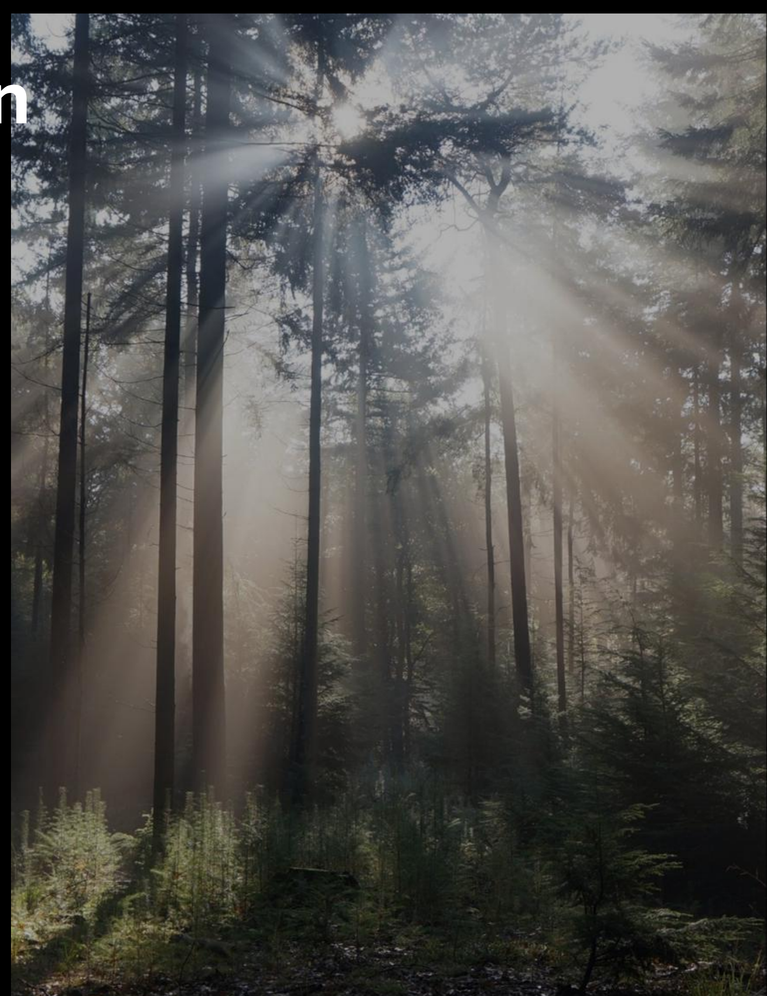
GEMTEC
Consulting Engineers
and Scientists

Capital Region Service Commission

Climate Change Adaptation & Mitigation Framework

August 2025



Town of Oromocto

Central York Rural Community

Nackawic-Millville Rural Community

City of Fredericton

Village of New Maryland

Rural Community of Hanwell

Municipality of Grand Lake

Village of Fredericton Junction

Village of Tracy

Capital Region Rural District

Village of Arcadia

Sunbury-York South Rural Community

Harvey Rural Community

Nashwaak Rural Community

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Acknowledgements

The development of the Climate Change Adaptation and Mitigation Framework for the Capital Region Service Commission was made possible through the expertise and dedication of GEMTEC Consulting Engineers and Scientists and the CRSC staff.

Special thanks to Arpana Datta, Alexandre Belle, Mitra Ahmadijamal, Jeff Trail, Jihad El Zamer, and Hans Arisz for their technical guidance, analytical support, and collaboration in shaping this framework.

I. EXECUTIVE SUMMARY

GEMTEC Consulting Engineers and Scientists has developed this Climate Change Adaptation and Mitigation (CCA&M) Framework for the Capital Region Service Commission (CRSC) to support municipalities across the Capital Region in proactively addressing the growing challenges of climate change. The framework provides a comprehensive, region-specific foundation for understanding key climate hazards, assessing community vulnerabilities, and identifying practical, scalable actions that municipalities can take to strengthen resilience and reduce emissions.

New Brunswick is already experiencing the accelerating impacts of a changing climate, including more frequent and severe floods, heatwaves, droughts, wildfires, high wind, and biological hazards influenced by climate drivers. These hazards carry cascading effects across infrastructure, ecosystems, public health, emergency response capacity, and local economies. They pose risks that are particularly acute for rural and low-capacity communities. This framework reflects both observed and projected climate trends across the Capital Region, aligning with provincial guidance and incorporating localized data, scientific best practices, and peer-reviewed case studies from across Atlantic Canada.

The document is structured to guide municipalities through the process of adaptation and mitigation planning, beginning with climate risk identification and moving toward strategic implementation. It also provides direction for integrating climate considerations into asset management, land use planning, procurement, and service delivery. A key emphasis is placed on community engagement, cross-sector collaboration, and equitable adaptation. This ensures that vulnerable populations and small communities are not left behind in resilience planning.

Climate Hazard	Key Impacts on the Capital Region	Strategic Focus Areas
🌡️ Extreme Heat & Drought	Overloaded cooling infrastructure, crop failure, livestock stress, reduced aquifer recharge	Urban greening, heat-health alerts, groundwater protection, irrigation efficiency
🌊 Flooding & Heavy Precipitation	Sewer overflows, road washouts, housing instability, contaminated water supplies	Floodplain zoning, stormwater upgrades, green infrastructure, emergency alerts
🌬️ Wind & Wildfires	Power outages, emergency evacuation, public health from smoke exposure, structural damage	Resilient building codes, fire route mapping, backup power systems, regional coordination
🐛 Biological	Decline in native biodiversity, tree loss, spread of Lyme disease, degraded wetland function	Ecological monitoring, biosecurity enforcement, public education, land stewardship, Forest Management
🔁 Compound & Cascading Risks	Heat-drought-fire feedback loops, multiple system failures, disproportionate impacts on small and rural communities	Integrated planning, rural-specific response strategies, equity-focused adaptation

II. INTRODUCTION

The Capital Region Service Commission (CRSC) retained GEMTEC Consulting Engineers and Scientists to develop this Climate Change Adaptation and Mitigation (CCA&M) Framework. The goal of this document is to support CRSC's member communities by identifying key climate hazards, assessing their interconnected risks, and outlining practical and strategic adaptation responses. This Framework is aligned with the *Guide for Climate Change Adaptation Planning* issued by the New Brunswick Department of Environment and Local Government and is tailored to the environmental, economic, and social context of the Capital Region.

Climate change is not a distant concern; it is already altering infrastructure performance, disrupting seasonal patterns, and increasing the frequency and intensity of extreme events. Across New Brunswick, communities are contending with more severe flooding, prolonged heatwaves, extended droughts, damaging windstorms, and escalating wildfire threats. These events carry cascading impacts that strain emergency response capacity, impair public health, and compromise ecological systems.

Municipalities sit at the frontline of climate adaptation. As administrators of infrastructure, emergency services, land-use planning, and public communications, they play a pivotal role in developing local climate resilience strategies. This Framework is designed to help them navigate that role by:

- Identifying and assessing climate hazards most relevant to the region, including extreme heat, drought, flooding, high wind, wildfires, and invasive species proliferation (see **Section III: Climate Hazards & Associated Risks**);
- Analyzing risks across physical infrastructure, public health, ecosystems, agriculture, emergency response systems, and local economies;
- Connecting these risks to evidence-based, locally applicable adaptation solutions (see **Section V: Strategic Adaptation Actions**), covering twelve key focus areas such as infrastructure resilience, emergency preparedness, flood management, energy systems, land use, and nature-based solutions;
- Supporting municipalities in aligning future capital investments and land-use decisions with projected climate conditions.

Importantly, the Framework also emphasizes governance capacity, social equity, and inter-municipal collaboration. Effective climate adaptation is not limited to technical retrofits or emergency protocols; it requires integrated planning, inclusive engagement, and continuous learning.

To guide the development of localized CCA&M Plans, this document encourages municipal decision-makers to consider the following questions:

📌 **Preparedness**

- Are we adequately prepared for the accelerating impacts of climate change?
- Is our Emergency Measures Organization (EMO) plan equipped to respond to compound events such as heatwaves during power outages or flash floods following winter thaws?

📌 **Risk Awareness**

- How exposed are our road networks, culverts, drinking water systems, and energy infrastructure to changing precipitation patterns, freeze-thaw cycles, and high-wind events?

📌 **Social and Economic Impacts**

- What are the expected consequences for public health, particularly for aging and heat-sensitive populations and rural communities with limited emergency infrastructure?
- How will agricultural and forest productivity, insurance costs, and service continuity be affected by drought, flooding, or invasive species?

📌 **Action Planning**

- Which adaptation measures can be prioritized in the short, medium, and long term to balance urgency, feasibility, and co-benefits such as emissions reduction or biodiversity gains?
- How do we ensure that rural and urban communities alike have the tools and partnerships needed to implement and sustain their adaptation plans?

This Framework is not a prescriptive checklist. Rather, it serves as both a technical foundation and a decision-support tool to help municipalities design actionable, context-sensitive CCA&M Plans. It presents observed regional trends, localized datasets, downscaled climate projections, and tested solutions that can be integrated into official plans, asset management systems, zoning bylaws, and community outreach programs.

Ultimately, the CRSC Climate Change Adaptation and Mitigation Framework aims to empower municipalities with the evidence, tools, and foresight required to protect residents, preserve ecosystems, and build climate-resilient communities across the Capital Region.

Table 1. CRSC Communities.

Fredericton	Fredericton Junction	Rural District
Oromocto	Tracy	Sunbury-York South
New Maryland	Hanwell	Central York
Nackawic-Millville	Harvey	Nashwaak
Grand Lake	Arcadia	

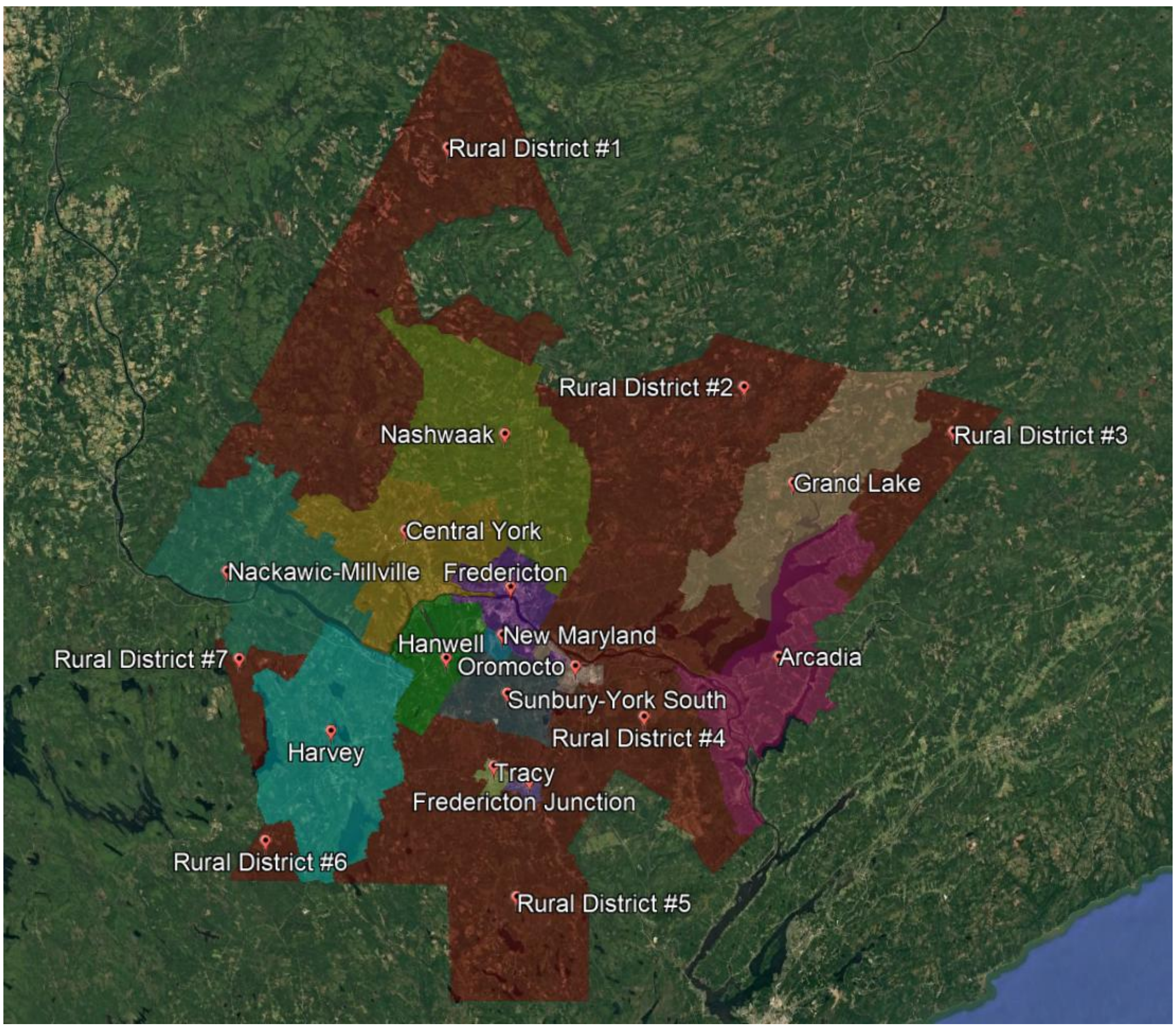

Figure 1. Map of the Capital Region Service Commission, New Brunswick, from Google Earth Pro.

III. CLIMATE HAZARDS & ASSOCIATED RISKS

The selection of climate hazards was guided by a review of existing Climate Change Adaptation Plans and Frameworks developed across New Brunswick, with particular attention to both major urban centers and smaller regional hubs. Each hazard was assessed using current scientific literature, localized exposure data, and an evaluation of its risks to infrastructure, ecosystems, and public health. This validation confirmed that the identified hazards remain highly relevant and continue to pose serious challenges to the Capital Region under both current conditions and projected climate scenarios. The compounding nature of these hazards places increasing strain on emergency response systems, requiring more frequent, simultaneous deployments and greater inter-municipal coordination to maintain safety and continuity of services.

1. 🔥 Heat-Associated Risks

🌡️ Environmental & Ecosystem Impacts

- Accelerated eutrophication (excessive buildup of nutrients in water bodies) in nutrient-rich water bodies, degrading water quality.
- Altered groundwater temperatures disrupting cold-water fish habitats (e.g., brook trout).
- Increased algal and bacterial growth in lakes, rivers, and drinking water sources.
- Reduced snow cover and ice duration affecting aquatic oxygen levels and species.
- Lower albedo (the reflectivity of a surface) effect from reduced snow cover amplifying the urban heat island effect.

🏙️ Infrastructure & Built Environment

- Shortened lifespan of infrastructure due to heat-induced material stress (e.g., asphalt softening).
- Higher maintenance and cooling costs for municipal buildings and public housing.
- Strain on electrical grids during peak demand, increasing risk of outages.
- Premature deterioration of water systems due to thermal expansion and biological fouling.

👥 Public Health & Safety

- Increased heat-related illness and mortality, especially among vulnerable groups.
- Exacerbation of respiratory conditions due to elevated ozone and particulates.
- Reduced nighttime cooling, worsening chronic heat stress, especially in apartment buildings.
- Disproportionate impact on the elderly, chronically ill, and socially isolated residents.

🌾 Agriculture & Food Systems

- Reduced crop yields and quality due to extreme heat events.
- Livestock heat stress affecting animal health and productivity.
- Changes in growing seasons requiring adaptation in crop selection and scheduling.
- Soil moisture loss increasing need for irrigation and water conservation.

🔄 Cascading and Compound Risks

- Increased wildfire scale, frequency and duration due to prolonged dry periods.
- Escalation of drought conditions into late summer and fall.
- Expansion of invasive species favored by warmer conditions.
- Increased vector-borne disease risks (e.g., ticks, mosquitoes).
- Mid-winter thaws disrupting snowpack and increasing ice jam risks.

Note: Vector-borne diseases are illnesses transmitted by carriers such as mosquitoes or ticks, which are sensitive to changes in temperature and humidity.

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2. 🌾 Drought-Associated Risks

💧 Water Supply & Hydrology

- Decline in well recharge, especially in rural and private systems.
- Water delivery disruptions in smaller or remote communities.
- Reduced surface water in rivers, streams, and reservoirs.
- Stress on aquifers and increased demand on groundwater.

🌿 Ecosystems & Habitats

- Wetland drying, affecting amphibians and aquatic species.
- Reduced stream flows raising water temperature and reducing oxygen.
- Vegetation stress and loss of soil moisture.
- Diminished ecosystem services such as water filtration and carbon capture.

Agriculture & Food Systems

- Lower productivity and crop failure, especially for rainfed and shallow-root crops.
- Forage shortages for livestock, raising feed costs and stress.
- Need for expanded irrigation systems.
- Increased risk for agricultural producers due to variability.
- Income volatility and long-term financial instability for producers, especially in uninsured or single-crop operations.

Infrastructure & Services

- Water use restrictions impacting recreation and industrial processes.
- Reduced water pressure and fire suppression capability.
- Strain on older water systems under low-flow conditions.
- Service interruptions where infrastructure is single-source reliant.

Public Health & Well-being

- Concentration of contaminants in reduced water volumes.
- Combined heat-drought events increasing health stress.
- Water insecurity for marginalized or rural populations.
- Psychological strain on agricultural communities.

Cascading & Compound Risks

- Heightened wildfire risk from dry vegetation and forestry combined with low fuel moisture.
- Reduced hydropower reliability.
- Water conflict between user groups (agriculture, residents, ecosystems).
- Soil degradation increasing future drought impact.

3. 🌊 Flooding-Associated Risks (Stream overflow and Rainfall)

🌍 Environmental & Ecosystem Impacts

- Soil contamination from stormwater overflows and urban pollutants.
- Disruption of aquatic habitats from flow changes and sediment.
- Wetland degradation from repeated flooding and siltation.
- Spread of invasive species via floodwaters.

🏗️ Infrastructure & Municipal Systems

- Riverbank erosion damaging infrastructure and utilities.
- Overwhelmed sewer systems leading to backflow and local flooding.
- Road washouts and traffic disruption in low-lying areas.
- Damage to building foundations and public assets.

🏘️ Housing, Property & Land Use

- Depressed land values in flood-prone zones.
- Resident displacement during major floods.
- Long-term housing instability from recurring damage.
- Development limits due to floodplain expansion and zoning constraints.

💧 Public Health & Safety

- Mold and air quality deterioration after floods.
- Exposure to waterborne contaminants.
- Drinking water system disruption and contamination.
- Increased health risks for vulnerable populations.

🔄 Cascading & Compound Risks

- Utility failure in flood zones (e.g., water, electrical).
- Emergency (fire, police and ambulance) service interruption.
- Increased economic risk in multi-hazard zones.
- Insurance limitations or unaffordability.

4. 🌬️ Wind Extremes – Associated Risks

🏗️ Infrastructure & Utilities

- Damage to power lines, poles, and grid infrastructure.
- Telecommunication failure during emergencies.
- Building damage including roofing, windows, and structural compromise.
- Debris damage to external systems (e.g., HVAC equipment, solar panels).

🌳 Urban & Natural Systems

- Canopy loss and increased urban exposure to heat and runoff.
- Tree fall risks blocking roads and emergency routes.
- Root destabilization harming subsurface infrastructure.
- Erosion from fallen vegetation.

🚑 Public Safety & Emergency Response

- Blocked response routes.
- Injury risk from debris.
- Shelter disruption and delayed evacuation.
- Fire or gas risk from utility damage.

🏠 Residential & Community Assets

- Roof and structural failure in vulnerable housing.
- Moisture intrusion leading to mold and rot.
- Financial strain on uninsured and underinsured households.

💡 Economic Disruption

- Utility downtime affecting commerce.
- Costly cleanup and repair for municipalities.
- Disruption to logistics and transit networks.

🔄 <u>Compound Risks</u>

- Wind-driven wildfire spread.
- Tree vulnerability post-drought.
- Municipal budget strain from increased storm frequency.

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5. 🔥 Wildfire-Associated Risks

🏡 <u>Property & Land Use</u>

- Increased losses in wildland–urban interface areas.
- Evacuation pressures and trauma.
- Insurance costs and coverage challenges.
- Land value and zoning restrictions.

Note: Wildland–urban interface refers to areas where human development meets or intermingles with natural vegetation.

🧑‍⚕️ <u>Public Health & Air Quality</u>

- Respiratory impacts from smoke.
- Long-distance smoke exposure events.
- Mental health effects.
- Stress on health systems during fire events.

🌲 <u>Ecosystems & Forests</u>

- Loss of carbon sinks and shade through tree loss.
- Habitat degradation for fire-sensitive species.
- Disrupted regeneration and ecosystem cycles.
- Proliferation of fire-adapted invasive species.
- Biodiversity loss.

💧 <u>Watersheds & Water Quality</u>

- Erosion increasing sediment and nutrient runoff.
- Drinking water contamination.
- Water treatment challenges.
- Altered water run-off post-fire, including faster runoff and reduced water retention.

🛠️ <u>Infrastructure</u>

- Utility damage and risk of ignitions.
- Road, culvert, and structural damage.
- Communication breakdowns.

🚒 Emergency Management

- Increased demands on local fire departments.
- Resource strain during evacuations.
- Climate-resilient training and gear needs.

🔄 Long-Term Risks

- Fire–drought–heat feedback loops.
- Chemical release from burned infrastructure.
- Decline in ecosystem services.
- Reduced adaptive capacity from compounding risks.

Note: Feedback loops are self-reinforcing processes where climate impacts intensify each other, such as heat increasing drought which in turn increases fire risk, and so on.

6. 🐛 Biological-Associated Risks

Figure 2. Emerald Ash Borer from the New Brunswick Invasive Species Council.

🌿 Ecosystem Impacts

- Biodiversity loss from species displacement.
- Ecosystem simplification.
- Decline of key species.
- Wetland, forest, and grassland degradation.

🌾 Agriculture & Forestry

- Crop loss and quality issues.
- Increased chemical use.
- Reduced timber quality.
- Operational costs for treatment, monitoring and fire protection.

🏘️ Urban & Community Infrastructure

- Urban tree loss and green space degradation.
- Infrastructure damage from aquatic invasives.
- Municipal resource demands for management.

👥 Public Health

- Disease expansion (e.g., Lyme disease).
- Contact risks from allergenic plants.
- Psychological and economic stress.

🔄 Compounding Effects

- Invasives worsening wildfire risk.
- Weakened ecosystems under drought and heat.
- Greater management costs long term.
- Lower resilience in native systems.

Table 2. Species of Concern in New Brunswick.

Category	Species
🐟 **Fish & Aquatic Animals**	Goldfish - Green Crab - Invasive Gamefish - Invasive Crayfish - Red-Eared Sliders - Asian Carp - Zebra/Quagga Mussels
🌿 **Aquatic Plants**	Eurasian Watermilfoil
🌾 **Terrestrial Plants**	Giant Hogweed - Japanese Knotweed - Garlic Mustard - Invasive Phragmites - Japanese Barberry - Glossy Buckthorn - Woodland Angelica - Oriental Bittersweet - Dog-Strangling Vine
🪲 **Forest Pests**	Emerald Ash Borer - Hemlock Woolly Adelgid - Spotted Lanternfly - Asian Longhorned Beetle - Spongy Moth - Brown Spruce Longhorn Beetle - Jumping Worms
🐗 **Terrestrial Wildlife / Pathogens**	Wild Pigs - European Rabbits - White-nose Syndrome *(bats)*

IV. CLIMATE DATA

1. Methodology

This framework considers the time period of 1981 to 2010 climatological baseline, a widely accepted reference period, to benchmark all climate variables. Although this baseline already reflects early signs of human-induced climate change, it provides a stable and consistent foundation for comparing historical conditions with future projections.

