Case Study Series
Using Better Data to Identify Climate Change-Related Infrastructure Vulnerabilities in Canadian Communities
# Agenda

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About Us

ENTERPRISE ASSET MANAGEMENT & BUDGETING

RESEARCH
- Public Sector Digest
- Applied Research
- Policy Analysis & Grant Services

CONSULTING
- Asset Management Training
- Asset Management Plan & Program Development
- Climate Change Adaptation Plans

SOFTWARE
- Enterprise Asset Management (EAM)
- CMMS & GIS
- Enterprise Budget Management
Panel

Elaine Aucoin, P. Eng
Director Environmental Planning and Management
City of Moncton

Genevieve Russell
Green Infrastructure Strategy Special Project Manager
City of Saskatoon

Angela Schmidt
Storm Water Utility Manager
City of Saskatoon

Kim Jusek, P.Eng., MEPP
Municipal Program Manager
Canadian Water Network
The Challenge

• Municipal assets and public services are vulnerable to the impacts of climate change
• Water, wastewater and stormwater infrastructure may already be in poor condition or under serviced
• Canadian municipalities/utilities are lacking the data required to accurately identify climate change-related infrastructure vulnerabilities
Solutions

Five case studies of Canadian utilities collecting and utilizing data to support infrastructure vulnerability assessment.
Kenora Asset Risk Assessment

Climate Change Impacts

- Increased temperature and increased severity of rainfall events have resulted in higher frequency of storms, severe winds and flooding
- Variability in temperatures can exacerbate freeze/thaw cycles
- Higher risk of forest fires due to higher temperatures and drier conditions
- Increase in short-term costs for immediate repairs, as well as long-term costs as a result of accelerated asset deterioration
Kenora
Asset Risk Assessment

Starting with asset management

• Unique asset portfolio includes 19 vehicular bridges and 64 lift stations

• Use of CityWide Asset Manager & GIS to host asset attribute data and create projections to support project prioritization

• 2016-2017 worked with PSD to develop their asset management program, culminating in a comprehensive AMP
Kenora
Asset Risk Assessment

Aligning Climate Change Adaptation with Asset Management

• Accepted into FCM’s Climate and Asset Management Network (CAMN)
• PSD was hired (with CAMN funding) to complete a Climate Change Adaptation and Resilience Study
• The study concluded that the City’s current level of service and asset management procedures would not prevent adverse effects of climate change
Kenora
Asset Risk Assessment

Climate Change Risk Assessment Framework

Consequence of Failure

- Economic 60%
  - Land Use & Identified area 100%
    - Replacement Cost
  - Asset Type 100%
- Environmental 10%
  - Land Use & Identified area 30%
- Social 30%
  - Population Density 70%
Kenora
Asset Risk Assessment

Next steps
• Risk Assessment Framework will be used to inform short and long-term financial strategies
• Matrices can be modified over time to fit Kenora’s changing priorities
• City staff plan to gather replacement cost data and introduce more climate change impact measures within the matrices
Climate Change and Asset Management Resiliency Roadmap (CARR)

Aligning Adaptation with Asset Management for Greater Resilience

- PSD partnered with Oxford University
- CARR includes
  - State of Maturity Assessment
  - Data Gap Analysis
  - Climate Change Adaptation Plan
- Currently working with St. Clair Township
Climate Change Impacts

- Increase in average temperatures across all seasons
- Drier summers, wetter winters, and more heavy precipitation events
- Frequency and severity of wildfire, extreme rainfall or snow, freezing rain, high winds, and lightning are expected to increase
Edmonton
Flood Mitigation and Mapping

Edmonton’s Climate Resilient Adaptation Strategy and Action Plan

• Phase 1: Investigation
  • Participated in BARC (Building Adaptative and Resilient Communities)
  • Utilized Global Covenant of Mayors for Climate and Energy Climate Risk and Adaptation Framework and Taxonomy

• Phase 2: Direction Setting

• Phase 3: Taking Action
  • Five paths to climate resilience – approved November 2018
  • https://www.edmonton.ca/city_government/documents/Climate_Resilient_Edmonton.pdf
Edmonton
Flood Mitigation and Mapping

