



## Building a Climate-Resilient City: Disaster preparedness and emergency management

### KEY MESSAGES:

- Projections for more intense and frequent extreme weather events need to be integrated with disaster and emergency management planning.
- Contingencies for spare capacity and flexibility to deal with climate hazards occurring simultaneously or in quick succession need to feature in disaster and emergency management planning.
- Strategic investments in disaster prevention measures, including climate-resilient green infrastructure and updated building codes, will provide significant long-term cost savings and social benefits.
- Continuous outreach and engagement processes can ensure that citizens prepare for and can respond to climate-related disasters.

Climate change is already being experienced in Alberta, and will alter the frequency, intensity, duration and timing of extreme weather events in the coming decades. Alberta's mean annual temperature could rise by 2.0°C by 2030s and 4.0°C by 2060s (compared to the 1990s) should global greenhouse gas emissions continue to increase at their current pace.<sup>1</sup> This level of warming is greater than the projected increase for the Earth as a whole.

Alberta's climate is also expected to become more variable; while average temperatures will increase by a few degrees, temperature extremes—particularly days where the temperature climbs above 30°C—will become more common. Warmer temperatures will very likely result in more severe flooding and extreme weather, more days and nights with dangerously hot temperatures, and changes in the amount and distribution of precipitation. Should global rates



of greenhouse gas emissions decline, the change in Alberta’s climate will be less severe, but still pose a risk of more extreme weather events.

The anticipated changes in Alberta’s climate have worrying implications for municipal systems, including disaster preparedness, emergency management and public health.<sup>2</sup> There is growing risk of more severe and frequent disaster-level events, leading to impacts on city water resources, failures of infrastructure when design assumptions are exceeded by changing conditions, and increased potential for human morbidity and mortality.

Building a more resilient city can help reduce the potential negative consequences of climate change. A resilient city is one in which its institutions, communities, businesses and individuals have the capacity to “survive, adapt and grow” in response to any kind of shock or stress that they may experience. Such cities integrate the qualities of flexibility, redundancy, robustness, resourcefulness, reflectiveness, inclusiveness and integration into all aspects of city functions (see Box 1). These qualities of resilience are considered to be essential to preventing the breakdown or failure of a system and enabling it to take action in a timely manner.<sup>3</sup>

This paper examines the potential implications of climate change for disaster preparedness and emergency management in Alberta’s cities, and presents options by which the resilience of these systems may be enhanced. It is one of a series of papers prepared by the [Prairie Climate Centre](http://prairieclimatecentre.ca) to provide the public and government officials with an overview of the means by which to build cities that are resilient to the impacts of climate change, drawing on lived experience and best practices.

### BOX 1. QUALITIES OF A RESILIENT CITY<sup>4</sup>

**Reflective:** People and institutions reflect and learn from past experiences and leverage this learning to inform future decision making.

**Robustness:** Urban physical assets are designed, constructed and maintained in anticipation of high-impact climate events.

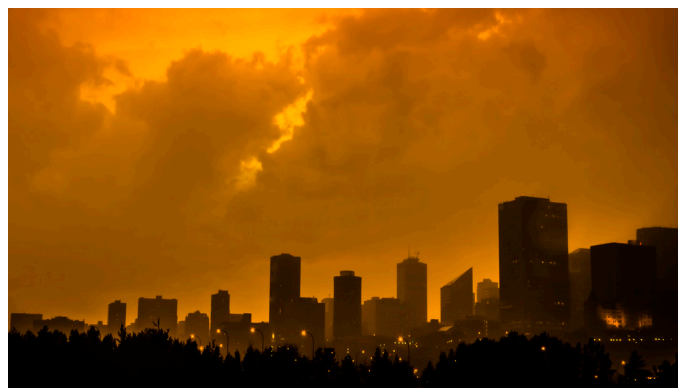
**Redundancy:** Spare capacity is built into the system to account for disruptions and surges in demand. It also involves multiple ways of fulfilling a need or function.

**Flexible:** Refers to the willingness and ability to adopt alternative strategies in response to changing circumstances or sudden crises. This can be achieved through new knowledge and technologies.

**Resourcefulness:** Citizens and institutions are aware of climate risks, able to adapt to shocks and stresses and can quickly respond to a changing environment.

