



Building a Climate-Resilient City: Economics and finance

KEY MESSAGES:

- Climate change impacts such as damage to infrastructure, productivity losses and adverse health effects have large financial implications for municipalities.
- Investment in climate resilience reduces exposure to climate risks, lowers liability costs, and improves investor confidence and credit ratings.
- Multiple-bottom-line accounting methods embed climate risk awareness and the benefit of cost-effective adaptation benefits.
- Monetizing the value of ecosystem services valuation allows cities to identify and prioritize high-value natural and green infrastructure climate solutions.

Alberta has experienced significant changes in recent decades, including changes in its climate. Average annual temperatures are increasing and could rise by 2.0°C by the 2030s and 4.0°C by the 2060s (compared to the 1990s) should the current rate of global greenhouse gas emissions remain unchanged. Total average annual precipitation is also likely to increase, but this change will vary from season to season—likely increasing more in the winter and declining in the summer.¹ These climatic changes are expected to lead to a host

of environmental and weather hazards, including more severe flooding and extreme weather, and more days and nights with dangerously hot temperatures. Temperature extremes—particularly days where the temperature climbs above 30°C—will become more common. These hazards have worrying implications for municipal systems, including impacts on city water resources, failures of infrastructure when design assumptions are exceeded by changing conditions, increased human morbidity and



mortality, and increased severity and frequency of disaster-level events. Under a lower level of global greenhouse gas emissions, climatic changes will be less severe but still significant.

These growing climate risks have clear implications for local economies and the financial well-being of municipal governments.

Municipal governments are directly or indirectly responsible for much of the population, public services and infrastructure most affected by climate change—from bridges and roads to schools and urban parks. Regulatory and financial instruments such as zoning, taxation and user fees shape the nature of urban life and development, and can be used to cultivate all aspects of adaptive resilience. Indeed, ensuring the resilience and sufficiency of economic resources is foundational to all other aspects of municipal adaptation planning. And improving urban resilience to climate change will promote economic resilience in turn.

This paper explores how economic and financial measures can contribute to building a resilient city—or a city in which institutions, communities, businesses and individuals have the capacity to function and “survive, adapt and grow” in response to anticipated and unanticipated shocks and stresses. 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.² This paper is part of a series prepared by the [Prairie Climate Centre](#) 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

The Economics of Adaptation

Climate change is already costing Albertans dearly: the federal Working Group on Adaptation and Climate Resilience notes that: “The province of Alberta has been hit by 7 of the 10 most expensive disasters in Canadian history.”³ As the climate warms, weather will become more chaotic and the potential for disastrous weather events and losses will only grow.⁴ Canada’s National Round Table on the Environment and Economics demonstrated that our changing climate has inevitable social and economic costs, including lost productivity, increased risks to human health, damage caused by extreme weather disasters and losses in vulnerable resource-based industries such as forestry. It also demonstrated that timely and well-chosen adaptation measures can be extremely cost-effective at reducing the severity of these impacts.⁵ Similarly, the *Stern Review* concludes that “the benefits of strong and early action far outweigh the economic costs of not acting,” and estimates that the impacts of climate change will cost at least 5 per cent of global GDP every year, “now and forever,” whereas the costs of adaptation and mitigation will be on the order of 1 per cent of GDP.⁶ Both reports demonstrate that targeted early spending on adaptation and developing resilience are much better uses of public funds than delayed and reactive approaches to climate change impacts as they become acute.

Climate change impacts involve threats and costs touching on all aspects of contemporary municipal life, and many of its effects on urban environments have yet to be effectively quantified. Multiple-bottom-line approaches to planning can help define vulnerabilities as well as account for the effectiveness of adaptive measures. Many municipalities already apply “triple-bottom-line” accounting, which defines return on investment in financial, environmental and social terms. We broaden this to a “multiple” bottom line to reflect the need to account for climate change adaptation approaches. This strategy is largely consistent with the approaches

outlined in Calgary's Triple Bottom Line Policy Framework and Edmonton's The Way We Green strategy, but expands on the environmental aspect of planning to specifically require consideration of the need to adapt to climate change in planning and budgeting processes. Well-planned adaptation measures can improve the quality of urban life as well as protect lives and infrastructure, strengthen community ties and improve economic performance.

BOX 1. QUALITIES OF A RESILIENT CITY⁷

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.

