

## **The Impact of Climate Change on Canadian Municipalities and Infrastructure**

Toronto's record-breaking rainfall in July 2013 occurred less than a week after Calgary lifted a state of emergency following relentless downpours that flooded large parts of its downtown, and as many as 30 nearby towns and municipalities. The Alberta floods in June 2013 caused four deaths and displaced tens of thousands of people. Calgary's cleanup and repair bills are now estimated to be about \$6 billion, making it the most expensive hazardous event in Canadian history. The price tag for Toronto's flood damage is likely to be more than \$1.2 billion with insured losses of \$850 million, making it the most expensive hazardous event in Ontario's history. In the summer of 2014, historic wildfires in the Northwest Territories burned ten times the average forest area, deteriorating air quality, and forcing the closure of the main highway to Yellowknife several times during the month of July.

Most recently, the winter of 2015 saw extreme weather across Canada. Western Canada had well above normal temperatures, which translated into below normal snowfalls. Eastern Canada experienced a prolonged extreme cold snap. These extremes impacted many ski communities across Canada resulting in significant local economic losses. Furthermore, there is now concern that there may be a potential freshwater deficit this summer in Western Canada that could affect water supplies for irrigation and domestic use.

The record-breaking cold temperatures in Ontario and Quebec also resulted in a substantial increase in heating costs, as well as a stress on infrastructure, as witnessed by the frequent water main breaks. For the first time in 75 years, Toronto did not reach the melting point in February. Both Quebec City and Ottawa broke records, with the average temperatures for February around minus 18 degrees Celsius.

In the Maritimes, record snowfalls caused frequent business and school closures, roof collapses from snow loads, and snow clearing costs substantially exceeding their budgets. Both Moncton and Halifax doubled their average snowfall in February. As March Break came to a close, Charlottetown had surpassed 5 meters of snowfall.

### **Municipalities on the frontlines**

The Canadian Climate Forum (the Forum), a national charity that convenes climate science for effective decision-making, considers municipalities one of the key stakeholders on the frontlines facing serious environmental challenges. With over 80% of Canadians living in cities it is the responsibility of our municipal

governments to implement mitigation and adaptation strategies to protect its citizens, and address significant climate related challenges.

Scientific consensus, such as that of the 5<sup>th</sup> Assessment from the Intergovernmental Panel on Climate Change (IPCC), regarding the contribution mankind is having on the climate has never been stronger. It is commonly accepted that the resulting changes occurring globally will become more pronounced unless substantial reductions are made to the release of greenhouse gases – particularly carbon dioxide.

The consequences are a direct result of a warmer earth system, and include:

- An increase in heat extremes and the related occurrence of drought
- Additional energy available for more intense storms and the associated increase in heavy precipitation events
- A warming ocean and the melting of glaciers and ice sheets on land that is rising the sea-level
- The melting of the permafrost layer
- Changes to the global atmospheric and oceanographic circulation patterns that risk enhancing these and other yet to be determined effects.

For municipalities, these changes are contributing to the already challenging job of sustaining communities in a tight fiscal environment. Our population is dependent on transportation, telecommunication services and energy and water infrastructure; all of which are at risk in the face of extreme weather events driven by an evolving climate. Moreover, we are served by aging and increasingly expensive infrastructure, the maintenance of which is difficult given our existing fiscal climate. Valuable property along vulnerable shorelines is increasingly at risk. In addition, Canada's aging population, and a strained healthcare system may increasingly struggle to cope with climatic extremes.

Cities elsewhere have been on the frontlines of such impacts; Moscow experienced 11,000 excess deaths beyond normal mortality in the record heat wave that beset that northern city in July and August 2010. Canadian cities are not immune from such impacts.

## **Very Real Risks**

The individual risks associated with a changing climate can together increase the probability and impact of a hazardous event. This risk is further compounded by the challenges already being faced by municipal leaders and others responsible for the provision of services, as well as the protection of the public and their property.

For example, along the extensive coastlines of Canada, rising sea levels combined with a decrease in sea ice, and the potential for more intense storms, result in a significantly higher storm surge and coastal flooding threat. Since

coastlines are normally favorable locations for development, ongoing urbanization increases the exposure to such risks of both population and property.



Storm Surge Impacts from Hurricane Juan. Credit: Chris Fogarty

Similarly, watersheds - small and large - are at higher risk for flooding from severe summer storms, extended periods of wet weather, or snowmelt. Sometimes all three of these elements combine during intense spring storms. In addition, some areas are even vulnerable to coastal storm surge flooding at the same time that fresh water levels are rising.

Correspondingly, intense summer heat, like that experienced in Moscow, places the population at risk; especially the elderly and economically disadvantaged. Furthermore, drought can stress water supplies impacting the quantity and quality of water that is sorely needed during periods of hot weather. An increase in wildfires impacts the air quality and can threaten entire communities, as was the case in British Columbia and the Northwest Territories in the summer of 2014.

In our northern communities, thawing permafrost is a significant threat to infrastructure, particularly the integrity of buildings. Scientists have measured a general rise in ground temperatures over the last several decades; the coldest permafrost is warming and weakening, and the warmer permafrost is thawing. This is resulting in asset failures, often greatly reducing useable service life of expensive infrastructure.



Permafrost highway - Yukon Credit: Government of the Northwest Territories

Meanwhile, changes in temperature and precipitation patterns, especially during the snow season, are providing additional risk to the resiliency of infrastructure as snow loads increase.