**Inclusive:** Inclusive processes emphasize the need for broad consultation and many views to create a sense of shared ownership or a joint vision to build city resilience.

**Integrated:** Integrated processes bring together and align city systems to promote consistency in decision making and investments. Exchange of information between components of the system enables them to function collectively and respond rapidly.





## Implications of Changing Climate-Related Risks

Albertans are familiar with the impacts of extreme weather events. In recent decades, Edmonton experienced the infamous 1987 “Black Friday” tornado and, in 2004, a record-breaking hailstorm that forced the evacuation of 30,000 people from the West Edmonton Mall.<sup>5</sup> More recently, the 2013 flood in southern Alberta caused extensive damage to Calgary and other centres. With CAD 1.7 billion in insurance costs, this event held the record as being Canada’s costliest natural disaster—until the Fort McMurray wildfire in 2016, which caused insured losses of CAD 3.58 billion.<sup>6,7</sup>

Calgary and Edmonton are fortunate to have resourceful emergency response systems that have enabled them to respond effectively to these events. For instance, well-executed municipal emergency management plans, in combination with very high rates of civic volunteerism and effective upstream management of the Bow watershed, enabled Calgary to be on its feet again in time for the annual Stampede just weeks after the 2013 flood.

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Research has demonstrated that climate change—in particular warmer temperatures—played an important role in shaping the climatic conditions that led to the 2013 flood in southern Alberta. Events of this magnitude are very likely to become more common in the future.<sup>8</sup>

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In municipalities across Canada, though, planning for extreme weather events has typically been based on the assumption that past climatic patterns will continue into the future. Municipalities often build their infrastructure and calculate risk based on historical return rates, such as the concept of a one-in-100-year flood. Climate change, though, is making the climate system less predictable and more variable. It is changing the frequency and severity of disasters, and therefore altering the definition of what constitutes a 100-year flood event.

An increase in extreme weather events in Alberta—such as heavy winds, hail, flash flooding, lightening, tornadoes and days with very hot temperatures—will have a measurable impact on municipalities’ critical disaster management operations. An often underappreciated

implication is the impact it will have on the reliability of weather forecasts—a critical factor in disaster planning. As the weather becomes more variable, the ability of disaster management teams to anticipate the occurrence of an extreme weather event will become more challenging. There may be the potential for more disasters to occur with very little warning or with sudden, unanticipated intensity—similar to the hailstorm that hit Calgary in August 2012. The storm, which followed in the wake of a heat wave, turned summer into winter in the course of an hour, smashing windows and damaging buildings.<sup>9</sup>

Climate change is also likely to increase the potential for multiple disasters to occur in a single season. Cities may experience multiple floods, or even flip between flood and drought, within the space of a few months. In 2016, for example, the very hot weather in Fort McMurray that led to the wildfire in May and forced the town's evacuation was followed by anomalously high rainfalls in June.<sup>10</sup> As climate-related disasters become more intense and frequent, or longer in duration, more time and money are needed to restore services and rebuild local economies. When such events occur in short succession, cities may be unable to fully recover from one extreme event before the next one occurs.

A further concern for emergency planners is the risk climate change poses for the infrastructure they rely upon to transport equipment, store food and fuel, and house people displaced by disasters. Rising temperatures and changes in precipitation regimes will influence the weathering and erosion rate of infrastructure, reducing its lifespan and degrading its tolerance to environmental stresses. A greater number of increasingly more intense weather events will enhance the likelihood that infrastructure—roads, bridges, dikes, shelters—may be damaged or face catastrophic loss, thereby affecting the ability of disaster managers to effectively respond to emergency situations.<sup>11</sup> Additional infrastructure (e.g., more back-up generators, refuge areas,

telecommunications) may be needed to ensure continued delivery of emergency services.<sup>12</sup>

Cities such as Edmonton and Calgary may also be increasingly affected by climate-related disasters in the smaller communities that surround them. As occurred following the Fort McMurray wildfire, in times of crises these cities play a role in providing equipment and aid to neighbouring communities. As the frequency of extreme events increases across the province, these cities may experience greater demands for support not only from their own citizens but also from people displaced from homes in other parts of Alberta.

