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Land use planning tools

for local adaptation to climate change

Canada

Aussi disponible en français sous le titre : Outils d'aménagement locaux pour l'adaptation aux changements climatiques

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Synopsis: This document describes planning tools being used across Canada to help communities prepare for climate change, increase adaptive capacity and build resilience. It is directed to individuals and groups interested in climate change adaptation at the local level, including planners and other local government staff, elected officials, community organizations, local residents and business leaders.

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1.0 Introduction

Canada's climate is changing rapidly. Although all levels of government have important roles to play to advance adaptation, action at the local level is particularly important because that is where many of the impacts of climate change will be felt most directly.[1]

Local governments in Canada can manage the risks and opportunities presented by climate through a variety of practices, including adoption and enforcement of bylaws; collection of taxes and user fees; operation of transportation, utilities and other public infrastructure; establishment of subsidies, tax credits and other incentive programs; administration of emergency management and response systems; and public outreach and education initiatives.

Land use planning is one of the most effective processes to facilitate local adaptation to climate change.[3,4] Historically, local governments have used land use planning tools – official plans, zoning, development permits and others – to minimize risks to communities from floods, wildfires, landslides and other natural hazards.[5] As the climate changes, so will the frequency and magnitude of climate-related hazards, posing a challenge for community planners. A recent survey by the Canadian Institute of Planners confirmed that "planners gravitate to tools they know best and are looking for ways to adapt known tools when addressing climate change."[6]

Adaptation defined

Climate change adaptation refers to actions that reduce the negative impact of climate change and/or take advantage of new opportunities. It involves making adjustments in our decisions, activities and thinking because of observed or expected changes in climate.[2]

Some ways municipalities act

- planning and land use controls: zoning, official plans, development reviews
- provision of public services: utilities, public transit, road maintenance, snow removal, fire and police, emergency preparedness
- forum for public dialogue and information: public awareness campaigns, deliberation on bylaws and programs, information on city services
- collection of taxes and user fees: property taxes, recreational facility fees, parking fees
- management of public land and buildings: establishment of parks, renovation of civic buildings, operation of water treatment plants

This document describes tools in the land use planning sector that communities can use in preparing to adapt to climate change. In addition, it provides information on decision-support tools, tools that provide information and resources to help planners and local decision makers take effective adaptation action.

A brief example of each tool and its use by a Canadian community is given. Not every case discussed here was explicitly motivated by a desire to adapt to climate change. However, the significance of the tool to adaptation planning is clear in each case. An effort was made to select examples from communities of varying sizes and from all regions of Canada.

Although the examples are of broad utility, the design and application of a particular planning tool can vary greatly from one jurisdiction to another, depending on provincial or territorial laws and other factors. We describe the provincial and territorial roles in local adaptation planning in Appendix A. Readers interested in knowing how a particular tool is applied in a specific community should consult provincial, territorial and local laws.

It is important to keep in mind that land use planning is used to pursue many local policy objectives, including providing affordable housing, stimulating job growth, preserving the character and heritage of a community, reducing greenhouse gas emissions, protecting biodiversity and enabling efficient transportation. A key challenge for planners and local decision makers is how to incorporate and balance the need to prepare for climate change through adaptation with other local development objectives. Another consideration is how to integrate (mainstream) consideration of changing climate into the wide array of decisions made by local governments, from operating municipal services to capital spending, enforcement and inspection activities, collection of taxes, and administration of disaster response programs.

Planning tools and climate change risk reduction

Generally speaking, planning tools can be used to reduce climate risks in four ways:

- limiting development in hazard-prone areas
- ensuring that the built environment can withstand a range of environmental stress
- helping to preserve natural environments that protect communities against hazards (for example, dunes that absorb coastal storm effects)
- educating stakeholders and decision makers about risks and opportunities and fostering dialogue about adaptation

PHOTO COURTESY OF NARADA THOMAS

2.0 Land use planning tools

This section describes seven of the most prominent land use planning tools in use across Canada and explains how communities can use them to more effectively adapt to climate change.

Land use planning refers to the processes and instruments employed to manage the use of land and the physical development of a community for the common interest.

A variety of statutory and other measures – bylaws, incentives, information and guidance, spending programs – may be applied to control how land is used. The scale of action is usually the neighbourhood, a whole town or city or a metropolitan area. Tools for the regulation of individual buildings, such as building codes, green building standards, property taxes and the like, are closely related to land use planning but are not covered in this document.

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2.1 OFFICIAL PLANS

An official plan is a formal planning document, often required by provincial law, that sets out a comprehensive long-term vision and the goals and objectives for the development of a community.[7] Preparing such a plan typically begins with expert analyses of local conditions and includes public consultations as well as reviews by local advisory committees and provincial and other authorities. After the plan is finalized, the local council adopts it formally by enacting a bylaw. Provincial approval may be required as well.

Also entitled general, community or master plans, these documents identify the major social, economic and environmental challenges facing the community and articulate strategies to address them. Official plans are in force for a relatively long period (10 years or longer) with updates required periodically (every five years in some provinces). They may designate some areas of the community as appropriate locations for new growth while others are to be preserved or revitalised. Official plans serve as guiding documents for subsequent local policies, programs and bylaws (such as zoning codes and subdivision controls).