Preparing for the implementation of adaptation measures means anticipating higher expenditures, but costs can be minimized by applying multiple-bottom-line, adaptive design thinking as broadly as possible. Many adaptation strategies can also help reduce greenhouse gas emissions, improve the livability of urban environments and promise long-term cost savings. A number of these strategies can involve implementing best-practice urban and economic development strategies to ensure the provision of climate change benefits. Combining natural systems with engineered infrastructure, protecting and extending urban forests, and promoting the use of green roofs can all contribute to climate change mitigation and adaptation, but also demonstrably improve citizens' quality of life and improve property values. A similar set of interlocking benefits can be derived by efforts to limit urban sprawl.⁸ Cultivating a multiple-bottom-line perspective can include funding adaptive measures that enhance resilience at a lower cost than conventional approaches. Seattle, for instance, has been able to lower both stormwater and paving costs by moving to a resilient low-impact development approach to managing runoff.⁹





As these examples suggest, climate change will affect the natural world, the built environment and the interactions between them. Thus, an important and innovative aspect of financing climate adaptation is the valuation of ecosystem services. This process allows cities to assess and leverage existing natural features of the landscape and ecosystems to augment or even replace more expensive, less robust engineered solutions.¹⁰ Concrete examples include natural management of flood or stormwater by riparian zones and wetlands¹¹ and the positive impact of urban forests on air quality and the urban heat island effect.¹² The value of such ecosystem services has rarely been incorporated into budgets, and doing so would be a significant step to bringing an intrinsically resilient adaptation perspective to bear on development. This can be accomplished by way of a natural asset policy that defines the value of ecosystems and sets a price on the services they provide.

Financing adaptation relies to no small extent, then, on eco-asset accounting: determining the value and the vulnerability of such ecosystem services in order to account for the combined financial and ecological benefits of adaptation measures.¹³

Eco-asset accounting projects are being undertaken from coast to coast, from assessments of the value of natural features on B.C.'s Georgia Strait¹⁴ to the Atlantic Infrastructure Management Network's reporting projects in the Maritimes. A comprehensive ecosystem services valuation was recently completed in Gibsons, British Columbia (see Box 2), using an approach that is now being applied in larger municipalities: Nanaimo and West Vancouver in British Columbia, and Peel and Oakville in Ontario. The Federation of Canadian Municipalities is launching two funding programs—the Municipal Asset Management Program and the Municipalities for Climate Innovation Program—in the spring of 2017 that could support eco-asset accounting programs.

BOX 2. CASE STUDY: ECO-ASSET PRICING IN GIBSONS, B.C.

The Town of Gibsons undertook a pioneering eco-asset survey because a conventional asset inventory estimated future maintenance costs at the unsustainable level of more than one third of the town's annual infrastructure budget. They turned to ecosystem services as a way to save money by taking better advantage of the lower costs and higher resiliency of natural systems.¹⁵

The project consisted of several steps: assessing asset conditions; determining asset worth; determining the impact of increased demands on the asset; developing objectives for the asset; preparing an operations and maintenance plan; and developing a financial plan. The project benefits include managing risk by quantifying the costs and benefits of natural systems, and saving costs by ensuring the health of resilient natural services.

As a result of applying this process, Gibsons determined that three natural systems in particular provide immense benefits for little cost:

- Aquifer: water storage and filtration
- Creeks, ditches, wetlands: rainwater management
- Foreshore area: natural seawall

Gibsons has taken its inventory and moved forward with an ongoing natural asset management strategy intended to both take better advantage of these assets and to ensure they are appropriately maintained. Engaging in a systematic process allows them to make strategic long-term plans, and to avoid traditionally reactive and ad-hoc approaches to natural systems, an approach that often fails to recognize them as valued elements of municipal infrastructure.

Financing resilience thus demands the long-term strategic use of traditional planning processes and financial instruments of municipal government, but also taking up innovative approaches to measurement and management as well as new sources of directed funding. Applying a resilience approach to financing will help cities successfully finance measures that support adaptation to climate change and build resilience. A variety of strategies can be implemented to enhance three of the qualities of resilient cities: robustness, redundancy and resourcefulness.

Building Robustness

Municipal finances must retain the capacity to meet ongoing and competing demands in the face of material and socioeconomic climate change shocks. For example, climate projections show winter precipitation increasing by approximately 20 per cent for Calgary and Edmonton by the 2060s, which will likely demand a corresponding increase in snow-removal capacity. Projections also show a 25 per cent increase in average summer temperature, which will require more heat-related repairs to paved surfaces not engineered for the new climate reality.¹⁶ Proactive planning that takes climate change into account can help ensure a full understanding of future climate-dependent infrastructure and maintenance requirements. Applying a multiple-bottom-line approach to existing sources of infrastructure funding will ensure that these funds secure adaptation benefits in addition to the regular demands of ongoing maintenance and new construction.

Financial robustness is of course directly enhanced by new sources of money, such as Alberta’s carbon levy. By law, income from the levy can be used “for initiatives related to reducing emissions of greenhouse gases or supporting Alberta’s ability to adapt to climate change.”¹⁷ The Alberta government estimates that CAD 2.2 billion will thereby be made available for green infrastructure.¹⁸ This is a large pool of new money available for climate-change-specific mitigation and adaptation measures that might be impossible to fund using existing sources of infrastructure funding.