Through dedicated measures, municipal governments can take steps to build their capacity to manage the growing potential for extreme weather events as the climate changes, and in turn contribute to building a more climate-resilient city. These interventions may focus on enhancing three of the qualities of resilient cities: robustness, redundancy and resourcefulness.





## **Building Robustness**

A key step to building more climate-robust disaster preparedness and emergency management systems is purposefully and systematically integrating consideration of how climate change may affect future hazard risks when assessing and updating strategies and plans. This will help identify strategies to either eliminate or lessen the severity of economic and personal losses caused by climate events before they occur. A forward-looking approach is increasingly needed to account for changes in the probability of hazards occurring and the potential emergence of new risks. Anticipatory disaster risk management and a focus on managing the processes that create risk—rather than reactive responses and a focus on managing events—becomes more important as the climate system becomes more variable and less predictable.<sup>13</sup>

Tools such as a Hazard Identification and Risk Assessment (HIRA) can be used to facilitate this forward-looking, proactive approach to emergency management. HIRA enables a systematic assessment of the risks associated with various hazards—present and future—and helps prioritize where actions are needed to build resiliency. As this assessment is undertaken on a regular basis, it enables emergency management plans to take into account changes in hazards and risks over time.<sup>14</sup> This tool has been applied in Calgary, Ontario<sup>15</sup> and the Northwest Territories<sup>16</sup> to improve disaster preparedness as well as response and recovery.

More robust capacity to manage climate hazards can also be enabled by reviewing existing regulations to assess their potential to increase vulnerability in the coming years. As hazard risks change, floodplain management plans, land-use plans, infrastructure regulations, building codes and building standards will need to be revised to reduce the risk of future damage. Supported by tools such as climate projections and hydrologic scenarios, emergency planners can provide their expertise to inform decisions regarding

regulatory changes needed to minimize current and anticipated climate risks.

Robustness within emergency management systems can be further increased over time by embracing a continuous learning process in which actors and institutions reflect critically on past experiences to understand the importance of failure, continually improve practices and update plans on an iterative basis.<sup>17</sup> This approach can encourage planners to re-think and re-evaluate approaches before rebuilding after a disaster. Incorporating “building back better” principles into disaster recovery and disaster assistance programs can serve to increase resilience to similar, or more extreme, types of disasters in the future. This approach can also facilitate identification of circumstances in which there is an economic rationale for providing additional funding to rebuild damaged infrastructure to a standard above its pre-disaster condition. This investment would be made in anticipation of the additional improvements enabling the infrastructure to better withstand future climate hazards—and therefore lower costs in the long term.

Incorporating a longer-term perspective into emergency planning and budgeting, in conjunction with a greater focus on disaster preparedness and prevention, can also help identify opportunities in which the initial upfront costs of an investment will be offset by cost savings in the long term. Better disaster readiness should mean that less damage is caused by an extreme event, and any damage that does occur requires less time and fewer resources to repair. Money invested in these types of programs also tends to remain within the community, helping to spur the local economy. Conversely, not strengthening existing emergency planning processes increases the likelihood that more money will need to be spent on disaster relief and insurance—costs that tend to move money away from the local economy.<sup>18</sup>



A longer-term, holistic assessment can lead to reassessments of the economic feasibility of some large-scale infrastructure investments. Disaster mitigation projects, such as flood diversions, water reservoirs or aquifer storage and recovery, which are currently considered too costly or ambitious, might become feasible and necessary in light of the possibility of more frequent disasters and greater loss per event.<sup>19</sup> The Manitoba Red River Floodway is a prime example of such an infrastructure project. After the City of Winnipeg was devastated by flooding in 1950, Manitoba invested an estimated CAD 63 million to construct a floodway that diverts water around the city instead of flowing through it. Between 1960 and 2008, it is estimated that the province saved CAD 8 billion in avoided recovery costs due to damage from subsequent flood events. The floodway also provides the added benefit of reduced disruption to local economies and damage to assets, infrastructure and lives.<sup>20</sup>

### **Promoting Redundancy**

Incorporating greater flexibility or spare capacity into disaster preparedness and emergency management systems can help cities meet the anticipated challenges of climate change. Building greater redundancy into emergency management systems could better enable them to effectively manage multiple hazards occurring simultaneously or in short succession, as well as more quickly adapt to changing events.