Climate change adaptation can be incorporated directly into a municipality's official plan, either in a dedicated section or embedded throughout the document. Such texts normally detail local climate change risks and opportunities, an overarching adaptation vision and policy, as well as priority adaptation needs. Adaptation strategies and actions in official plans include mainstreaming adaptation into all or selected municipal operations, undertaking a comprehensive municipal risk assessment process to prioritize risks and opportunities, developing a comprehensive municipal adaptation action plan, or obtaining critical information or technical data for making effective and appropriate adaptation decisions.

Iqaluit's General Plan[8]

Iqaluit (population 6200), the capital of Nunavut, is one of the first Canadian communities to integrate climate change adaptation into its General Plan. One of the five priority vision statements identifies Iqaluit as "a community that adapts to climate change." The plan sets out two high-level objectives to realize this vision: (1) to study the impacts of climate change on the community and (2) to adopt policies that recognize the long-term impacts of climate change. The plan includes more detail on the climate change issues of concern to the community (for example, increases in temperature and precipitation, permafrost thaw, decreases in sea ice, and accelerated coastal erosion) and priority adaptation actions related to municipal infrastructure.

PHOTO COURTESY OF MICHELE BERTOL

Elkford's Official Community Plan[9,10]

The District of Elkford is a small community (population 2500) in the Rocky Mountains of southeastern British Columbia. Historically, Elkford has dealt with several climate-related hazards, including flooding, drought and wildfires. A changing climate magnifies all these risks. In 2008, Elkford, with support of the Columbia Basin Trust, a provincial crown corporation, developed a local adaptation strategy to assess the risks posed by climate change and identify corresponding adaptation actions. The Adaptation Strategy was developed concurrently with a revision to Elkford's Official Community Plan (OCP), allowing the two to be fully integrated. Consideration of climate change in all decision making is one of the OCP's 11 guiding principles. Adaptation actions in the OCP include a wildfire protection zone in which any development application must be accompanied by a fire hazard and risk assessment conducted by certified professionals before a permit is issued. The OCP also calls for the development of a community evacuation plan in the event of an extreme wildfire or flooding.

PHOTO COURTESY OF DISTRICT OF ELKFORD

2.2 LOCAL PLANS ON SPECIAL MATTERS

In addition to official plans, local governments adopt many other kinds of plans. Those plans may focus on one function of local government (such as public transit or storm water management), on a sector or issue of special significance to the community (such as the development of the arts or the needs of senior citizens) or on a neighbourhood with special planning needs.[11] As with official plans, these local plans are often developed through a formal planning process, including public consultation, and provide an assessment of conditions, a long-term vision and a set of goals and actions for the particular issue or area in question.

A growing number of Canadian municipalities have adopted plans that specifically address the need to adapt to climate change. Some communities have chosen to develop stand-alone adaptation plans. Those documents typically outline the climate change impacts of concern to the community, the associated risks and opportunities, and the community's vision and proposed actions for dealing with those changes. Many other communities have integrated consideration of climate change adaptation into local plans that address other issues. For example, a municipality may integrate adaptation into its capital improvement plan for storm water sewer systems.

Stratford's Climate Change Adaptation Plan[12]

The Town of Stratford (population 8046), a rapidly growing community in Prince Edward Island, is located on a peninsula just south of the provincial capital, Charlottetown. The main climate change issues of concern to the community are coastal erosion, which already threatens several important heritage buildings and homes, sea level rise, storm surge and inland flooding.

In 2010, the Town, in partnership with the Canadian Institute of Planners and the Atlantic Planners Institute, created a long-term strategic plan to prepare Stratford for climate change. The process comprised four stages: (1) forming a core working group to establish overarching objectives, engage key stakeholders and conduct background research into local climate change impacts; (2) organizing public meetings to assess current and future vulnerabilities (following a presentation of the potential climate change impacts, a survey was distributed to all participants at the public meeting to gauge climate change-related opportunities and threats for the community); (3) conducting a risk assessment, building on results of the vulnerability assessment, to rank the most important climate change impacts and identify priority areas for adaptation action; and (4) preparing a final adaptation plan that included recommended adaptation actions by theme (for example, heritage properties, parks and recreation, private properties, emergency services, storm water infrastructure). Stratford has since integrated adaptation considerations into all new or updated community action plans, including its draft Official Plan, Strategic Plan and Master Stormwater Management Plan.

PHOTO COURTESY OF WINSTON MAUND

Edmonton's Urban Forest Management Plan[13]

Edmonton (population 812 201), the capital of Alberta, is located along the North Saskatchewan River. The city's urban tree canopy is seriously threatened by drought, insect infestations, disease, storms and climate change. These threats spurred Edmonton to create the Urban Forest Management Plan (UFMP) to guide the management of the tree canopy over a 10-year period. The UFMP includes developing an inventory of the urban forest (completed 2009), a review of existing planting strategies, a communication plan and potential tree planting partnerships. Many of these actions will increase resilience to drought conditions, which may be exacerbated by climate change. For example, Edmonton's Forestry Unit is testing the use of different tree species, such as red maples, and alternative tree watering techniques.

