	Special concern
Rock bass	*Ambloplites rupestris*	-	-
Sauger	*Stizostedion canadense*	-	-
Shorthead redhorse	*Moxostoma macrolepidotum*	-	-
Silver redhorse	*Moxostoma anisurum*	-	-
Smallmouth bass	*Micropterus dolomieu*	-	-

[44] Ottawa Riverkeeper, 2023b.

Spottail shiner	*Notropis hudsonius*	-	-
Trout-perch	*Percopsis omiscomaycus*	-	-
Walleye	*Stizostedion vitreum*	-	-
White perch	*Morone americana*	-	-
Yellow perch	*Perca flavescens*	-	-

The Future in a Changing Climate

With climate change, temperatures will rise in the coming years, which will impact freshwater fish species that will be confronted by various challenges. Among these, alterations to seasonal patterns, including shifts in rainfall and the freezing and melting of rivers, pose a significant threat.[45] Moreover, rising water temperatures represent a threat to fish species as it leads to a decrease in dissolved oxygen levels in the water, a lower pH (more acidic) and higher conductivity.[45] These rapid changes in water temperature and other physical parameters can create lethal conditions for certain fish species, resulting in heightened mortality rates[46] or, at least, impact fish health, reproduction and survival. These changes are anticipated to become increasingly dramatic and unpredictable, posing a considerable concern for our freshwater ecosystems.[47]

Furthermore, vulnerable, threatened, or endangered populations face an increased risk of extinction due to these adverse effects on their habitats. Indeed, fish species have evolved to live in a certain habitat with precise characteristics such as depth range and water-temperature range.[47] With changes to the river habitat, some species may survive better and take more place in the river, whereas the populations of others may decrease or completely vanish.[46] These changes will impact the possibility of accessing wildlife food for community members.

[45] Ottawa Riverkeeper, 2023b.
[46] Marco-Lopez *et al.*, 2010.
[47] Lynch *et al.,* 2016.

Adapting to the Impacts of Climate Change

Strategies from Kanehsatà:ke community members, employees and elected chiefs are presented in Table 7 below.

Table 7. Strategies to Implement Against Climate Change – Fish.

Objectives	Activities	Timeframe	Budget	Potential Partners
Protect the species at risk in the river	Monitor important fish species in the Ottawa River Create a conservation plan for the fish species at risks and their habitat that are on the territory of Kanehsatà:ke	Mid-term	$$	Ottawa River Association, watershed organizations, Fisheries and Ocean Canada

Animals, Birds and Insects

Current Conditions

In recent years, the species composition in the area surrounding the community has undergone noticeable changes, affecting various animals, birds, amphibians, and insects. Some species have experienced a shift in their abundance, with certain species becoming more prevalent while others have declined or even disappeared. Additionally, new species have been observed near the community. Members have reported a decrease in the sightings of jays, cardinals, ducks, bullfrogs, foxes, butterflies (such as the Monarch), grasshoppers, and bees.[48] Conversely, there has been an increase in the presence of ticks, coyotes, sparrowhawks, turkeys, bears, mice, squirrels, beavers, and rabbits, with these species either being newcomers or becoming more common in the area.[48] Moreover, community members have noted an increased prevalence of deer, regarded as symbolic leaders among the animals, while the bald eagle, symbolic leader of the birds, has become rarer (Thanksgiving Address – A1). These observations highlight the dynamic nature of the local ecosystem and the impacts of changing environmental conditions on the distribution and abundance of species.

The abundance of endangered or vulnerable species in the region serves as a clear indication of the ecological challenges faced in the area. Within a 50 km radius of Kanehsatà:ke, six bird species, three turtle species, and one frog species have been designated as endangered or vulnerable[49] (Table 8; Endangered and Vulnerable Animal Species Distribution map). It is important to note that numerous other species, although not currently listed, could potentially face the same fate if their population health deteriorates in the future. Hence, the community has created a plan for the conservation of the Monarch Butterfly, by planting milkweed to improve access to food for the endangered butterflies.

These changes in species' abundance and type highlights the pressing need for conservation efforts and proactive measures to safeguard the biodiversity of the area and ensure the continued survival of important species.

Table 8. Animal Species With Status Near Kanehsatà:ke.[49]

Species Name (English name)	Species Name (Scientific name)	Type	Status of the Species (Quebec)	Status of the Species (Canada)
Bald eagle	*Haliaeetus leucocephalus*	Bird	Vulnerable	-
Peregrine falcon	*Falco peregrinus anatum*	Bird	Vulnerable	Threatened
Red-headed woodpecker	*Melanerpes erythrocephalus*	Bird	Threatened	Endangered
Loggerhead shrike	*Lanius ludovicianus*	Bird	Threatened	Endangered
Yellow rail	*Coturnicops noveboracensis*	Bird	Threatened	Special concern
Least bittern	*Ixobrychus exilis*	Bird	Vulnerable	Threatened

[48] Community interviews, Kanehsatà:ke, September 2022.
[49] AERN, 2023a; CDPNQ, 2023.

Wood turtle	*Glyptemys insculpta*	Reptile	Vulnerable	Threatened
Common map turtle	*Graptemys geographica*	Reptile	Vulnerable	Special concern
Spiny softshell	*Apalone spinifera*	Reptile	Threatened	Endangered
Western chorus frog	*Pseudacris triseriata*	Amphibian	Threatened	Threatened
Monarch	*Danaus plexippus*	Insect	-	Endangered

The community is also experiencing the emergence and spread of invasive bug species such as Japanese beetles (*Popillia japonica*), Asian Lady Beetles (*Harmonia axyridis*), ash borers (*Agrilus planipennis*), black slugs (*Arion ater*),[50] as well as certain species of caterpillars, wasps, and spiders.[51] These invasive insects threaten both the environment and the well-being of the people. They can cause damage to native plant species, disrupt ecological balance, and potentially impact agricultural activities. Addressing and managing the presence of these invasive species is crucial to maintaining the health and sustainability of the local ecosystem and ensuring the community's overall well-being.

Moreover, the impacts of climate change can contribute to the spreading of diseases such as trichinella; a parasite in bears; *Francisella tularensis,* a bacteria found in rabbits; and Lyme disease, a bacteria carried by blacklegged ticks.[52] Community members are particularly at risk of catching Lyme disease, which is transmitted to humans through the bite of infected ticks. These ticks can be found on dear, dogs, and wild grass. Typical symptoms of the disease include fever, headache, fatigue, and a characteristic skin rash and, if left untreated, infection can spread to joints, the heart, and the nervous system. The map bellow, entitled Lyme Disease Distribution and Risk illustrates the locations of the highest risk of catching the disease. Even though the community is in the *possible* risk category, it is more likely that the risk is *significant* and there is just not enough information about ticks in Kanehsatà:ke.

The Future in a Changing Climate

Climate change adversely affects the survival of endangered species in several ways. Firstly, rising temperatures can disrupt the delicate balance of ecosystems, altering habitats and negatively impacting the species that rely on them. Changes in temperature can affect reproductive patterns, migration routes, and availability of food sources, making it difficult for endangered species to adapt and thrive (see Endangered and Vulnerable Animal Species Distribution map). Secondly, climate change is linked to extreme weather events such as hurricanes, droughts, and wildfires. These events can directly destroy habitats, reduce food availability, and lead to population decline and even extinction. Furthermore, climate change can disrupt the intricate ecological relationships between species. For example, changes in temperature can cause mismatches in timing between predators and prey or disrupt pollination patterns, threatening the survival of species that depend on these relationships for their survival. Lastly, climate change can exacerbate existing stressors and threats that endangered species already face, such as habitat loss, pollution, and

[50] AERN, 2023a; CDPNQ, 2023.

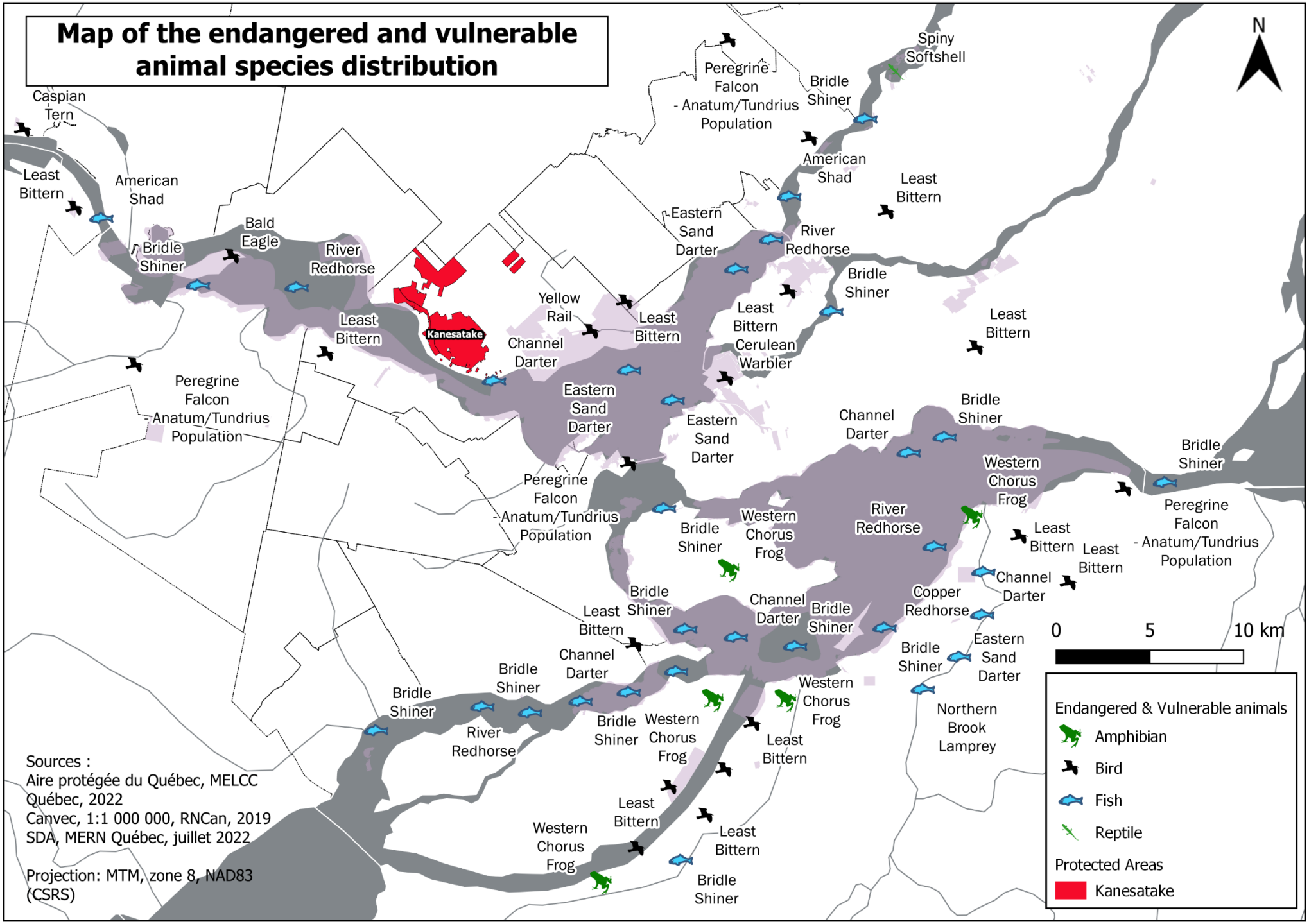
[51] Community interviews, Kanehsatà:ke, September 2022.