The historical time period was sourced from climate model data from ClimateData.ca that provides climate model data for 1950 to 2100 and validated using historical data from nine weather stations located within the Capital Region Service Commission (CRSC). These stations were chosen for their geographic distribution and data completeness. Their inclusion improved increased confidence in regional observations.

The analysis focused on variables most relevant to regional infrastructure, ecosystems, and public safety: temperature extremes, total and extreme precipitation, freeze-thaw cycles, wind speeds, and wildfire risk indicators. Each variable was analyzed across annual and seasonal, in some cases, to detect both chronic changes and short-term hazards.

To evaluate future risks, the framework applies the SSP5-8.5 (Shared Socioeconomic Pathways) and RCP-8.5 (Representative Concentration Pathways) scenarios, both are high-emissions trajectory marked by continued fossil fuel dependence and limited global mitigation. This scenario is not a forecast, but rather a stress test used to explore the upper bounds of plausible climate impacts.

Projections were generated using statistically downscaled models from the ClimateData.ca and ClimateAtlas.ca ensemble. ClimateData.ca was selected as the primary data source due to its high spatial resolution (10 km grids), comprehensive variable coverage, and integration of observational and modeled climate data. For variables not available through ClimateData.ca, supplementary data from ClimateAtlas.ca (50 km grids) were used to ensure completeness. The 50th percentile ensemble average was used to reflect a central estimate. To account for uncertainty, the full range of model outputs was also reviewed, with particular attention to variables most sensitive to emissions trajectories, such as precipitation intensity and fire weather indices.

While all climate modeling carries some degree of uncertainty, particularly at the local scale, there is strong directional consensus across models. Temperatures are rising, precipitation is becoming more intense, and extreme weather events are increasing. These signals offer a robust foundation for long-term planning and proactive adaptation.

2. CRSC Grid boundary

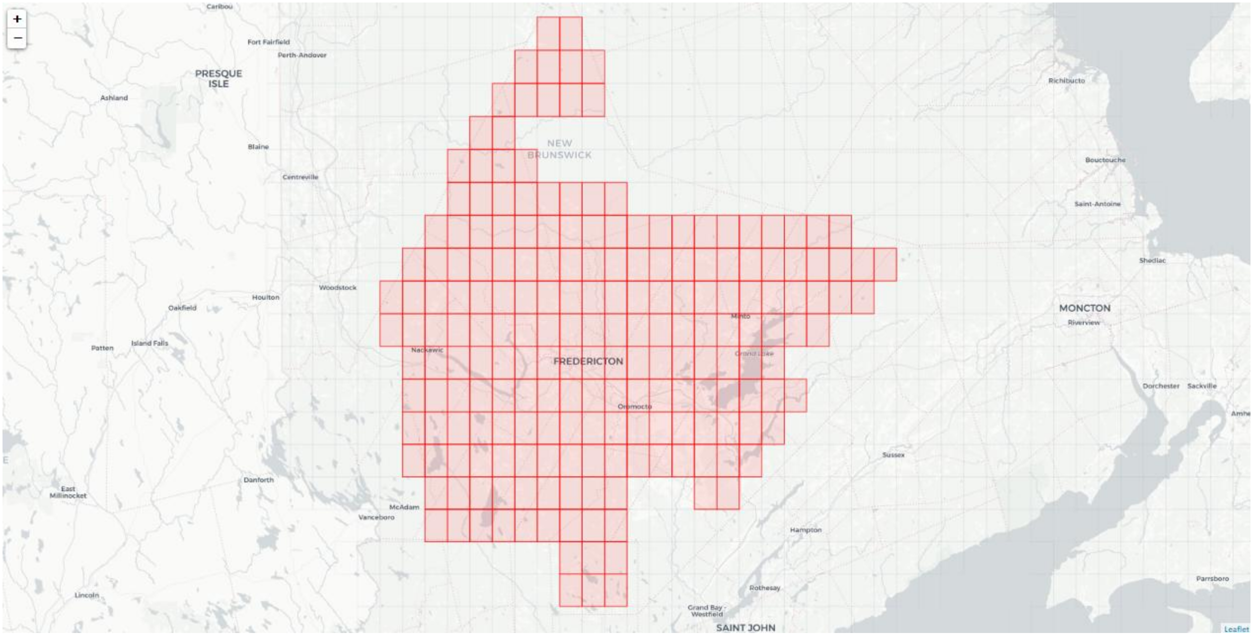


Figure 3. Map of the CRSC ClimateData.ca 10km grids.

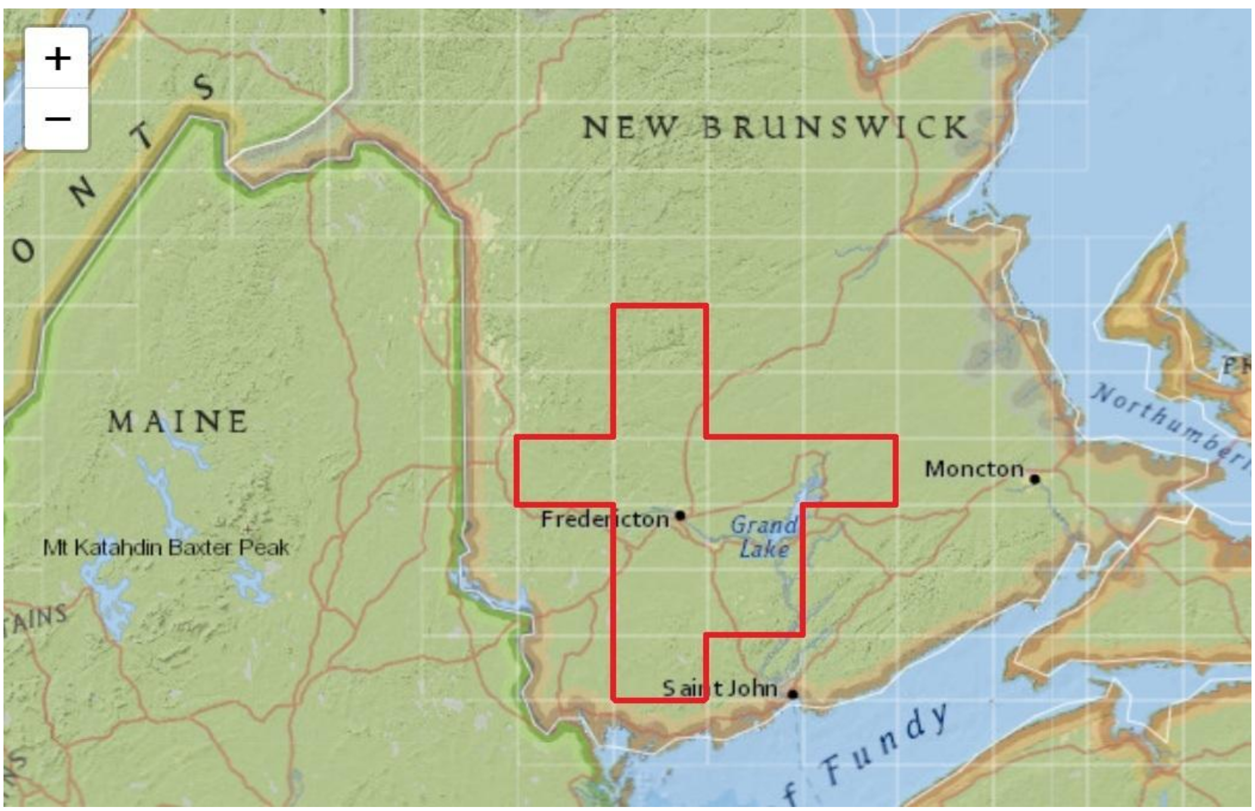


Figure 4. Map of the CRSC ClimateAtlas.ca 50km grids.

3. Results

The following section presents the results of the climate analysis for the Capital Region Service Commission (CRSC), focusing on observed patterns and projected changes in high-impact climate indicators. These include temperature thresholds, precipitation extremes, floods, cold-weather metrics, wildfire potential and wind exposure, factors that influence the resilience of built infrastructure, ecological stability, and public health systems.

Results are organized by future period: 2011 to 2040 (near term), 2041 to 2070 (mid-century), and 2071 to 2100 (end of century). Each is compared against the 1981 to 2010 historical baseline, with the exception of wildfire projections, which use 1971 to 2000 as the available historical reference period. All projections are based on the SSP5-8.5 high-emissions scenario and use the 50th percentile ensemble average, as described in the Methodology.

The following figures and tables show how climate variables are expected to shift in timing, intensity, and duration. Changes in seasonal precipitation, extreme heat, cold-weather events, and wildfire conditions are highlighted to support infrastructure planning, emergency preparedness, and environmental risk management.

All data visualizations draw from consistent model sources and reference periods. Captions have been streamlined to emphasize variable-specific insights without restating methodology, keeping the focus on what matters most: how and where climate conditions are expected to change.

Figure 5. Winter storm wallops the Maritimes with heavy snow, ice pellets and high winds. The Globe and Mail article published in 2019.

Hurricane

Hurricanes are becoming more intense in Atlantic Canada, and the implications are increasingly relevant for communities within the Capital Region Service Commission (CRSC). These changes are not abstract. They are already influencing regional weather patterns, flooding dynamics, and infrastructure exposure.

From 1991 to 2020, the average Atlantic hurricane season produced 14 named storms, seven hurricanes, and three major hurricanes (Category 3 or higher). This baseline now appears conservative. Storms are strengthening more quickly and reaching higher wind speeds than in past decades, largely due to warmer sea surface temperatures. More of them are reaching major hurricane status, increasing the likelihood of damaging wind events and storm surge when landfall occurs.

Heavy rainfall has also become more frequent and more intense. Warmer air carries more moisture, which means hurricanes now deliver higher volumes of rain in less time. For inland communities across the CRSC, this raises the risk of surface flooding, stormwater system overload, and water damage in areas that were not previously at high risk. Many of these systems were designed using older rainfall intensity assumptions that no longer apply.

Although most CRSC communities are located away from the immediate coastline, they are not insulated from coastal impacts. Rising sea levels are pushing storm surges farther inland. Critical infrastructure such as transport routes, power distribution, and supply chains remains regionally interconnected. A coastal failure can cascade into the interior, disrupting services and emergency response capacity. Post-tropical systems, which often maintain hurricane-force winds and heavy precipitation, are increasingly tracking toward the Saint John River basin. These events combine riverine flooding (when streams and rivers exceed the capacity of their natural or constructed channels to accommodate water flow and water overflows the banks) with flash rainfall (rapid and intense rainfall event that can lead to sudden and dangerous flooding, often within a few hours of the rain), expanding the flood footprint and complicating response.

Forecasting future hurricane risk in New Brunswick is still constrained by limited historical data. There have been relatively few direct landfalls in the province, which makes local projections less certain. However, ocean warming in the Gulf of Maine, more frequent storm warnings, and increased rainfall extremes all point in the same direction. The risk is growing, and planning frameworks have yet to catch up.

The results suggest that many existing systems such as land-use zoning, drainage design standards, and emergency protocols are not aligned with today's hazard profile. Without updates, communities will remain vulnerable to a type of event that is becoming less rare and more destructive. Regional coordination and forward-looking investment are now essential if CRSC communities are to remain resilient in the face of intensifying storms.

Temperature data

Table 3. Temperature variable definitions and implications.

Climate Variables	Definition	Implications
Daily Temperatures	Average or range of daily high and low temperatures.	Provides baseline data for modeling thermal stress, agricultural viability, and building energy efficiency.
High Temperatures	Average number of days per year exceeding 30°C.	Critical for planning urban heat mitigation, public health responses, and energy demand management (e.g., cooling systems).

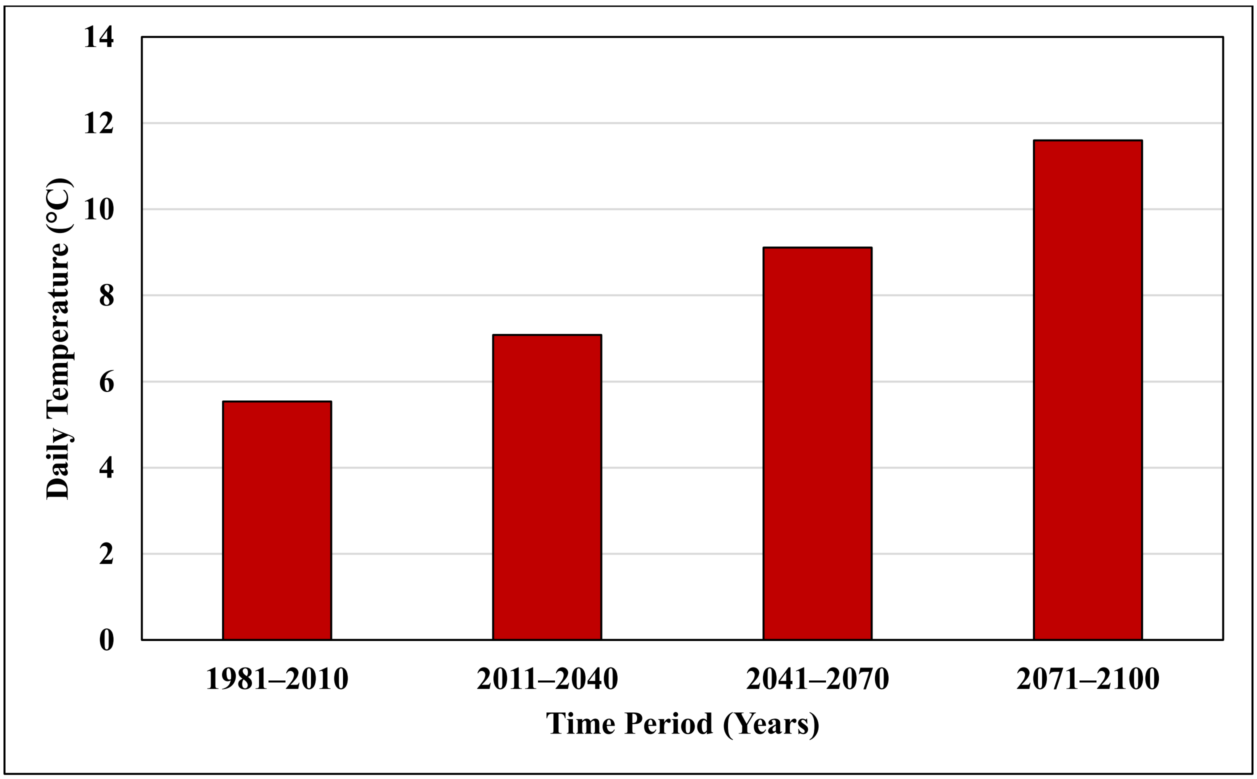
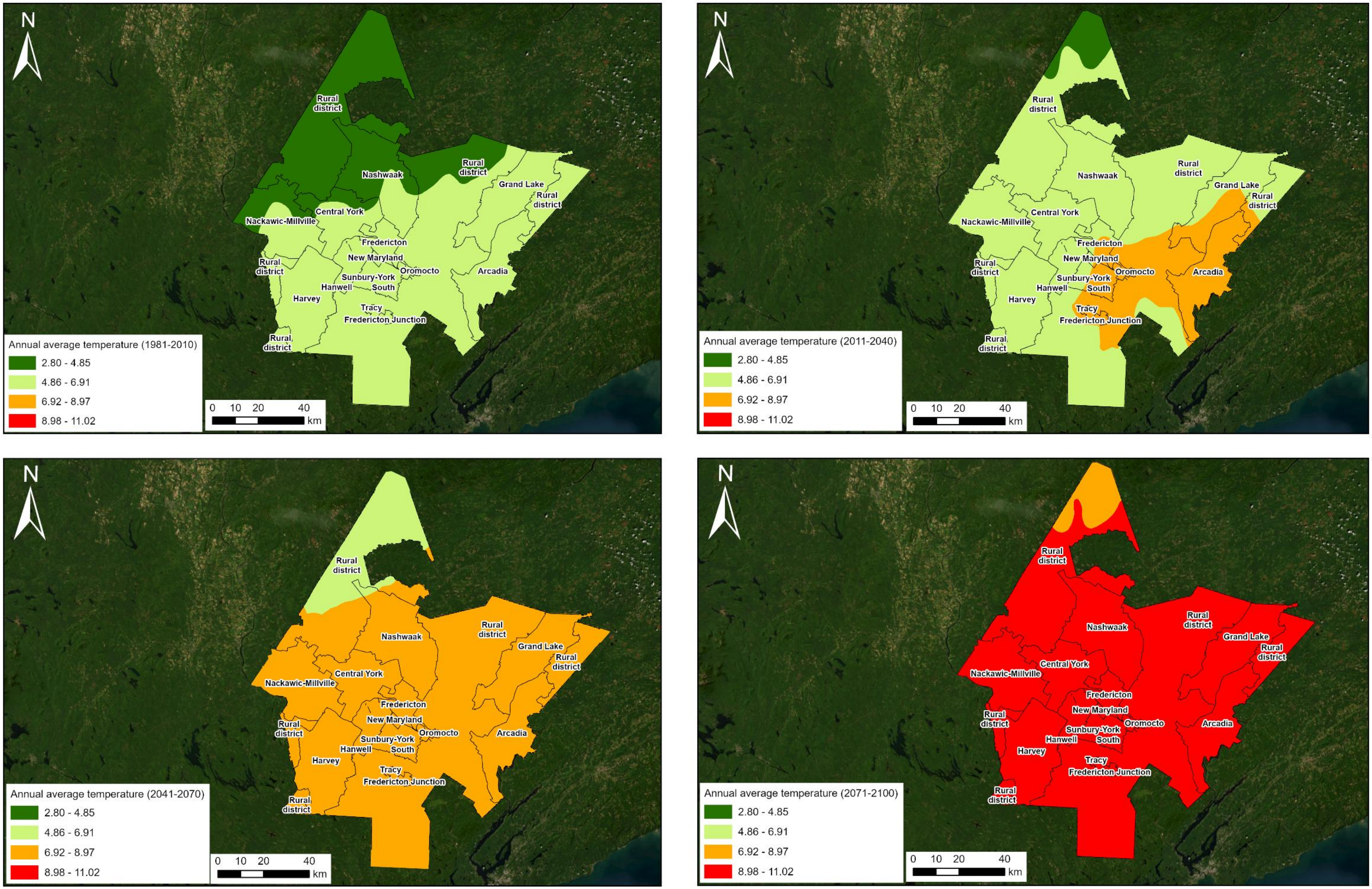


Figure 6. Projected daily temperature (°C) for the Capital Region across three future periods 2011-2040, 2041-2070, and 2071-2100 compared to the historical baseline (1981-2010). Projections are based on the SSP5-8.5 high-emissions scenario (50th percentile ensemble average) using data from ClimateData.ca.



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Rural district
Annual average temperature (1981-2010)
2.80 - 4.85
4.86 - 6.91
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8.98 - 11.02
0 10 20 40
km
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Annual average temperature (2011-2040)
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Annual average temperature (2041-2070)
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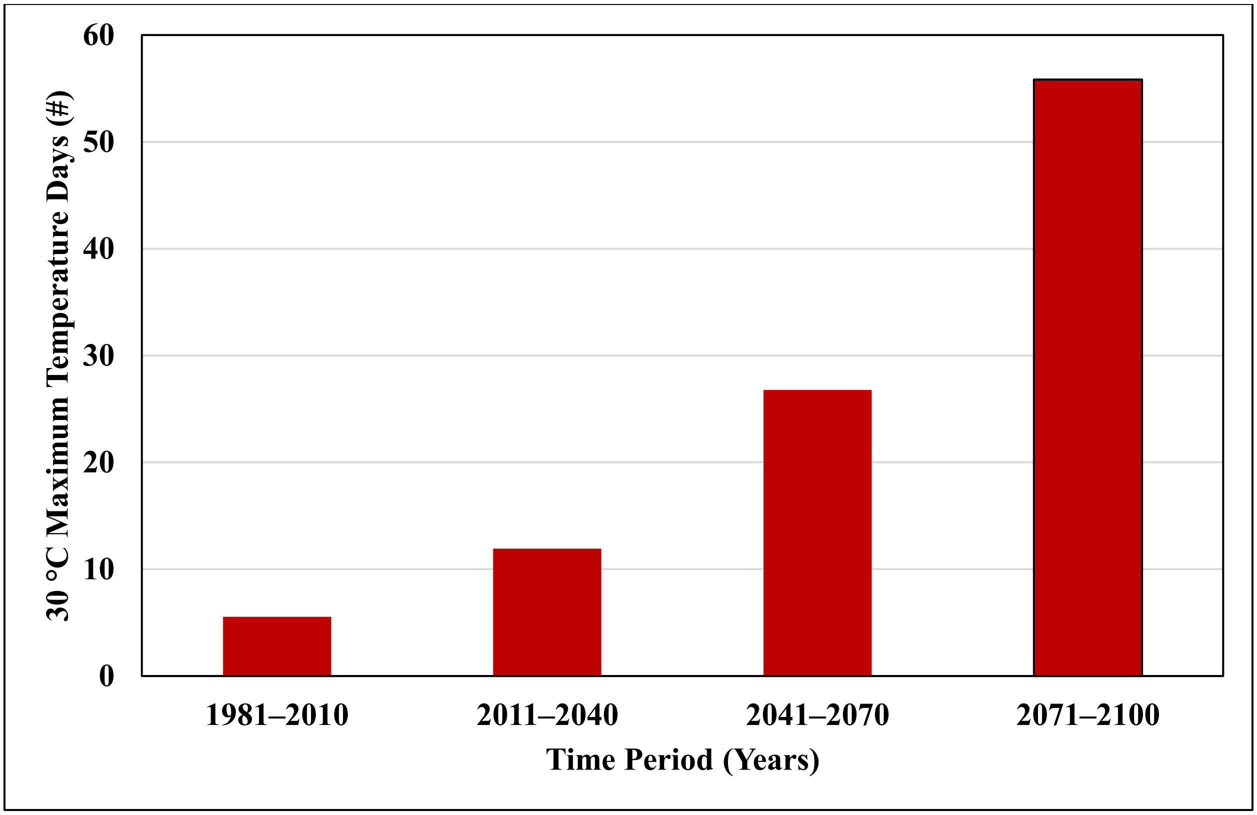
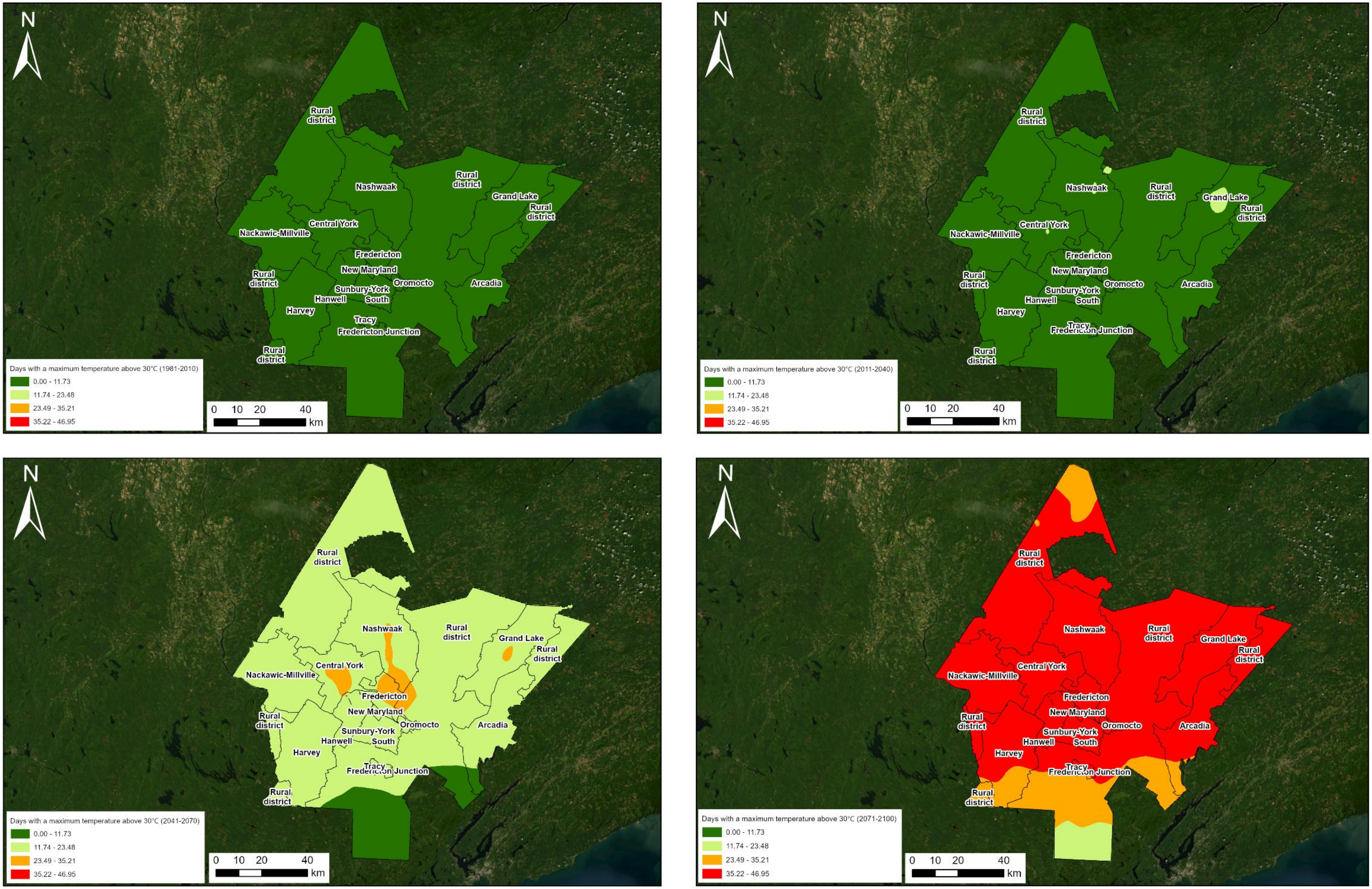