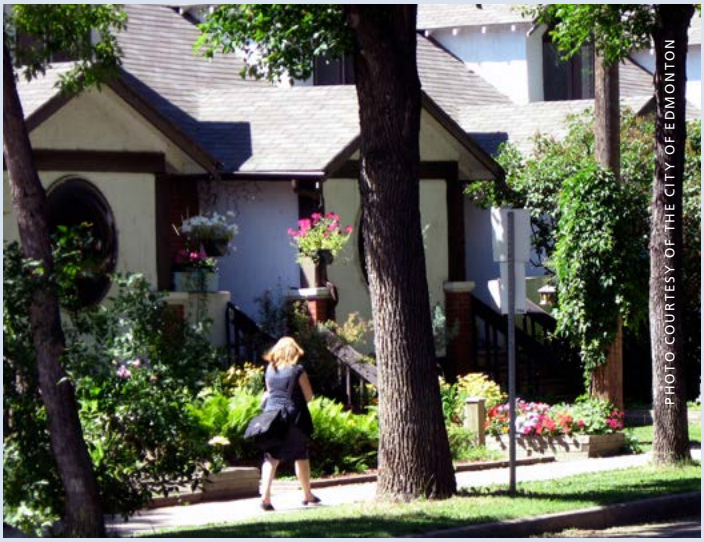

PHOTO COURTESY OF THE CITY OF EDMONTON

imagineCALGARY[14]

Calgary (population 1 096 833) is situated in southern Alberta. The impact of climate change on water quality and quantity is of particular concern in the area. Local rivers are expected to experience decreased flow because of decreased precipitation and reduced glacial coverage in the headwaters of the river basins.[15] imagineCALGARY was a community visioning and consultation process undertaken in 2005 to produce a 100-year roadmap for Calgary's development. The process engaged more than 18 000 Calgarians representing businesses, community agencies, non-profits and governments as well as the public. Calgary is one of the first communities in Canada to consider climate change in its long-range planning. The City commissioned scoping reports to investigate how four major trends might impact the city: demographic changes, resource scarcity, technology transformation and climate change. Since publishing the imagineCALGARY plan in 2007, the City has implemented its vision and targets in subsequent land use plans and strategies. Numerous local partner organizations in the private, non-profit and public sectors have also committed to achieving the vision by changing their policies and practices.

PHOTO COURTESY OF NICOLA JOHNSON

2.3 ZONING

Zoning is a regulatory tool widely used by municipalities to control land use within their borders.[7,16,17,18] It is a key tool for implementing the goals and objectives set out in a municipality's official plan. Zoning bylaws divide the entire community into zones. For each zone, only certain land uses are permitted (for example, commercial, residential, industrial). In addition to restrictions on the use of the property, the zoning bylaws may impose requirements on buildings, including maximum height, lot coverage and density, as well as building type and setbacks. Those requirements are reflected in a zoning map for the jurisdiction. Zoning restrictions usually apply only prospectively.[19]

Zoning codes can be used by municipalities to limit new development in hazard-prone areas (for instance in areas subject to wildfires, landslides or coastal erosion) or to prescribe building standards that reduce vulnerability to environmental stress.[20,21] For example, in areas of high flood risk, all development may be prohibited, while in areas where the risk is lower, the ground floor of new buildings and structures may be required to be built above a minimum height to avoid flood damage.[22] Given that climate change often magnifies existing hazard risk, municipalities could respond by modifying existing zoning restrictions to factor in the greater intensity, frequency or duration of certain hazards as climate changes.

Beaubassin-est's sea level rise protection zone[23]

Beaubassin-est (population 6200), a small coastal community in southeast New Brunswick, is vulnerable to the impacts of sea level rise and storm surge flooding. The Community is one of the first in New Brunswick to implement a minimum height standard for buildings to address climate change impacts. Council passed an updated zoning bylaw in March 2011 to better protect new construction in the community's coastal zone.

The bylaw identifies a sea level rise "protection zone" in which the minimum ground floor elevation of any new building must be at least 1.43 metres above the current 1-in-100-year flood mark. The regulation is an overlay zone – all previous zoning conditions apply. Rather than restrict development outright, the zoning bylaw imposes stricter building requirements on developers. This new regulation provides an opportunity to educate developers as well as the community at large about the impacts of climate change and sea level rise. This update to the bylaw was based on the best available scientific understanding of sea level rise for the area and a high resolution digital map that the community commissioned to help identify potential flood levels.

PHOTO COURTESY OF SÉBASTIEN DOIRON

Rosemont–La Petite-Patrie's zoning bylaw to reduce the urban heat island effect[24,25]

Rosemont–La Petite-Patrie (population 131 000) is a central borough in Montréal, Quebec, that is very densely built. The urban heat island effect is pronounced in many parts of the borough. Urban heat islands are areas in cities where ambient air temperatures tend to be hotter than in surrounding areas. They occur where there is little vegetation and a high percentage of dark surfaces, such as tar roofs, asphalt roads and parking lots.

In April 2011, the borough council revised its comprehensive zoning bylaw to include four regulatory measures aimed at tackling urban heat islands: (1) when replacing an existing roof or constructing a new building, the owner must install either a green roof or a highly reflective roof; (2) for all new parking lots of 10 or more spaces, at least 15 percent of the area must be open ground landscaped with plants, bushes and trees; (3) all new paving materials must meet a minimum specified surface reflectivity rating; and (4) when constructing a new building, at least 20 percent of the building site must remain open ground and be landscaped with plants, bushes and trees.

These four measures apply to all public and private property throughout the borough. More than 300 permits for reflective roofs were issued in the first year after the bylaw was passed.