Financial robustness is not just a matter of spending, however. It is also a matter of ensuring the security of existing financing through strategic enterprise risk management. Adapting to climate change will help mitigate exposure to catastrophic losses, but also to increased insurance costs. Implementing adaptive measures that moderate or avoid climate impacts will therefore not only generally reduce environmental and financial risk and the financial (as well as human and material) costs of disasters, but also provide direct savings in the form of reduced liability costs.

Moreover, municipal economics are highly dependant on factors—such as credit ratings and property values—whose volatility can be influenced by proactive risk mitigation. Implementing resilience measures that reduce municipal vulnerability will help ensure financial robustness by maintaining property values, credit ratings, investor confidence and citizen security. Robust planning for adaptation and adaptation finance will position cities as forward-thinking and prepared, which will attract investment and in-migration (or at least forestall the out-migration of workers and investment dollars) in a world increasingly competing in terms of preparedness for the risks posed by climate change.



Promoting Redundancy

Financial redundancy means protecting municipal finances from single points of failure and from unexpected fluctuations or interruptions in available resources.¹⁹ Property tax income is relatively stable thanks to the demand-based relationship between tax rates and assessed values: the tax revenue required by municipal budgets determines the tax rate that is applied to the total assessed value of property in order to raise the necessary amount. This means that tax rates are highly dependent on assessed property values. Adaptation efforts will help protect against widespread climate-change-induced loss of assessed values that would require unpopular and politically untenable increases in rates in order to maintain necessary levels of municipal spending.

Initiatives that promote redundant outcomes will permit the mobilization of diverse sources of income for adaptation. For example, prioritizing “low-carbon, climate-resilient” projects and initiatives—those that help cities both adapt to the now-inevitable effects of global warming and mitigate its magnitude—offer redundancy inasmuch as they can be financed using instruments specifically designed for infrastructure in general, climate change mitigation or climate change adaptation. The multiple-bottom-line approach magnifies the effects of any given initiative while also multiplying possible sources of funding.

Public-private partnership (PPP) arrangements could be considered a funding mechanism for some adaptation projects, especially if they involve sharing the costs of technical innovation or providing revenue streams that could be attractive to private partners. Examples of this might include smart grid delivery of power, the provision of redundant mesh networks for communications, or expanding the electrification of the transportation grid. PPP arrangements have been used successfully for years across Canada: in Ontario, for example, the Region of Waterloo partnered with Toromont Energy Ltd. in the late 1990s to collaborate on capping the regional landfill and using its offgassing methane to supply Toromont’s gas-fired power generating plant. This project has multiple benefits: it diversifies generating capacity for the electrical grid, captures waste methane, and provides both income for Toromont and royalties for Waterloo.

User fees are increasingly an option for municipalities to raise revenue by a mechanism that has the added benefit of directly connecting costs and consequences. Natural and resilient management approaches to stormwater management, for example, are frequently incentivized with a system of user fees and credits for property owners, and through design standards and permit requirements for developers. Edmonton, for example, uses a fee-based system for stormwater financing; it found a credit system inefficient because of expense



and complexity. Philadelphia has introduced a stormwater management credit system limited to projects with a minimum size of over 10 acres, which lowered costs, simplified administration, and encouraged uptake.²⁰

Bonds, particularly green bonds, provide attractive means of financing investments that will build climate resilience. Bonds offer investors long-term, reliable instruments for managing money, especially in the face of global economic uncertainty. Under current conditions of low interest rates and global volatility, a low-interest bond issue can attract investors pursuing either securely backed or multi-bottom-line returns. Investors who value reliability and triple-bottom-line returns are willing to accept low and even negative interest rates for the sake of reliability. In the summer of 2016, for example, CIBC raised almost CAD 2 billion in its negative interest rate bond issue, which offered an interest rate of -.009 per cent and was oversubscribed by 100 per cent.²¹ A well-designed bond issue could provide a very low (or even negative) interest rate approach to debt financing that could raise considerable sums for relatively little cost.

There is a growing number of bond options, including “green,” “climate” and “water” bonds that can be tailored to specific municipal goals, and that offer different degrees of certification and risk profile for institutional investors. They have been widely used by all levels of government in the United States, but are relatively new to Canada. The specific use of “green” bonds rather than other kinds of bonds can not only raise funds, but can simultaneously demonstrate municipal commitment to adaptation and thereby promote enhanced financial stability through climate risk reduction. As government-backed securities, bonds have a low-risk profile that appeals to long-term investors with diversified portfolios. Green bonds issued for adaptive measures double down on this stability inasmuch as they directly fund improvements to the physical and financial environment that help

secure their own value as reliable investments.