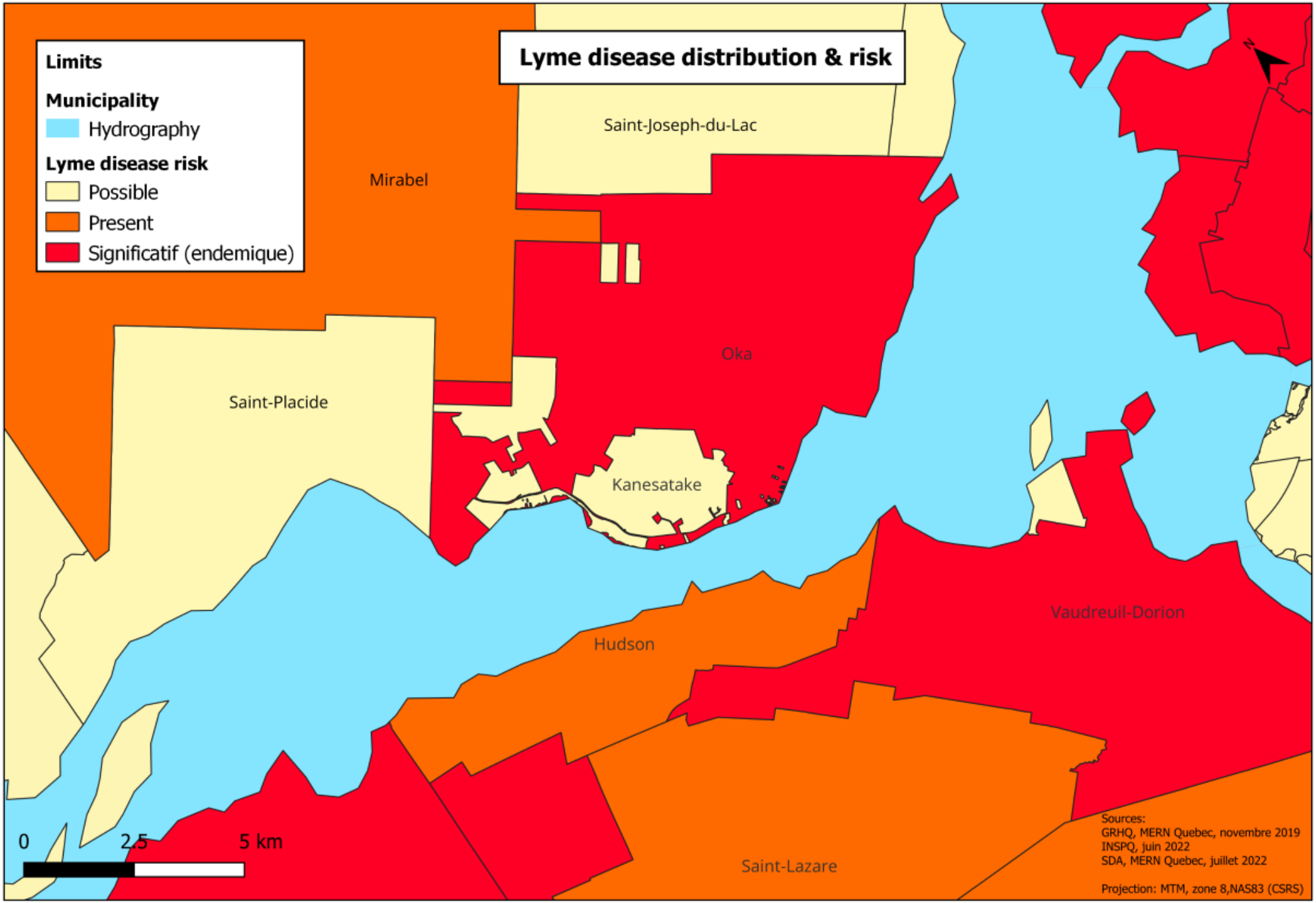
[52] Health Director, Kanehsatà:ke, July 2022; Quebec, 2023.

invasive species. These cumulative impacts can further diminish their chances of survival.[53] Moreover, with climate change, some diseases can become more common, especially ones carried by animals since their distribution might change considerably due to climate change.

Lastly, some species that are culturally important may decrease, such as the bald eagle and bees since they are already vulnerable to climate change and habitat modification. Bees play a crucial role in the ecosystem by facilitating the pollination of plants, cultivated or picked by community members, through the transfer of pollen from male to female plant parts.

[53] Alberti-Dufort *et al.*, 2022.


Map of the endangered and vulnerable animal species distribution
N
Caspian Tern
Least Bittern
American Shad
Bridle Shiner
Bald Eagle
River Redhorse
Least Bittern
Kanesatake
Yellow Rail
Channel Darter
Least Bittern
Peregrine Falcon Anatum/Tundrius Population
Eastern Sand Darter
Peregrine Falcon - Anatum/Tundrius Population
Bridle Shiner
Western Chorus Frog
River Redhorse
Least Bittern
Channel Darter
Bridle Shiner
Least Bittern
Channel Darter
Bridle Shiner
Bridle Shiner
River Redhorse
Bridle Shiner
Western Chorus Frog
Least Bittern
Western Chorus Frog
Least Bittern
Bridle Shiner
Peregrine Falcon - Anatum/Tundrius Population
Spiny Softshell
Peregrine Falcon - Anatum/Tundrius Population
Bridle Shiner
American Shad
Least Bittern
Eastern Sand Darter
River Redhorse
Bridle Shiner
Least Bittern
Cerulean Warbler
Least Bittern
Channel Darter
Bridle Shiner
Eastern Sand Darter
Western Chorus Frog
Bridle Shiner
Peregrine Falcon - Anatum/Tundrius Population
Least Bittern
Least Bittern
Channel Darter
Copper Redhorse
Bridle Shiner
Eastern Sand Darter
Northern Brook Lamprey
0
5
10 km
Endangered & Vulnerable animals
Amphibian
Bird
Fish
Reptile
Protected Areas
Kanesatake
Sources :
Aire protégée du Québec, MELCC Québec, 2022
Canvec, 1:1 000 000, RNCan, 2019
SDA, MERN Québec, juillet 2022
Projection: MTM, zone 8, NAD83 (CSRS)


Lyme disease distribution & risk
Limits
Municipality
Hydrography
Lyme disease risk
Possible
Present
Significatif (endemique)
Saint-Joseph-du-Lac
Mirabel
Oka
Saint-Placide
Kanesatake
Vaudreuil-Dorion
Hudson
Saint-Lazare
0
2.5
5 km
N
Sources:
GRHQ, MERN Quebec, novembre 2019
INSPQ, juin 2022
SDA, MERN Quebec, juillet 2022
Projection: MTM, zone 8,NAS83 (CSRS)

Adapting to the Impacts of Climate Change

Strategies from Kanehsatà:ke community members, employees and elected chiefs are presented in Table 9 below.

Table 9. Strategies to Implement Against Climate Change – Animals, Birds and Insects.

Objectives	Activities	Timeframe	Budget	Potential Partners
Management & conservation of biodiversity	Map the local areas of important or endangered species Survey animals that are living on the territory to learn about the health of animal populations Manage species within the territory	Mid-term	$$	Eco-museum, TerraHumana, University of Ottawa
Create protected areas in the community	Chose areas with a high biodiversity level Raise awareness and consider the next 7 generations in the planification and use of these locations Create walking paths to give people respectful access to the conservation areas	Long-term	$$	Band Council, schools, Grand Conseil de la Nation Waban-Aki (similar project)
Create a plan to manage invasive species within the territory	Create a monitoring program of the black legged tick Inform the population of the problems and risks linked to black legged ticks.	Short/mid term	$$	

Trees

Current Conditions

Trees have many uses and purposes for community members. They provide shade and oxygen, they produce nuts and sap that people can eat, and they are used in arts and crafts activities.[54] The pine forest—on the east side of the community—represents a rich cultural and historical location that community members still use today for sports and cultural events.[55]

In recent years, some species, such as the ash, elm, pine, apple tree and the maple, the leader of the trees (Thanksgiving Adress – Appendix 1) have become sick with fungi or insects.[54] In Oka Park near Kanehsatà:ke, many ash trees have suffered or died from ash borer (insect) infestations. This impacts the making of black ash baskets, a valued cultural practice, that is at risk of disappearing.[56] Traditionally, the wooden stick for lacrosse was made from hickory trees, which are now rare in the region.[57] Today, they are mostly made with ash trees which, as indicated above, are also in precarious health.

The Future in a Changing Climate

Anticipated changes in climate could have positive impacts on tree growth in the short to medium term. Trees are already showing some direct impacts of higher temperatures, such as earlier bud burst. However, these growth gains could be limited by temperature increases that exceed the tolerance threshold of certain species.[58] Also, if some species grow faster or survive better than the others, changes in the ecosystem balance could be seen in the future.

The six maps below (Past and Future Distribution of Culturally-Important Trees) summarize the future habitat suitability and abundance distribution of different tree species, based on their actual needs and climate projections. Five tree species are of particular interest, based on their local presence and cultural use. The red pine species shows limited availability of new habitat, with several or more favourable habitats located towards the northern part of the community. However, there are many less favourable habitats and habitat loss within the community, suggesting a potential decrease in abundance over time. On the other hand, the sugar maple species has many favourable habitats, but lacks new or more favourable habitats. In the eastern and southern regions of the community, there is a decline in favourable habitat and habitat loss. In contrast, both the bitternut hickory and shagbark hickory species have many new or more favourable habitats, although there is a lack of habitat in the northern areas. These species are expected to fare well in their future habitats. The red ash species has few new habitats, but there is a significant presence of favourable habitat. However, in the northern part of the community, a lack of habitat is projected to occur over time. Nevertheless, this species shows a promising ability to survive in the future climate and habitat