PHOTO COURTESY OF ROSEMONT – LA PETITE-PATRIE

2.4 LAND SUBDIVISION AND DEVELOPMENT CONTROLS

Communities across Canada employ many different tools to control the layout and design of proposed developments and to reduce adverse impacts on the community. The controls, which may apply to subdivisions of land, new construction or alterations to existing buildings, allow local officials to evaluate projects case by case.[7] Among them are

- **subdivision controls –** which apply when a developer wants to divide a parcel of land, often for residential development. Generally, subdivision plans must demonstrate good access and efficient utility service for all the proposed lots and also address concerns about financial, environmental and other impacts.
- **site plan controls, development permits, development agreements and similar tools –** which require developers to submit detailed designs to be assessed against specified criteria. For example, a proposal may be reviewed for the quality of the design of public areas, the fit with the historic character of the neighbourhood, or the extent of disturbance to ecologically sensitive land.
- **comprehensive development zones, planned unit developments and similar instruments –** that apply to large sites in which non-standard or innovative designs and techniques are to be used, and a customised approach to zoning and site design is appropriate.

As part of the evaluation of proposals under these types of regulations, local officials may seek changes to projects prior to approval. Further, the developer may be required to pay development charges, dedicate a portion of the site for public use or provide some other concession or amenity.

These project-based, discretionary development controls can be very useful for adapting to climate change at the neighbourhood scale. For example, as part of the review of a subdivision proposal, the developer may be asked to assess the increased risk of erosion due to climate change and to determine how it may affect the development. The municipality may require that appropriate adaptation measures be taken by the developer, such as shoreline restoration or increased development setbacks. The lots in a proposed subdivision may be clustered in the least hazardous part of the property. In other cases, a site plan control ordinance may be used to require that green design features that address the impacts of climate change be incorporated (for instance, providing shade and rooftop gardens to decrease the public health risk from urban heat islands).

Toronto's Green Standard

PHOTO COURTESY OF THE CITY OF TORONTO

Toronto, Ontario (population 2.6 million), is situated at the centre of a conurbation of more than 5 million people. Climate change impacts of concern for the city include increased health risks due to extreme heat, higher incidence of pests and diseases (such as West Nile virus) and more extreme rainfall with consequences for storm-water systems and other infrastructure.[26]

The Toronto Green Standard (TGS) is a set of performance measures for site and building design, covering energy and water efficiency, air and water quality, ecological services and solid waste management. The standards work with the regular development approval and inspection process, and apply to all new development subject to subdivision or site plan controls or for which a zoning amendment is required.[27] Although adaptation is not explicitly mentioned, the TGS addresses several climate change impacts of concern to the city. For example, one provision, applicable to non-residential development of three stories or less, requires the use of light-coloured materials, open-grid pavement or shading on at least 50 percent of the site to reduce urban heat. Another provision requires that new developments retain at least the first 5 millimetres (mm) from each rainfall through rainwater reuse, plantings and other practices, thereby reducing storm water runoff. A more stringent set of voluntary standards has been adopted. Developments that meet those stricter standards are eligible for reductions in development fees.

Halifax Regional Municipality development agreements

Halifax Regional Municipality (HRM) (population 390 000) is the most populous urban community in Atlantic Canada and the capital of Nova Scotia. Climate change, which is expected to bring more frequent storms to the area, will likely increase the vulnerability of coastal development and infrastructure.[28] Various community plans, including the 2006 HRM Regional Plan, already call for new developments to be constructed a minimum height above the ordinary high-water mark.[29]

One flexible mechanism that planners in Halifax use to address coastal threats is development agreements. Certain areas of the community are designated as zones where review and approval of development projects proceed through negotiation. Local bylaws specify in general terms the matters to be considered in such negotiations, giving planners latitude to address a broad range of issues regarding environmental protection, natural hazards and other concerns.[30] The developer may be asked to produce relevant information (such as the impacts of wave-run up on a particular property) and to consider and adopt appropriate hazard mitigation strategies. In a recent development in downtown Dartmouth (an HRM municipality), local officials and the developer agreed to establish minimum elevations for a new marina and other seaside structures that were several metres higher than provided in area plans. This was consistent both with the developer's interest in protecting the property and the community's interest in minimizing risk. The development agreement process enabled planners and developers to exchange information on storm surge and wave run up on this site, and to produce a more resilient project design.

PHOTO COURTESY OF HALIFAX REGIONAL MUNICIPALITY

2.5 COVENANTS AND EASEMENTS

Covenants and easements (known as real servitudes in Quebec) are formal agreements that place restrictions on the use of land or grant a person (or the public) the right to use land owned by another.[31,32] For example, a covenant may prohibit building a structure that casts a shadow on a neighbouring property. An easement may allow the public to pass through private land to reach a beach. Both covenants and easements are said to "run with the land," which means they bind current as well as future owners. There are strict and complex legal requirements that apply when creating easements or covenants.

Covenants may serve local planning goals in different ways:

- **as a development control tool –** Municipalities may use covenants when entering development agreements, applying controls on subdivisions and other development projects or imposing conditions on issuing a development permit. In such cases, these instruments ensure that community interests are protected and that the developer's promises about the operation and maintenance of the property are enforceable long after construction. Covenants may be used in "green developments" that use innovative energy, waste water treatment and other systems that require public access and the collaboration of future owners for proper operation and maintenance.[33]
- **as a conservation tool –** A special form of covenant, known as a conservation covenant or easement has been established by law in many provinces. It places restrictions on the use of land to protect its natural values. For example, a conservation covenant may prohibit the removal of native vegetation and prohibit any structures on a portion of the property that contains sensitive ecosystems. The owner who enters into a conservation covenant continues to own the land and may live on it, sell it, or pass it on to heirs but the covenant's restrictions on development are followed in the future, regardless of who owns the land.[34] In exchange, the land owner may be eligible for tax reductions or credits.