An area in which greater redundancy may be built into emergency management plans is communications. Ensuring the availability of multiple approaches and lines of communication (such as television, Internet, email, text messages, social media channels and radio) can better guarantee clear and continuous information exchange between emergency managers and the public during different phases of an emergency situation—even if one or more communication channels is disrupted during the event.<sup>23</sup>

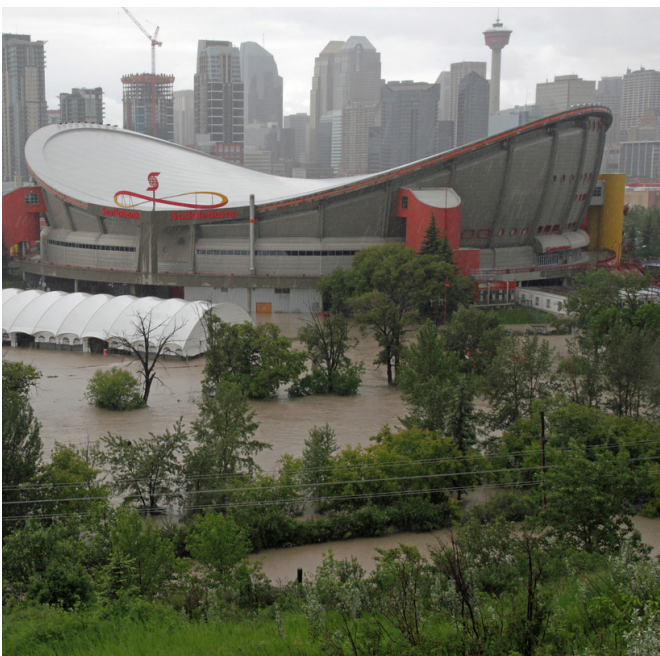
### **BOX 2. CITY OF BALTIMORE COMBINED ALL HAZARDS MITIGATION AND CLIMATE ADAPTATION PLAN<sup>21, 22</sup>**

In 2013, the City of Baltimore initiated a process to develop a unified plan that addresses existing hazards while also preparing for the anticipated hazards resulting of climate change. The process integrated the city's All Hazard Mitigation Plan (required by the Federal Emergency Management Agency to remain eligible for disaster-related assistance) with floodplain mapping and a climate change adaptation plan.

The integrated plan was prepared through the Disaster Preparedness and Planning Project, which combined research with a participatory engagement process. Expert insight was provided by a 42-member advisory committee and inputs from working groups. The resulting plan identified 50 strategies and 231 actions focused on four areas: buildings, natural systems, infrastructure and public services. It reflects the need to use a transformational and cross-sectoral approach to mitigate risk and adapt to climate change.

Through this process, Baltimore has been able to prepare a comprehensive and new risk-preparedness system that simultaneously addresses both current and anticipated climate-related hazards. Discussions around hazard mitigation were used to engage agency directors on the need to adapt to climate change and ensured that adaptation strategies are incorporated into the city's Capital Improvement Planning Process. The process used by Baltimore provides a framework for other cities interested in a unified approach to the management of current and future hazards.

Emergency managers may also need to look at the need to build greater capacity to respond to specific climate risks, such as the greater likelihood of heat-related risks. Calgary and Edmonton could experience up to seven times more days with temperatures above 30°C by the 2060s, which implies that heat waves will become a significant health hazard in the future.<sup>24</sup> Cities may need to make strategic investments to increase the capacity of vulnerable citizens, such as the sick, the elderly and low-income families, to manage heat events. This could include ensuring that citizens can take refuge in existing public spaces with air conditioning, like malls, community centres, libraries and arenas; expanding the range of recreational facilities, such as splash pads and pools; installing public drinking fountains and water bottle refilling stations in high traffic areas; and designing and retrofitting buildings using standards such as those set by Leadership in Energy and Environmental Design (LEED)<sup>25</sup> and the Living Building Challenge.<sup>26, 27</sup> Increasing the number and size of green spaces, such as green roofs and community gardens, presents another way to help reduce the urban heat island effect, thereby reducing stress on citizens and their need for air conditioning.<sup>28</sup>



### ***Encouraging Resourcefulness***

Enhancing the capacity of citizens to effectively engage in disaster preparedness and emergency management is key to building a disaster-resilient city. Citizens need to be aware of their responsibility to take individual actions to prepare for emergencies and to proactively participate in collective responses to maintaining the safety of their neighbours and community.