Figure 7. Projected mean number of days with a maximum temperature above 30°C (#) for the Capital Region across three future periods 2011-2040, 2041-2070, and 2071-2100 compared to the historical baseline (1981-2010). Projections are based on the SSP5-8.5 high-emissions scenario (50th percentile ensemble average) using data from ClimateData.ca.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Fredericton Junction
Rural district
Days with a maximum temperature above 30°C (1981-2010)
0.00 - 11.73
11.74 - 23.48
23.49 - 35.21
35.22 - 46.95
0 10 20 40 km
Days with a maximum temperature above 30°C (2011-2040)
Days with a maximum temperature above 30°C (2041-2070)
Days with a maximum temperature above 30°C (2071-2100)

Precipitation data

Table 4. Precipitation variable definitions and implications.

Climate Variables	Definition	Implications
Annual Precipitation	Total precipitation in a year.	Fundamental for water resource planning, flood forecasting, and ecosystem management under shifting climatic regimes.
Fall Precipitation	Total precipitation during fall months.	Informs stormwater system design, agricultural scheduling, and erosion control for the transitional season.
Winter Precipitation	Total precipitation during winter months.	Affects snowpack, meltwater planning, and flood risk forecasting during spring thaw.
Spring Precipitation	Total precipitation during spring.	Key for assessing flood risk, agricultural planting windows, and soil moisture availability.
Summer Precipitation	Total precipitation during summer months.	Vital for drought monitoring, irrigation planning, and wildfire risk assessments.
Maximum Dry Days	Longest consecutive period without measurable precipitation.	Useful for drought vulnerability assessment, crop stress forecasting, and wildfire susceptibility.
3-Day Precipitation (Flood)	Maximum precipitation total over any 3-day period.	Highlights extreme rainfall events, informing flood control design and emergency preparedness.

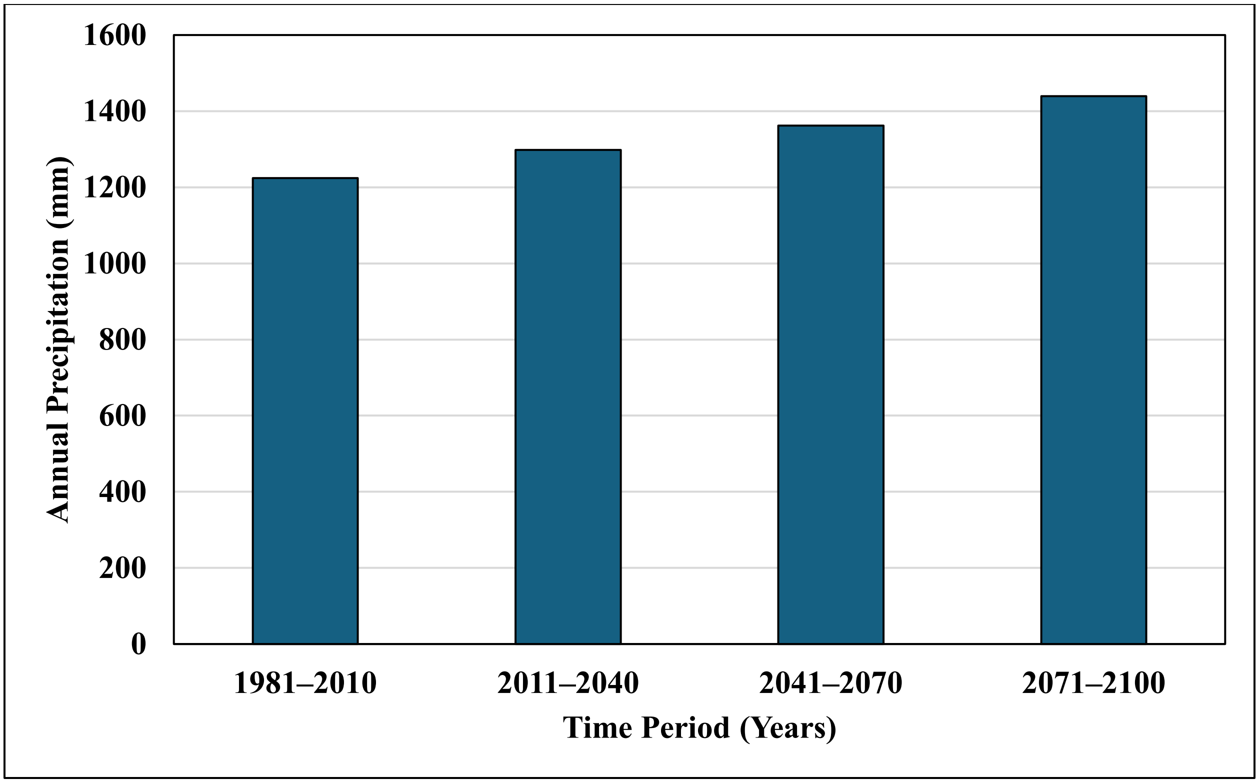
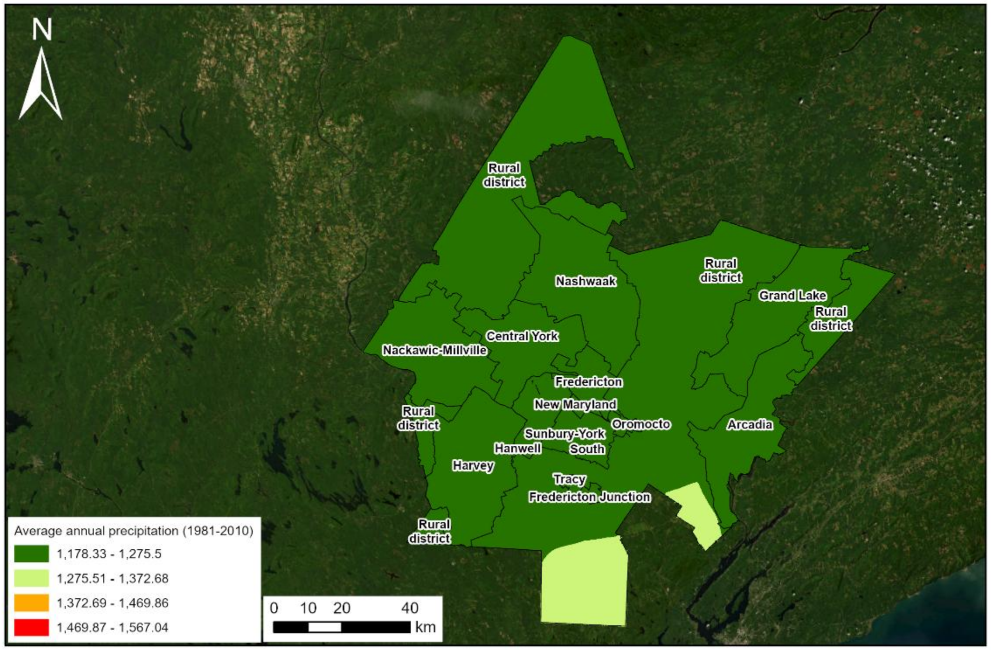


Figure 8. Projected mean annual precipitation (mm) for the Capital Region based on three future time periods 2011-2040, 2041-2070, and 2071-2100 relative to the historical baseline (1981-2010). Projections are derived from the SSP5-8.5 high-emissions scenario at the 50th percentile ensemble average, using data sourced from ClimateData.ca.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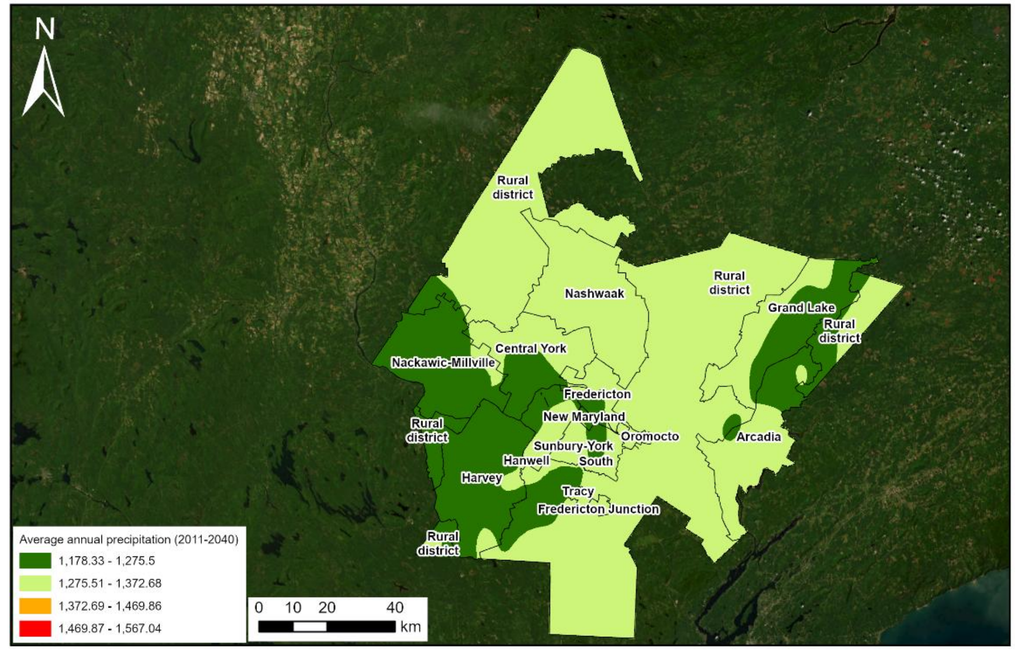
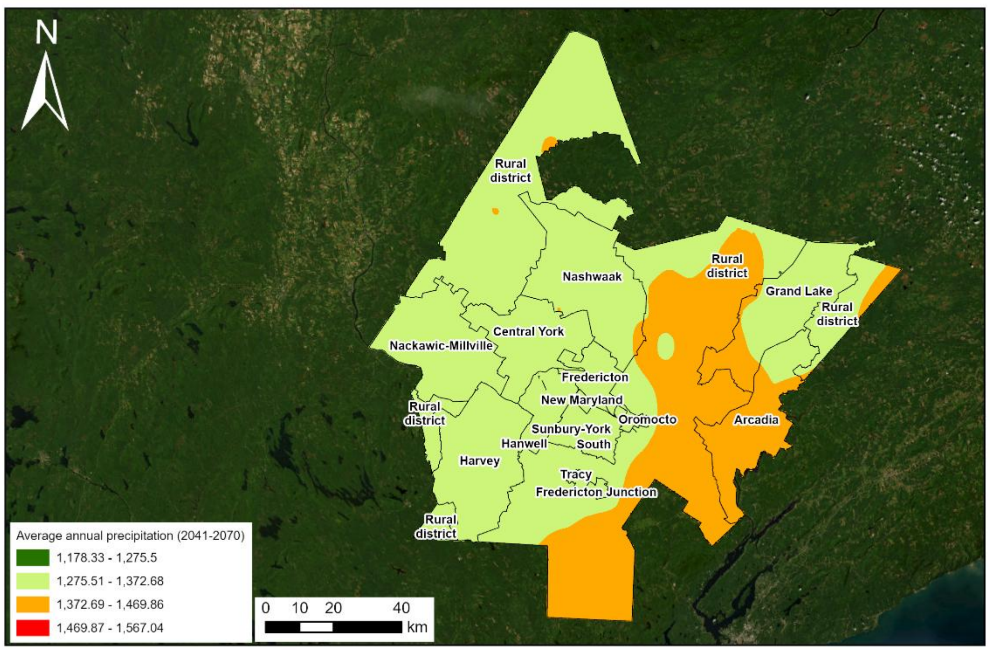
Fredericton Junction
Rural district
Average annual precipitation (1981-2010)
1,178.33 - 1,275.5
1,275.51 - 1,372.68
1,372.69 - 1,469.86
1,469.87 - 1,567.04
0 10 20 40
km


N
Rural district
Nashwaak
Rural district
Grand Lake
Rural district
Central York
Nackawic-Millville
Fredericton
New Maryland
Rural district
Sunbury-York South
Oromocto
Arcadia
Hanwell
Harvey
Tracy
Fredericton Junction
Rural district
Average annual precipitation (2011-2040)
1,178.33 - 1,275.5
1,275.51 - 1,372.68
1,372.69 - 1,469.86
1,469.87 - 1,567.04
0 10 20 40
km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Rural district
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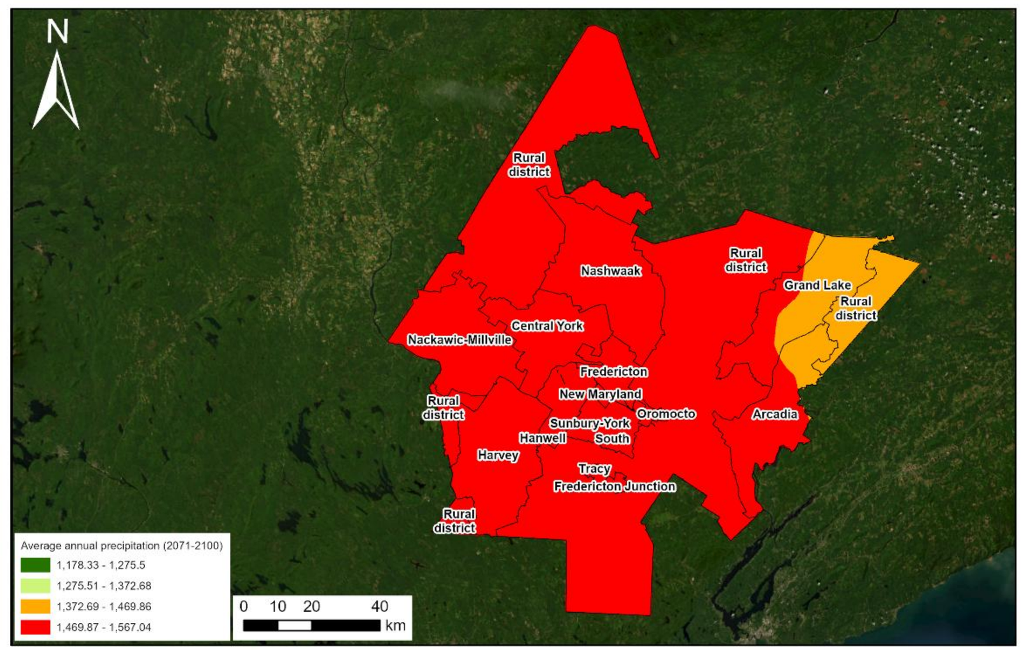
Rural district
Grand Lake
Rural district
Central York
Nackawic-Millville
Fredericton
New Maryland
Rural district
Sunbury-York South
Oromocto
Arcadia
Hanwell
Harvey
Tracy
Fredericton Junction
Rural district
Average annual precipitation (2041-2070)
1,178.33 - 1,275.5
1,275.51 - 1,372.68
1,372.69 - 1,469.86
1,469.87 - 1,567.04
0 10 20 40
km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Rural district
Nashwaak
Rural district
Grand Lake
Rural district
Central York
Nackawic-Millville
Fredericton
New Maryland
Rural district
Sunbury-York South
Oromocto
Arcadia
Hanwell
Harvey
Tracy
Fredericton Junction
Rural district
Average annual precipitation (2071-2100)
1,178.33 - 1,275.5
1,275.51 - 1,372.68
1,372.69 - 1,469.86
1,469.87 - 1,567.04
0 10 20 40
km

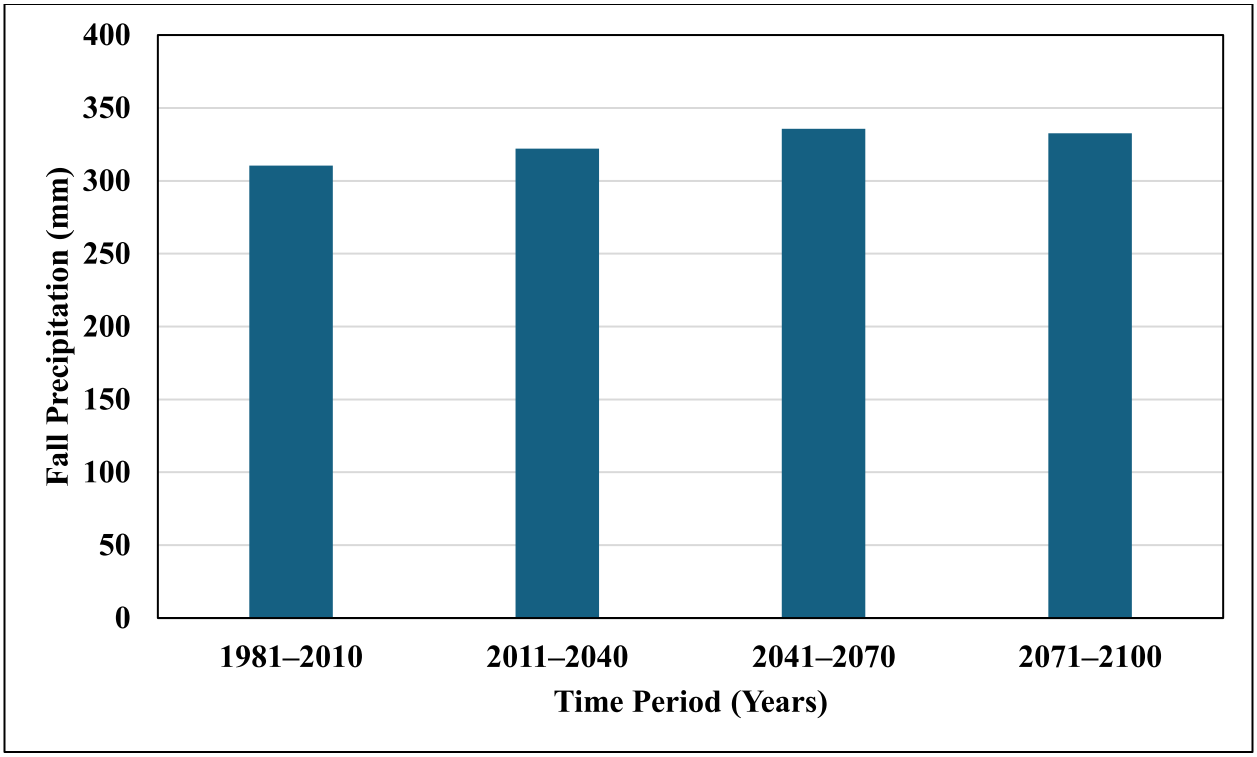
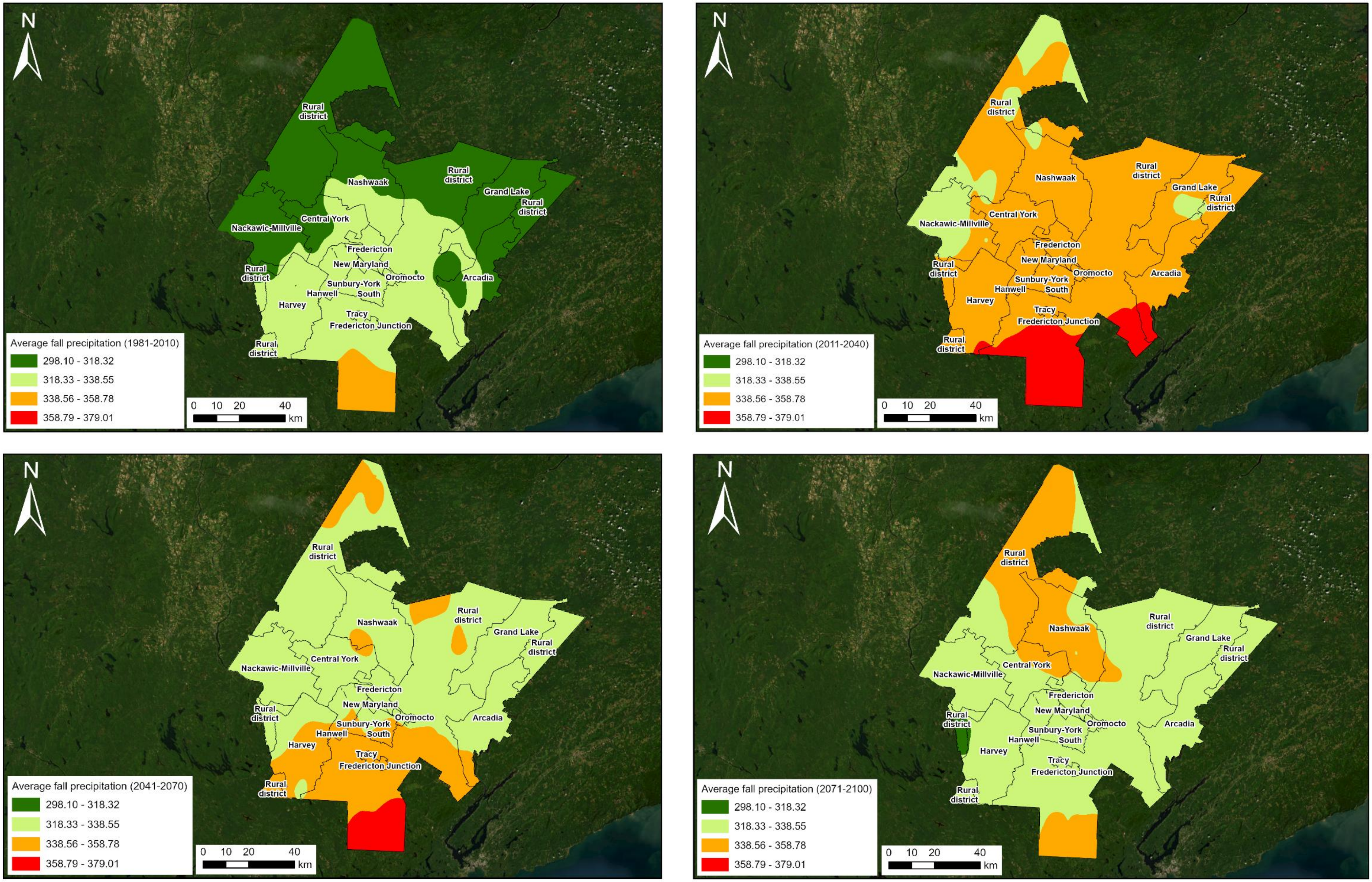


Figure 9. Projected mean fall precipitation (mm) for the Capital Region across three future periods 2011-2040, 2041-2070, and 2071-2100 compared to the historical baseline (1981-2010). Projections are based on the SSP5-8.5 high-emissions scenario (50th percentile ensemble average) using data from ClimateData.ca.