Covenants and easements can play an important role in climate change adaptation planning. For example, a municipality may acquire a conservation easement to prevent residential development on a coastal area threatened by sea level rise and storm surge flooding. A covenant may be negotiated with owners in an area to prevent construction of docks, sea walls or other coastal protection structures in order to allow marshes and dunes to migrate inland naturally.[35] Covenants and easements may also support local efforts to monitor climate change by, for example, allowing access to a coastal property for purposes of measuring erosion rates.

Island Trust's NAPTEP Covenant

The Islands Trust (population 25 000) is a federation of local governments in the Gulf Islands and Howe Sound islands of British Columbia. The Islands Trust Fund acts as the conservation arm of the federation, charged with protecting the ecosystems in the region through land acquisition, conservation covenants and education programs. Since 1990, it has protected more than 1073 hectares (ha) of land on 84 properties.[36]

Adaptation to climate change, especially the protection of biodiversity, is one key concern of the Trust Fund. The effects of changing climate are already evident in local ecosystems: vegetation is experiencing earlier green-up, wildlife migration patterns are changing, and insect outbreaks are more common.[37] Up to 30 percent of assessed animal species are believed to be at high risk of extirpation (local extinction).[38] By establishing, monitoring and managing conservation areas, the Trust Fund aims to maintain the ecological functions of high biodiversity areas in the face of a changing climate. Under the Trust Fund's Natural Area Protection Tax Exemption Program (NAPTEP) Covenant, land owners receive a 65 percent reduction in property taxes on the protected portion of their land. The Trust Fund is developing a tool to estimate the biodiversity value of properties to prioritize future acquisitions.

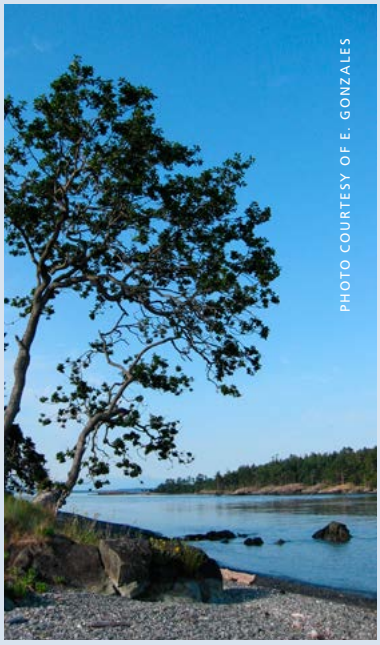
PHOTO COURTESY OF E. GONZALES

Kamloops wildland-urban interface covenant

Kamloops (population 85 678), in the Thompson River Valley of central southern British Columbia, is particularly vulnerable to wildfires because of its dry climate. Wildfires are one of several risks projected to increase as a result of changing climate. In the summer of 2003, three large wildfires reached the city's perimeter, threatening homes and infrastructure. They increased local awareness and concern about the impacts of wildfires on the community.

Covenants are one of a suite of tools the City uses in its efforts to reduce wildfire risk.[39] In 1992, the City instituted a policy specifying that, as a condition of subdivision approval, all new subdivisions within hazardous zones must register a restrictive covenant.[40] Under such a covenant, developers and home owners are bound to undertake actions to reduce fire risks, including maintaining fuel-buffer zones around homes; controlling roofing materials and installation of wooden shacks and shingles; screening of all eaves, attics, decks and openings under floors to prevent the accumulation of flammable material; and installing approved spark arresters in all wood stoves. All subdivisions constructed since 1992 in high to extreme wildfire hazard areas have registered restrictive wildfire covenants. Kamloops is revising the 1992 covenant to improve clarity and ensure it conforms to the City's latest fire hazard assessment mapping.

PHOTO COURTESY OF BRIAN AVERY

2.6 DESIGN GUIDELINES

Design guidelines describe preferred practices in the design of certain aspects of a development project (for example, buildings, public areas, infrastructure, mechanical systems, landscaping). Municipalities may develop design guidelines for several reasons: to improve environmental performance, reduce infrastructure costs, enhance aesthetics, increase public safety or create more accessible public spaces. Examples include guidelines for the design of parking lots, streetscapes, building facades, storm water ponds, heritage districts and public squares. A combination of text and photographs, sketches and architectural drawings describe preferred designs.

Municipalities often develop these publications as supplementary educational tools to help developers, design professionals (such as architects, landscape architects, engineers and planners) or the general public to improve upon existing design and construction practices. They also illustrate various ways in which developers may meet required municipal or provincial development standards.

Some municipalities require that developers comply with such design guidelines and demonstrate compliance during the formal review of development proposals.

