



# IMPACTS OF CLIMATE CHANGE

## on municipal infrastructure

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**The effects of** our actions now on future changes in the climate have long lead times. What we do now can have only a limited effect on the climate over the next 40 or 50 years. On the other hand what we do in the next 10 or 20 years can have a profound effect on the climate in the second half of this century and in the next.

*No one can predict the consequences of climate change with complete certainty; but we now know enough to understand the risks. Mitigation - taking strong action to reduce emissions - must be viewed as an investment, a cost incurred now and in the coming few decades to avoid the risks of very severe consequences in the future. If these investments are made wisely, the costs will be manageable, and there will be a wide range of opportunities for growth and development along the way. For this to work well, policy must promote sound market signals, overcome market failures and have equity and risk mitigation at its core.* (Stern, 2006)

This year, the UN-based Intergovernmental Panel on Climate Change (IPCC) released a number of reports outlining the human and natural drivers of climate change, the adaptive capacity and vulnerability of human and natural systems, and mitigation opportunities. These reports found that climate change impacts on infrastructure will be compounded by aging infrastructure, an aging population, poorly adapted building stock and urban form, pollution and population growth. Without increased investment in proactive, adaptation measures, the increasing temperature and changes in weather patterns will have adverse impacts. Additionally, projected climate change impacts are both dynamic and uncertain and accordingly, the implementation of adaptation measures will necessitate an iterative process.

### Northern impacts

Natural systems will be impacted in northern areas where changes to frozen ground will cause instability. Increased ground move-

ment is a major concern for water, sewer, and road infrastructure. Underground pipes and storage tanks are at risk for increased bursting and breaking. This has additional environmental impacts in terms of lagoon or septic seepage.

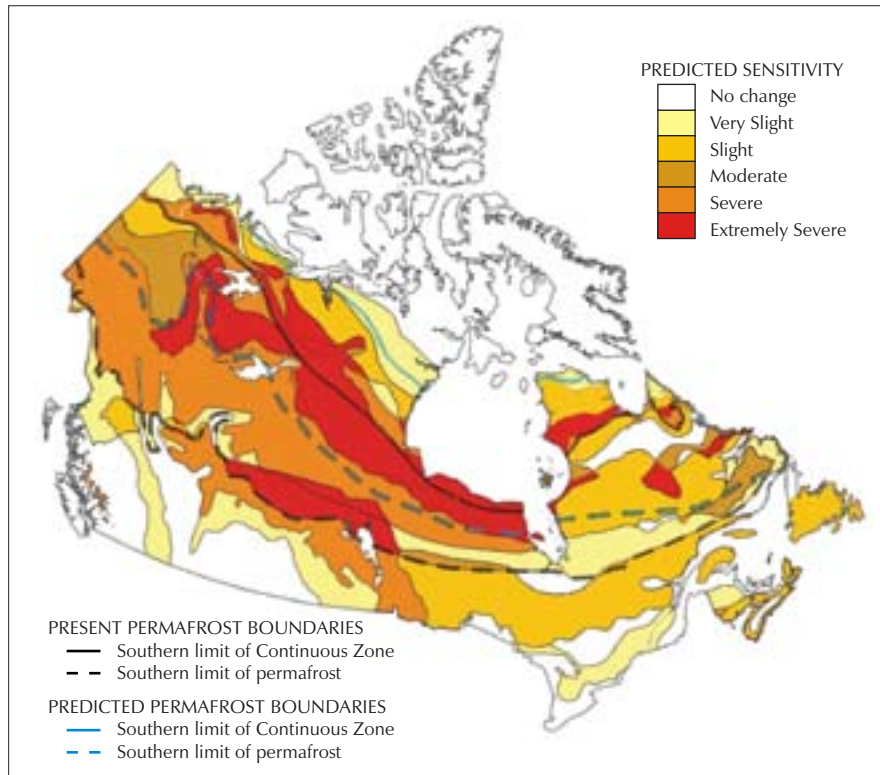
Winter roads will also be impacted. Manitoba has a 2,000 km network of ice roads each winter that allows for the movement of necessities, including food, fuel and building supplies, to remote communities. In 1997-98 the Provincial Government spent approximately \$15.5 million to airlift supplies to these communities as the warm winter temperatures prohibited quality ice roads (Infrastructure Canada, 2006). Since then, there has been a conscious shift to move these transportation routes over land, minimizing water crossings where possible to reduce infrastructure vulnerability and ensure safety is maintained. This continues to be an issue as was seen in the shortened winter road season in 2007.