Participatory development of disaster preparedness plans can be a critical step in building the resourcefulness of citizens. Through these processes, emergency planners can better understand the needs of community members, address knowledge and capacity gaps, and build stronger relationships with citizens. The Whole Community Approach to Emergency Management increasingly being adopted across the United States is a means through which participatory engagement can be achieved. Through this method, emergency managers, government officials, community leaders, local organizations and residents evaluate the needs of their community and determine ways to strengthen their assets and capacities. Benefits of this approach include a shared understanding of needs, greater empowerment of communities, stronger social infrastructure and increased preparedness for disasters.<sup>29</sup>

Participatory processes are also needed after a disaster to evaluate the effectiveness of plans and learn from successes and challenges. Participatory post-disaster evaluations can be used to reassess needs, facilitate two-way knowledge sharing, inform recovery efforts and help empower communities. Such assessments are particularly important for ensuring ongoing public acceptance and trust of emergency management processes.<sup>30</sup> For example, after Hurricane Sandy slammed into New York City in 2012, killing 72 people, several recommendations were made to make the city more resilient to similar events in the future. These included: improving hospital evacuation coordination and pre-planning, increasing the volume of



fuel on hand for backup generators, improving coordination with emergency assets from outside jurisdictions, and increasing the robustness and redundancy of electrical infrastructure to help limit the extent and duration of power outages. To help pay for and implement these recommendations, municipal and state economic policy changes were suggested, including introducing more retrofit grants and subsidized loans.<sup>31</sup>

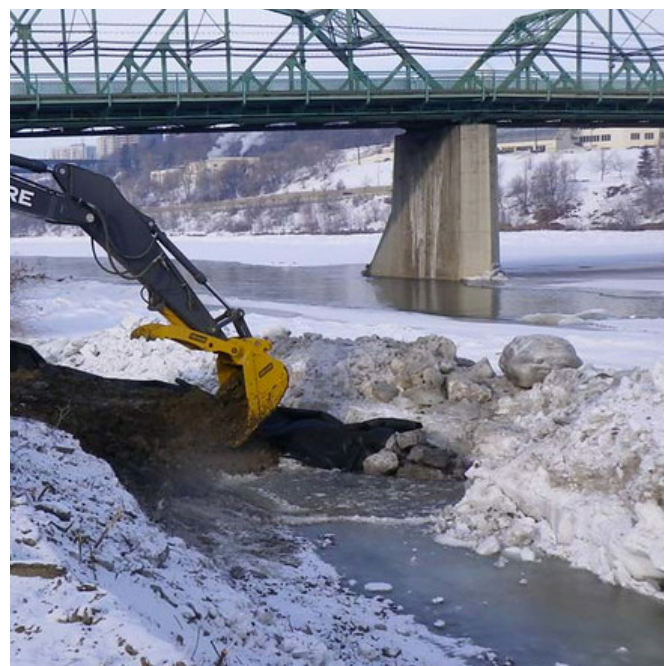
Strengthening public awareness of climate-related risks and disaster preparedness practices can also contribute to building resilience. Public awareness campaigns that use multiple communication channels (e.g., different media, different languages) can help raise awareness of actions citizens can take individually and collectively to prepare for disasters. These campaigns require strong partnerships with community organizations working with vulnerable populations (such as the elderly, homeless, and newcomers and refugees) to increase health and safety throughout the city. Special attention also should be provided for individuals with physical and intellectual limitations to meet their specific needs (mobility equipment, visual or hearing aids, access to counselling services, medications etc.).<sup>32</sup>

After a disaster, public awareness campaigns can provide people with access to the additional help they may need to overcome the emotional and physical stress caused by a disaster. As extreme weather events occur with greater frequency, post-disaster recovery plans and actions may need to include greater investment of financial and human resources in actions that address citizens' physical and emotional health—helping them to improve upon their pre-disaster situation.<sup>33</sup>