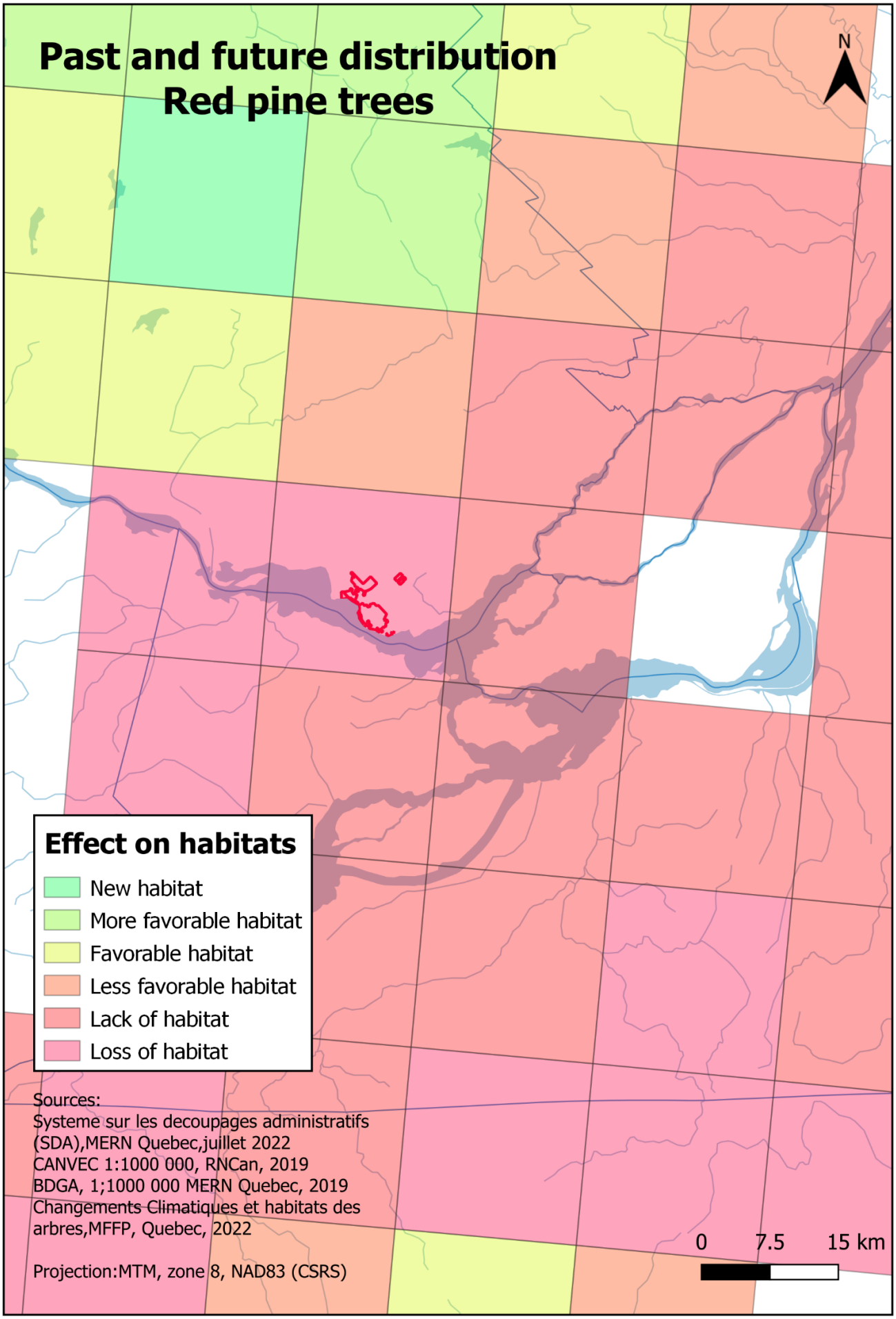
[54] Community interviews, Kanehsatà:ke, September 2022.
[55] Health Director, Kanehsatà:ke, July 2022.
[56] Culture Center Director, Kanehsatà:ke, April 2022.
[57] Meagher, 2016.
[58] Alberti-Dufort *et al.,* 2022.

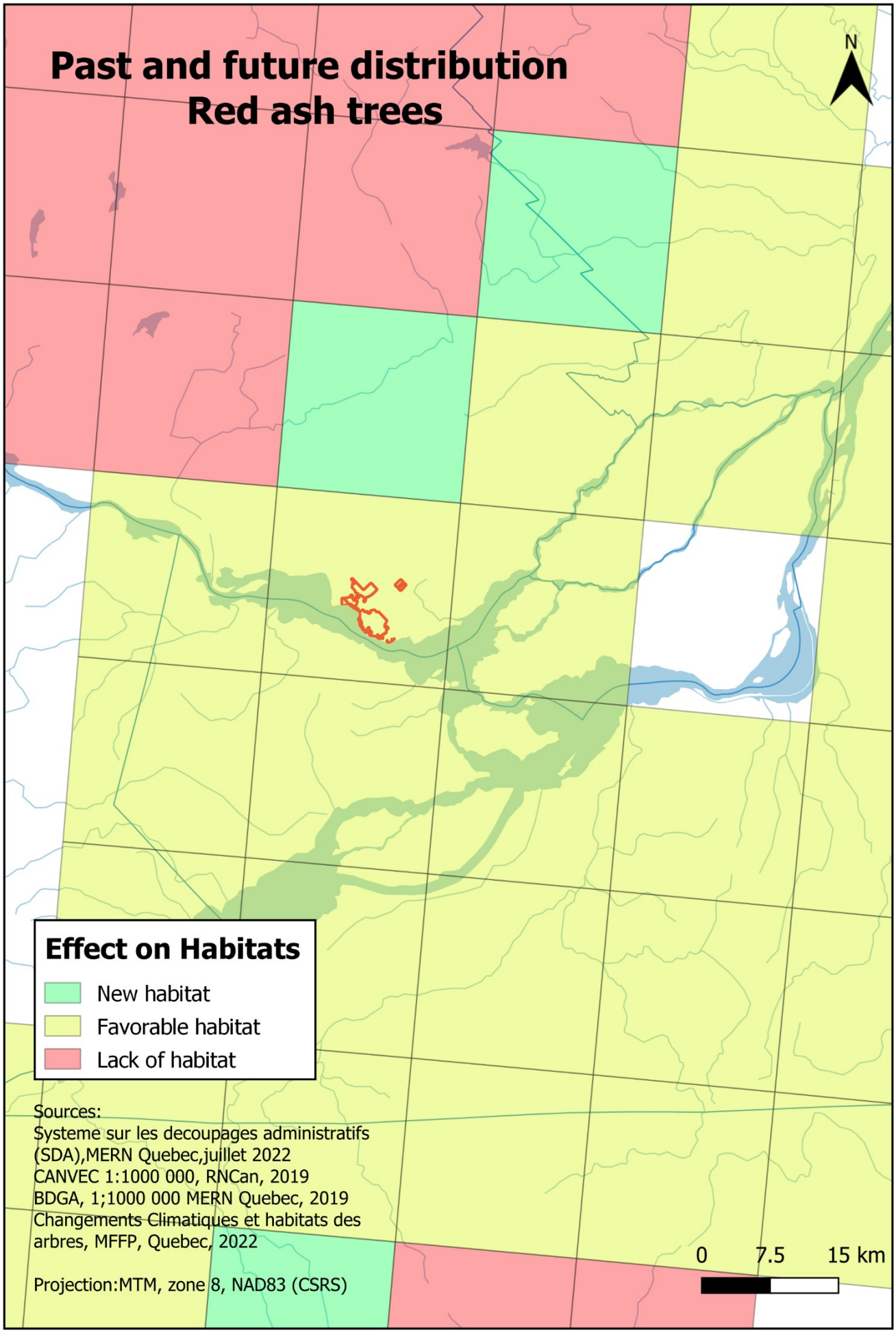
conditions. Lastly, the black ash species faces challenges as almost all habitats become less favourable. This species is likely to struggle in adapting to future conditions.

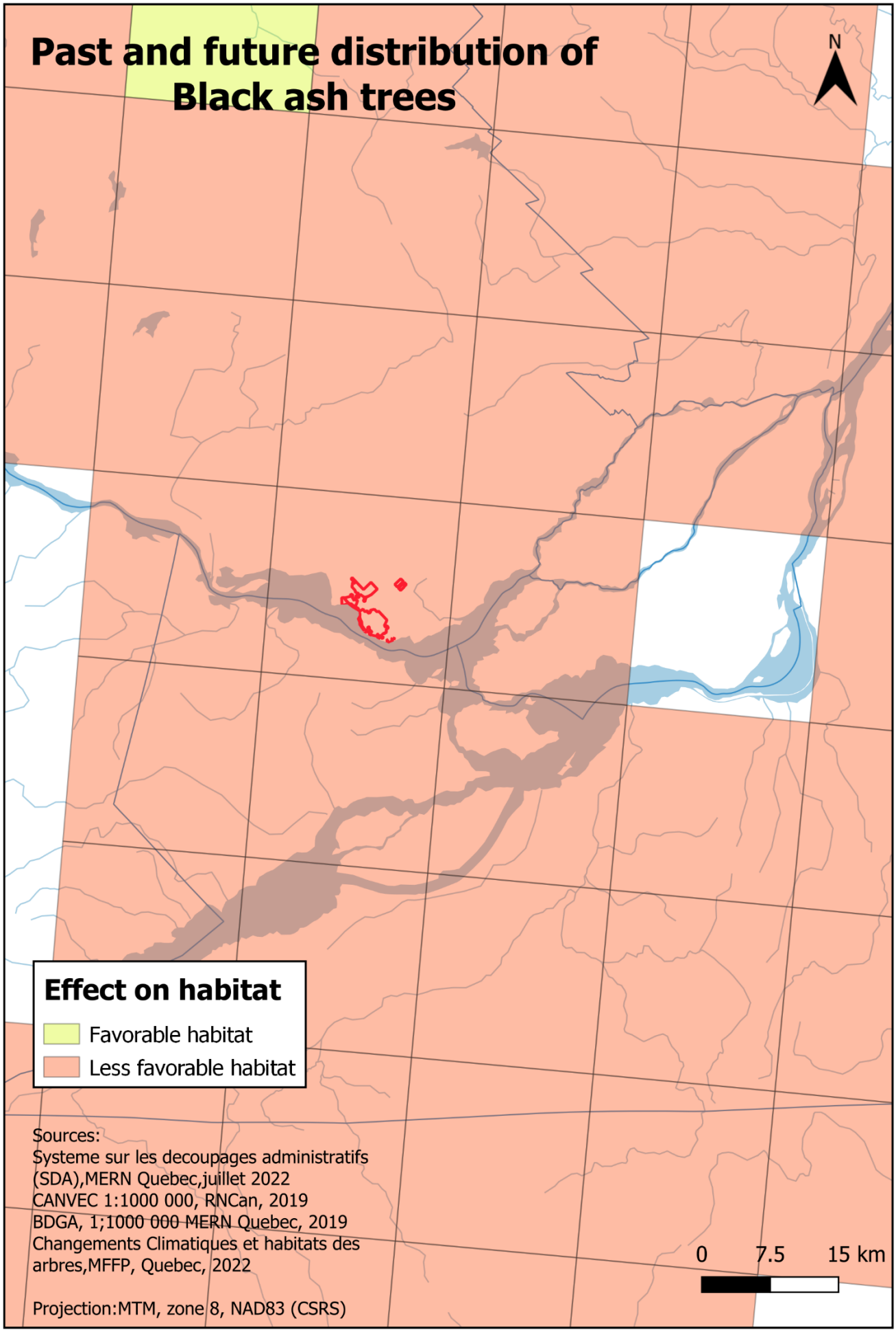
Furthermore, temperature increases and changes in precipitation regimes could dry trees and soil matter and increase the risk of forest fires.[59] Also, the concentration of freeze-thaw cycles during winter is likely to increase the damage caused to trees. In addition to affecting their normal growth and shape, the injuries inflicted by freezing rain can make trees more vulnerable to damage from insects and disease. The climate's increased propensity for storms and more frequent freeze-thaw episodes in winter also leads to a rise in injuries related to falls or the collapse of structures, as well as tree and debris falling incidents. These factors contribute to an elevated risk of injuries and damages associated with winter weather events.[60]