Green bonds and climate bonds can be issued to fund projects with specifically environmental or climate-change-related goals. Ontario has been issuing green bonds provincially since 2014, and they have contributed CAD 1.2 billion to public transit expansion projects.²² Their first bond issue of CAD 500 million was almost five times oversubscribed; clearly there is strong demand for these products. Their usefulness may be limited by provincial limits on municipal debt financing, but they are potentially a strategic tool that can be used to attract new investment from the growing number of institutional investors and “ethical” or “green” funds that bring an explicitly multiple-bottom-line perspective to investing.

And of course, traditional debt financing can be well suited to adaptation projects. Both Calgary and Edmonton are currently below the provincially regulated limits on debt servicing costs and tax-financed debt. Although debt financing can be politically unpopular, public education and a demonstrated multiple-bottom-line return on investment could make various forms of borrowing a viable means to support aspects of adaptation that cannot be otherwise financed, such as new flood control measures, expanded active transportation infrastructure, or “soft” investments that provide social services and cultivate better linkages between communities to promote collaborative citizen resourcefulness.

Encouraging Resourcefulness

Municipal governments directly influence the living and working conditions of many people, and can use outreach and incentive programs to enlist them in adaptation actions that will improve the resilience of the cities in which they live. This includes mobilizing an informed citizenry to take action in their own homes and everyday lives, but also collaborating with business and industry to foster skills and resources that will allow all members of



the municipal community to develop greater resilience.

There are many aspects of adaptation that are not under direct municipal control, and indeed some aspects of resilience are more efficiently delegated to property owners by appropriate incentives rather than directly implemented by cities themselves.²³ Such non-governmental actors can be mobilized to implement aspects of resilient adaptation through financial and regulatory incentives, but also using non-financial strategies such as public education and recognition programs. Certification or award programs that recognize climate change preparedness offer a mechanism based on public recognition instead of financial compensation, and yet can reap financial rewards in the form of sustained or improved property values or business opportunities as well as improved adaptive resilience and risk mitigation.

Incorporating adaptation and mitigation standards into tendering, zoning and permitting processes will not only result in direct adaptive benefits, but will rapidly develop adaptation skills and perspectives among developers and other commercial entities that do business with government and in the community. In this way, cities can promote and cultivate both the expertise and ethos of adaptation. Outreach and education programs can further engage the business community as a key stakeholder in the development of adaptive tools and practices.

The valuation of ecosystem services allows cities to assess the benefits of existing natural features of the landscape for a decision to either augment or replace it with more expensive engineered solutions.²⁴ Loss of permeable soil and vegetation, for example, will worsen problems with stormwater management, increase the risks of overland flooding and exacerbate urban heat island effects. The value of such ecosystem services has rarely been incorporated into

budgets, and doing so would be a significant step to bringing an intrinsically resilient adaptation perspective to bear on development (see Box 2). This can be accomplished by way of a natural asset policy that defines the value of ecosystems and sets a price on the services they provide.

Alberta's Modernized Municipal Government Act grants municipalities the long-sought power to subclass non-residential properties. In addition to offering more control over property tax income, the power to subclass will make it possible for cities to use tax incentives to reward or penalize properties that variously improve or impede ecosystem services, bringing an adaptive resilience perspective directly to bear on land-use planning.

Direct financial incentives, including grants and loans to support individuals' adaptation efforts, can be effective and—under the right circumstances—even largely self-funding. Examples of this include establishing a fund providing homeowner loans for adaptive property improvements that result in a financial credit. This credit could initially be repaid to the fund for the balance of the loan plus interest, and thereafter delivered directly in the form of tax or user-fee relief. Similarly, development fees or fines can directly fund incentives rewarding compliance or improvement.

And of course municipalities have many regulatory tools to encourage or require adaptation measures. Development incentives such as expedited permitting, zoning upgrades and reduced permit requirements can be used to promote adaptive outcomes. More stringent uses of zoning and permitting can make mandatory elements of adaptation that are merely encouraged by more flexible market-based mechanisms, and it is likely that successful adaptation measures will require both approaches.



Recommendations

Strategic

- Embed adaptive resilience requirements into planning, permitting and zoning processes.
- Engage in a structured valuation of ecosystem services to quantify climate change risks and measure adaptive improvements.

Regulatory/Administrative

- Assess construction, maintenance and development projects using robustness criteria that take climate change impacts into account, for example applying Engineers Canada's Public Infrastructure Engineering Vulnerability Committee (PIEVC) Engineering Protocol to all engineering projects.

Economic Instruments

- Apply multiple-bottom-line accounting principles to planning, permitting and zoning in order to incorporate adaptive benefits across the board.
- Direct climate-change-specific funding to high-impact, adaptation-specific projects that are unlikely to be funded from other sources.
- Use property subclassing to promote adaptive land use.

Voluntary/Community Linkages

- Provide financial and other supports to networks of individuals and non-governmental organizations whose efforts strengthen resilience.





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