EPCOR’s Stormwater Integrated Resource Plan (SIRP)

• Strategic Goal: To become a flood resilient city

• Established mitigation priorities through public engagement
  • Protecting public health and safety and minimizing social impacts from flooding

• Risk frameworks were then developed using various forms of data, and were based on the four types of flooding impacts used in the public engagement survey
Edmonton
Flood Mitigation and Mapping

Using the risk framework to inform adaptation

• EPCOR has broadened the mix of capital and operational investments to also include green infrastructure and flood proofing of at risk properties

• Move away from developing capital projects that are “named” projects to performance-driven projects

• May 2019, EPCOR presented a proposed capital plan to the Utility Committee and is now developing a 20-year capital plan

https:\\www.epcor.com\floodmitigation
Edmonton
Flood Mitigation and Mapping

Next steps

• City Council approval for increased funding for SIRP program to allow implementation in next 20 years

• Updates to Design standards to support climate change adaptation and increased use of green infrastructure

• Additional staff to support homeowner flood proofing programs, emergency response and maintenance and improvements of drainage system surface and pipe networks

• Implement a smarter stormwater network that will allow the utility to anticipate and react to storms in real time and optimize capacity of the existing system
Climate Change Adaptation

Elaine Aucoin
Director, Environmental Planning and Management
Climate Change Trends

• Temperature and Precipitation
• Extreme Weather Events
• Sea Level Rise
Understanding the Moncton Context
Understanding the problem
Potential Impacts & Vulnerabilities
Climate Change Adaptation Measures for the GMA
Study Methodology

- Task 1: Climatic and Meteorological Assessment
- Task 2: Flooding Risk Assessment
- Task 3: Infrastructure Risk Assessment
- Task 4: General Governance Assessment
Task 1

Climatic & Meteorological Assessment

Short Duration Rainfall Intensity-Duration-Frequency Data

Données sur l’intensité, la durée et la fréquence des chutes de pluie de courte durée

2010/04/13

MONCTON A
NB
8103200

1946 - 2007
58 years / ans

Latitude
46° 6’N

Longitude
64° 41’W

Elevation / Altitude
70 m

Return Periods / Périodes de retour
Years / ans
100 50
25 10
5 2

Intensity (mm/hr) / Intensité (mm/h)

Duration (min) / Durée (min)

Hours / Heures

1 2 3 4 5 10 15 20 30 60

5 10 15 20

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
### Task 2
Flood Risk Assessment

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<th>Projected Total Water Level (m)</th>
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<tr>
<td></td>
<td>1:100</td>
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<tr>
<td></td>
<td>Saxby Gale</td>
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<tr>
<td>Today</td>
<td>9.25</td>
</tr>
<tr>
<td>Year 2025</td>
<td>9.38</td>
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<tr>
<td>Year 2055</td>
<td>9.67</td>
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<td>Year 2085</td>
<td>10.05</td>
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Projected total water level: Storm surge + sea level rise (0.85m) + land subsidence (0.15m)
Identification of Infrastructure at Risk

➢ Transportation
➢ Storm Drainage
➢ Sanitary Sewer Collection and Treatment
➢ Water Supply & Distribution
General Governance

Non structural strategies:

• Develop policy framework for addressing development in flood prone areas
• Develop floodplain maps and associated regulation
• Information and education
• Disaster preparedness and response
Climate Change Adaptation and Flood Management Strategy

June 2013
Availible in English

Stratégie d’adaptation aux changements climatiques et de gestion des inondations

Juin 2013
Available in French
Emergency Preparedness

Emergencies often strike quickly, and leave little time for gathering belongings or putting together an emergency kit. The best way to cope with a crisis is to be prepared in advance.

We hope the information provided to you in this section of our website will provide a clear understanding of your role and responsibilities when it comes to preparing for an emergency.

**Municipal Emergency Measures Plan**

What you need to know about how the City of Moncton will respond to a major emergency!