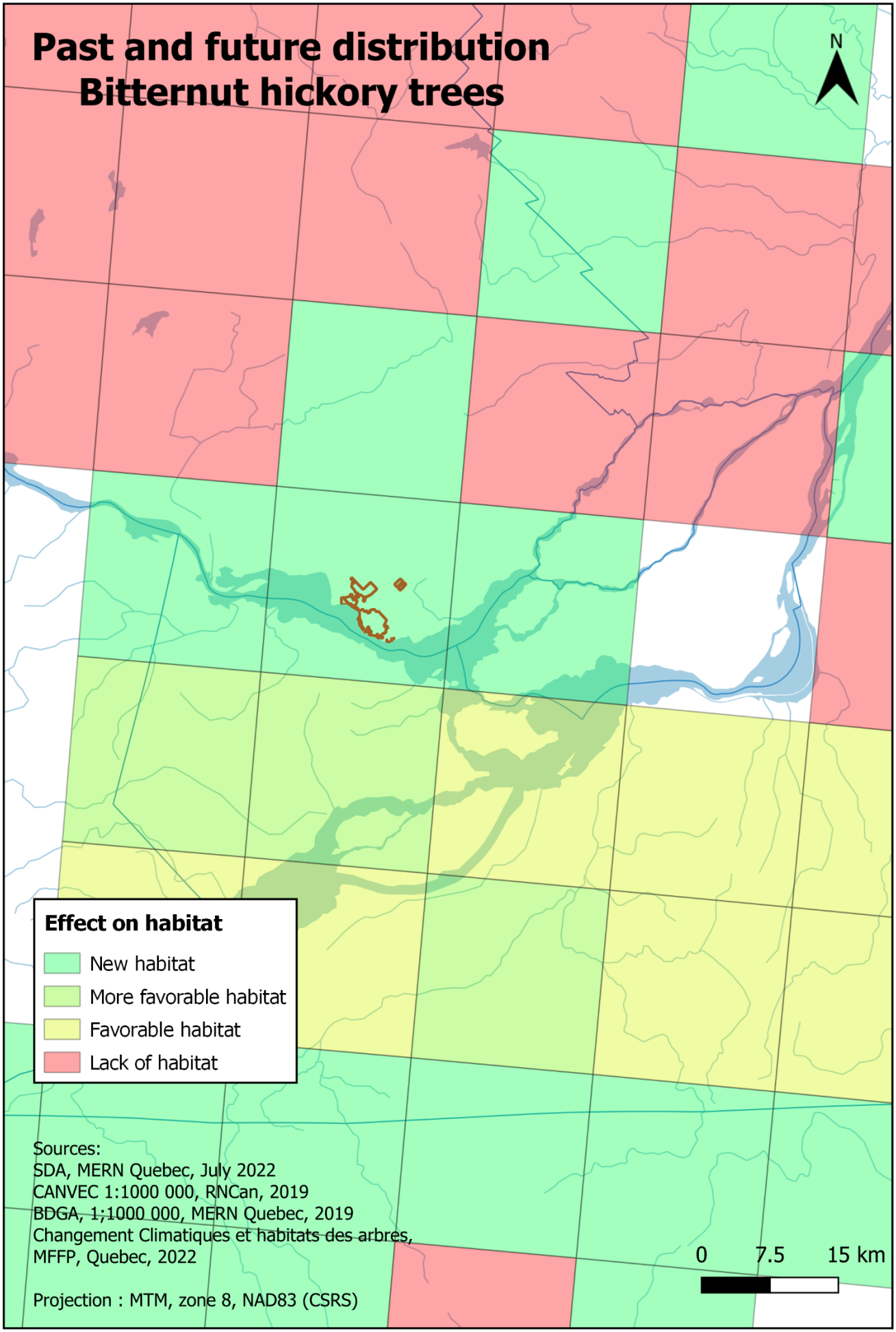
Moreover, maple syrup production is vulnerable to climate change because it depends entirely on a precise temperature range. Indeed, the sap is abundant only when daytime temperatures are above zero and night temperature below zero degrees Celsius. With springs arriving earlier, producers must begin tapping and sap harvesting operations earlier to avoid yielding losses. Over time, the season will become increasingly shorter until the right temperature range is no longer present.[61]

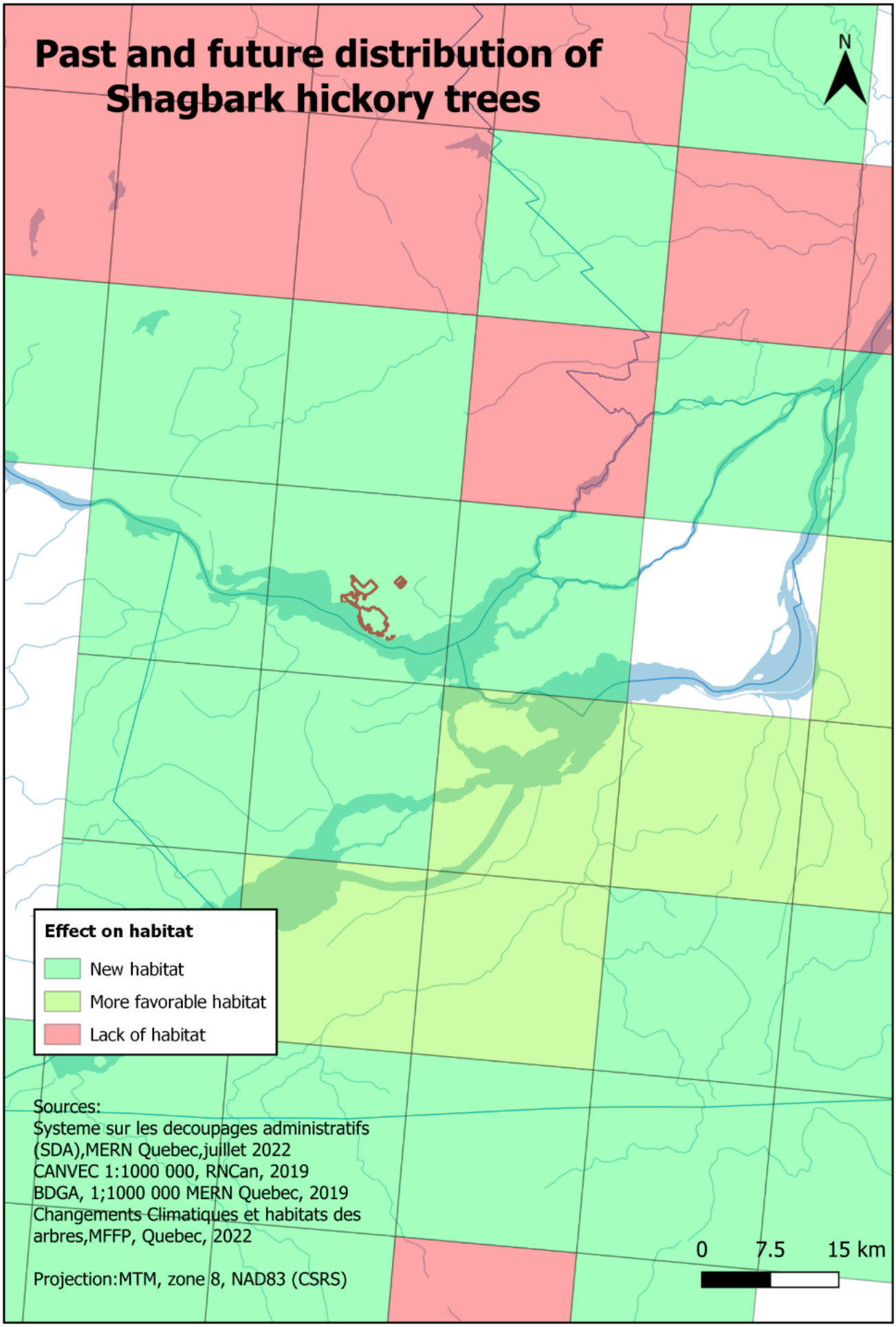
[59] Ouranos, 2017.
[60] Prairie Climate Centre, 2019a.
[61] Alberti-Dufort *et al.,* 2022.

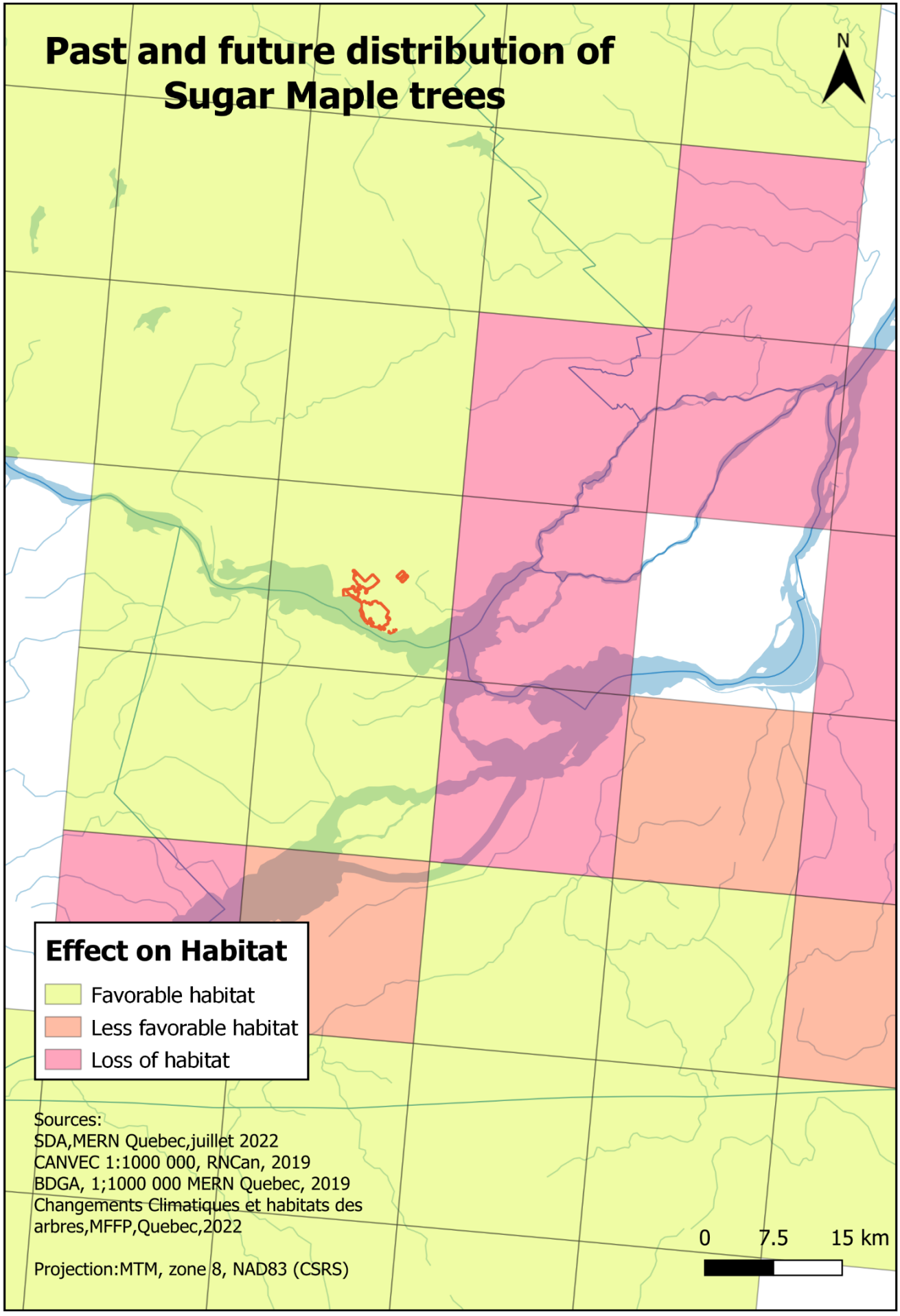

Past and future distribution
Red pine trees
N
Effect on habitats
New habitat
More favorable habitat
Favorable habitat
Less favorable habitat
Lack of habitat
Loss of habitat
Sources:
Systeme sur les decoupages administratifs (SDA),MERN Quebec,juillet 2022
CANVEC 1:1000 000, RNCan, 2019
BDGA, 1;1000 000 MERN Quebec, 2019
Changements Climatiques et habitats des arbres,MFFP, Quebec, 2022
Projection:MTM, zone 8, NAD83 (CSRS)
0
7.5
15 km


Past and future distribution
Red ash trees
N
Effect on Habitats
New habitat
Favorable habitat
Lack of habitat
Sources:
Systeme sur les decoupages administratifs (SDA),MERN Quebec,juillet 2022
CANVEC 1:1000 000, RNCan, 2019
BDGA, 1;1000 000 MERN Quebec, 2019
Changements Climatiques et habitats des arbres, MFFP, Quebec, 2022
Projection:MTM, zone 8, NAD83 (CSRS)
0
7.5
15 km