For example, the new Ross River (Yukon) School that opened in 2001 was closed in January of 2015 as a result of structural foundation problems that made the building vulnerable to heavy snow loads and strong winds. Engineers are now attempting to develop a plan to 're-life' the building. This situation is repeating itself in many places and on many occasions in the North.

### **Comprehensive Risk Assessment**

Canadians are facing a number of challenges in ensuring that infrastructure is designed, built and managed in a way that considers climate change impacts. Some communities have benefitted from flood mapping or even better, a comprehensive hazards assessment. Others have conducted engineering assessments on the vulnerability of infrastructure to climate change (e.g. Public Infrastructure Engineering Vulnerability Committee [PIEVC] protocol). Many municipalities have also completed somewhat high-level climate change action plans that highlight the risks in their community.

In order to ensure that climate change is featured as a high priority in infrastructure development and management, there is a need for comprehensive risk assessments. These must be developed upon sound scientific and engineering foundations that require:

- An understanding of the climate related sciences, as well as data, tools and techniques needed for baseline and future climate change scenarios.
- Engineering expertise to assess the threat to the infrastructure including its interaction with the natural environment (land and water)
- An understanding of the complex relationships between climate and infrastructure in Canada in terms of their exposure and vulnerability to climate hazards, and shifts in average climate conditions differentiated by region and type of infrastructure
- Developing codes, standards and policies that inform engineering designs in the early planning of infrastructure projects
- Increasing the availability of information and resources on climate change risks to infrastructure and adaptation measures to counter those risks.

### **Effective Decision-Making**

In light of these changes and risks, and because of the many other climate change related issues now facing Canada, there is **growing need and resolve to plan and prepare**.

At the federal level, Natural Resources Canada has developed the 'Adaptation Platform' to bring together key stakeholders from government, industry and professional organizations to collaborate on adaptation priorities that will help make Canada more climate-resilient. Under the 'Adaptation Platform', Provinces and Territories have partnered to establish Regional Adaptation Collaboratives (RACs). For example, the Pan-Territorial Adaptation Strategy (2011) and Pan-Territorial Adaptation Partnership now drive sustained inter-governmental initiatives. RACs work to consolidate and develop knowledge on critical issues like hazard mapping and permafrost engineering design.

Many communities have assessed and developed plans to address their climate change vulnerabilities. The Federation of Canadian Municipalities Partners for Climate Protection program provides resources and support to municipalities for reducing greenhouse gas emissions and implementing climate change adaptation strategies. More recently, provincial and municipal efforts are now being directed towards the development of asset management plans by 2018 in response to federal requirements for the continuation of the Gas Tax Agreement. These plans should consider the additional risks to infrastructure from climate change.

Universities and colleges across Canada are receiving targeted support from the National Science and Engineering Research Council (NSERC) and the Canadian Foundation for Innovation (CFI) for climate change research, or related programs on environmental change monitoring and adaptation technologies.

There has also been action on the part of the engineering profession, through development and testing (2006-2014) of a climate change vulnerability assessment protocol for engineered structures. And, more recently, a plan to institute a new certification program, for “climate resilient engineering professionals.”

### **Recommendations for Action**

The people and the economy of Canada are dependent on an infrastructure that is vulnerable to climate change. Government and industry must therefore effectively assess and manage this risk to ensure resilience.

While some critical stepping-stones are in place, a national strategy for climate adaptation in Canada is lacking, unlike in other countries such as Australia. It is recommended that Canada demonstrate leadership by establishing a coherent climate infrastructure *Action Plan* comprising the following components.

**Effective Governance:** Leverage the ‘Adaptation Platform’ and the work of the RACs to establish a governance mechanism and a Canada-wide program to ensure leadership and collaboration between the federal government, the territories and provinces, municipalities, and First Nations.

This could include:

- Predictable, long term and stable funding from governments to address climate change impacts and infrastructure resiliency.
- Positioning governments to adopt a proactive approach in emergency planning and response through the early identification of climate change impacts that pose a threat to infrastructure
- Integration of mitigation and adaptation opportunities into government operations and decision-making to help governments become more effective in managing risks to infrastructure, economies, human health and safety, traditional culture and heritage, and ecosystems.
- Capacity building through knowledge sharing involving all levels of government, academia, industry and the international community. This approach would go a long way to increasing understanding of the approaches, tools and techniques that address climate change issues, and improve infrastructure resiliency.

**Knowledge Generation:** Develop a national research and development initiative to ensure past and future research is effectively transferred, and knowledge gaps are identified, prioritized and funded. Knowledge also includes: integrated monitoring; open and accessible data and modeling; as well as capacity building and training.

Some of the more important gaps include:

- Understanding the complex relationship between climate and infrastructure in Canada in terms of their exposure and vulnerability to climate hazards.
- The development of new approaches in colleges and universities to facilitate skills development and research. For example, consider incorporating into the engineering curriculum mandatory courses dealing with climate change impacts, and infrastructure design and management

**Standards, Policies and Planning** strategies need to be developed taking into account the community and infrastructure context, and the best available knowledge. As examples:

- Integration of climate change priorities into engineering design of infrastructure projects (CSA Group 2012).
- Development of codes, standards and policies that inform engineering designs in the early planning of infrastructure projects.
- Increase the availability of information and resources on climate change risks to infrastructure and adaptation measures to counter those risks.
- Differentiate by region and type of infrastructure climate change impacts and risks for key infrastructure initiatives throughout Canada.

Written for the Canadian Climate Forum by Board of Director and Meteorologist Jim Abraham.

The Forum is a national charity with a mandate to convene, mobilize, and disseminate climate science knowledge to guide best practices and policy related to climate mitigation and adaptation strategies.