Quick Links
- Public Safety and Emergency Preparedness
  - Canada
  - 72hours.org
  - Canadian Red Cross

Important contact numbers - Before and during an emergency event

If your property has been damaged due to an emergency event, we suggest that you register your property with the Provincial Emergency Measures Organization’s Damage Reporting Line - 1-888-298-8555. The New Brunswick Emergency Measures Organization (NB EMO) co-ordinates preparedness for emergencies. At the federal, provincial and municipal levels, planning is the key to emergency preparedness. You can also consult their website.

4-1-1 Emergency URGENCE

Les situations d’urgence surviennent souvent rapidement, et elles laissent peu de temps pour rassembler ses biens ou une trousse d’urgence. La meilleure façon de faire face à une situation de crise est de se préparer à l’avance.

Nous espérons que l’information fournie ici vous indiquera clairement votre rôle et vos responsabilités en ce qui concerne les préparatifs en cas d’urgence.

Plan municipal des mesures d’urgence

Découvrez comment la Ville de Moncton assurera la gestion d’un sinistre!

Numéros importants - Avant et pendant une situation d’urgence

Emergency situations are a reality!

They can result from human actions, such as an industrial accident, or caused by Mother Nature. Are you prepared?
The City of Moncton will do its best to ensure the safety of residents in the event of a major emergency. Our first responders (fire, police, ambulance and Public Works crew) are well trained and ready to jump into action when called upon. But emergency preparedness is everyone’s responsibility.

Making our city more resilient

While we can’t predict when a serious accident might occur, weather-related events can generally be anticipated and planned for. Rather than wait until such a situation arises, make it a priority to plan for your family’s well-being. Get informed today!

In recent years, the City has taken many steps to plan for a crisis situation, including adopting the Climate Change Adaptation and Flood Management Strategy. By using historical data and forecast modelling, it was established that Moncton’s biggest risk, in terms of a major emergency, is the increased occurrence of hurricanes due to climate change, and related flooding (both in low-lying zones near the Petitcodiac River, and when the storm sewer system is surcharged). This means that all residents and businesses could be affected by flooding.

1-in-100 year flooding event

It is now standard practice to plan for the future considering climate change impacts. This map represents a 1-in-100 year flooding event – in the year 2100. We can see which areas would be affected most by the flooding of the Petitcodiac River, if such a weather event was to occur.

This could also mean that our storm sewer system would have nowhere to empty its pipes full of rain water, and could back-up into basements.

The possibility of the river flooding and associated sewer back-ups may occur with heavy rainfall and a high tide event. To decrease the chances of sewer backing up into your basement, ensure your house is equipped with a backwater valve. The City will even fund a portion of the installation cost (see Backwater Valve Incentive Program).

Saxby Gale flooding

October 4, 1869

The infamous Saxby Gale caused much devastation in Moncton with a 2 m storm surge, during high tide. The event is commemorated in Bute Park, where the peak water level is marked.
Jonathan Creek Culvert Renewal
Backwater valve incentive program
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Minimum geodetic elevation

22 No development of occupied floor space or indoor parking area shall be permitted in any zone, unless the minimum geodetic elevation of any floor is at least 10.5 metres.
Zero Net Increase Policy

“zero net” means the peak discharge rate of stormwater runoff from a post development property is equal to or less than the peak pre-development discharge rate of stormwater runoff for the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year design storm event.
Stormwater Management Initiatives

**QUANTITATIVE**
- Flood Reduction Measures

**QUALITATIVE**
- Pollutant Reduction Measures
CITY OF MONCTON

Naturalized Stormwater Management Guidelines

DRAFT No. 2 | MARCH 2015

New Brunswick
Your Environmental Trust Fund of New Brunswick
Fonds d'Environnement pour la Nouvelle-Brégirande

FCM
Fédération des municipalités du Canada
Fédération canadienne des municipalités

WSP
trace
Nature Plus Solutions
Natural Resources Canada

MONCTON
Naturalized Stormwater Management

- Minimize the threat of flooding
- Reduce runoff volume
- Improve surface water quality
- Protect receiving water bodies
- Promote multi-functional use of stormwater management systems combined with land for public purpose
- Develop a sustainable stormwater system
Wetland Plant Zonation: Building in Sustainability
Pilot Projects
Pilot Project #2: Grande Allée

Approximate location of Naturalized Storm Water Management Pond
Wynwood Basin
2019
Stormwater Management & Neighborhood Planning
QUESTIONS?