Past and future distribution of Black ash trees
N
Effect on habitat
Favorable habitat
Less favorable habitat
Sources:
Systeme sur les decoupages administratifs (SDA),MERN Quebec,juillet 2022
CANVEC 1:1000 000, RNCan, 2019
BDGA, 1;1000 000 MERN Quebec, 2019
Changements Climatiques et habitats des arbres,MFFP, Quebec, 2022
Projection:MTM, zone 8, NAD83 (CSRS)
0
7.5
15 km


Past and future distribution
Bitternut hickory trees
N
Effect on habitat
New habitat
More favorable habitat
Favorable habitat
Lack of habitat
Sources:
SDA, MERN Quebec, July 2022
CANVEC 1:1000 000, RNCan, 2019
BDGA, 1;1000 000, MERN Quebec, 2019
Changement Climatiques et habitats des arbres,
MFFP, Quebec, 2022
Projection : MTM, zone 8, NAD83 (CSRS)
0
7.5
15 km


Past and future distribution of Shagbark hickory trees
N
Effect on habitat
New habitat
More favorable habitat
Lack of habitat
Sources:
Systeme sur les decoupages administratifs (SDA),MERN Quebec,juillet 2022
CANVEC 1:1000 000, RNCan, 2019
BDGA, 1;1000 000 MERN Quebec, 2019
Changements Climatiques et habitats des arbres,MFFP, Quebec, 2022
Projection:MTM, zone 8, NAD83 (CSRS)
0
7.5
15 km


Past and future distribution of Sugar Maple trees
N
Effect on Habitat
Favorable habitat
Less favorable habitat
Loss of habitat
Sources:
SDA,MERN Quebec,juillet 2022
CANVEC 1:1000 000, RNCan, 2019
BDGA, 1;1000 000 MERN Quebec, 2019
Changements Climatiques et habitats des arbres,MFFP,Quebec,2022
Projection:MTM, zone 8, NAD83 (CSRS)
0
7.5
15 km

Adapting to the Impacts of Climate Change

Strategies from Kanehsatà:ke community members, employees and elected chiefs are presented in Table 10 below.

Table 10. Strategies to Implement Against Climate Change – Trees.

Objectives	Activities	Timeframe	Budget	Potential Partners
Monitor trees to lean about their species, abondance and health	Learn about what makes trees sick Cut the sick trees and plant new ones (native species) Monitor the tree canopy index	Mid-term	$$	MFFP for free trees every May
Reduce wildfire risks in the community	Monitor bush condition and dryness to know the fire risks Promote safe fire practices with community members Organized community cleanup activity Stay alert to wildfire risks (https://sopfeu.qc.ca/en/restrictions/) and provide members with the information	Mid-term	$	SOPFEU for fire risks level and prevention tools

Roots, Plants and Medicines

Current Conditions

Plants hold immense cultural significance within the community, serving multiple purposes such as sustenance, healing, and artistic expression. They are deeply intertwined with Mohawk traditions and are valued for their diverse uses. Wild berries, including strawberries, which are regarded as the "leader" of the berries, along with raspberries, blackberries, and grapes, are essential components of the traditional diet. In addition to their delicious flavour, these berries offer numerous health benefits, aiding in the prevention of chronic and cardiovascular ailments such as diabetes and hypertension. The knowledge of their medicinal properties and nutritional value is passed down through generations, highlighting the importance of these plants in maintaining the well-being and cultural heritage of the Mohawk people.[62]

However, the impact of higher temperatures on wild berries is concerning, as their abundance has significantly diminished, and the ones that do manage to grow are often small or dry.[63] The early onset of hot temperatures in spring, followed by sudden cooling, poses a significant challenge to these plants, both wild and cultivated, as they emerge from their winter vegetative rest.[62] Furthermore, the dry conditions experienced in summer adversely affect the growth and availability of medicinal plants, compromising the production of essential oils that contribute their healing properties.[63] Consequently, the reduced abundance and diminished medicinal potency of these plants have major implications for their traditional use in healing practices within the Mohawk community.

Within a radius of 50 km of Kanehsatà:ke, there are many endangered and vulnerable plant species, highlighting the importance of conservation efforts (Table 11).

Table 11. Plant Species With Status Near Kanehsatà:ke.[64]

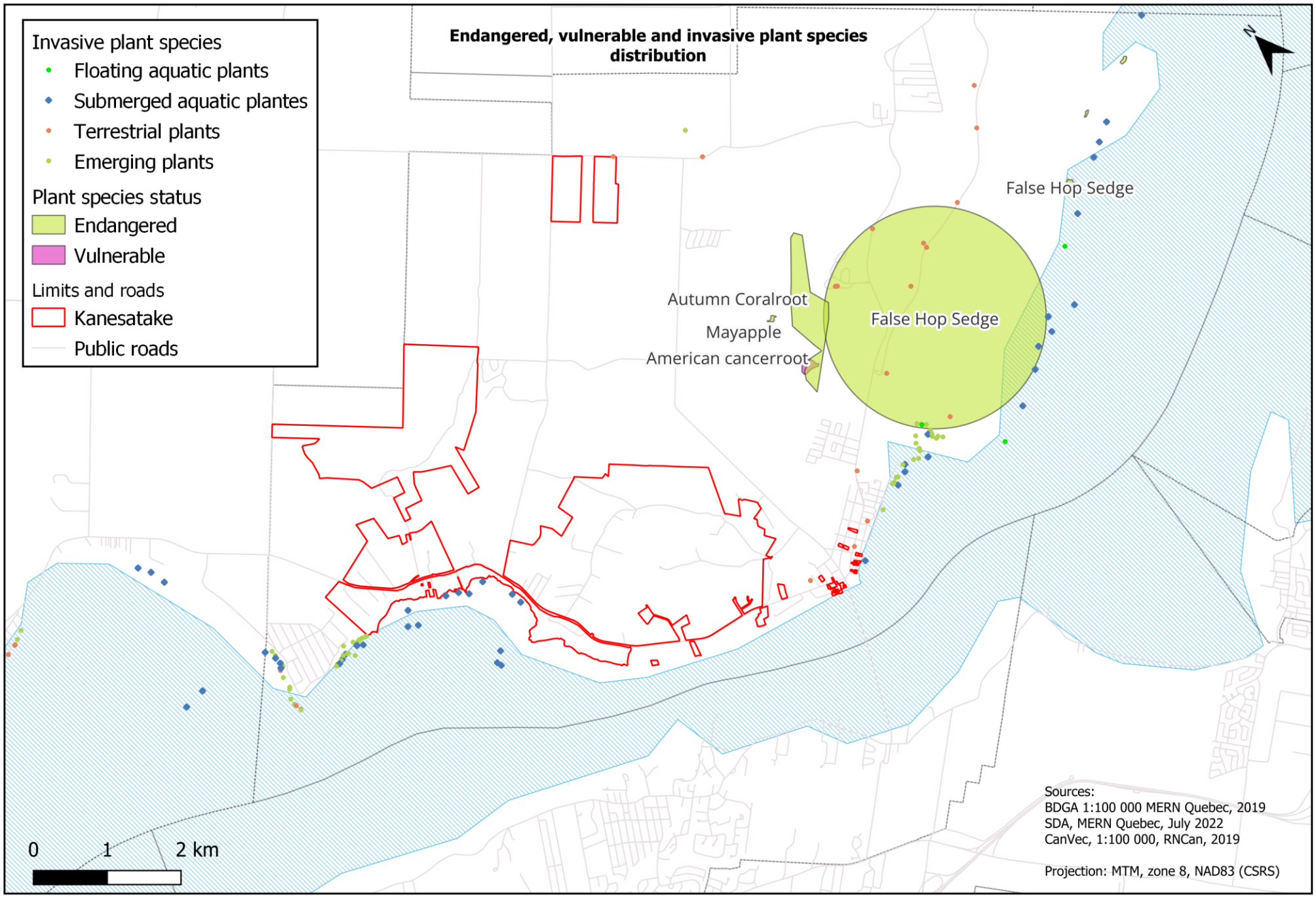
Species Name (English name)	Species Name (Scientific name)	Status of the Species (Quebec)	Status of the Species (Canada)
Small white leek	*Allium tricoccum*	Vulnerable	-
Green dragon	*Arisaema dracontium*	Threatened	Special concern
Forked three-awned grass	*Aristida basiramea*	Threatened	Endangered
False hop sedge	*Carex lupuliformis*	Threatened	Endangered
White wood-aster	*Eurybia divaricata*	Threatened	Threatened
Common water-willow	*Justicia americana*	Threatened	Threatened
Spring forget-me-not	*Myosotis verna*	Threatened	-
Southern twayblade	*Neottia bifolia*	Threatened	-

[62] Community interviews, Kanehsatà:ke, September 2022.
[63] Alberti-Dufort *et al.,* 2022.
[64] CDPNQ, 2022.

Mayapple	*Podophyllum peltatum*	Threatened	-
American cancerroot	*Conopholis americana*	Vulnerable	-
Autumn coralroot	*Corallorhiza odontorhiza var. odontorhiza*	Threatened	-
False mermaidweed	*Floerkea proserpinacoides*	Vulnerable	-
Douglas' knotweed	*Polygonum douglasii*	Vulnerable	-
Lizard's tail	*Saururus cernuus*	Threatened	-

In addition to existing plant species, new species have emerged in the area, including invasive plants that pose significant challenges to ecosystems and human well-being. For instance, the giant hogweed (*Heracleum mantegazzianum*) is known for its ability to cause severe burns on the skin when individuals come into contact with its sap. Moreover, the Eurasian watermilfoil (*Myriophyllum spicatum*) and Japanese knotweed (*Reynoutria japonica*) are highly invasive species that thrive due to their exotic nature and lack of natural predators. Their presence poses a threat to native plants and biodiversity as they can outcompete and overpower local species. Efforts to manage and control these invasive species are crucial to protect the integrity of the ecosystem and mitigate their adverse impacts on both the environment and communities.

The Endangered, Vulnerable and Invasive Plant Species Distribution map provided below depicts the boundaries of invasive species (indicated by green and pink polygons) and the distribution of aquatic and terrestrial plants (indicated by coloured dots) with their respective status. To safeguard these species at risk, specific locations have intentionally been omitted from the map to ensure their protection. The presence of these endangered and vulnerable plant species serves as an important reminder of the urgency to safeguard and preserve them within the local ecosystem. It underscores the importance of implementing measures to protect their habitats and promote their long-term survival.


Endangered, vulnerable and invasive plant species distribution
Invasive plant species
Floating aquatic plants
Submerged aquatic plantes
Terrestrial plants
Emerging plants
Plant species status
Endangered
Vulnerable
Limits and roads
Kanesatake
Public roads
False Hop Sedge
Autumn Coralroot
Mayapple
American cancerroot
False Hop Sedge
N
0
1
2 km
Sources:
BDGA 1:100 000 MERN Quebec, 2019
SDA, MERN Quebec, July 2022
CanVec, 1:100 000, RNCan, 2019
Projection: MTM, zone 8, NAD83 (CSRS)

The Future in a Changing Climate

Climate change has significant impacts on local plant life. Indeed, the region has historically experienced consistent and predictable snow cover during the winter season, which provided insulation and protection for plants against extreme cold. However, with the changing climate, the duration and depth of snow cover have become less reliable. This erratic snow cover disrupts the natural growth and development cycles of plants, leading to various consequences. For instance, some plant species rely on a prolonged period of snow cover to provide a protective layer and ensure proper dormancy. Without sufficient snow cover, these plants are more vulnerable to frost damage and increased exposure to harsh winter conditions. Additionally, irregular snow cover affects the moisture content of the soil, leading to fluctuations in water availability for plants during critical growth stages. This imbalance can impact plant health, nutrient uptake, and overall productivity. Furthermore, altered snow cover dynamics can also affect the timing of spring growth and flowering, which may disrupt the synchronization between plants and their pollinators or other ecological interactions. To mitigate the negative impacts of changing snow cover, it is crucial to monitor and understand these changes and implement appropriate adaptive measures to support the resilience and survival of plant species in the region.