N
Rural district
Nashwaak
Rural district
Grand Lake
Rural district
Central York
Nackawic-Millville
Fredericton
New Maryland
Oromocto
Arcadia
Rural district
Sunbury-York South
Hanwell
Harvey
Tracy
Fredericton Junction
Rural district
Average fall precipitation (1981-2010)
298.10 - 318.32
318.33 - 338.55
338.56 - 358.78
358.79 - 379.01
0 10 20 40
km
Average fall precipitation (2011-2040)
298.10 - 318.32
318.33 - 338.55
338.56 - 358.78
358.79 - 379.01
Average fall precipitation (2041-2070)
298.10 - 318.32
318.33 - 338.55
338.56 - 358.78
358.79 - 379.01
Average fall precipitation (2071-2100)
298.10 - 318.32
318.33 - 338.55
338.56 - 358.78
358.79 - 379.01

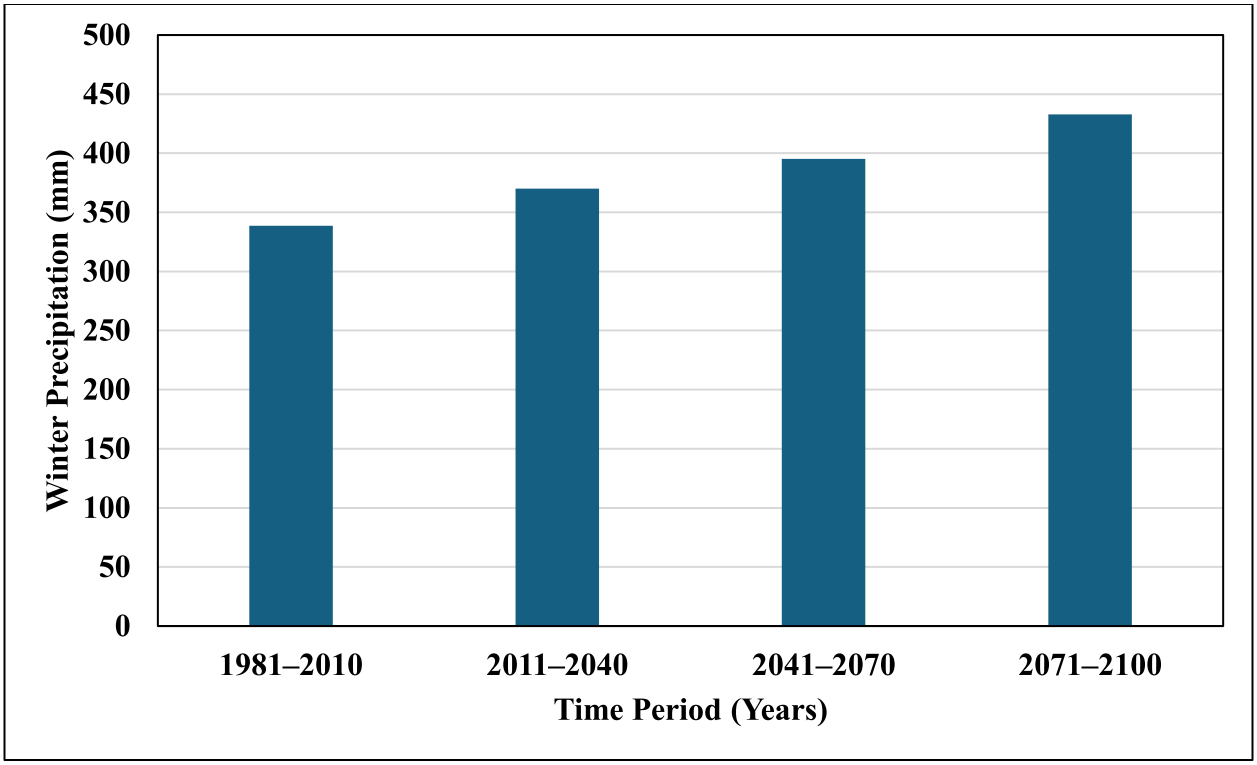
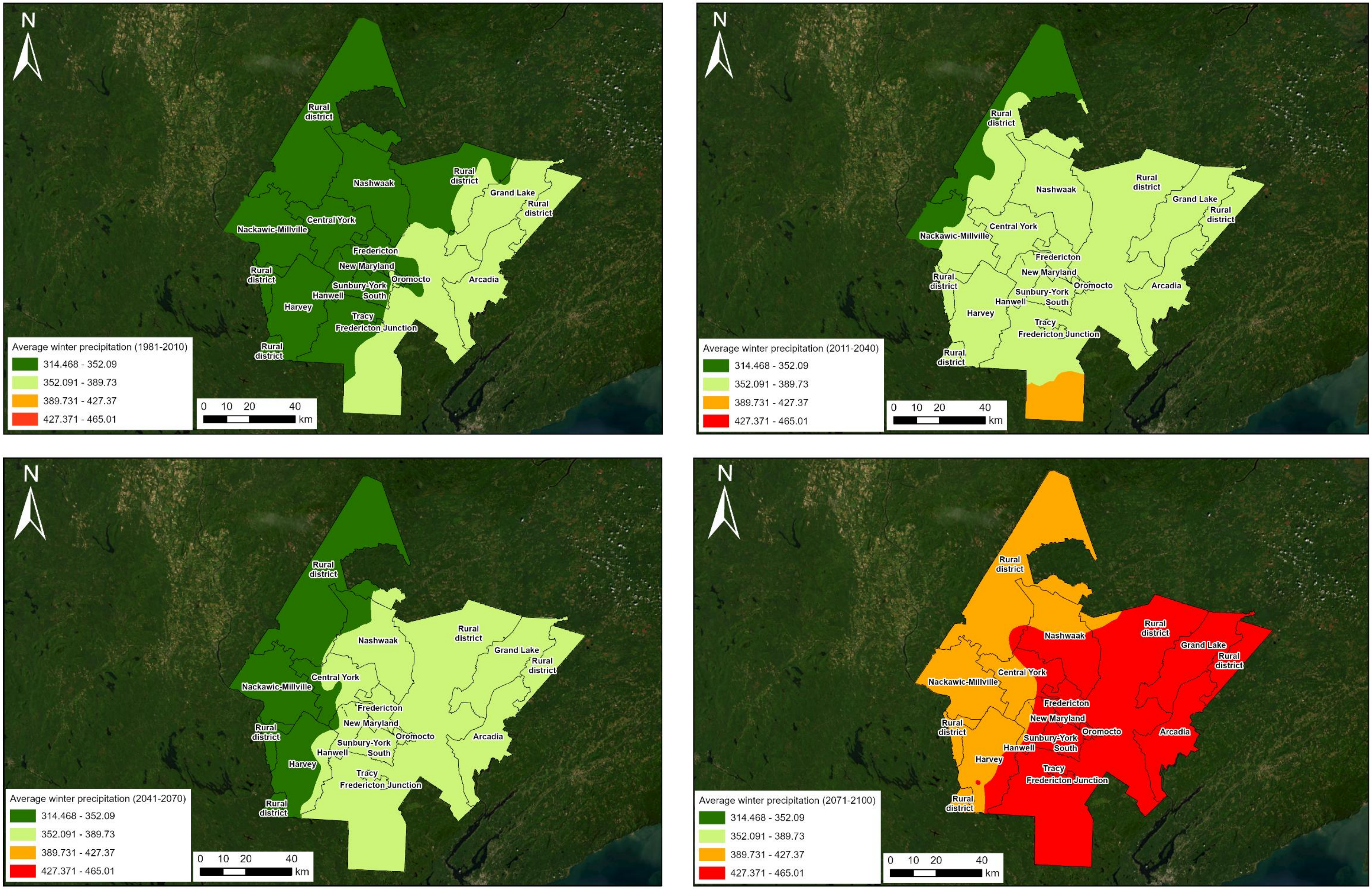


Figure 10. Projected mean winter precipitation (mm) for the Capital Region across three future periods 2011-2040, 2041-2070, and 2071-2100 compared to the historical baseline (1981–2010). Projections are based on the SSP5-8.5 high-emissions scenario (50th percentile ensemble average) using data from ClimateData.ca.


N
Rural district
Nashwaak
Rural district
Grand Lake
Rural district
Central York
Nackawic-Millville
Fredericton
New Maryland
Rural district
Sunbury-York South
Oromocto
Arcadia
Hanwell
Harvey
Tracy
Fredericton Junction
Rural district
Average winter precipitation (1981-2010)
314.468 - 352.09
352.091 - 389.73
389.731 - 427.37
427.371 - 465.01
0 10 20 40
km
Average winter precipitation (2011-2040)
314.468 - 352.09
352.091 - 389.73
389.731 - 427.37
427.371 - 465.01
Average winter precipitation (2041-2070)
314.468 - 352.09
352.091 - 389.73
389.731 - 427.37
427.371 - 465.01
Average winter precipitation (2071-2100)
314.468 - 352.09
352.091 - 389.73
389.731 - 427.37
427.371 - 465.01

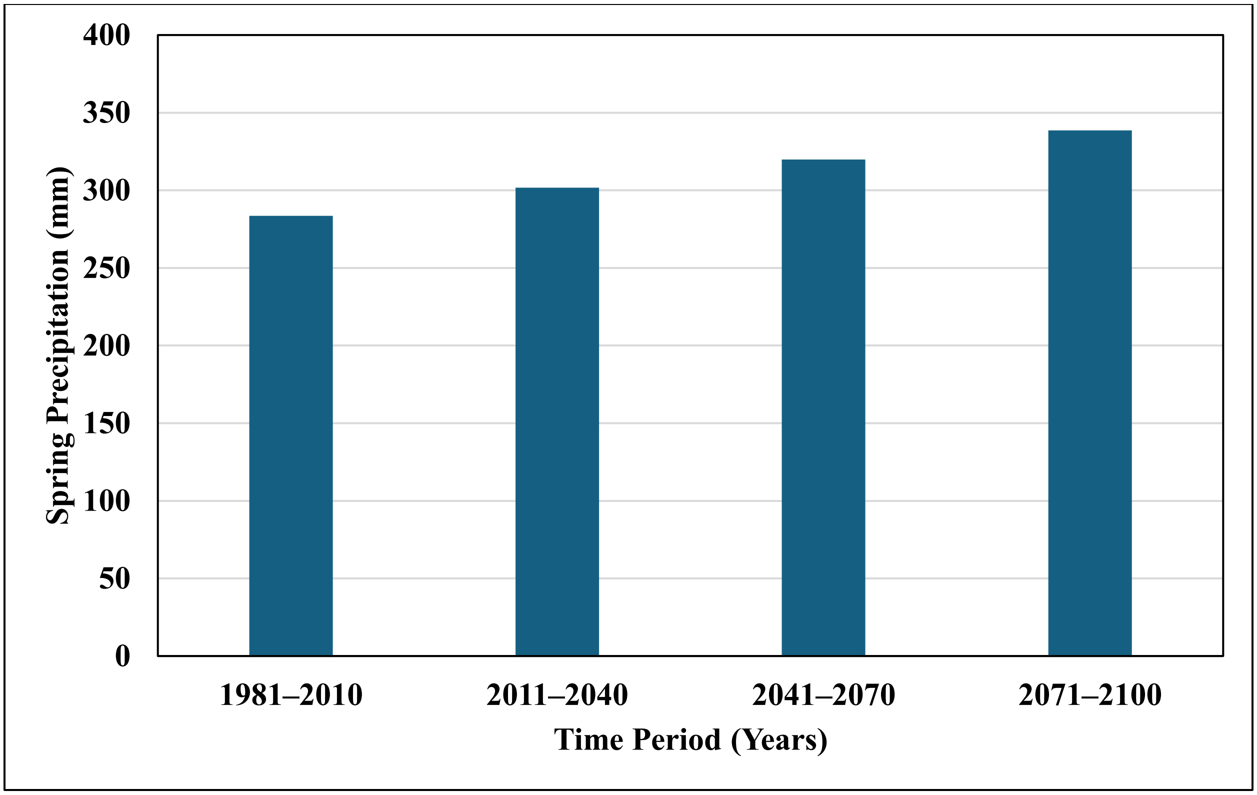
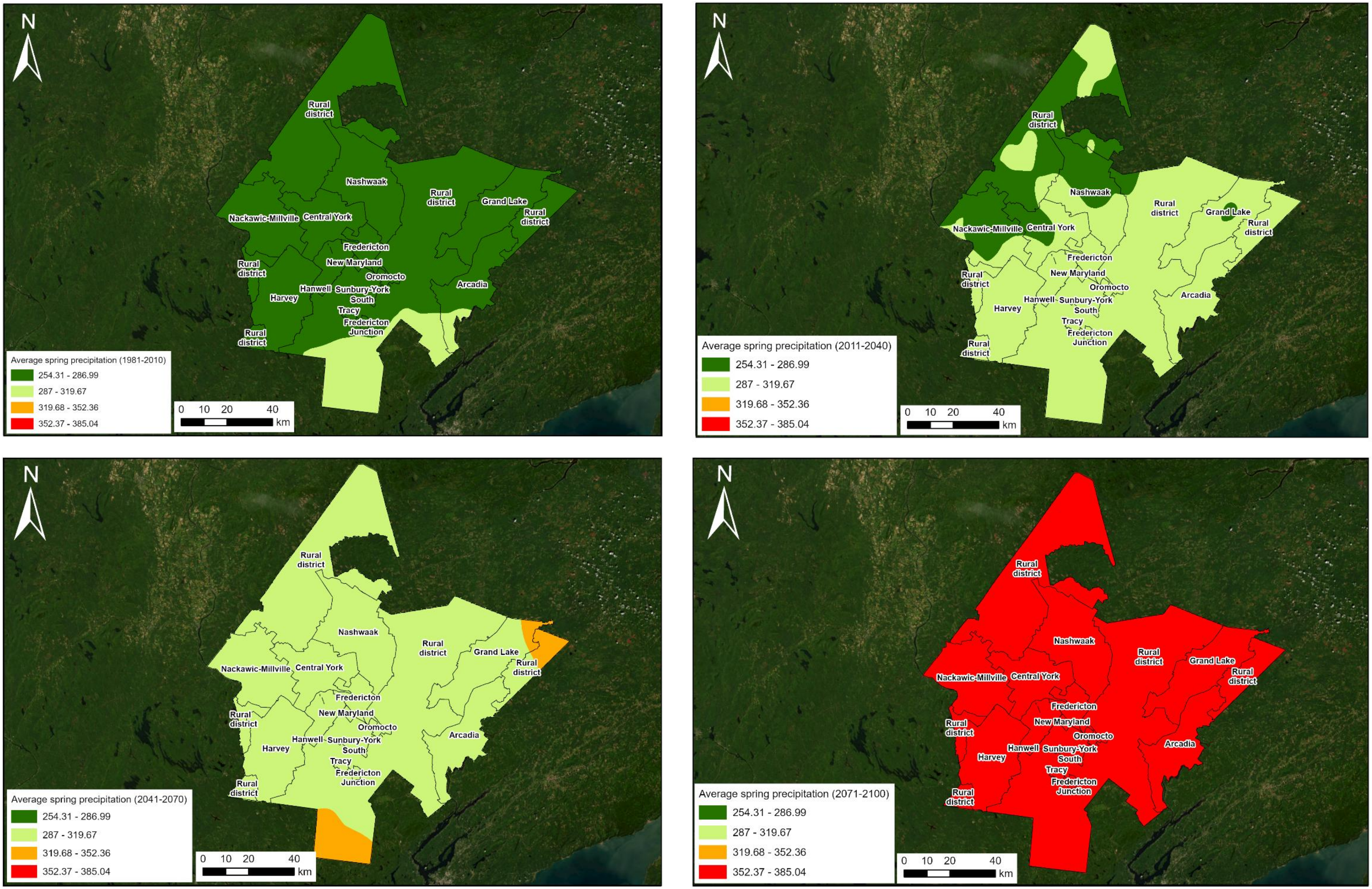


Figure 11. Projected mean spring precipitation (mm) for the Capital Region across three future periods 2011-2040, 2041-2070, and 2071-2100 compared to the historical baseline (1981–2010). Projections are based on the SSP5-8.5 high-emissions scenario (50th percentile ensemble average) using data from ClimateData.ca.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Rural district
Nashwaak
Rural district
Grand Lake
Rural district
Nackawic-Millville
Central York
Fredericton
New Maryland
Oromocto
Rural district
Hanwell
Sunbury-York South
Harvey
Tracy
Fredericton Junction
Arcadia
Rural district
Average spring precipitation (1981-2010)
254.31 - 286.99
287 - 319.67
319.68 - 352.36
352.37 - 385.04
0 10 20 40
km
Average spring precipitation (2011-2040)
Average spring precipitation (2041-2070)
Average spring precipitation (2071-2100)

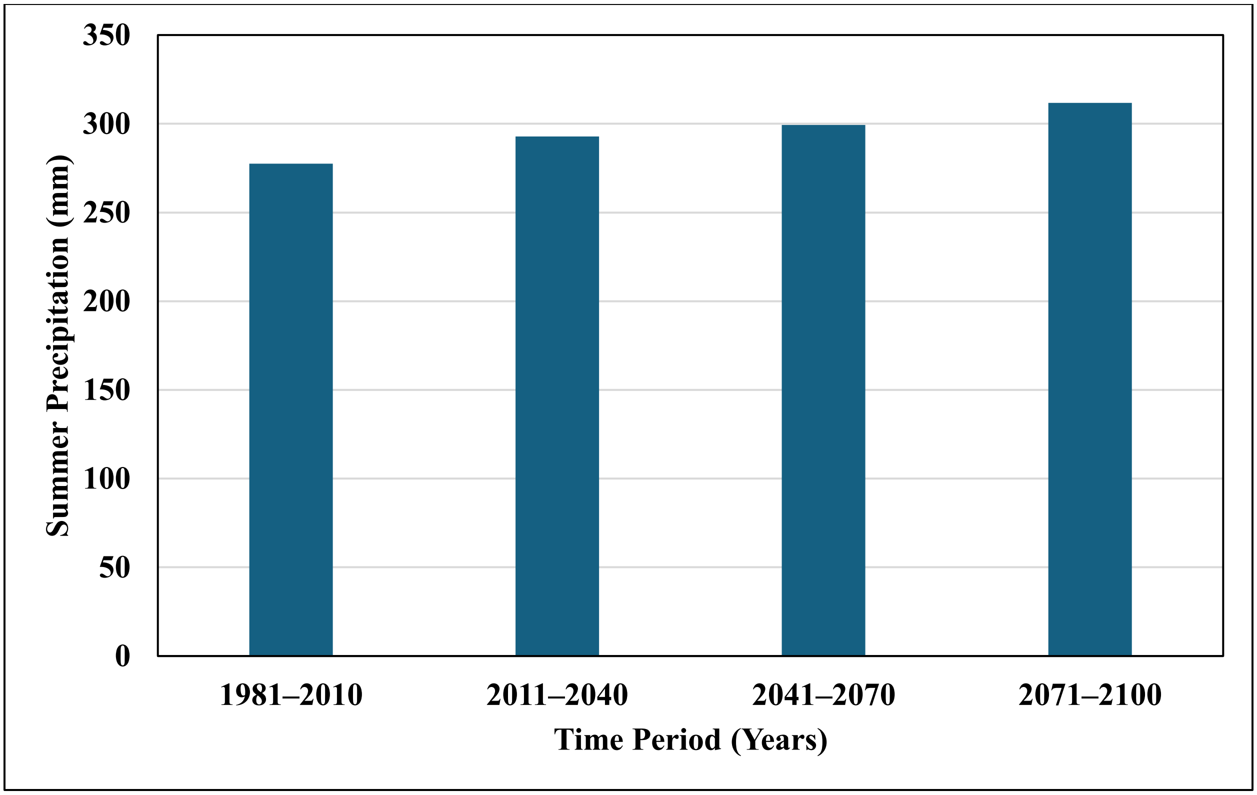
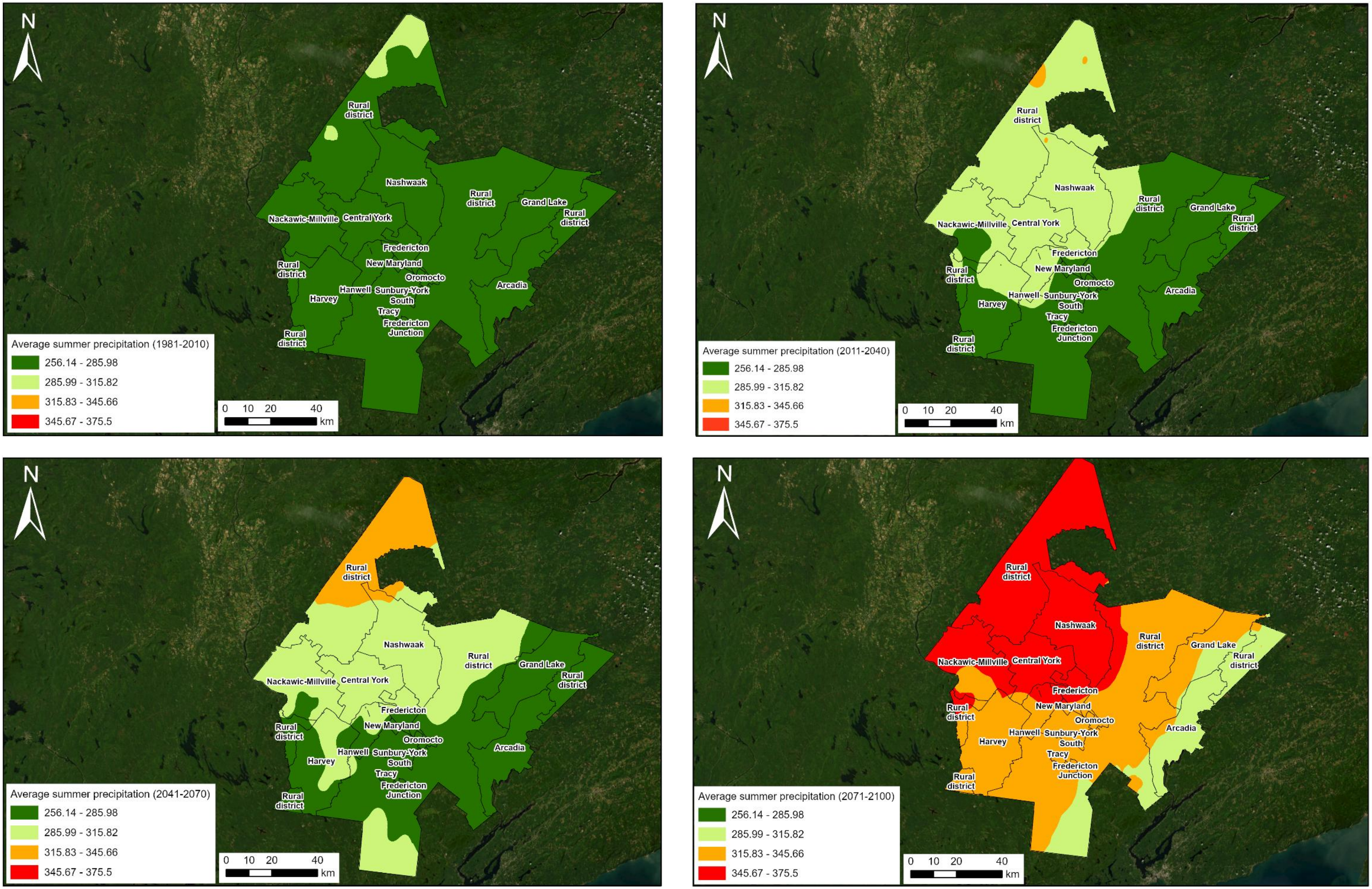


Figure 12. Projected mean summer precipitation (mm) for the Capital Region across three future periods 2011-2040, 2041-2070, and 2071-2100 compared to the historical baseline (1981–2010). Projections are based on the SSP5-8.5 high-emissions scenario (50th percentile ensemble average) using data from ClimateData.ca.