### Water

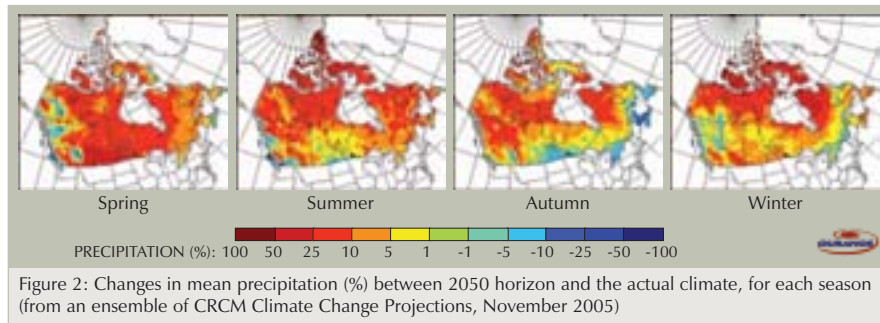
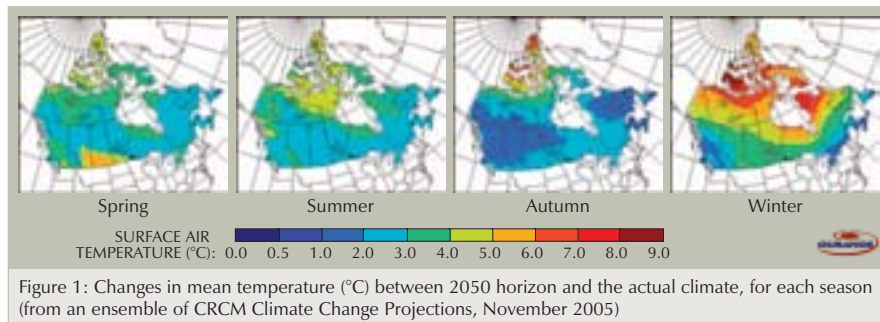
In terms of climate change adaptation, water resources are frequently cited as one of the highest priority issues. Water and wastewater infrastructure is viewed as being most vulnerable to climate change as it is a system that is closely connected to human health, the economy and the environment.

Hydrological systems are changing with increased runoff and earlier spring peak discharge from snow- and glacier-fed rivers. As well, warming of water temperatures is causing changes in ice cover, salinity, oxygen levels and circulation (IPCC, 2007). These changes will have impacts on the infrastructure that is designed to manage natural systems such as water and wastewater infrastructure, drainage systems, flood mitigation infrastructure and energy infrastructure. Projected declines in river flows coupled with growing consumption rates will demand change both in infrastructure and human behaviour.

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Peatland sensitivity map of Canada (Kettles and Tarnocai, 1999)



Currently, the literature indicates that *no-regrets*, proactive measures are required to assist in adaptation to climate change. This means that measures would provide benefits to communities whether projected climate changes occur or not. For water supply and wastewater infrastructure this should include water conservation, demand management measures, long term planning for flooding and drought conditions, increased water quality protection and improved procedures for equitable allocation of water (Infrastructure Canada, 2006). These measures should be part of larger planning efforts, some of which are already occurring in Manitoba, including source water protection plans at the watershed scale.

## Urban design

Land use plans created for urban and rural areas can assist in minimizing communities' vulnerabilities to climate change. Sprawling development requires increased quantities of infrastructure, and therefore material inputs, increasing a community's vulnerability potential. All provincially funded buildings now require LEED (Leadership in Energy and Environmental Design) certification to increase energy performance and environmental sustainability, and municipalities should require the same for all land development through local land use planning.