Climate change is exerting a profound influence on the presence and distribution of plants in the surrounding area of the community. As temperatures rise and precipitation regimes are altered, drier conditions prevail, and some plant species could be unable to withstand these challenging circumstances and face the risk of extinction. Conversely, these shifting habitats may create favourable conditions for the expansion and thriving of other plant species, like new species—including invasive ones—that could become more common in the community and create notable changes in these ecosystems.

Moreover, climate change introduces a growing desynchronization between the life stages of plants and the shifting temperatures, necessitating their adaptation to changing environmental conditions. This adaptation is crucial for their survival. However, these changes also have implications for people who traditionally rely on nature's cues, such as specific plant stages or the migration patterns of animals, to guide their activities like hunting, trapping, picking, and fishing. The unreliability of these bioindicators due to climate change disrupts the practise of these traditional activities and necessitates adaptations in response to the shifting dynamics of the natural world.

Thus, it is crucial to develop a comprehensive understanding of the changing plant composition and the potential ecological impacts associated with these transformations. By acknowledging and studying these changes, proactive measures can be taken to preserve and protect vulnerable species, while effectively managing the spread of invasive plants to ensure the integrity of the local ecosystem.

Adapting to the Impacts of Climate Change

Strategies from Kanehsatà:ke community members, employees and elected chiefs are presented in Table 12 below.

Table 12. Strategies to Implement Against Climate Change – Roots, Plants & Medicines.

Objectives	Activities	Timeframe	Budget	Potential Partners
Management & conservation of land and biodiversity	Map the local areas of important or endangered plant species, like berries and medicines (keep information secret so people won't overharvest) Create a conservation plan to manage important species within the territory	Mid-term	$$	Eco-museum, TerraHumana
Create protected areas in the community	Identify areas with a high biodiversity level Raise awareness and consider the next 7 generations in the planning and use of these areas	Long-term	$$	Band Council, schools, Nature Conservancy of Canada
Manage invasive species within the territory	Create a monitoring program for new and invasive plant species Inform the population of the problems and risks linked to invasive and dangerous plant species	Short/mid-term	$$	Nature Conservancy of Canada

Three Sisters and Agriculture

Current Conditions

The Mohawk Nation has a rich history of cultivating specific vegetables, notably the trio of squash, corn, and beans known as the three sisters, which complement each other harmoniously in agriculture. Elders of the community used to raise pigs and grow potatoes and corn, relying on the land for sustenance. However, the lack of available land has hindered these traditional practices, resulting in a shift away from a once self-sufficient and communal way of life. Memories of a time when people helped one another and practised effective food preservation techniques evoke a sense of nostalgia.[65]

Despite the decline in agriculture as a livelihood within the community, many individuals continue to cultivate the three sisters in their own backyards, preserving the cultural significance and knowledge associated with these crops. The landscape has undergone notable changes, with fewer fields and more trees. However, some community members take pride in their blueberry farm that boasts over 650 bushes and 23 different varieties, showcasing their resilience and determination to maintain their connection to the land.[65]

Within the community, tensions have arisen between non-Indigenous landowners and members of the Mohawk Nation due to the ownership and use of lands for conventional farming activities. These lands were originally Mohawk territory, but they are now subjected to the heavy use of pesticides by non-Indigenous farmers to combat diseases and invasive insects, resulting in environmental concerns.[66] The introduction of ladybugs, imported to control pests, has also altered the balance of local ecosystems. The community's renowned apple orchards have faced considerable challenges in the past decade, leading to the cutting down of many trees due to disease. As a result, vineyards have emerged as a replacement for the orchards.[65]

Finally, community members have observed the increasing difficulty in predicting weather patterns and determining the optimal time for transplanting plants in outdoor gardens. The onset of spring has become less defined, with warmer temperatures often followed by sudden cold spells that can be detrimental to new plantings.[65] The microclimate in the region, influenced by the surrounding mountains, contributes to a lack of rainfall and intensifies drought conditions. These evolving environmental factors pose significant challenges for the community and its agricultural practices.

The Future in a Changing Climate

Climate projections indicate that the frost season for the community is expected to decrease by 22 to 42 days (Table 13).[67] This reduction in frost days can have positive implications for agriculture, as there will be fewer days with below zero temperatures. Consequently, the growing season is projected to be longer, providing more time for crop development.

[65] Community interviews, Kanehsatà:ke, September 2022.
[66] Environment Director, Kanehsatà:ke, November 2022; Community interviews, Kanehsatà:ke, September 2022.
[67] Prairie Climate Centre, 2019a.

Furthermore, climate projections suggest minimal changes in the total number of freeze-thaw cycles. However, the seasonality of these cycles is expected to undergo major shifts. Winter is projected to experience more freeze-thaw events, while spring and fall will likely see a decrease in such occurrences.[68]

Nevertheless, it is important to note that climate projections also indicate an increase in heatwaves and droughts during the summer. These extreme weather events have the potential to negatively impact crop growth and productivity. It will be crucial for farmers to implement adaptation strategies, such as efficient irrigation systems and heat stress management, to mitigate the adverse effects of these changing climate conditions on crop cultivation.

Table 13. Future Frost Prediction for Kanehsatà:ke Based on a High Carbon Emission (RCP8.5) Scenario.[67]

Variable	1976–2005	2021–2050		2051–2080	
	Real mean value	Predicted mean value	Change	Predicted mean value	Change
Frost-free season	160 days	182 days	↑ 14%	202 days	↑ 26%
Date of last spring frost	April 29	April 20	↓ 9 days	April 11	↓ 18 days
Date of first fall frost	Oct. 9	Oct. 22	↑ 13 days	Nov. 2	↑ 24 days
Growing season precipitation (mm from April 1 to Oct. 31)	594 mm	620 mm	↑ 4%	626 mm	↑ 5%

Food security is becoming an issue for some members of the community, since there is less agriculture done by members due to the lack of available land; there are more insect pests that attack cultures and there is no community garden or greenhouse to help members in need. Changes in climate can influence agricultural practices, including the use of fertilizers and pesticides. Incorrect application of these chemicals due to changing weather patterns can lead to increased pollution of nearby water bodies, as well as more pesticides in the food that is being eaten.

Overall, the anticipated decrease in the frost season, the altered seasonality of freeze-thaw cycles, and the projected increase in heatwaves and droughts and bugs abundance, present both opportunities and challenges for crop agriculture. Adapting to these changes will be essential to ensuring the resilience and sustainability of farming practices in the community. By incorporating resilient farming practices, such as improved irrigation systems, crop diversification, and heat stress management, the community can better navigate the challenges and opportunities presented by these future climate projections.

[68] Ouranos, 2015.

Adapting to the Impacts of Climate Change

Strategies from Kanehsatà:ke community members, employees and elected chiefs are presented in Table 14 below.

Table 14. Strategies to Implement Against Climate Change – Three Sisters & Agriculture.

Objectives	Activities	Timeframe	Budget	Potential Partners
Build a community greenhouse to help with food security & sovereignty	Create a committee to oversee the greenhouse project Assess different options for the greenhouse (location and type, i.e., below the frost level of the ground) Involve youth and elders in greenhouse management	Mid-term	$$	Ideas: greenhouse company, university, Lufa Farms
Build retention systems to keep natural waters accessible during droughts	Use areas that are already prone to flooding to build a retention system	Mid-term	$$$	Engineering firm
Prediction tool for freezing days	Use meteorological application (i.e., MétéoCAN) to warn members of the risk of frost in effect and help prevent impacts on the crops	Short-term	$	

Wind and Thunder

Current Conditions

In Mohawk culture, thunder holds symbolic significance as a representation of the grandfathers (Thanksgiving Address – Appendix 1). Over the past decade, an increase in severe storms has been observed, particularly in summer, characterized by stronger and more persistent winds throughout the year. Notably, tornado warnings have become a frequent occurrence in the area in the summer, whereas such events were exceptionally rare just a few decades ago.[69]

In addition to intensifying storms and stronger winds, the community has been grappling with the adverse consequences of these climatic changes, particularly in terms of power outages. High winds accompanying severe storms have resulted in frequent power cuts, disrupting the normal functioning of the community.[70] These power outages can have far-reaching effects, impacting essential services, communication networks, and daily activities that rely heavily on electricity. The increased frequency of these power disruptions highlights the need for robust infrastructure and emergency preparedness measures to mitigate the impact on the community's well-being and ensure the timely restoration of power.

The Future in a Changing Climate

In areas such as Kanehsatà:ke, extratropical depressions are the main component that impact the climate and its variability. However, the complexity of these depressions makes it difficult to analyze historical data and to project scenarios into the future. Currently, projections for a high-carbon scenario suggest a decrease in cyclonic activity over all major depression tracks affecting Quebec in winter for the period 2081–2100, compared to 1980–1999.[71]

To date, there have been insufficient models and projections addressing thunderstorms, making it difficult to establish a high level of confidence in the variation of thunderstorm occurrences over time. However studies conducted thus far suggest increasing frequency. According to these studies, thunderstorms are projected to bring more precipitation by the year 2100. Therefore, the research indicates that the climate will become more conducive to thunderstorm activity.[71]

The Intergovernmental Panel on Climate Change (IPCC) considers it almost certain that the frequency and intensity of the most intense hurricanes (categories 4 and 5 on the Saffir-Simpson Scale) have been on an upward trend since the 1970s. Quebec is indirectly affected by hurricanes when they develop into post-tropical cyclones. At this time, it is not yet possible to determine whether the frequency and intensity of post-tropical cyclones that cause severe weather events (torrential rains, strong winds, high waves) in

[69] Community interviews, Kanehsatà:ke, September 2022.
[70] High school workshop, Kanehsatà:ke, January 2023.
[71] Ouranos, 2015.

southern Quebec and the Gulf of St. Lawrence will change in the coming decades. However, it is possible to state that post-tropical cyclones will bring greater amounts of precipitation.[72]

It is also difficult to predict how tornadoes will develop in the future. Tornadoes form in particularly intense storm clouds in which the winds and energy present can trigger rotational motions. The conditions that can lead to the formation of tornadoes are specific and complex. For this reason, a future climate more conducive to thunderstorms may not necessarily result in an increase in tornadoes.[72]

Efforts to improve resilience and develop sustainable energy sources can play a crucial role in reducing the community's vulnerability to power outages caused by high winds or strong storms.

[72] Ouranos, 2015.

Adapting to the Impacts of Climate Change

Strategies from Kanehsatà:ke community members, employees and elected chiefs are presented in Table 15 below.

Table 15. Strategies to Implement Against Climate Change – Wind and Thunder.

Objectives	Activities	Timeframe	Budget	Potential Partners
Integrate storm and wind risks in the emergency plan	Finish the emergency plan with the emergency committee and integrate wind risks	Short-term	$	Band Council
Create a partnership with Red Cross to access help & money faster in an environmental emergency	Contact Red Cross and other local organizations to discuss a possible partnership to deal with future natural hazards	Mid-term	$	Band Council, Red Cross, other local organizations

Infrastructure and Energy Sources

Current Conditions

Infrastructure, including community buildings (schools, Band Council, Cultural Center, Health Center, daycare, etc.), houses, roads, dams, and electrical networks, can be significantly impacted by various natural hazards such as freeze-thaw cycles, heavy rainfall, flooding, and storms characterized by strong winds or tornadoes. These events have the potential to cause substantial damage and disruption to the affected infrastructure.