N
Rural district
Nashwaak
Nackawic-Millville
Central York
Rural district
Grand Lake
Rural district
Fredericton
New Maryland
Oromocto
Rural district
Hanwell
Sunbury-York South
Harvey
Arcadia
Tracy
Fredericton Junction
Rural district
Average summer precipitation (1981-2010)
256.14 - 285.98
285.99 - 315.82
315.83 - 345.66
345.67 - 375.5
0 10 20 40 km
Average summer precipitation (2011-2040)
256.14 - 285.98
285.99 - 315.82
315.83 - 345.66
345.67 - 375.5
Average summer precipitation (2041-2070)
256.14 - 285.98
285.99 - 315.82
315.83 - 345.66
345.67 - 375.5
Average summer precipitation (2071-2100)
256.14 - 285.98
285.99 - 315.82
315.83 - 345.66
345.67 - 375.5

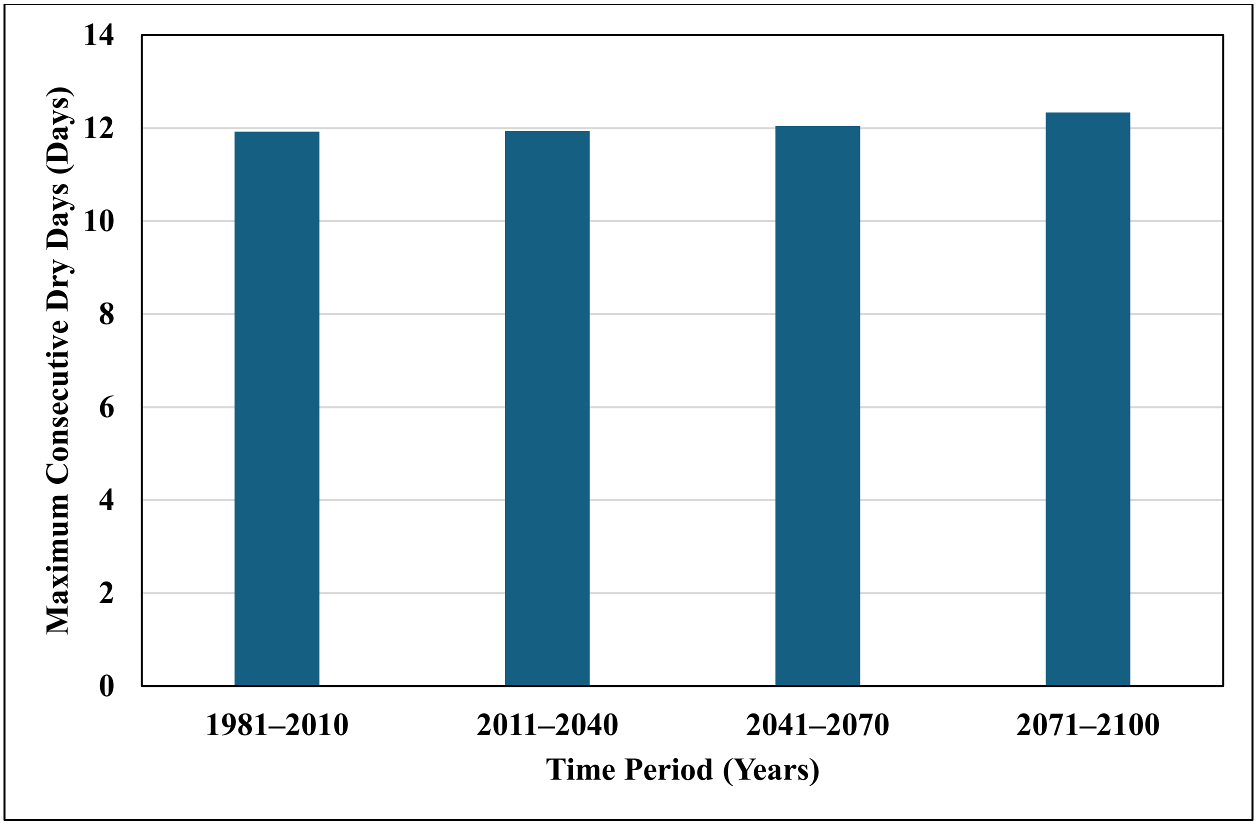
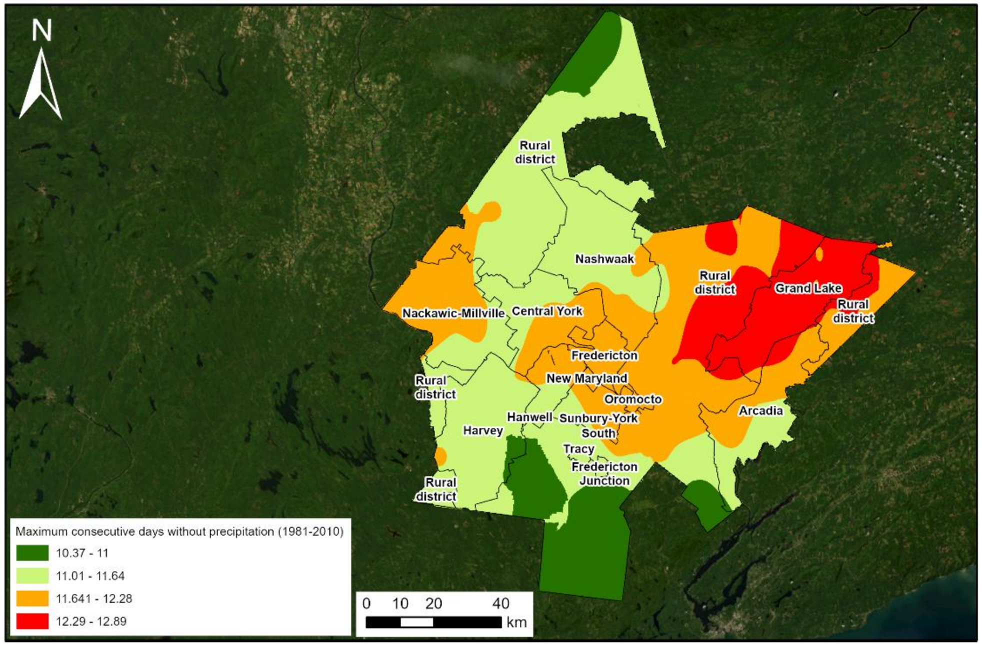
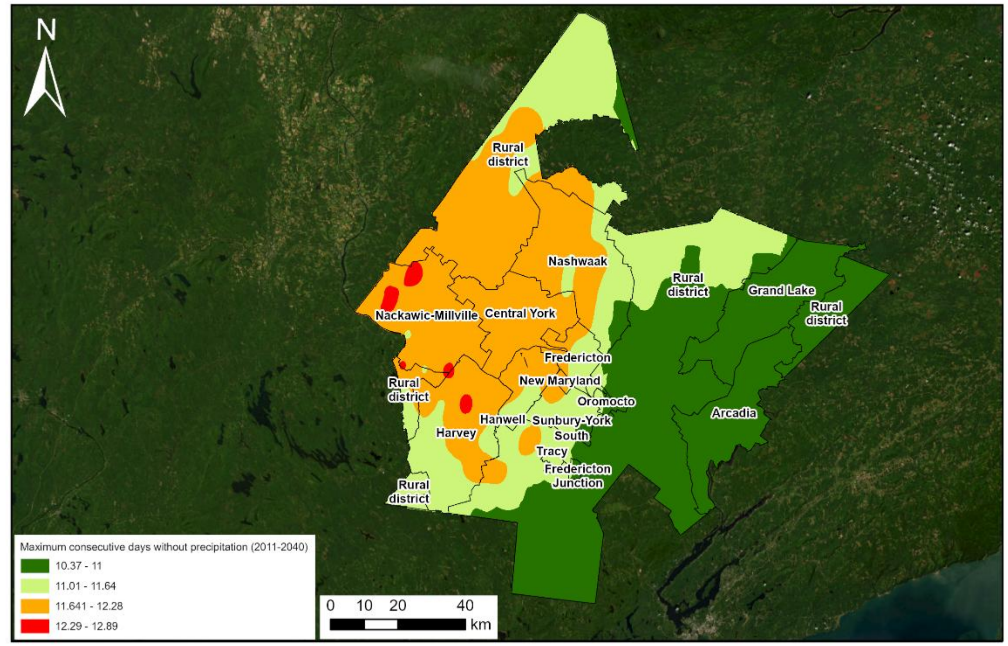
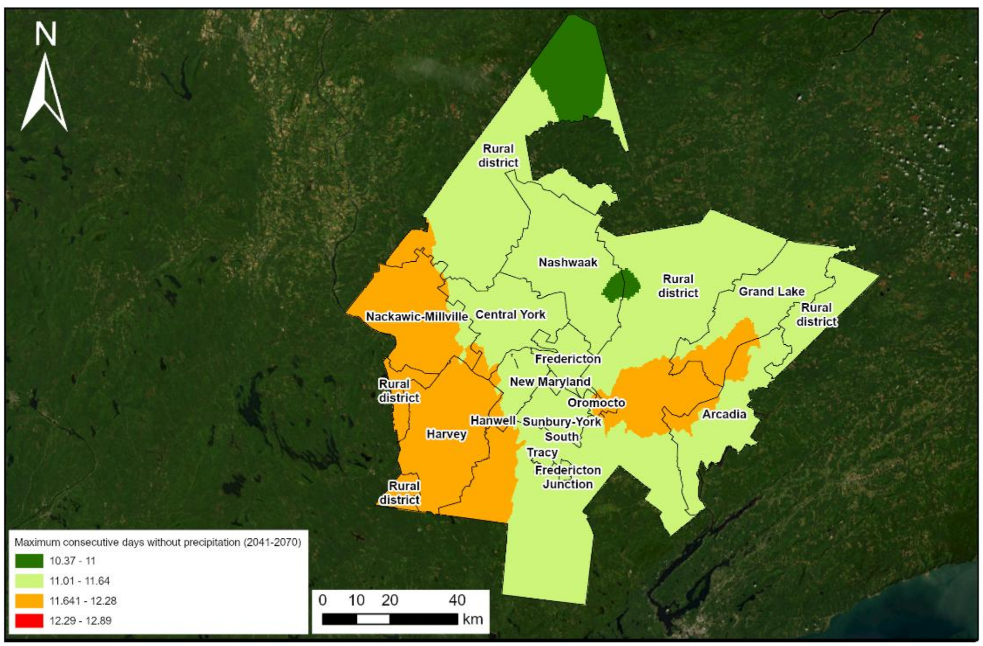
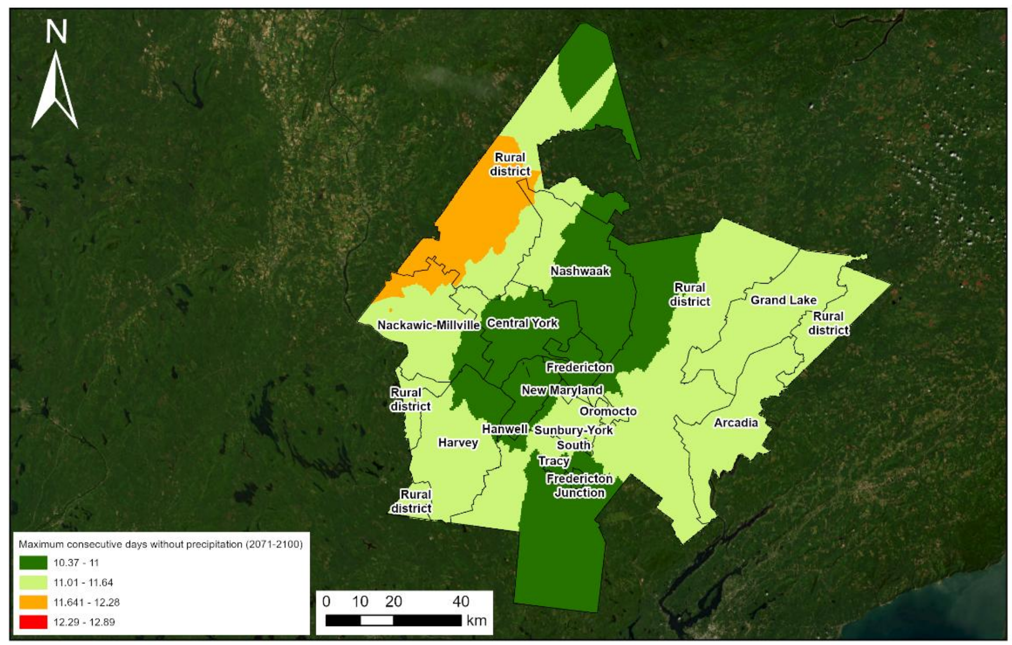


Figure 13. Projected mean maximum number of consecutive dry days (Days) for the Capital Region across three future periods 2011-2040, 2041-2070, and 2071-2100 compared to the historical baseline (1981-2010). Projections are based on the SSP5-8.5 high-emissions scenario (50th percentile ensemble average) using data from ClimateData.ca.


N
Rural district
Nashwaak
Rural district
Grand Lake
Rural district
Nackawic-Millville
Central York
Fredericton
New Maryland
Oromocto
Rural district
Hanwell
Sunbury-York South
Arcadia
Harvey
Tracy
Fredericton Junction
Rural district
Maximum consecutive days without precipitation (1981-2010)
10.37 - 11
11.01 - 11.64
11.641 - 12.28
12.29 - 12.89
0 10 20 40
km


N
Rural district
Nashwaak
Rural district
Grand Lake
Rural district
Nackawic-Millville
Central York
Fredericton
New Maryland
Oromocto
Rural district
Hanwell
Sunbury-York South
Arcadia
Harvey
Tracy
Fredericton Junction
Rural district
Maximum consecutive days without precipitation (2011-2040)
10.37 - 11
11.01 - 11.64
11.641 - 12.28
12.29 - 12.89
0 10 20 40
km


N
Rural district
Nashwaak
Rural district
Grand Lake
Rural district
Nackawic-Millville
Central York
Fredericton
New Maryland
Oromocto
Rural district
Hanwell
Sunbury-York South
Arcadia
Harvey
Tracy
Fredericton Junction
Rural district
Maximum consecutive days without precipitation (2041-2070)
10.37 - 11
11.01 - 11.64
11.641 - 12.28
12.29 - 12.89
0 10 20 40
km


N
Rural district
Nashwaak
Rural district
Grand Lake
Rural district
Nackawic-Millville
Central York
Fredericton
New Maryland
Oromocto
Rural district
Hanwell
Sunbury-York South
Arcadia
Harvey
Tracy
Fredericton Junction
Rural district
Maximum consecutive days without precipitation (2071-2100)
10.37 - 11
11.01 - 11.64
11.641 - 12.28
12.29 - 12.89
0 10 20 40
km

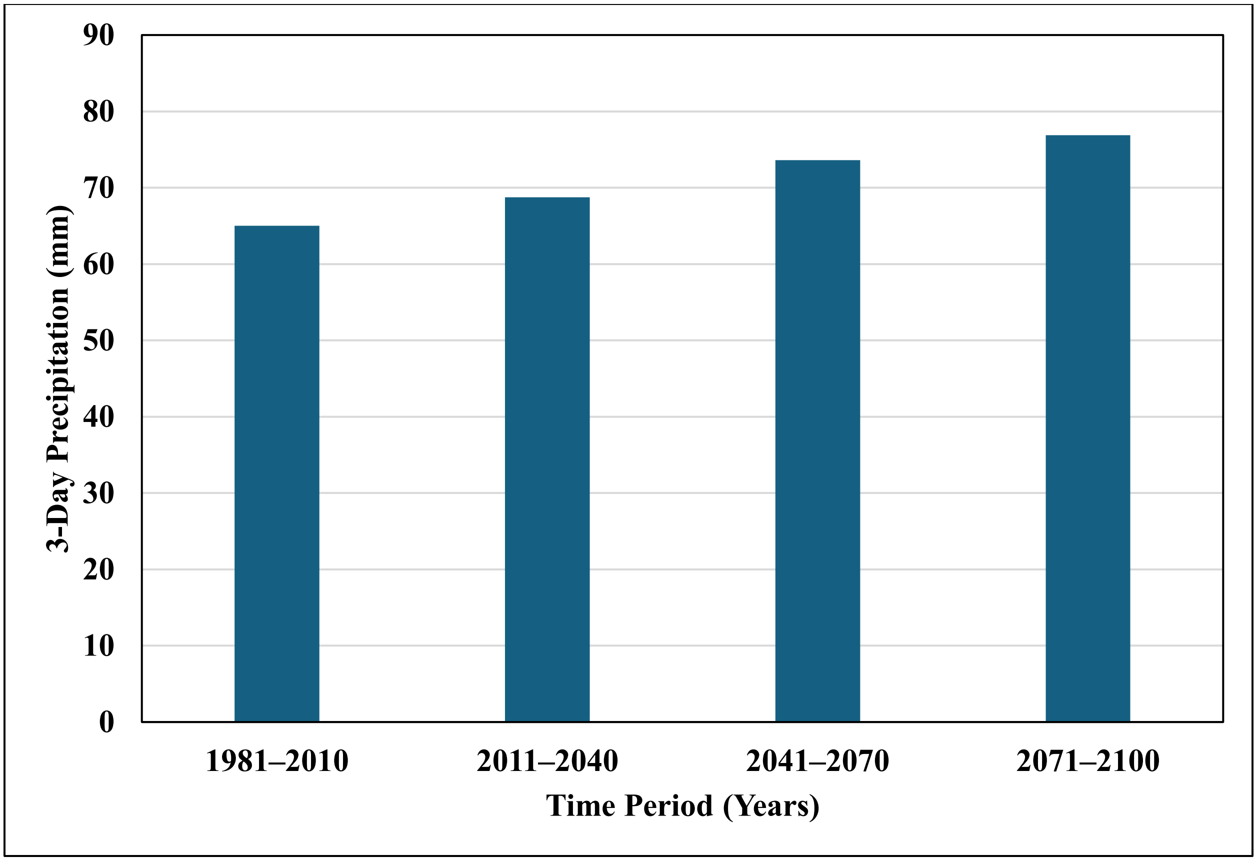
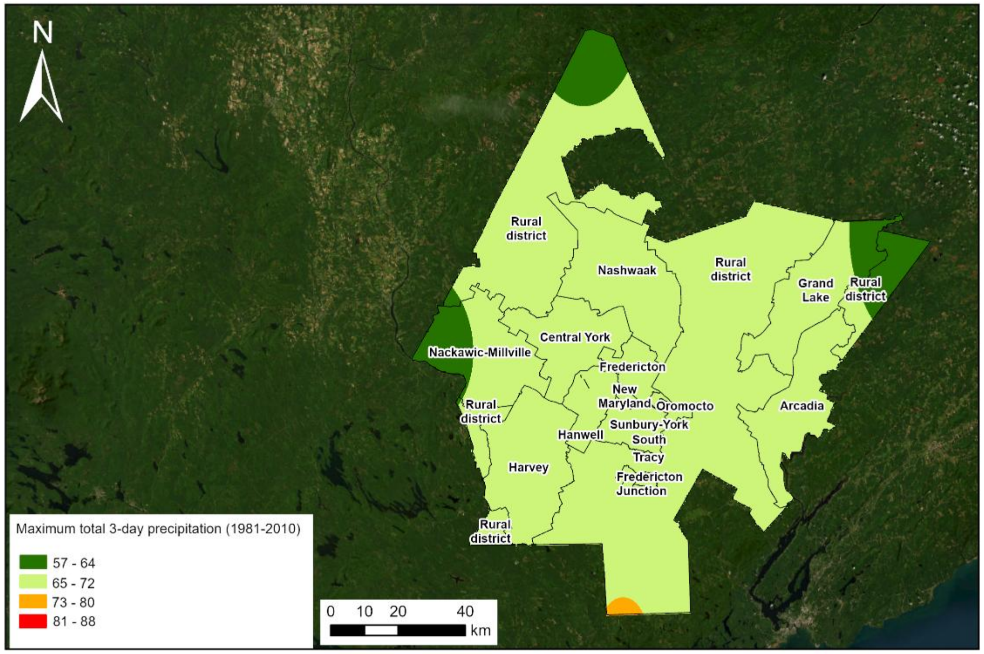
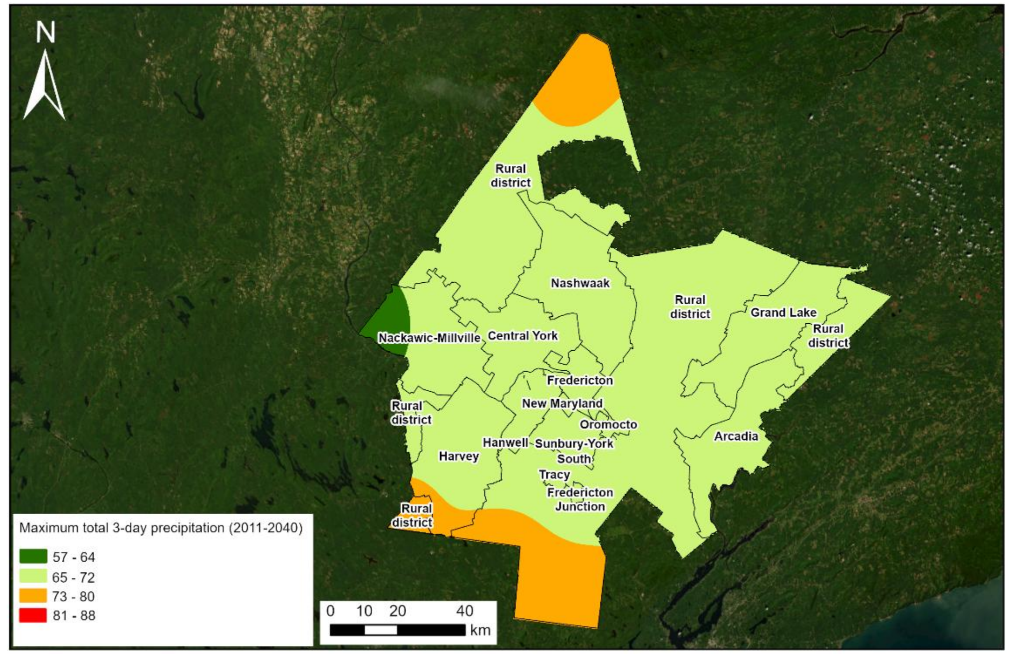
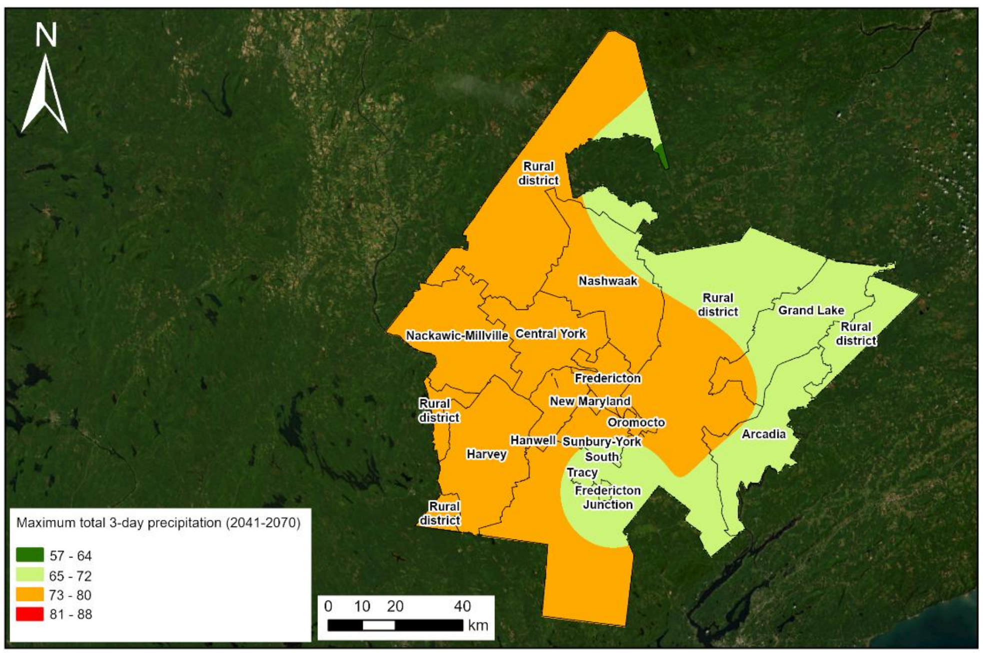