Elaine Aucoin, Director Environmental Planning and Management
(506) 853-3495
Elaine.aucoin@moncton.ca
Presentation Overview

• Local Climate Action Plan
• Green Infrastructure Strategy
• Flood Control Strategy
• Climate Change Implications for Storm Water Design Standards
Local Actions: Saskatoon’s Adaptation Strategy

• **Strategy Purpose**: To identify projected local climatic changes, plan for likely impacts, and implement an action plan to manage climate risk to civic operations.
Our Climate Action Plan
Saskatoon’s Changing Climate and Potential Impacts
Local Actions: Saskatoon’s Adaptation Strategy

• 30 initiatives across four theme areas:
  – **Decisions**: Thinking strategically about tomorrow, today
  – **Staff**: Safe, healthy, and productive
  – **Services**: Prepared for change and ready to serve
  – **Assets**: Designing and building with the future in mind
Green Infrastructure Strategy

Strategy Purpose:

• To establish a vision, actions, and implementation framework to reach Saskatoon’s Comprehensive Green Network

• Identify initiatives to integrate green infrastructure into land use planning and asset management
Saskatoon’s Green Network

**Vision:** Saskatoon’s Green Network supports sustainable habitat for people and nature.

1. **Governance:** The Green Network is governed with an emphasis on collaboration and triple bottom line solutions.

2. **Ecology:** The Green Network conserves biodiversity, supports high quality habitat, and increases climate resilience.

3. **Community:** The Green Network facilitates place-making, honours culture, and inspires community-led transformation.

4. **Storm Water:** More rain is managed where it falls. Storm water is recognized as an important resource.

5. **Open Space:** The Green Network links all residents of Saskatoon to high quality, interconnected green space.
What is Green Infrastructure?

- Natural Areas
- Naturalized Parks
- Wildlife Friendly Feature
- Wildlife Crossings
- Neighbourhood Parks
- Green Ways
- Green Streets
- Storm Water Ponds
- Bio-swales Roofs
- Green Roofs
- Urban Tree Canopy
- L.I.D.
- Storm Water Dry Ponds

**Green Strategy**

City of Saskatoon
Ecology Actions

- Aquatic Assets
- Formal Green Space
- Meevasin Conservation Zone
- Natural Assets
- P&G Green Network

Action 11: Protect, Restore and Manage
Action 12: Connect and Naturalize

"Korman Prairie is privately owned & restricted to public access."
Storm Water Actions

Action 14 - Integrate into the City
- Natural Waterbodies and Drainage

Action 15 - Increase Low Impact Development
- Areas of Interest

*Average amount of hard surface based on zoning category.
2014 Surface Flood Risk Assessment

30 Known Flood Areas Ranked based on Combined Risk: Likelihood & Impact of Flooding

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<thead>
<tr>
<th></th>
<th>2 YEAR STORM</th>
<th>5 YEAR STORM</th>
<th>10 YEAR STORM</th>
<th>100 YEAR STORM</th>
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<tr>
<td>Flooded Sites</td>
<td>2</td>
<td>47</td>
<td>56</td>
<td>122</td>
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<tr>
<td>Flooded Buildings</td>
<td>0</td>
<td>29</td>
<td>39</td>
<td>97</td>
</tr>
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\[3 \times (\text{Building Risk}) + 2 \times (\text{Site Risk}) + (\text{Road Risk})\]
Surface Flooding in Saskatoon

July 10, 2017

August 8, 2017
2018 Flood Control Strategy

• Objective: Protect most buildings possible within $54 budget
• 40% Cost sharing from Government of Canada over 9 years
• Approved level of service: 1- in-10 year rain event
• Prioritized the top 10 areas taking into account risk and cost:
  – Benefits over half of total properties at risk
Climate Change Impact on Saskatoon’s Rainfall & Implications for Infrastructure

1. How has historical rainfall changed?

2. How is future rainfall expected to change?

3. What is cost of changing storm water design standards relative to risk?
Historical Blended
Annual Maximum Precipitation (AMP)

Significant natural variability in rainfall
Trend analysis conducted for each 30 year segment to determine amplitude change:
- Longer duration rainfall (hourly+) shows significant increasing trends over last 30 years: climate change impact?