The design of a community's physical components – such as parking lots, parks and roadways, drainage ditches or a neighbourhood as a whole – can reduce or magnify the impacts of climate change at the local scale.[41,42] Good design can contribute to building resilience to climate change at the local level.[43] For example, selecting appropriate building materials and landscaping can reduce the risk of wildfires. Although many municipalities have developed design guidelines without climate change in mind, their use can improve resilience to the impacts of climate change. Conversely, design guidelines may recommend or impose development standards that may inadvertently decrease resilience to climate change. For example, a municipality may prescribe building wide roads to accommodate emergency vehicles. However, those wide roads may also increase storm water volumes and magnify the urban heat island effect.

Regina's *Xeriscape Workbook*[44]

Regina, Saskatchewan (population 193 100), is situated in the middle of the southern prairies, the driest major region of Canada. The city has very little local access to water. For the Canadian prairies, increases in water scarcity and drought are one of the most serious risks presented by climate change.

Xeriscape is an alternate form of landscaping that relies on drought-tolerant plants to reduce outdoor watering requirements during the summer. In 1993, the City of Regina produced the *Xeriscape Workbook*, which provides practical guidelines for low-water, low-maintenance landscaping. The Workbook is distributed at free workshops in the spring and fall and on the City's Web site. In the late 1990s, the City partnered with a local school to create a xeriscape educational and demonstration site. The garden features 45 plant types, a false creek and an amphitheatre with a teacher's rock for outdoor classes and lessons. Climate change was not a consideration when the City first developed the Workbook. However, the application of the landscaping practices within the Workbook helps reduce water consumption, an important climate change adaptation action.

PHOTO COURTESY OF CHET NEUFELD

Toronto's Draft Design Guidelines for "Greening" Surface Parking Lots[45]

The City of Toronto developed guidelines for green parking lot design with the goal of improving the urban design and environmental performance of surface parking lots within city boundaries. Traditionally, parking lot design has been based mainly on functional criteria (to maximize parking lot spaces and minimize maintenance costs) with little regard to the quality of the urban design or environmental performance. The new guidelines provide design options and strategies, in both graphic and written form, to meet the following objectives: enhance the safety and attractiveness of the public realm, provide shade and high-quality landscaping, reduce the urban heat island effect, manage storm-water quality and quantity on-site, and incorporate sustainable material and technologies. All proposals for new parking lots within city limits, both public and private, must consider the guidelines before receiving development approval. The guidelines also help developers comply with the Toronto Green Standard. Although not designed explicitly as a climate change adaptation measure, the application of the guidelines, particularly the urban heat island and storm-water management measures, increase the city's resilience to climate change.

PHOTO COURTESY OF THE CITY OF TORONTO

2.7 ENVIRONMENTAL REVIEW OF DEVELOPMENT PROJECTS

An environmental assessment (EA) is a structured process used by governments to evaluate the environmental, social and economic impacts of development. It can be applied to a specific project, such as the construction of a bridge or to a plan or policy intended to guide future projects. Many kinds of developments are required to undergo an EA. For instance, federal and provincial law may require EAs for major industrial projects, projects that use federal or provincial funds or for development on crown lands.[46] Some municipal infrastructure projects such as extensions of sewers and the construction of water mains, roads and transit systems may be subject to provincial EA requirements. In 2003, the Canadian Environmental Assessment Agency issued guidelines for incorporating climate change considerations in EAs, one of the first federal agencies in the world to do so.[47]

In addition, municipalities can require formal environmental reviews, sometimes called environmental impact studies (EISs), as part of the local process for the evaluation of development proposals. For example, developers may be required to submit an EIS for plans of a subdivision or for a building project located in or near sensitive or protected areas. The scope and process for a particular EIS will vary depending on the nature of the project, applicable environmental and planning laws, policies in the official community plan and municipal bylaws, and the resources available to local authorities.

EAs, EISs and other forms of environmental review have proven to be ready platforms for consideration of climate change concerns. The applicable legislation and guidelines for EAs and EISs may require that local climate change be incorporated as one aspect of the natural environment to be considered and that measures to address climate change impacts be incorporated into the project's design and management plan. In other cases, climate change impacts may not be a direct consideration in the EA process. Despite this, measures enacted in response to the EA may help build resilience to a changing climate.

Saint John waterfront redevelopment

Saint John (population 70 063), the largest municipality in New Brunswick, is located on the north shore of the Bay of Fundy at the mouth of the Saint John River. Climate change in this region is expected to cause a rise in coastal water levels, more intense precipitation and storm events, and more significant coastal and inland erosion and flooding.[48]

The Saint John Waterfront Development Corporation, on behalf of the City, plans to redevelop 2.43 ha of land on the waterfront. The street grid is to be extended, buildings renovated and new residences, shops and a hotel constructed. A portion of the development site was formerly a Canadian Coast Guard base and is owned by Fisheries and Oceans Canada. Accordingly, the transfer of the property to the Corporation requires a screening under the *Canadian Environmental Assessment Act*.[49] The EA screening, completed in March of 2010, included consideration of the potential impacts of climate change and sea level rise on the project.[50] The Corporation agreed to ensure that the climate and potential sea level rise are considered where relevant in the design of the infrastructure components of the project. The loadings and stresses associated with climate change, potential sea level rise and other environmental forces are to be addressed through engineering design as the planning for the project continues.