Despite advances in technology, capacity and human capital, communities remain dependent on an increasingly global hinterland. The future sustainability and security of municipalities depends on increasing regional self-reliance, in essence using ecosystem thinking to design more complete communities. At the very basic level this means that communities should be designed to reduce per-capita consumption through increasingly efficient design, thereby decreasing the costs and quantities of water, sewer, transportation and other infrastructure.

*"Resilient societies [societies that persist in the face of adversity] are nimble societies, those capable of long-term planning and of abandoning deeply entrenched but ultimately destructive core values and beliefs" (Rees, 2007).*

There are many precedents that municipalities can access in order to design integral communities, such as the smart growth principles. Currently the Alberta Green Building Council is undertaking a project known as Green Streets, which is working to develop green standards for transportation infrastructure, similar to the LEED standards that are available for buildings. As well, the US Green Building Council is advancing

LEED standards beyond buildings and into neighbourhoods. These Neighbourhood Development tools will assist communities in creating and evaluating plans for environmental sustainability.

These tools are being developed in response to growing concerns with climate change vulnerabilities and adaptation. This is echoed by US Attorney General Jerry Brown's recent warning to community leaders throughout the United States that political leaders need to proactively take the opportunity to ensure that new development is environmentally sustainable. These warnings came to light following Brown's recent lawsuit against San Bernardino County where he alleged that it did not adequately consider greenhouse gas (GHG) emissions when updating its development plan. In essence, this means that the county knowingly acted in an unsustainable and environmentally detrimental manner. The lawsuit was settled when the county agreed to set an emissions reduction target and reduce GHG emissions.

Municipal development plans and zoning bylaws represent an opportunity to encourage urban design that is environmentally sustainable and adaptable to climate change.

## Natural systems

Climate change impacts are projected to cause shorter winters and earlier springs. This change in weather patterns will play a large role in a number of areas including ecosystem and species lifecycles. Increased risk of storm activity, forest fires, pests and diseases are likely to occur in a warmer climate. We are seeing examples of this already, including the 2003 European heat wave where health crises combined with drought and subsequent crop shortages in Southern Europe amassed to a death toll of over 35,000 people. Temperatures reaching

in excess of 45 degrees Celcius, flash floods in Switzerland and the loss of 10% of forest cover in Portugal due to fires, represent prime examples of the changes occurring worldwide. From heat waves to drought to storms, infrastructure will be impacted.

In Manitoba a major concern associated with climate change is increased storm frequency, severity and duration. Extreme weather events are increasingly projected as greenhouse gases continue to cause changes in climate. The Canadian Prairies are becoming better known for thunderstorms that generate tornados. Although tornados are most common in the southern areas of the province, they have been seen as far north as Thompson. Southern Manitoba has been subject to the most dangerous hailstorms in the province. In the summer of 1996 a hailstorm caused over \$100 million dollars damage to property. In 1997's Flood of the Century approximately 22,000 people were displaced with damage estimates at \$500 million for Manitoba and \$4.5 billion in North Dakota. These intense weather events and associated costs demonstrate how vulnerable infrastructure can be.

Current engineering standards and codes are based on historic climate data, however the Canadian Council of Professional Engineers (CCPE) has initiated a climate change adaptation program. CCPE indicates that "climate change will, over the years, necessitate changes to building codes, engineering practices and standards, and will affect the way facilities are designed, ultimately altering the economic lifespan of infrastructure and thereby impacting commerce and industry" (Infrastructure Canada, 2006). This work, however, is still at an early stage in terms of engineering design change. Mitigation efforts are needed to ensure that infrastructure is protected from changes in natural systems.

## Conclusion

The design, construction, repair and protection of infrastructure must be considered in the scope of long term environmental (and socioeconomic) considerations and climate change. This will require proactive adaptation measures developed through whole systems thinking. Without this, climate change will have potentially devastating and costly impacts. Throughout all planning processes for infrastructure development it is important to remain clear that projected climate change impacts are both dynamic and uncertain making *no-regrets* initiatives important.

The costs of adaptation strategies cannot currently be borne solely by municipalities, nor should they be. Many infrastructure projects are developed by the order of government closest to the people, however, municipal governments are not in a position to cover the full price of these systems. All orders of government need to work collaboratively to implement adaptation measures in order for responsibilities and costs to be manageable. ♻

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