Regularly held scenario exercises provide an additional means through which the resourcefulness of communities can be enhanced. Disaster and public health crisis scenarios can be designed as citywide events with coordinating hubs located in each neighbourhood. Testing

disaster management plans through scenario exercises has many advantages; while providing emergency responders and planners with an opportunity to identify potential vulnerabilities in the disaster management plan, these exercises also educate citizens and can increase the number of registered volunteers. Public-private partnerships can be developed to increase participation in such events. Companies can be encouraged to provide incentives to employees who participate in city-run scenario-building exercises or take part in office-wide emergency training.<sup>34</sup>

Collectively, these options for enhancing the resourcefulness of community members can deliver an essential component of any well-planned disaster management strategy—volunteers. Outreach and engagement processes can help identify volunteers with important skills (such as counsellors, psychologists, health practitioners and translators) that can be matched to areas where they are most needed. Volunteers recruited prior to disasters can be trained in basic first aid, leadership, communication or other basic skills to improve community resourcefulness.<sup>35</sup>







## Recommendations

While Calgary and Edmonton have effectively managed past events, they are also incorporating lessons learned to further strengthen their capacity to minimize risks and manage future events. Calgary, for example, has integrated lessons from the 2013 flood across the city and surrounding areas, and plans to implement a combination of structural and non-structural measures to provide sufficient flood protection on both the Bow and Elbow rivers. Similarly, Edmonton is continually expanding its storm-readiness plans by promoting the installation of residential backwater valves.<sup>36, 37</sup>

Calgary and Edmonton could consider undertaking the following measures to further strengthen their resilience to a more variable and uncertain climate:

### *Strategic*

- Use available climate scenarios to develop disaster risk scenarios that can inform revisions and updates to emergency plans and disaster management practices and ensure that they are no longer based exclusively on an assumption that the climate of the past will continue into the future.
- Provide professional development opportunities to increase municipal emergency planners' awareness of the potential consequences of shifts in climate extremes for disaster risk management.
- Invest in building the climate resilience of infrastructure, such as transportation, communication, energy and water systems, to decrease the vulnerability of disaster response systems during times of crisis.
- Engage all levels of government in disaster preparedness and emergency management efforts to ensure coordinated responses and the strategic and timely provision of financial assistance to priority needs.

### *Regulatory/Administrative*

- Leverage city permit processes to restrict development in areas, such as flood plains, anticipated to be at increasing risk due to climate change or where insurance against climate-related hazards is no longer available.
- Integrate guidelines into city planning to ensure that new development, redevelopment or replacement of infrastructure integrates and enhances natural landscapes and green infrastructure.
- Consider development limitations and by-law enforcement mechanisms within the regulatory regime to ensure the protection of natural spaces that provide both natural hazard protection and health benefits.
- Expand the number of publicly available spaces designated as emergency cooling shelters during times of excessive heat (e.g., shopping malls, libraries and community centres).

### *Economic Instruments*

- Incorporate the economic benefits of ecosystem services provided by, for example, urban forests, natural riparian zones and parks, into cost-benefit assessments to encourage the retention and expansion of urban ecosystems.
- Promote the provision of tax incentives to registered emergency management and disaster preparedness volunteers similar to the tax credit offered to volunteer firefighters.
- Recognize that disaster loss estimates are often inconsistent and therefore tend to underestimate the potential negative economic and social consequences of a disaster.



### Voluntary/Community Linkages

- Strengthen public education campaigns to increase the likelihood that citizens will keep emergency preparedness kits in their homes.
- Engage communities in developing neighbourhood evacuation and disaster preparedness plans.
- Provide first-aid and disaster scenario training to increase the pool of trained volunteers that can be called on in emergency situations.

## References

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- <sup>11</sup> Lemmen, D.S., Warren, F.J., Lacroix, J., & Bush, E. (Eds.) (2008). *From impacts to adaptation: Canada in a changing climate 2007*. Ottawa: Government of Canada.
- <sup>12</sup> Options for building the resilience of urban infrastructure are explored in the papers within this Building a Climate-Resilient City series focused on transportation, buildings, water and waste, and energy and information and communications technology (ICT).
- <sup>13</sup> This focus is consistent with commitments made in the Sendai Framework for Disaster Risk Reduction (2015–2030).
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- <sup>28</sup> These options are explored in greater detail in the paper *Building a Climate-Resilient City: Urban ecosystems* written as part of this series.
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For more information visit: <http://prairieclimatecentre.ca/>

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