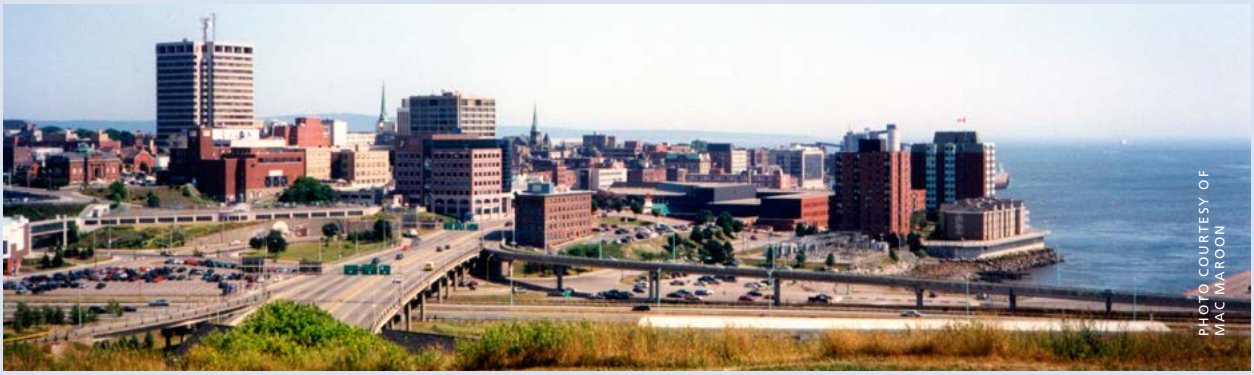

PHOTO COURTESY OF MAC MAROON

Town of Ajax environmental review of land development and infrastructure projects

Ajax, Ontario (population 109 600), is located on the north shore of Lake Ontario. Climate change is expected to bring Ajax more frequent and more severe extreme weather. This, plus proposed urbanization in the region, could increase local risks such as flooding, fouled beaches and decreased water quality in Lake Ontario, the primary source of water for Ajax.[51]

Ajax proactively uses EAs and EISs in its efforts to address climate change concerns. For example, to improve the quality of water discharged into Lake Ontario, Ajax is developing a master plan for the retrofit of its storm-water system. As part of that process, the Town conducted a Municipal Engineers Class EA to evaluate various retrofit measures.[52] The EA recommended a two-stage action plan involving (1) adopting "Healthy Community Practices," such as more strategic street sweeping practices, low-impact development approaches, community education programs and ongoing storm-water quality monitoring; and (2) using results from the monitoring program to determine whether engineered measures, such as retrofits to sewers, trenches and channel expansions, are needed.

Further, pursuant to environmental and climate change adaptation policies in its Official Plan, Ajax requires that an EIS be submitted with all applications for developments on land designated as a natural heritage or hydrologic features of provincial, regional or local significance. The EIS must evaluate adverse impacts of the proposed development and establish appropriate actions to address those impacts.

PHOTO COURTESY OF KEVIN GAYNOR

PHOTO COURTESY OF JAMES MALONE

3.0 Decision-support tools

Decision-support tools are designed to assist decision makers in the process of developing and implementing climate change adaptation plans and policies. This section describes five decision-support tools that are particularly relevant to planners and local officials involved in the preparation and implementation of plans and measures that address climate change adaptation. Many of the tools described here help planners to translate scientific findings about climate change into a language and format that is suitable for making decisions about adaptation. These tools can also be useful for integrating local and traditional knowledge into the planning process.[53] Appendix B lists additional resources on decision-support tools.

Recommended criteria for decision making (for example, no-regrets, win-win, the precautionary principle, reversible strategies)[54] and techniques for appraising adaptation options (for example, cost-benefit analysis, cost effectiveness, multicriteria analysis),[55] although important in the adaptation process, are not discussed in this document.

DECISION-SUPPORT TOOLS	ADAPTATION EXAMPLES	PAGE
3.1 Assessments of community vulnerability and risk	Heat and health vulnerability assessment in Windsor, Ontario	20
	Dawson Climate Change Risk Evaluation	21
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3.1 ASSESSMENTS OF COMMUNITY VULNERABILITY AND RISK

One of the first steps in the local adaptation planning process is an assessment of how climate change affects a community. Assessments can take several forms.[i] Some emphasize projections of climate change impacts in the community, while others focus on the factors that produce local vulnerability and constrain the ability of the community to take adaptive actions. The knowledge gained through vulnerability and risk assessments can help decision makers develop effective adaptation measures.

Many guidelines and frameworks have been developed to help communities undertake local climate change assessments.[57] Some are generic tools that may apply generally to all communities, while others are targeted to certain types of communities (for example, rural communities) or particular forms of climate change impacts (for example, heat-related health risks). Many forms of knowledge, including scientific and technical expertise and local and traditional knowledge, can contribute to local assessments of climate change impacts and adaptation.

VULNERABILITY ASSESSMENTS

A vulnerability assessment is a structured process for identifying the vulnerability of human and natural systems to climate change.[58] The more exposed and sensitive an individual or community is to climate change, the higher its vulnerability. Vulnerability is also a function of adaptive capacity; the higher a community's capacity to undertake adaptive actions, the less vulnerable it is.

When conducting a vulnerability assessment, a broad range of socio-economic and physical factors should be considered, including climate conditions, the adequacy of housing and local infrastructure, the quality of emergency response systems and assistance networks, the availability of material and financial resources, and the general health and risk awareness of the population.[59,60] Consultation with local stakeholders and residents is crucial in assessments, both to understand existing vulnerabilities and to develop effective strategies to reduce them. The information gained from vulnerability assessments allows local officials to develop appropriate interventions such as improved health services, better access to transportation networks, and healthier buildings and urban spaces. The assessments also help to prioritize measures to assist the most vulnerable individuals and groups in a timely and cost-effective manner.