Houses

Currently, a significant portion of the investments required to address community housing needs comes from federal funding. Consequently, the Kanehsatà:ke Band Council is left to finance the remaining requirements through its own revenues. This has led to houses being overcrowded, which further exacerbates the deterioration of housing conditions and poses risks to health and social well-being.[73] These risks include respiratory diseases, flu, depression, strained family cohesion, and hindered academic success among youth, to name a few. Given these circumstances, the priority focus for community lies in maximizing the number of houses rather than emphasizing the resilience of housing to climate change impacts.[73]

The impact of floods extends beyond the natural environment, causing major damage to houses, buildings, and roads. The community of Kanehsatà:ke has recognized the importance of developing efficient and timely strategies for repairing infrastructure and communicating updates to community members in the event of natural hazards.[73] In response to 2019 flooding, the Grand Conseil de la Nation Waban-Aki (GCNWA) conducted assessments that revealed 24 houses were affected by the disaster. To mitigate future risks, the GCNWA proposed measures to address flooded houses, including filling basements and constructing sheds on the side. However, some residents preferred to retain their basements and opted for a second assessment to elevate their houses, a measure that was eventually implemented before subsequent flooding occurred. Relocation is currently unfeasible due to limited available land and financial constraints. While Indigenous Services Canada (ISC) provided funding for certain mitigation measures under the Building Back Better program, not all measures were covered by this assistance.

Exploring potential solutions, such as the construction of natural berms to elevate beachfront areas, considering non-residential zoning options, and evaluating the feasibility of retaining walls, could help mitigate these challenges.

Transportation

During storms, the safety of travel both within and outside the community becomes a concern. The road network plays a vital role in facilitating transportation for community members, ensuring the delivery of essential goods, food, and fuel. However, the occurrence of climate hazards can render roads impassable or unsafe, presenting challenging and potentially dangerous situations for residents.[73] For instance, winters

[73] Housing Sector, Kanehsatà:ke, September 2022.

have seen an increase in hazardous icy conditions on the roads, primarily caused by freezing rain episodes, making travel riskier.

Furthermore, the duration of the ice bridge over the Ottawa River, connecting Oka to Hudson, has been progressively shrinking during winter, causing inconvenience for those who rely on it when the ferry service is not operational.[74] The recurring issue of localized flooding resulting from frozen ditches, a consequence of freeze-thaw cycles, has also been a matter of ongoing concern.

Water infrastructure

Serious concerns have emerged regarding the Carillon Dam's structural integrity, as its potential failure would result in widespread flooding throughout the entire community.[75]

In 2020, the community experienced a period of low water levels, which also affected the wells due to drought conditions. To address these challenges, various strategies have been proposed, including implementing water retention techniques and conducting hydrological studies to rehabilitate creeks. Additionally, erosion has been identified as a pressing issue in specific drainage creeks, prompting the exploration of potential solutions such as harnessing currents for stabilization purposes.

Community members rely only on wells for their personal use of water, since no aqueduct exist in the community itself. The Location of Wells and Septic Systems in the Community map below highlights the locations of wells and septic systems, shedding light on water installations that were adversely affected by flooding. These installations were situated within the flood-prone zone along the shore. Notably, the wells and septic systems in the bay and forest shore areas were most impacted by the flooding events in 2017 and 2019. Indeed, when septic systems are flooded, the water in the wells, often close to the septic systems, can become contaminated, and it's becoming necessary to raise people's awareness of this so that community members' stop drinking water for few days, until water tests come clear again.

Energy sources

The community primarily relies on hydroelectricity as its main source of electricity. However, it is important to note that some houses within the community still use alternative heating methods such as oil or wood. These houses may have individual heating systems that rely on the combustion of oil or wood to generate heat. While hydroelectricity is a cleaner and more sustainable option for electricity, the presence of houses using oil or wood for heating highlights the need for continued efforts to transition towards more environmentally-friendly, energy-efficient heating solutions.

When power lines are severed or damaged, it becomes increasingly challenging to keep community members informed about the situation and provide them with essential instructions.[74] Establishing alternative communication channels and implementing robust emergency response protocols are crucial in addressing these challenges and ensuring the safety and well-being of community members during such events.

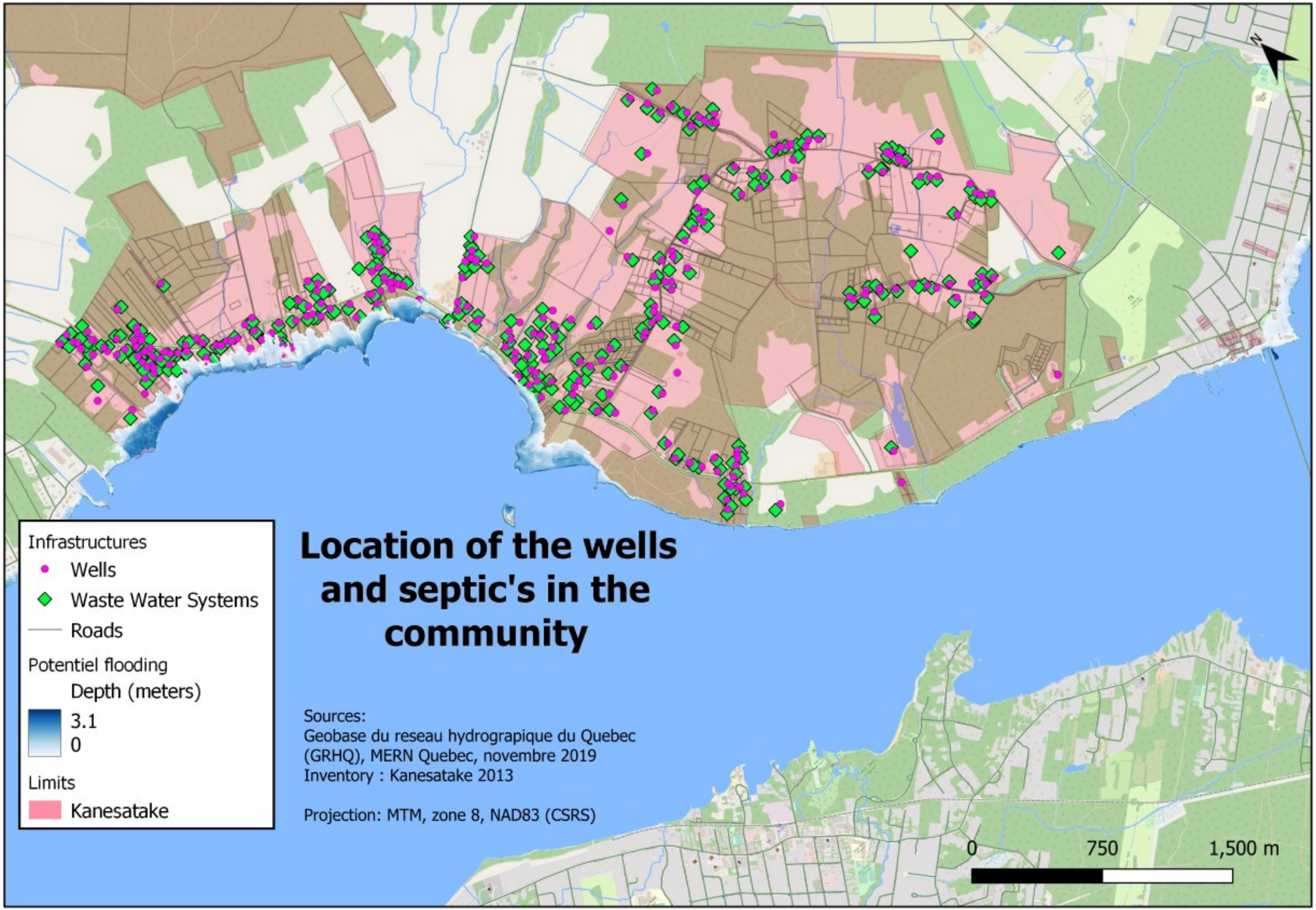
[74] Community interviews, Kanehsatà:ke, September 2022.
[75] Environment Director, Kanehsatà:ke, November 2022.

The Future in a Changing Climate

As climate change progresses, natural hazards are anticipated to intensify, amplifying their associated impacts.[76] The rise in global temperatures will have a profound effect on seasonal energy demand. By 2030, the decreased need for heating during winter months will only be partially offset by increased cooling requirements in summer. However, it is important to consider that numerous other factors, such as the growing adoption of electric vehicles and the expansion of greenhouse cultivation, may influence future energy demand patterns.[77]

Adapting infrastructure to climate change is an important part of building a more resilient and sustainable community. As the impacts of climate change become more pronounced, infrastructure systems such as transportation networks, buildings, water management systems, and energy grids will face increasing vulnerabilities. By adapting infrastructure to climate change, the community capacity to withstand and recover from these challenges increases. This involves integrating climate projections and future risks into the design, construction, and maintenance of infrastructure, implementing nature-based solutions, improving drainage and flood management systems, adopting energy-efficient technologies, and promoting sustainable and resilient practices. Investing in climate-resilient infrastructure not only safeguards communities but also ensures long-term economic viability, promotes environmental sustainability, and supports the well-being of present and future generations.

[76] Alberti-Dufort *et al.,* 2022.
[77] Hydro-Québec, 2019.


Location of the wells and septic's in the community
Infrastructures
Wells
Waste Water Systems
Roads
Potentiel flooding
Depth (meters)
3.1
0
Limits
Kanesatake
Sources:
Geobase du reseau hydrograpique du Quebec (GRHQ), MERN Quebec, novembre 2019
Inventory : Kanesatake 2013
Projection: MTM, zone 8, NAD83 (CSRS)
0
750
1,500 m
N

Adapting to the Impacts of Climate Change

Strategies from Kanehsatà:ke community members, employees and elected chiefs are presented in Table 16 below.

Table 16. Strategies to Implement Against Climate Change – Infrastructure and Energy Sources.

Objectives	Activities	Timeframe	Budget	Potential Partners
Integrate infrastructure into the emergency plan	Finish the emergency plan with the committee created Inform members on how to be prepared for different types of natural emergencies Plan how to repair the infrastructure, such as roads, faster after an emergency	Short-term	$	Band Council and housing sector
Develop a green energy transition plan	Develop a plan for green energy transition in the community Ex: Solar panels on the G&R site once decontaminated, windmills on the shoreline or the mountain, small turbine in streams to create electricity, etc.	Mid-term	$$	Band Council
Plan future infrastructure while taking climate change into consideration	Integrate climate change risks into infrastructure renovation or construction in the community Use environmentallyfriendly materials for new constructions Apply for funding for green renovation/construction. Ex: Deep Retrofit Accelerator Initiative	Mid/long-term	$$$	Band Council and housing sector

Closing Words

This adaptation plan seeks to protect people and preserve the environment, by emphasizing the importance of sustainable practices and inclusive decision-making processes to ensure a prosperous future for the community. Education and health have been taken into consideration, recognizing the significance of equipping community members with the knowledge and resources to adapt to the changing climate and safeguard their well-being. Culture and traditional knowledge hold a vital place within this plan, acknowledging its role, present and past, in preserving cultural identity and promoting resilience in the face of climate challenges. The profound connection to Mother Earth has guided our approach, emphasizing the need for sustainable stewardship and conservation efforts to protect the delicate balance of ecosystems.