How has historical rainfall changed? It’s complicated!
Global Climate Models (AR5, IPCC, 2014)

20 GCMs

Quantile-Quantile Downscaling

Equidistance Quantile Matching

2 Downscaling Methods

2 RCP Scenarios (RCP4.5 & 8.5)

2 RCPs

6 Return Periods

• 2, 5, 10, 25, 50, 100 Year Events

Quantile-Quantile Downscaling

Equidistance Quantile Matching

2 Downscaling Methods

2 RCP Scenarios (RCP4.5 & 8.5)

2 RCPs

3 Future Periods

3 Future Periods (2011-2040, 2041-2070, 2071-2100)

1,440 IDF Curves

Future Projected Precipitation

Climate Change

University of Saskatchewan

University of Concordia

City of Saskatoon
Future Design Rain Events in Saskatoon

Sample Case – 02-Year Return Period

(Nazemi & Goswami, unpublished data, 2019)
Expected Direction and Magnitude of Change Depends on Assumptions

All scenarios for 1-in-100 year rain predict increases in 2071 - 2100

(Nazemi & Goswami, unpublished data, 2019)
How much does it cost to reduce risk?

Preliminary Draft Results: Neighbourhood Cost-Risk Curve

Many possible climate change scenarios: costs increase sharply for storm water infrastructure to address more than 80%.
Contact Information

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Flood Control Strategy
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Climate Change Adaptation
climatechange@Saskatoon.ca
Saskatoon.ca/localactions
Climate Change Impacts

• High speed wind from tornadoes/thunderstorms has damaged infrastructure, resulting in power outages

• Breakage of underground infrastructure due to changes in freeze-thaw cycle

• High temperatures and stagnant water promote growth of algae, impacting drinking water quality
A strong foundation in asset management

- Leamington, Kingsville, Essex, and Lakeshore have all been engaging in asset management since before 2010
- Gathered data on core assets, including age, materials, replacement costs, condition, and lifecycle
- Utilizing CityWide Software to manage data inventory and facilitate condition assessments, lifecycle management, risk assessment, and define levels of service
UWSS
Drinking Water System Vulnerability Assessment

Using PIEVC Protocol to Assess Risk and Vulnerability
Key recommendations:

• Update extreme weather procedures for operations personnel
• Review operating procedures to account for potential power disruptions
• Modify storage systems for SCADA and other data to account for potential power disruptions
• In response to lower lake levels, renew and potentially modify the emergency intake
• Modify older elevated storage tanks sooner than originally planned to ensure adequate circulation and minimize water quality issues caused by warm weather
Adaptation efforts

• A change to the communication system from land lines to radios
• Creating communications system redundancies in case of power failure
• Purchasing four large portable generators in case of power failure
• Staff training sessions on climate-related risks
• Installing real-time instrumentation to measure algae on raw water intakes to predict water quality and alter water treatment as necessary
UWSS
Drinking Water System Vulnerability Assessment

Next steps

• Conduct climate risk assessment of linear asset conditions

• Integrate climate data into the asset management plans of Leamington, Kingsville, Essex and Lakeshore

• Continued culture change in both operations and planning to consider climate
Common Threads

- Gather and analyze quality data
- Coordinate with other community stakeholders
- Identify vulnerabilities and prioritize action
Draw on Diverse Datasets
Project Insights

• Climate, asset management, and other data
• Use community values to determine priorities
• Collect and use quality data
• Develop processes to support continuous improvement on data collection and analysis
Make the most of available resources and opportunities

Project Insights

- Leadership is required at multiple levels
- Lean on proven guidance frameworks
- Access relevant funding and expertise
Start now and embrace incremental progress

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Municipal Program Manager
kjusek@cwn-rce.ca
Get in Touch

Upcoming Webinars:

Introducing CityWide Permits: Driving More Efficient and Accurate Permit Processes for Your Organization

Grant Funding Opportunities for Canadian Municipalities

Condition Assessment of Infrastructure Assets

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London | Toronto | Victoria