Figure 14. Projected mean 3-day precipitation (mm) for the Capital Region across three future periods 2011-2040, 2041-2070, and 2071-2100 compared to the historical baseline (1981-2010). Projections are based on the RCP5-8.5 high-emissions scenario using data from ClimateAtlas.ca.


N
Rural district
Nashwaak
Rural district
Grand Lake
Rural district
Central York
Nackawic-Millville
Fredericton
New Maryland
Oromocto
Arcadia
Rural district
Sunbury-York South
Hanwell
Tracy
Harvey
Fredericton Junction
Rural district
Maximum total 3-day precipitation (1981-2010)
57 - 64
65 - 72
73 - 80
81 - 88
0 10 20 40
km


N
Rural district
Nashwaak
Rural district
Grand Lake
Rural district
Nackawic-Millville
Central York
Fredericton
New Maryland
Rural district
Oromocto
Arcadia
Hanwell
Sunbury-York South
Harvey
Tracy
Fredericton Junction
Rural district
Maximum total 3-day precipitation (2011-2040)
57 - 64
65 - 72
73 - 80
81 - 88
0 10 20 40
km


N
Rural district
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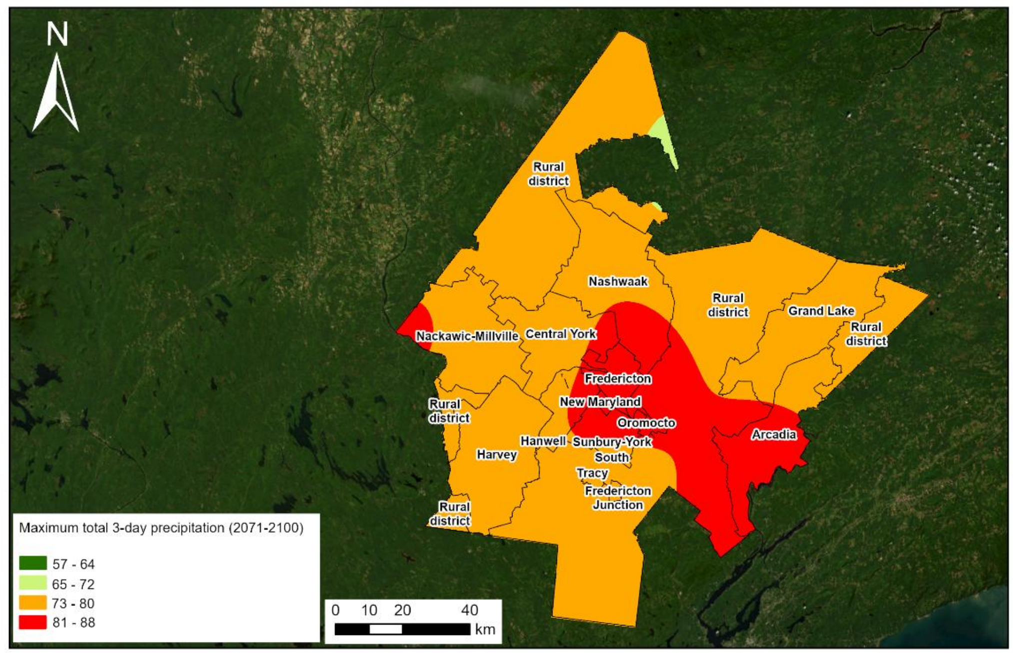
Rural district
Grand Lake
Rural district
Nackawic-Millville
Central York
Fredericton
New Maryland
Rural district
Oromocto
Arcadia
Hanwell
Sunbury-York South
Harvey
Tracy
Fredericton Junction
Rural district
Maximum total 3-day precipitation (2041-2070)
57 - 64
65 - 72
73 - 80
81 - 88
0 10 20 40
km


N
Rural district
Nashwaak
Rural district
Grand Lake
Rural district
Nackawic-Millville
Central York
Fredericton
New Maryland
Rural district
Oromocto
Arcadia
Hanwell
Sunbury-York South
Harvey
Tracy
Fredericton Junction
Rural district
Maximum total 3-day precipitation (2071-2100)
57 - 64
65 - 72
73 - 80
81 - 88
0 10 20 40
km

Cold-weather conditions data

Table 5. Cold-weather conditions variable definitions and implications.

Climate Variables	Definition	Implications
Low Temperatures	Average number of days per year below -25°C.	Indicates reduced cold stress risks and informs winter infrastructure durability, pest survival, and heating needs.
Ice Days	Days when the maximum temperature remains below 0°C.	Useful for assessing risks to transport, infrastructure strain, and potential shifts in seasonal cycles.
Freeze-Thaw Cycles	Daily maximum temperature > 0ºC and the daily minimum temperature is ≤ -1ºC.	Important for evaluating wear on infrastructure, road safety, and building integrity due to expansion/contraction cycles.

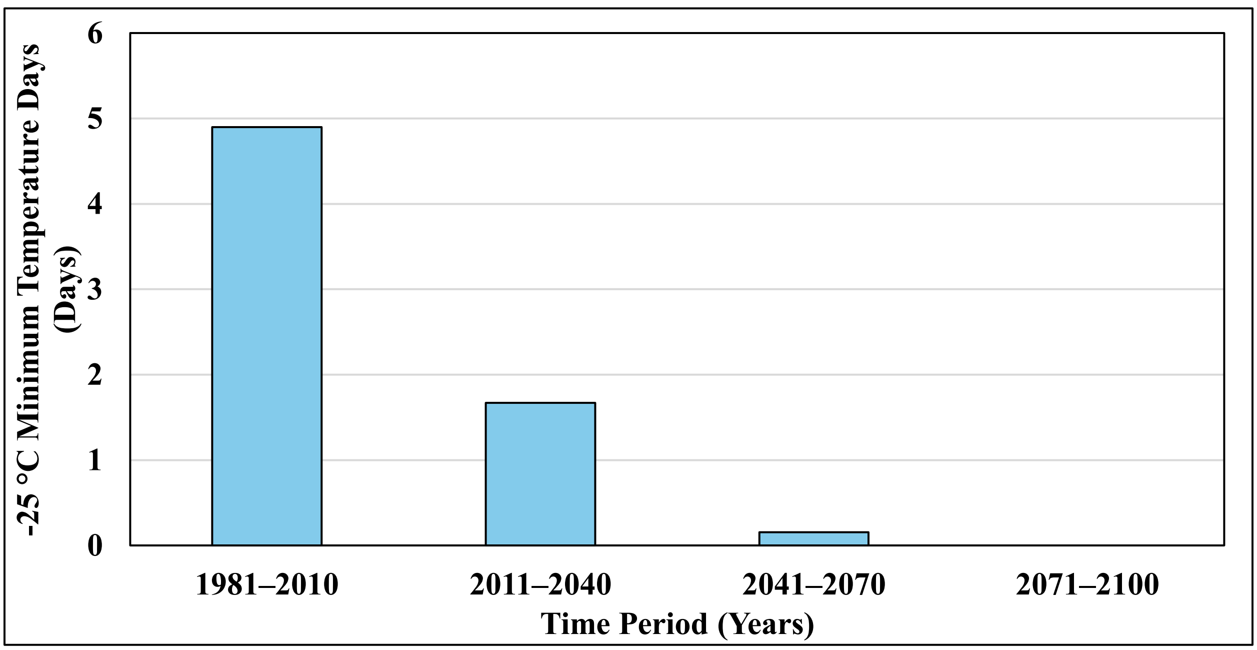
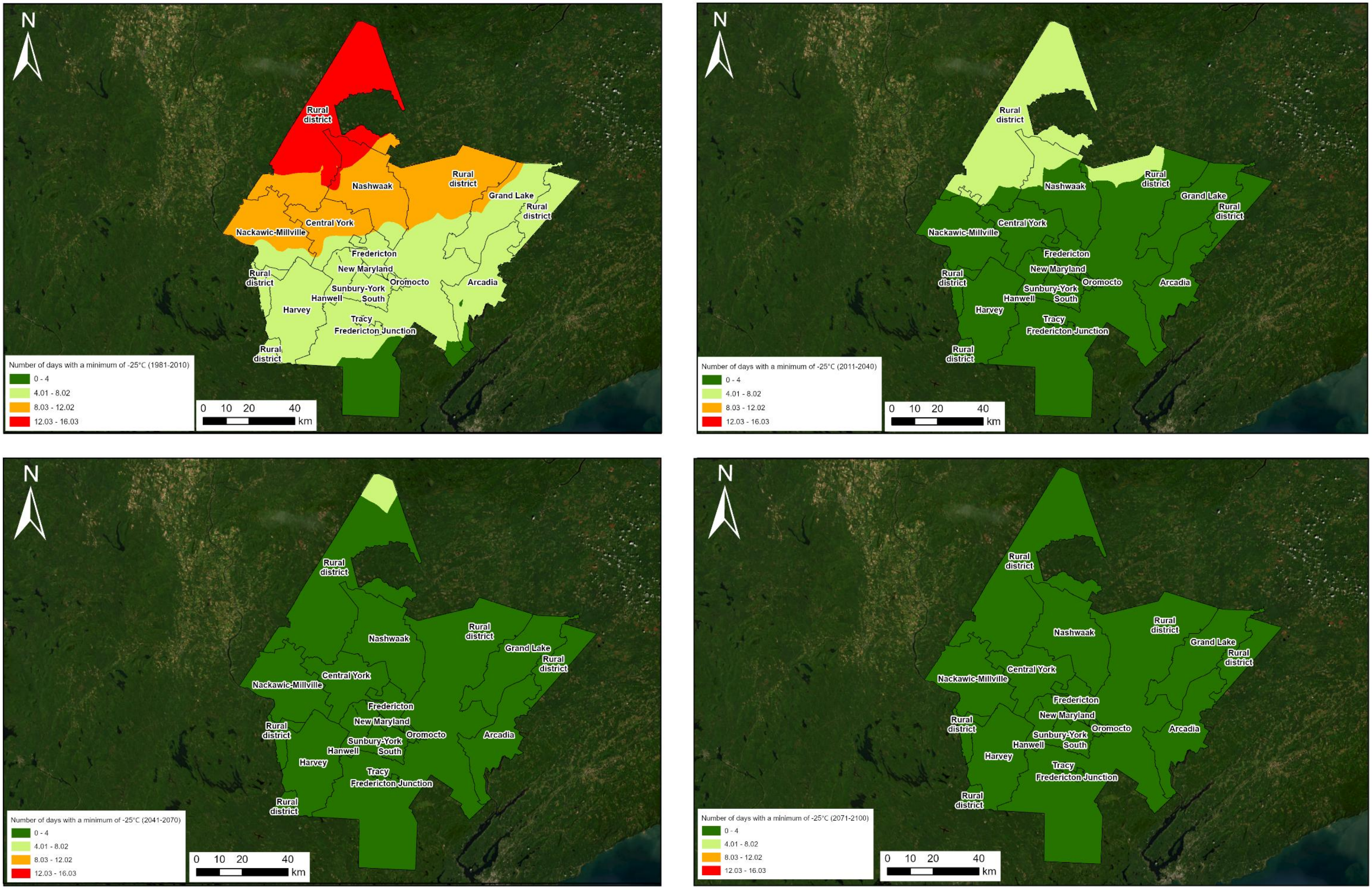


Figure 15. Projected mean number of days with a minimum temperature below -25°C (Days) for the Capital Region across three future periods 2011-2040, 2041-2070, and 2071-2100 compared to the historical baseline (1981-2010). Projections are based on the SSP5-8.5 high-emissions scenario (50th percentile ensemble average) using data from ClimateData.ca.


N
Rural district
Nashwaak
Rural district
Grand Lake
Rural district
Central York
Nackawic-Millville
Fredericton
New Maryland
Oromocto
Arcadia
Rural district
Sunbury-York South
Hanwell
Harvey
Tracy
Fredericton Junction
Rural district
Number of days with a minimum of -25°C (1981-2010)
0 - 4
4.01 - 8.02
8.03 - 12.02
12.03 - 16.03
0 10 20 40
km
Number of days with a minimum of -25°C (2011-2040)
Number of days with a minimum of -25°C (2041-2070)
Number of days with a minimum of -25°C (2071-2100)

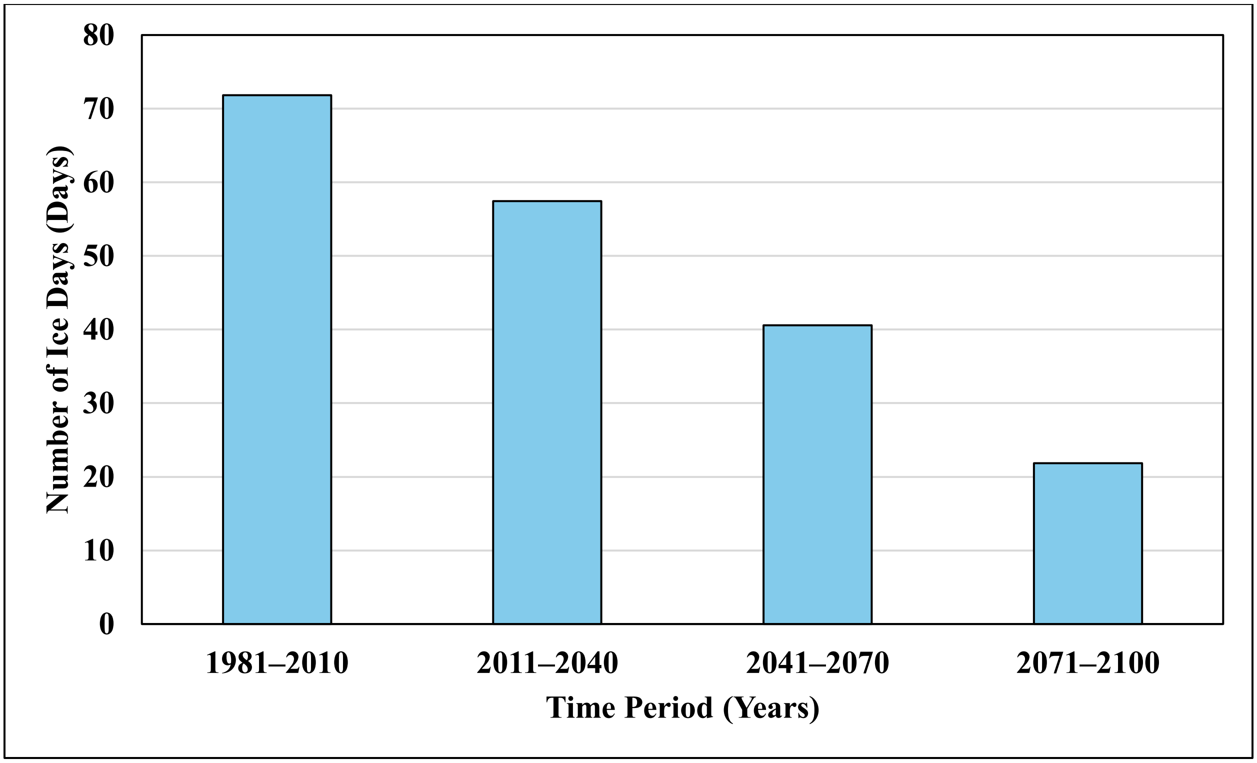
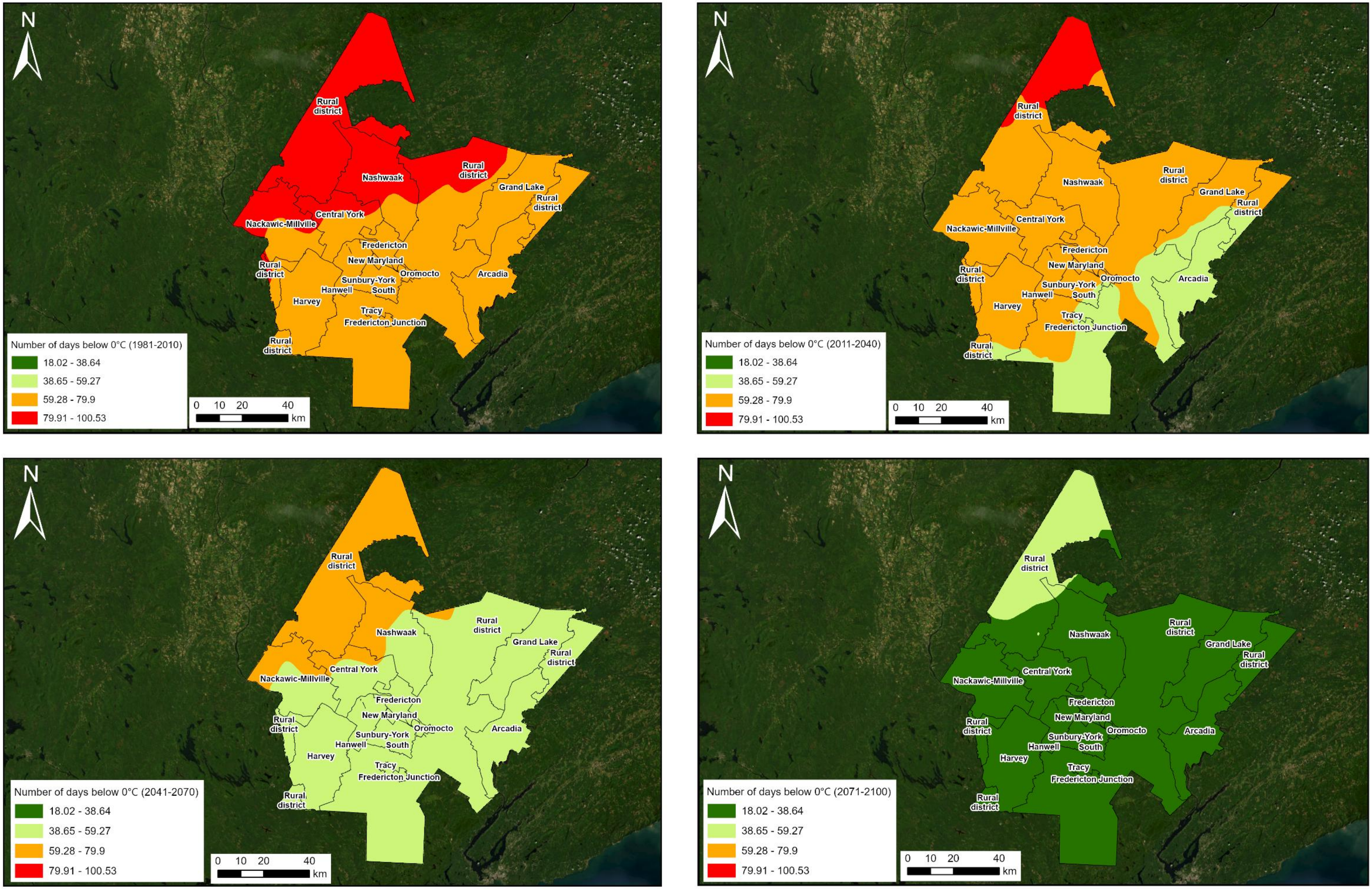


Figure 16. Projected mean number of ice days (#) for the Capital Region across three future periods 2011-2040, 2041-2070, and 2071-2100 compared to the historical baseline (1981-2010). Projections are based on the SSP5-8.5 high-emissions scenario (50th percentile ensemble average) using data from ClimateData.ca.