As discussed in this plan, climate change affects temperature, wind, precipitation, and water, as well as fish, birds, insects, trees, plants, and medicines. We need to recognize their interdependence and importance in our culture and environment. This plan responds to climate impacts by incorporating potential solutions for more sustainable practices, resilience, and new energy sources into infrastructure development and nature preservation, to ensure harmonious coexistence with the environment and fewer negative impacts from the changing climate.

The findings of the previous sections highlight the importance of implementing strategies to fight the negative impacts of climate change on the territory and community members. By addressing these interconnected aspects, this climate change adaptation plan strives to empower community members, preserve cultural heritage, foster sustainable development, and protect the natural resources that form the foundation of the community's identity. Priorities are mainly focussed on flood risks, but the presence of new animal species and bugs, and the diseases of fruits and trees are also of concern to the members. Strategies and adaptative measures must take into consideration current needs as well as those of the next seven generations.

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Appendix 1 - Thanksgiving Address

Preamble

Ohen:ton Karihwatehkwen - Thanksgiving Address

Sewatahonhsi:iost ken'nikarihwesha sewkwe:kon. Ne kati;tentshitewanonhwea:ton ne Shonkwaia'tison, ne wahi rohsa:anion akwe:kon tsi naho:ten teiotawenrie ne tsi Iohontsa:te.

Let us all listen for a moment. We will give thanks to the Creator, for it is he who has made everything that is in this universe.

Ake:kon enska entsitewahwe'non:ni nonkwa'nikon:rat anon ....

Let our minds come together as one mind and....

Teiethinonhwera:ton ne Onkwehshon:'a.

Let us give thanks to all the people.

Teiethinonhwera:ton ne Iethi'nistenha Ohontsa.

Let us give thanks to our mother earth.

Teiethinonhwera:ton ne Kahnekaronnion.

Let us give thanks to all waters.

Teiethinonhwera:ton ne Kentson'shon :'a.

Let us give thanks to all the fish.

Teiethinonhwera:ton ne Ohtera'shon :'a.

Let us give thanks to all roots.

Teiethinonhwera:ton ne Ohonte'shon :'a.

Let us give thanks to all plants.

Teiethinonhwera:ton ne Ononhkwa'shon :'a.

Let us give thanks to all medecines.

Teiethinonhwera:ton ne Otsinonwa'shon :'a.

Let us give thanks to all insects.

Teiethinonhwera:ton ne Tionhehkwen, ne ne ahsen nikontate'ken :'a – Onenhste, Onon'onsera, Osahe:ta.

Let us give thanks to the sustainers of life, the three sisters – corn, beans and squash.

Teiethinonhwera:ton ne Kahihshon :'a tanon kwah tkonwakowa :nen – Niiohontesha.

Let us give thanks to the fruits, and the leader, the strawberry.

Teiethinonhwera:ton ne Kontirio, tanon kwah thonwakowa :nen – Oskenon :ton.

Let us give thanks to the animals, and the leader, the deer.

Teiethinonhwera:ton ne Otsi'ten'okon :'a, tanon kwah thonwakowa :nen – A :kweks.

Let us give thanks to the birds, and the leader, the eagle.

Teiethinonhwera:ton ne Karonta'shon :'a tanon Okwire'shon :a tanon kwah thonwakonwa :nen – Wahta.

Let us give thanks to the trees, the shrubs, and the leader the maple.

Teiethinonhwera:ton ne kaie :ri nikawera :ke – Othore:ke E :neken, Na :kon, tanon Entie :ne.

Let us give thanks to the four winds – North, South, East and West.

Teiethinonhwera:ton ne Iethihsotho :kon Ratiwe :ras

Let us give thanks to our Grandfathers, the Thunders

Teiethinonhwera:ton ne Iethihsotha Ahshonthenhkha Karahkwa.

Let us give thanks to our Grandmother Moon.

Teiethinonhwera:ton ne Ehtshitewahtsi :'a Tiehkehnehkna Karahkwa

Let us give thanks to our older brother, the Sun

Teiethinonhwera:ton ne tsi Iostsistohkwaronnion Tsikaronhia:ke

Let us give thanks to the stars in the heavens.

Teiethinonhwera:ton ne Shonkwaia'tison (Ka'satstenhserako :wa Sa'oie :ra)

Let us give thanks to the Creator (all natural force/power)

O:nen tho niio:re wa'khwe:ni Toka' the:nen sonke'nikonhrhen i:se ne'e ia'sewatahsonteren tanon ska'nikon:ra' kenhak tanon tsonhnhiiohak.

This is as far as I am capable of. If I have forgotten anything, then you continue and be of one mind and keep healthy.

Appendix 2 - Introduction to Climate Change

What is climate change?

Climate change is the modification in climate happening because of global warming. Global warming is the rapid rise in global temperatures that is occurring because human activities are adding greenhouse gases (GHGs) to the atmosphere. The added GHGs are amplifying the Earth's natural greenhouse effect, causing the planet to warm 30 times faster than it did before the year 1900.[78] As the Earth gets warmer, the air patterns and ocean currents that drive climate are changing, affecting temperatures; rain and snowfall amounts; storm severity, frequency and location; and much more.[78]

The Earth's atmosphere is made of gases. Without the Earth's atmosphere, the Earth's average temperature would be -18°C. By trapping the heat energy released by the Earth, the natural greenhouse effect warms Earth to an average of 15°C and allows for life as we know it. Some gases do not trap much heat energy, like oxygen (O_2) and nitrogen (N_2), but others do, like carbon dioxide (CO_2) and methane (CH_4), which are called greenhouse gases (GHGs). When sunlight enters the Earth's atmosphere, the part that reaches the surface is absorbed by it and re-emitted as infrared energy (i.e., heat). This type of energy can be trapped by greenhouse gases in the atmosphere and can be radiated back to the surface, increasing the Earth's global temperature.[78]

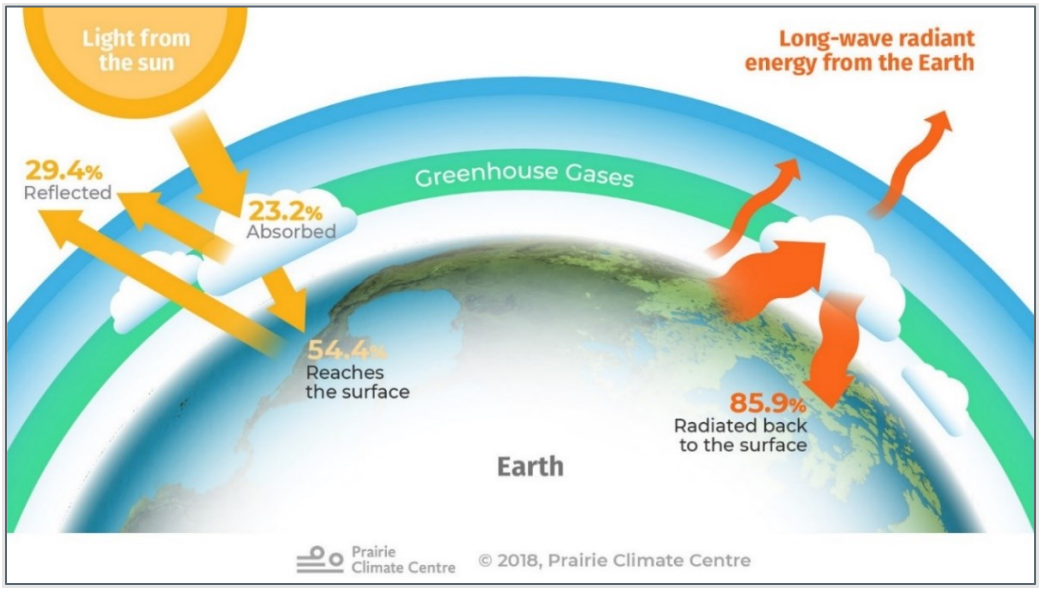

Figure S1. What is the Greenhouse Effect.[79]

Humans are affecting the natural greenhouse effect by adding greenhouse gases (GHGs) to the atmosphere due to the use of different types of energy that create GHG (Fig. S2). The main source of GHG in Quebec are carbon dioxide (CO_2) released from burning fossil fuels like coal and gas, methane (CH_4) released by

[78] Up North on Climate, 2022.
[79] Prairie Climate Centre, 2019a.

cattle and landfills, and nitrous oxide (N_2O) released primarily from fertilizers and agriculture. All these added GHGs have caused Earth's average temperature to rise nearly 1°C in the last 100 years.[80]

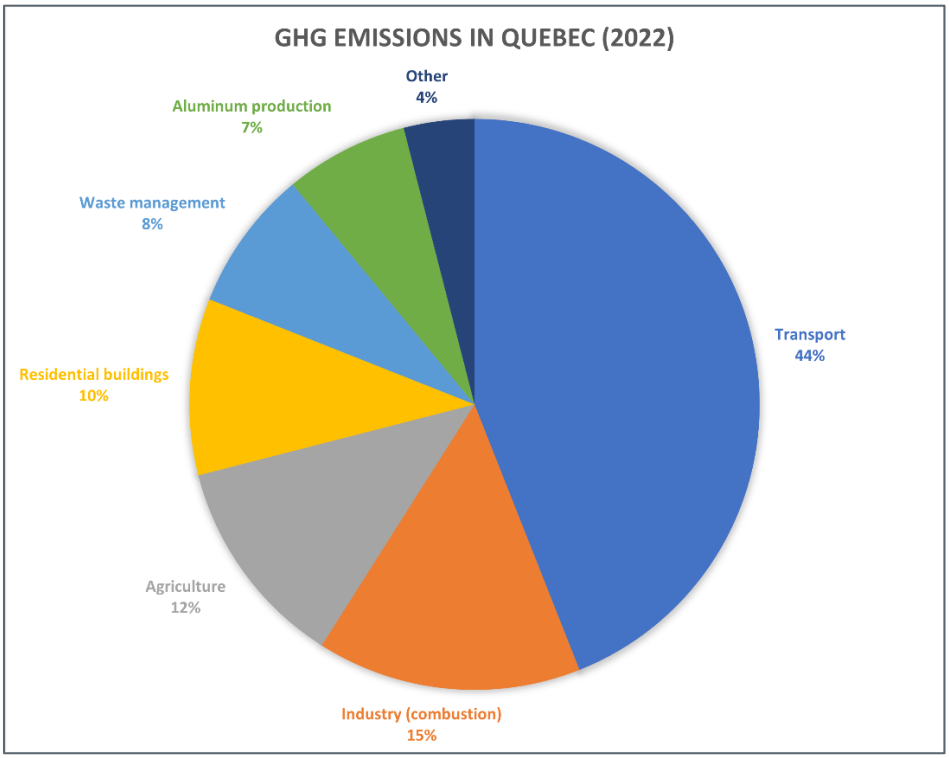

Figure S2. Greenhouse Gas Emissions in Quebec in 2022.[81]

There is also evidence that climate change is causing more frequent extreme weather events, like heat waves, storms, and heavy rain, that are more severe than in the past. Warmer temperatures and more humid air can lead to heat waves that last longer due to slow-moving air masses. A warmer atmosphere can hold more water vapour, which can then make heavy rain events or big snowstorms more likely.[80]

The land and communities have been shaped by climate throughout time. The plants and animals that are found on the land survive and thrive because the climate provides the conditions they need. But as the climate changes, and extreme events happen more often, plants and animals can find themselves struggling to survive in conditions that no longer give them what they need. Climate is also changing so quickly that they have little chance to adapt.

Buildings, roads, water systems, power lines and other community infrastructure have been designed for the climate expected for their specific region, and they can be challenged or even fail in a changing climate. Preparing now can help lessen the impacts and risks for the future.[80]

[80] Up North on Climate, 2022.

[81] Chair in Energy Sector Management, HEC Montréal, 2023.