N
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Nashwaak
Rural district
Grand Lake
Rural district
Central York
Nackawic-Millville
Fredericton
New Maryland
Oromocto
Rural district
Arcadia
Sunbury-York South
Hanwell
Harvey
Tracy
Fredericton Junction
Rural district
Number of days below 0°C (1981-2010)
18.02 - 38.64
38.65 - 59.27
59.28 - 79.9
79.91 - 100.53
0 10 20 40
km
N
Rural district
Nashwaak
Rural district
Grand Lake
Rural district
Central York
Nackawic-Millville
Fredericton
New Maryland
Oromocto
Rural district
Arcadia
Sunbury-York South
Hanwell
Harvey
Tracy
Fredericton Junction
Rural district
Number of days below 0°C (2011-2040)
18.02 - 38.64
38.65 - 59.27
59.28 - 79.9
79.91 - 100.53
0 10 20 40
km
N
Rural district
Nashwaak
Rural district
Grand Lake
Rural district
Central York
Nackawic-Millville
Fredericton
New Maryland
Oromocto
Rural district
Arcadia
Sunbury-York South
Hanwell
Harvey
Tracy
Fredericton Junction
Rural district
Number of days below 0°C (2041-2070)
18.02 - 38.64
38.65 - 59.27
59.28 - 79.9
79.91 - 100.53
0 10 20 40
km
N
Rural district
Nashwaak
Rural district
Grand Lake
Rural district
Central York
Nackawic-Millville
Fredericton
New Maryland
Oromocto
Rural district
Arcadia
Sunbury-York South
Hanwell
Harvey
Tracy
Fredericton Junction
Rural district
Number of days below 0°C (2071-2100)
18.02 - 38.64
38.65 - 59.27
59.28 - 79.9
79.91 - 100.53
0 10 20 40
km

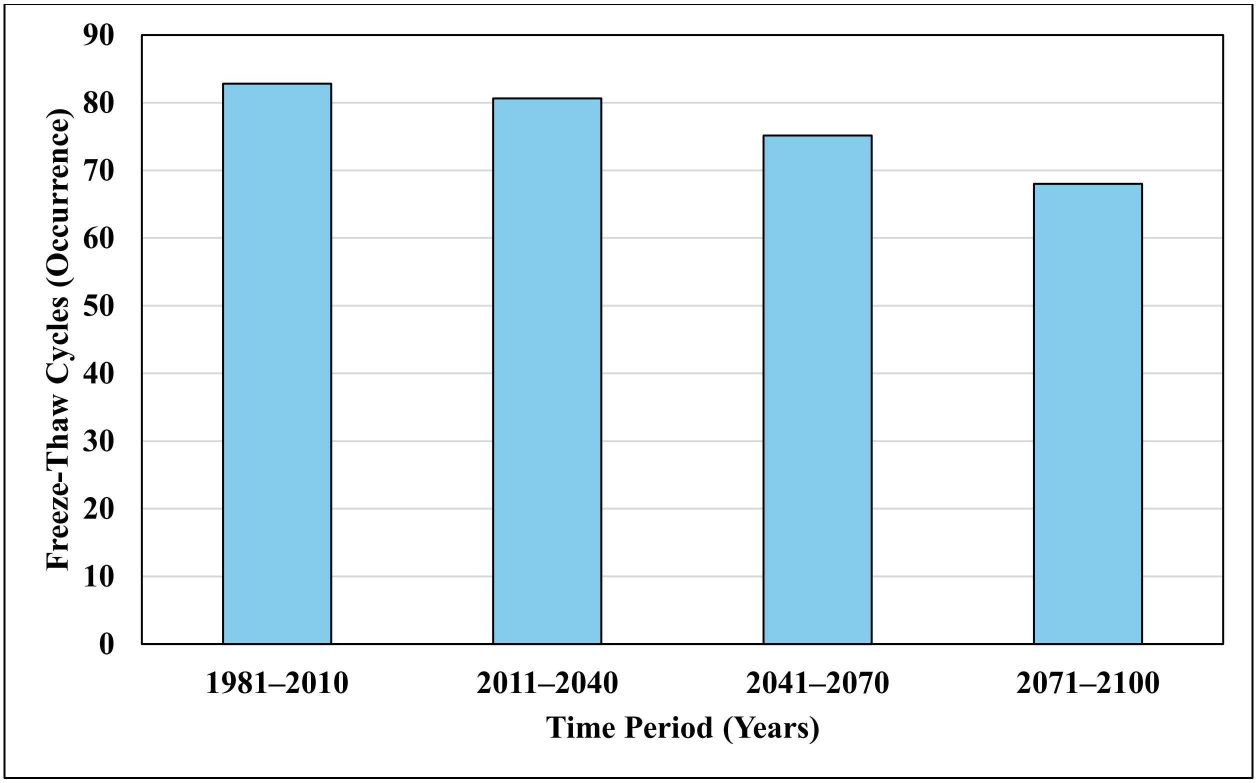
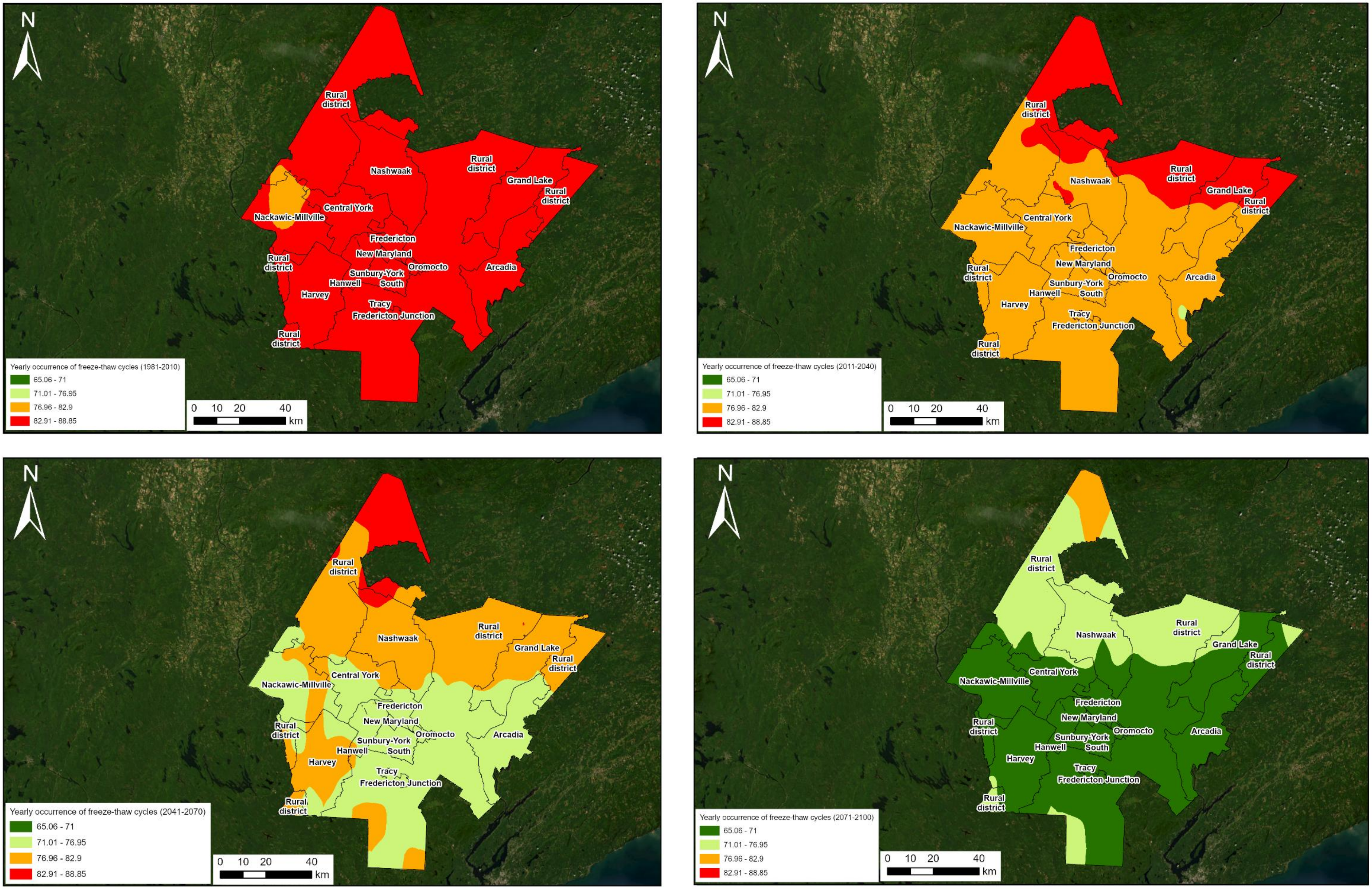


Figure 17. Projected mean number of freeze-thaw cycles (Occurrence) for the Capital Region across three future periods 2011-2040, 2041-2070, and 2071-2100 compared to the historical baseline (1981-2010). Projections are based on the SSP5-8.5 high-emissions scenario (50th percentile ensemble average) using data from ClimateData.ca.


N
Rural district
Nashwaak
Rural district
Grand Lake
Rural district
Central York
Nackawic-Millville
Fredericton
New Maryland
Rural district
Sunbury-York South
Oromocto
Arcadia
Hanwell
Harvey
Tracy
Fredericton Junction
Rural district
Yearly occurrence of freeze-thaw cycles (1981-2010)
65.06 - 71
71.01 - 76.95
76.96 - 82.9
82.91 - 88.85
0 10 20 40
km
Yearly occurrence of freeze-thaw cycles (2011-2040)
Yearly occurrence of freeze-thaw cycles (2041-2070)
Yearly occurrence of freeze-thaw cycles (2071-2100)

Wind speed data

Table 6. Wind variable definition and implications.

Climate Variables	Definition	Implications
Wind Speed	Average or peak wind velocities.	Relevant for infrastructure resilience, wind energy potential, and assessing wildfire spread risk.

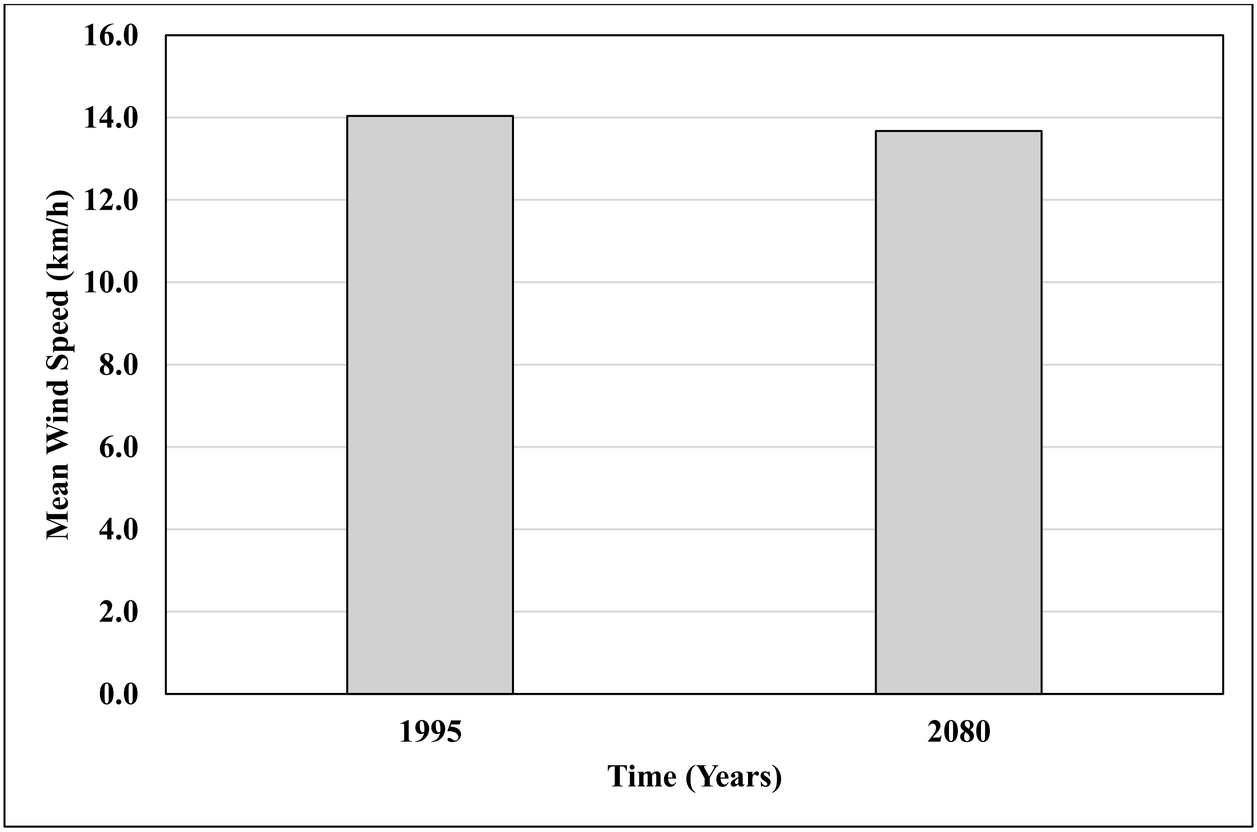


Figure 18. Projected mean wind speed (km/h) for the Capital Region comparing the historical baseline of 1995 and the future period of 2080. The projections are based on the RCP 8.5 projection model and were designed by Ouranos in 2016 for the New Brunswick province.

Wildfire data

Table 7. Wildfire variable definitions and implications.

Climate Variables	Definition	Implications
Fire Season Length	Number of days per year conducive to wildfires.	Essential for resource planning, fire suppression strategy, and community risk mapping.
Fire Weather Index	Composite measure indicating fire potential based on temperature, humidity, wind, and fuel moisture. (refer to **Figure 21**)	Supports early warning systems, land management, and emergency response planning.

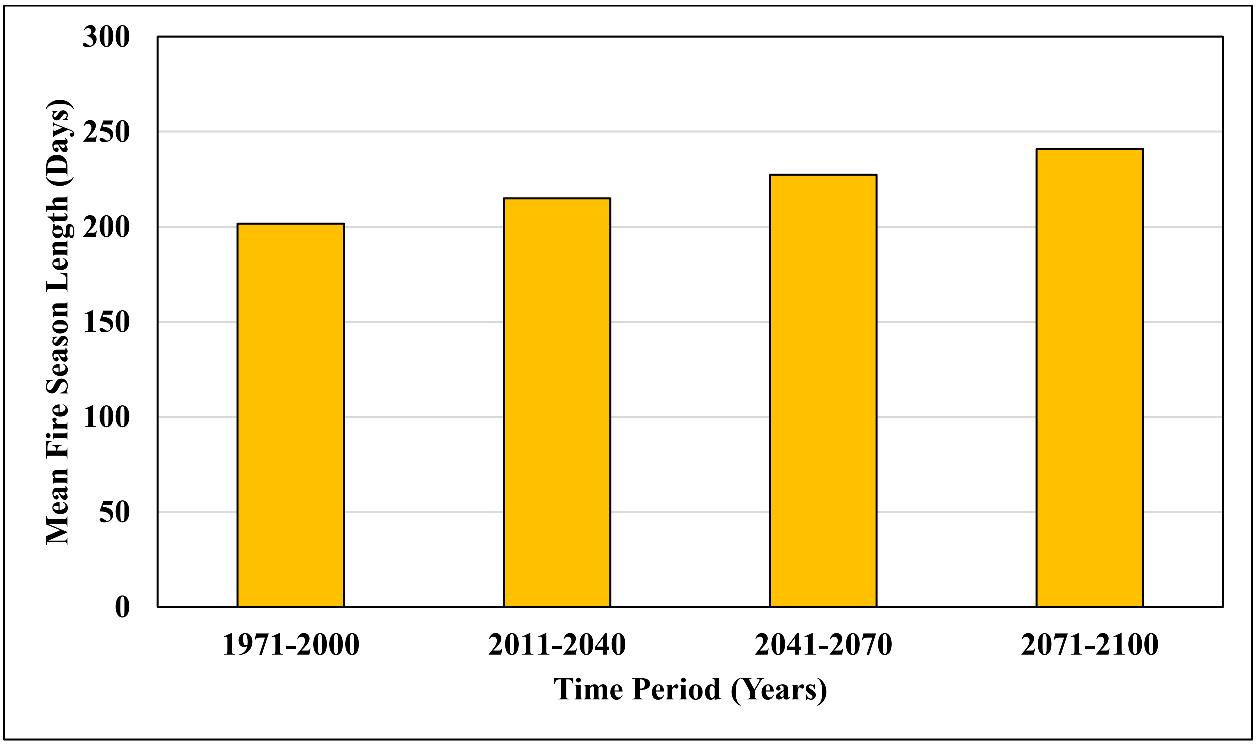
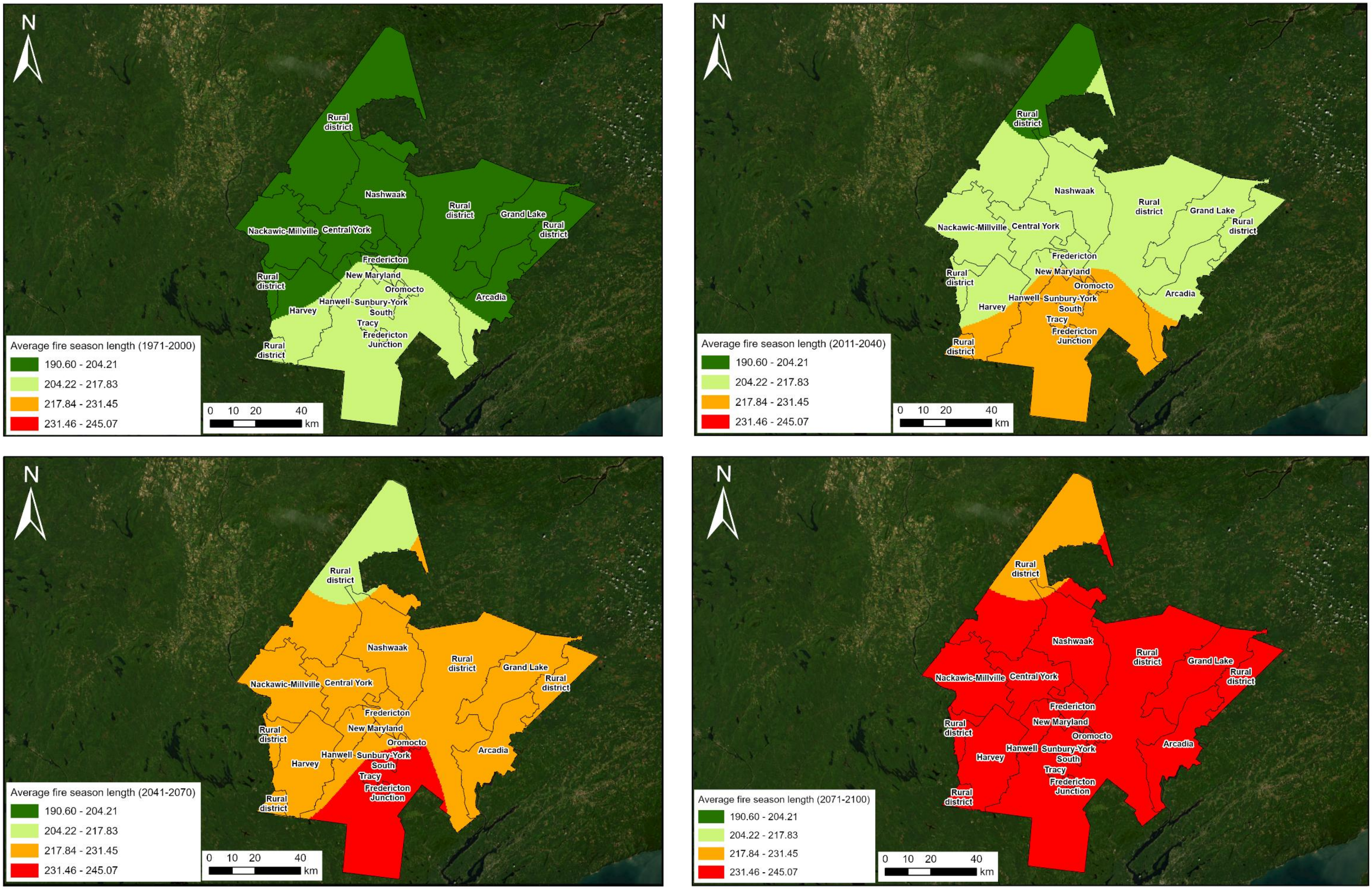


Figure 19. Projected mean fire season length (Days) for the Capital Region across three future periods 2011-2040, 2041-2070, and 2071-2100 compared to the historical baseline (1971-2000). Projections are based on the SSP5-8.5 high-emissions scenario using data from ClimateData.ca.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Average fire season length (1971-2000)
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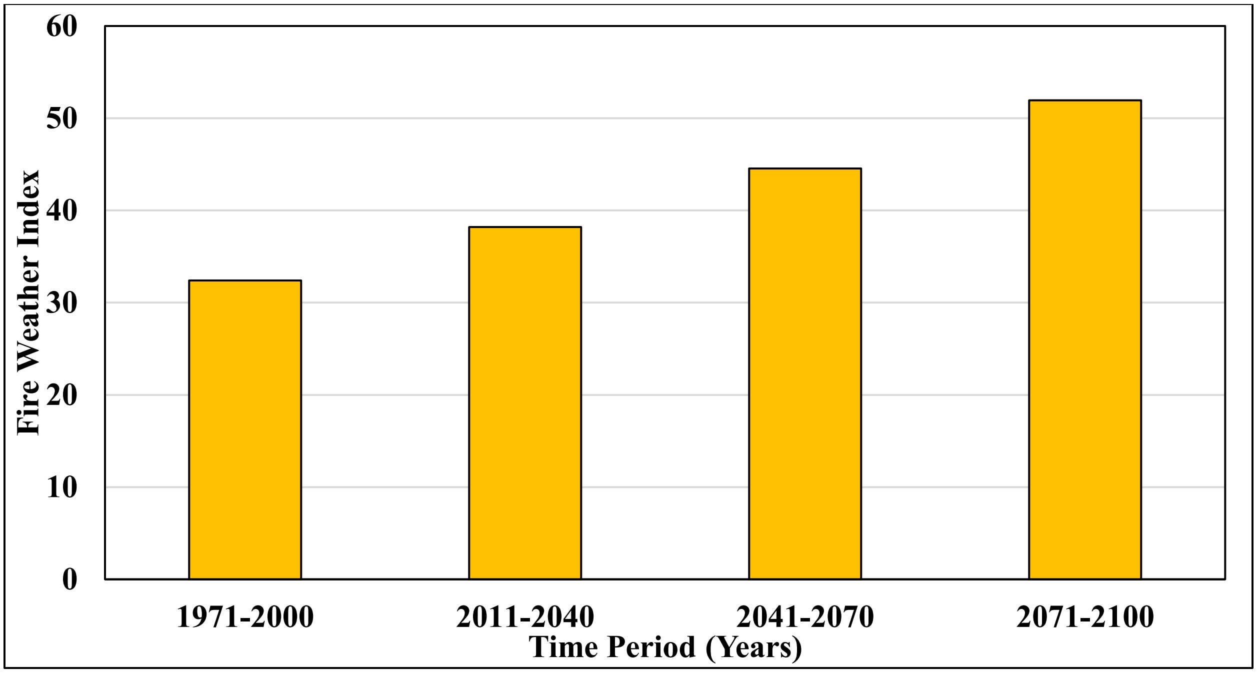
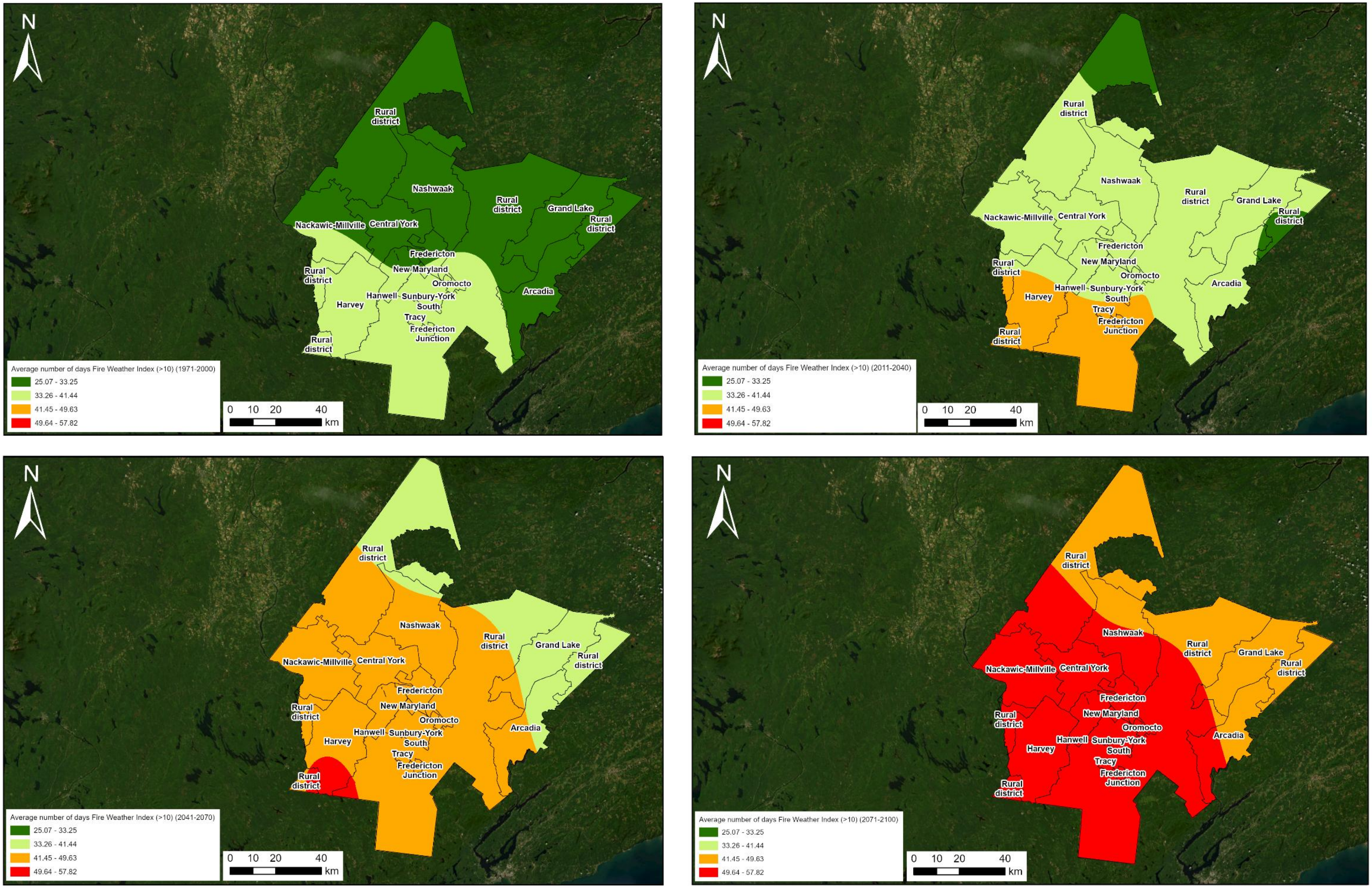


Figure 20. Projected mean fire weather index (FWI) for the Capital Region across three future periods 2011-2040, 2041-2070, and 2071-2100 compared to the historical baseline (1971-2000). Projections are based on the SSP5-8.5 high-emissions scenario using data from ClimateData.ca.

The Fire Weather Index (FWI) is a standardized tool used to assess wildfire risk in forested and wildland areas. Key environmental variables, such as temperature, humidity, wind speed, and recent precipitation are combined to generate numerical ratings. These ratings provide insight into the rising trend of wildfires.

Table 8. Danger level for Fire Weather Index.

FWI	FWI danger level
< 5.2	No Danger
5.2 - 11.2	Low
11.2 - 21.3	Moderate
21.3 - 38	High
38 - 50	Very High
50-70	Extreme
> 70	Very Extreme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Fredericton Junction
Arcadia
Rural district
Average number of days Fire Weather Index (>10) (1971-2000)
25.07 - 33.25
33.26 - 41.44
41.45 - 49.63
49.64 - 57.82
0 10 20 40
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Rural district
Average number of days Fire Weather Index (>10) (2011-2040)
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Average number of days Fire Weather Index (>10) (2071-2100)
25.07 - 33.25
33.26 - 41.44
41.45 - 49.63
49.64 - 57.82
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Climate Data summary

Table 9. Identified hazards in the Capital Region and their historical data (1981-2010) compared to their projected values for the end of the century period (2071-2100) to visualize trends in high carbon emission scenario.

	Climate Hazard	Baseline Values (1981-2010)	Trend	Projected Values (2071-2100)	Source(s)
Temperature	**High Temperatures** Average number of days per year with a maximum temperature > 30 ºC	6.66 Days/Year	↑	55.84 Days/Year	Climatedata.ca Climate.weather.gc.ca
	Low Temperatures Average number of days per year with a minimum temperature < -25 ºC	4.9 Days/Year	↓	0 Days/Year	Climatedata.ca
	Ice Days Average number of days per year with maximum temperature > 0 ºC	76.11 Days/Year	↓	21.85 Days/Year	Climatedata.ca Climate.weather.gc.ca
	Freeze-Thaw Cycles Daily maximum temperature > 0ºC and the daily minimum temperature is ≤ -1ºC	82.79 Occurrences	↓	67.99 Occurrences	Climatedata.ca
	Daily Temperatures Average daily temperature across the year (ºC)	5.3 ºC	↑	11.6 ºC	Climatedata.ca Climate.weather.gc.ca

Precipitation	**Annual Precipitation** Average annual precipitation of rainfall and snowfall	1121.12 mm	↑	1439.46 mm	Climatedata.ca Climate.weather.gc.ca
	Fall Precipitation Average fall season precipitation of rainfall and snowfall	296.17 mm	↑	332.52 mm	Climatedata.ca Climate.weather.gc.ca
	Winter Precipitation Average winter season precipitation of rainfall and snowfall	272.13 mm	↑	433.00 mm	Climatedata.ca Climate.weather.gc.ca
	Spring Precipitation Average spring season precipitation of rainfall and snowfall	280.69 mm	↑	337.54 mm	Climatedata.ca Climate.weather.gc.ca
	Summer Precipitation Average summer season precipitation of rainfall and snowfall	272.13 mm	↑	312.03 mm	Climatedata.ca Climate.weather.gc.ca
	Maximum Dry Days Average maximum consecutive days without precipitation	11.93 Days	↑	12.34 Days	Climatedata.ca
	3-Day Precipitation Average maximum total three days precipitation in the year	65.03 mm	↑	76.9 mm	Climateatlas.ca

Wind	**Wind Speed** Average annual wind speed	14.04 km/h	⇩	13.67 km/h	Csrno.ca
Wildfire	**Fire Season Length** Average number of days per year for the fire season	201.59 Days/Year	⇧	240.78 Days/Year	Climatedata.ca
	Fire Weather Index Average number of days per fire season (May to September period) with a high value >10	32.41 Days/Season	⇧	51.95 Days/Season	Climatedata.ca

V. EXAMPLES OF STRATEGIC ADAPTATION AND MITIGATION ACTIONS

A. 🆘 Emergency Measures Organizations

- Develop climate-informed Emergency Response and Communication Plans, incorporating localized hazard projections and updated protocols.
- Integrate early warning systems (e.g., flood alerts, wildfire indices) with public communication tools.
- Conduct joint training exercises with emergency services based on climate-driven disaster scenarios.
- Ensure emergency shelters are climate-resilient, accessible, and equipped with backup power, water, and air filtration.
- Formalize mutual aid agreements for rapid resource sharing across municipalities.
- Embed after-action reviews into emergency response and adaptation planning cycles.
- Recommend radio-based or SMS emergency alerts to reach residents in low-bandwidth rural areas.
- Develop rural-specific fire route mapping to support faster EMS and wildfire response.
- Establish mutual-aid agreements tailored to rural municipalities with limited staff and equipment resources.

B. 🏗️ Infrastructure Resilience

- Identify and map critical infrastructure at risk using climate hazard overlays and damage records.
- Plan for relocation, protection, or retrofitting of exposed assets.
- Incorporate freeze–thaw projections into road maintenance planning and materials selection.
- Elevate or redesign infrastructure in flood-prone areas to improve drainage and system resilience.
- Apply climate-informed design standards for buildings, water plants, and roads.
- Integrate nature-based elements (e.g., wetlands) into infrastructure systems for dual-use resilience.
- Use heat-resilient materials on roadways and sidewalks to mitigate urban heat impacts.
- Build redundancy and fail-safe systems into power, water, and communication networks.
- Establish climate-resilient procurement standards for municipal construction.
- Prioritize investments based on criticality, exposure, and co-benefits such as emissions reduction.

Example: Moncton, NB. In February 2023, the federal and provincial governments invested over $36 million in Moncton's downtown infrastructure, including stormwater and sanitary system upgrades, undergrounding utilities, and elevation of streets, all designed to improve resilience to heavier rainfall and climate stress.

C. 🌊 Flood Management

- Update floodplain maps and zoning using climate projections.
- Enforce land-use controls in high-risk flood zones.
- Install backflow protection valves in flood-prone sewer zones.
- Use Riverwatch tools, gauges, and real-time alerts tied to emergency protocols.
- Develop stormwater management plans that account for future rainfall patterns.
- Retrofit culverts and catch basins to accommodate projected runoff volumes.
- Apply green infrastructure: bioswales, rain gardens, permeable surfaces.
- Offer property-level flood adaptation support (grants, technical advice).
- Design urban spaces to emulate natural hydrological systems (e.g., green roofs, rain gardens).
- Standardize regional flood response protocols across municipal boundaries.

Example**:** Town of Sussex, NB (2024) launched a Basement Flood Prevention Subsidy Program, offering up to $3,000 per homeowner to install key flood mitigation measures. These include backwater (backflow) valves, sump pump systems, and disconnecting downspouts or weeping tiles from sanitary sewers.

D. 🌡️ Heat Adaptation & Urban Cooling

- Expand tree canopy in heat-vulnerable areas and transit corridors.
- Establish cooling centers and hydration stations for at-risk populations.
- Launch heat-health public education campaigns.
- Incentivize shaded, reflective, and permeable urban design in new builds.
- Retrofit parks, transit stops, and public spaces with shade infrastructure.
- Improve access to recreational water features (beaches, splash pads).
- Equip long-term care homes and shelters with backup power for cooling.
- Embed urban heat mitigation in land-use and green space planning.
- Pilot neighborhood-scale cooling innovations (e.g., green roofs, reflective coatings).
- Monitor heat-related illness trends with public health partners.

Example: Fredericton, NB expanded its Urban Forest Strategy with climate-resilient tree species and increased canopy to mitigate urban heat. The city partners in the provincial Heat Alert and Response System (HARS), providing tiered heat warnings, bilingual outreach, hydration centers, and public education during extreme heat events.

E. 💧 Drought Resilience

- Invest in groundwater development and aquifer mapping.
- Promote xeriscaping (water-conserving landscaping, drought-tolerant landscaping, and smart scaping) using native, drought-tolerant plants.
- Run water conservation campaigns and appliance rebate programs.
- Improve soil retention through regenerative practices and green infrastructure.
- Expand rainwater harvesting and greywater reuse for non-potable use.
- Diversify water supply systems and build interconnections for redundancy.
- Update bylaws with drought-triggered water use restrictions.
- Work with farmers to promote efficient irrigation and drought-adapted crops.
- Map drought risk to inform siting and continuity planning.
- Offer training and workshops on water stewardship and soil conservation.

Example: Upper Miramichi, NB partnered with provincial agencies to assess groundwater vulnerability and launched a rain barrel distribution program for residents, promoting water conservation during low-precipitation periods.

F. 🌬️ Wind & Storm Resilience

- Update building codes to account for higher wind thresholds.
- Assess and manage tree canopy to reduce windthrow risk.
- Reinforce emergency power supply with mobile generators and microgrids.
- Upgrade telecom infrastructure and underground key assets.
- Retrofit critical community facilities for wind resistance.
- Use natural windbreaks (hedgerows, forest buffers) in site planning.
- Monitor insurance access and affordability in high-risk zones.
- Train staff in storm damage assessment and debris clearance.
- Standardize wind-resistant specs for signage, transit shelters, etc.
- Include windstorm modeling in long-term asset management plans.

Example: Saint John, NB has updated its building code enforcement to reflect projected wind thresholds, especially in coastal zones, and secured provincial support for urban canopy risk management following multiple storm events.

G. ⚡ Energy & Emissions

- Promote municipal recycling programs to reduce landfill waste and associated emissions.
- Capture methane emissions from landfills for conversion into renewable energy sources (e.g., biogas generation).
- Expand protected bike lanes, pedestrian networks, and transit options.
- Support building retrofits and LED conversion programs.
- Offer incentives for residential and commercial renewable energy (solar, wind).
- Track emissions with municipal GHG inventories.
- Mandate energy benchmarking and disclosure for large buildings.
- Support resilient energy systems (e.g., microgrids, battery backup).
- Align zoning and housing policy to reduce car dependency.
- Partner with utilities for grid decarbonization projects.
- Embed climate targets into municipal budgets and master plans.
- Run public campaigns on energy conservation and home electrification.

Example: The Capital Region Service Commission (CRSC) operates a landfill gas collection system at its regional landfill, which captures methane and converts it into electricity. Providing a local model of circular energy recovery and emissions reduction.

H. 🌱 Nature-Based Solutions

- Protect and expand wetlands, forests, and riparian zones.
- Use bioswales, green roofs, and naturalized stormwater systems in cities.
- Restore floodplains using nature-based designs.
- Map and include natural assets in capital and planning frameworks.
- Apply Eco-DRR* techniques for slope stabilization and firebreaks.
- Manage invasive species to maintain biodiversity.
- Collaborate with Indigenous communities to integrate traditional knowledge.
- Plan for pollinator corridors and green space connectivity.
- Design multifunctional greenspaces for cooling, recreation, and air quality.
- Align with provincial conservation and biodiversity goals.

Example: Hampton, NB restored riparian buffers along Kennebecasis River tributaries to mitigate flooding, improve water quality, and enhance biodiversity corridors through its natural asset management approach.

**Note: Eco-DRR (Ecosystem-based Disaster Risk Reduction) is the sustainable use of ecosystems, such as, wetlands, forests, and green spaces, to reduce disaster risks by buffering climate-related hazards like floods, landslides, and heatwaves, while also supporting biodiversity and human well-being.*

I. 🏥 Public Health & Safety

- Track climate-sensitive health conditions (heat stress, respiratory illness).
- Establish clean-air shelters for smoke and poor air quality events.
- Expand mental health support during and after disasters.
- Prepare health emergency plans for compound risks (e.g., heat + power loss).
- Provide mobile services for cooling, hydration, and medical care.
- Train first responders in climate-health risks.
- Run outreach campaigns on personal readiness for heat, smoke, and flood.
- Retrofit care homes and shelters for backup power and climate resilience.
- Align housing and land-use decisions with health risk projections.
- Use health surveillance data to adjust public health policy.

Example: Fredericton, NB partnered with the New Brunswick Department of Health to develop and implement the provincial Heat Alert and Response System (HARS). Supported by Health Canada, this initiative includes locally tailored heat thresholds, tiered alerts, bilingual public outreach, and hydration center coordination. It is one of the first examples in Atlantic Canada of municipal–provincial collaboration on climate-health risk monitoring.

J. 🗺️ Land Use Planning

- Integrate climate scenarios into Municipal Plans, Rural Plans and zoning reviews.
- Restrict development in floodplains, fire zones, and erosion-prone lands.
- Apply greenbelt and conservation tools at the watershed scale.
- Incentivize compact development and low-risk site designs.
- Require climate impact assessments for major projects.
- Value ecosystem services in land use planning.
- Prioritize reuse of buildings and brownfield sites.
- Coordinate housing, transport, and greenspace planning for resilience.
- Collaborate across municipalities on shared risk zones.
- Update subdivision rules with elevation standards and stormwater requirements.

Example: Fredericton, NB embedded flood risk and heat exposure layers into its municipal GIS system to inform zoning decisions and Municipal Plan reviews. New developments in hazard-prone areas are now subject to stricter elevation and drainage criteria, reflecting the city's climate-smart growth strategy.

K. 🔌 Utility & Power Systems

- Increase grid resilience with decentralized generation and redundancy.
- Audit utilities for exposure to extreme events.
- Integrate renewables and battery storage in public infrastructure.
- Harden substations and water plants against flood and wind.
- Deploy smart grid* technology for load balancing and recovery.
- Promote conservation with pricing, incentives, and education.
- Expand backup power for healthcare, comms, and critical facilities.
- Retrofit old infrastructure with climate-ready upgrades.
- Coordinate utility capital planning to reflect shared risks.
- Use climate resilience as a standard in public procurement.

Example: Saint John Energy (Saint John, NB) has piloted a distributed energy resource project including battery storage and smart grid controls to increase energy resilience during storms. The city has also undertaken vulnerability audits of critical substations located in flood-prone zones.

**Note: Smart Grid is a digitally enhanced electricity network that uses real-time data, automation, and advanced sensors to improve the efficiency, reliability, and resilience of power distribution—especially during climate-induced disruptions or peak demand.*

L. 🤝 Community Engagement & Knowledge Sharing

- Run participatory mapping and scenario workshops.
- Create inclusive advisory groups with equity-seeking voices.
- Promote citizen science and local climate data collection.
- Host annual public progress forums and reports.
- Use plain language and visual media to explain adaptation plans.
- Expand climate education across age groups and institutions.
- Facilitate peer learning between municipalities and partners.
- Collaborate with artists and storytellers to ground adaptation in culture.
- Embed adaptive feedback loops in public engagement.
- Celebrate and support local leaders in resilience work.

Example: Fredericton, NB hosted its first Climate Action Symposium in October 2024 in partnership with QUEST Canada. This event brought together ~40 participants from local non-profits, community groups, and municipal staff to co-design climate solutions aligned with the city's Community Energy & Emissions Plan (CEEP). Outcomes included the formation of new community–municipal partnerships, a publicly released set of recommendations to guide future climate action, identification of engagement strategies to expand resident outreach and plans to make the symposium an annual event to maintain momentum in collaborative climate efforts.

Suggested practice: Smaller CRSC communities such as Tracy could host localized town halls or adaptation planning workshops that incorporate resident knowledge, plain-language materials, and input from EMO personnel. These sessions could feed directly into regional climate priorities and planning updates.

VI. CLIMATE CHANGE ADAPTATION AND MITIGATION PLAN METHODOLOGY

Step 1: Understand Climate Hazards and Anticipated Impacts

Objective: Enable council, municipal departments, regional agencies, and service providers to understand *which hazards demand priority response, planning, and funding*.

Action-Oriented Questions:

- Which climate hazards (e.g. flooding, extreme heat, winter storms, drought, erosion) most frequently or severely affect our jurisdiction?
- What is the probability and recurrence rate of these hazards over the next 10, 25, and 50 years?
- What essential services, assets, and community sectors have already been impacted?

How This Informs Policy:

- Provides risk justification for infrastructure upgrades, zoning revisions, emergency preparedness planning, and funding allocation.
- Builds a shared understanding across sectors (e.g., transportation, housing, utilities, health) to align priorities and timelines.
- Encourages data sharing among municipalities and regions to create a comprehensive risk profile.

Step 2: Identify Vulnerable Areas and At-Risk Infrastructure

Objective: Integrate spatial vulnerability into capital asset management, land-use planning, and development controls.

Action-Oriented Questions:

- Where have climate events caused disruptions or damage (e.g., flood-prone roads, heat-vulnerable housing, slope erosion)?
- Which critical infrastructure—roads, utilities, community facilities—faces increased exposure and requires reinforcement or relocation?
- Are there outdated or poorly located assets (e.g., culverts, sewage lines, shoreline buildings) that must be retrofitted or decommissioned?

How This Informs Policy:

- Supports risk-informed asset management by guiding capital budgets toward proactive investments in infrastructure resilience. When reactive investments are necessary, priority should be given to adaptation and mitigation measures, accompanied by a realistic timeline for replacements, upgrades, or the installation of new infrastructure.
- Assists emergency services in mapping hazard-prone routes and evacuation challenges.
- Offers insight for development permitting, land-use zoning, and site plan approvals.

Implementation Tip:

Use mapping tools and geospatial data to overlay climate projections on infrastructure inventories, this helps make decisions visible and defensible.

Step 3: Identify Vulnerable Social Groups and Service Gaps

Objective: Ensure emergency response, health, housing, and outreach services are targeted, equitable, and culturally appropriate.

Action-Oriented Questions:

- Which demographic groups are least equipped to prepare for, withstand, or recover from climate impacts?
- How do geographic isolation, income, disability, or access to services compound vulnerability?

Vulnerable Populations to Consider:

- Seniors and children.
- Low-income or single-parent households.
- Individuals with mobility or cognitive disabilities.
- Unhoused persons or those with insecure housing.
- Rural and Indigenous communities.

How This Informs Policy:

- Guides emergency preparedness plans and resource allocation for heat waves, floods, and power outages.
- Directs funding to resilience hubs, cooling centers, outreach programs, or accessible transport during emergencies.
- Supports collaboration with non-profits, First Nations, and health services in joint adaptation strategies.

Step 4: Assess Economic Consequences of Climate Impacts

Objective: Quantify and communicate economic risks to justify investment in climate resilience and attract funding.

Action-Oriented Questions:

- What are the costs of past climate-related damages (e.g., flood repairs, business disruptions)?
- Which economic assets (e.g., downtown cores, industrial parks, tourism zones, ports) are in high-risk zones?
- What is the potential economic loss from service disruption, property damage, and loss of access?

How This Informs Policy:

- Strengthens business cases for provincial/federal grants, insurance reforms, or relocation incentives.
- Informs land-use and investment decisions by identifying "no-build" or "upgrade priority" zones.
- Enables economic development and planning departments to engage business owners in co-developing adaptation measures.

Step 5: Assess Environmental, Social, Cultural, and Health Risks

Objective: Protect natural systems and ensure continuity of health and cultural wellbeing under climate stress.

Action-Oriented Questions:

- Which natural areas (e.g., wetlands, forests, riverbanks) provide critical services (e.g., flood mitigation, cooling) and are under threat?
- Where are environmental hazards (e.g., gas stations, waste sites, industrial storage) located in high-risk areas?
- What health effects (e.g., heatstroke, mold-related illness, mental health trauma) have already been documented?

How This Informs Policy:

- Justifies protecting or restoring natural buffers as "green infrastructure."
- Guides regulations and monitoring around hazardous sites in climate-sensitive zones.
- Informs public health strategies, including early warning systems, mobile outreach, and mental health support during disasters.

Table 10. Role distribution in implementing a climate change adaptation and mitigation plan.

Level	Role in Implementation
Municipality	Lead on land use, local infrastructure, social services, and emergency planning.
Regional Authorities	Coordinate across municipal boundaries, manage shared infrastructure, collect climate data.
Community Services	Identify vulnerable populations, deliver outreach and health services.
Stakeholders (NGOs, businesses, Indigenous communities)	Provide local knowledge, support implementation, co-develop culturally relevant strategies.

VII. CLOSURE

This Framework provides a strategic foundation to help Capital Region municipalities understand local climate risks and begin developing tailored Climate Change Adaptation and Mitigation (CCA&M) Plans. It emphasizes the importance of integrating climate considerations into infrastructure planning, emergency preparedness, land use, and community engagement. As climate challenges continue to evolve, proactive and locally informed planning will be essential. GEMTEC is pleased to support CRSC communities in applying this framework and is available to assist any municipality in advancing its own CCA&M planning process.

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