RISK MANAGEMENT

Risk management is a process widely used by businesses, governments and non-governmental organizations to identify and manage the adverse impacts of a change in conditions. The magnitude of a risk is calculated by examining the probability of the occurrence of an event and the severity of its impact. Risk management helps decision makers evaluate multiple threats and prioritize policy responses under conditions of uncertainty.

Risk management processes can be used by a community to evaluate risks associated with climate change and suggest adaptation measures. Risk management methodologies can provide a way to explore public attitudes and perceptions of risk, and this information can feed back into the assessment. The evaluation process may be formal or informal and may be quantitative or qualitative, depending on what works best for the municipality. In addition to common risk management processes (for example, ISO31000, CSA Q850), which can be used to assess climate change risks, several climate change-specific risk assessment tools have been developed to assist Canadian communities (see Appendix A).

i The IPCC[56] described several distinct conceptual frameworks for assessments of local climate change, including *impact-based approaches* that are climate scenario driven, *adaptation-based approaches* that focus on the capacity of communities and natural systems to respond effectively to stress, *vulnerability-based approaches* centered on the factors driving the susceptibility of individuals and groups to harm, *integrated approaches* that include modelling and other procedures for investigating climate change across sectors and scales and *risk management approaches* that focus directly on decision making.

Heat and health vulnerability assessment in Windsor, Ontario

Windsor (population 210 891) is Canada's most southerly city and has summertime temperatures that are among the highest in Canada.[61] Climate change is expected to significantly increase the number of extreme heat days annually in the region. This may exacerbate the risk of heat-related illness and deaths, particularly among seniors, the chronically ill and other vulnerable groups.

Windsor was one of four pilot communities in a Health Canada project to develop community-based Heat Alert and Response Systems (HARSs) to alert local residents when extreme temperatures pose a serious health concern and to activate a coordinated public health response. The City of Windsor and Health Canada collaborated to conduct a heat-health vulnerability assessment to help strengthen the design of the HARS as well as to engage important stakeholders. The vulnerability assessment proceeded in five steps:[62] (1) an initial assessment of the scope, objectives, work plan and stakeholders involved; (2) the collection and analysis of data, including an examination of the relationship between temperature and mortality; (3) the projection of future climate for the Windsor region; (4) a literature review to provide background information about the impacts of heat on health, vulnerability assessment methods, and best adaptation practices; and (5) workshops to consult with stakeholders and the community about existing vulnerabilities, adaptive capacity and potential adaptation actions. The vulnerability assessment provided information that allowed public health officials to develop more effective adaptation interventions.[63]

PHOTO COURTESY OF TOURISM WINDSOR ESSEX PELEE ISLAND

Dawson Climate Change Risk Evaluation[64]

Dawson City, Yukon (population 1350), is located just below the Arctic Circle at 64°N. In 2007, Dawson partnered with a local non-profit organization, the Northern Climate ExChange, to develop a community adaptation plan. An evaluation of climate change-related risks was an important component of the planning process.

Public consultations were undertaken to identify community vulnerabilities and potential opportunities arising from climate change. The project team and a local advisory committee distilled community issues into a list of 78 "community consequences" of climate change. For each of those, risk evaluation tables were completed jointly by the project team and the advisory committee. An overall priority level (low, medium and high) for each impact was established through consideration of the severity and likelihood of a particular impact and the capacity of the community to take action to address it. Suggested adaptation actions were formulated for all consequences, and one or more partner organizations (for example, Yukon government and Dawson City council) were identified to provide leadership. See the framework example, in this case used to analyse agriculture/urban land-use conflicts.

Risk evaluation framework

Community consequence		Agriculture expands and potentially conflicts with other land use types (urban development, industry and wilderness areas).
Risk evaluation criteria	Level of impact	Medium
	Likelihood	Medium
	Adaptive capacity	Unknown
Overall priority level		High
Suggested adaptation action		Incorporate flexible regulations and policies into land use and other planning processes (e.g. local area planning and environmental assessments).
Lead partner		Yukon Land Use Planning Council, Yukon Government

3.2 CLIMATE PROJECTIONS

A climate projection is a representation of the climate in an area at some specified time in the future.[65,66] Projections indicate plausible changes in a set of climate variables. Examples include changes in average and extreme precipitation and temperature, the number of frost-free days, sea level, and the length of the growing season. This information may be presented in numerical, visual (graphs or maps) or narrative form.

Climate projections are generated from the outputs of one or more climate models. These models are complex computer programs that simulate the behaviour of the atmosphere, the oceans, land surfaces, clouds and other key components of the climate system.[67] The models depict future conditions at different scales – some encompass the entire globe while others focus on specific regions. Generally, uncertainty increases at the finer spatial scales. To examine future climates, models incorporate assumptions about greenhouse gas emissions in the future. For example, some assume fast-rising emissions while others assume more gradual growth and eventual reductions in emissions. Uncertainty is an inherent part of all climate projections, owing to challenges in modelling complex climate systems and in foreseeing future global actions to reduce greenhouse gas emissions.

Climate change projections may be applied to local planning processes in various ways, including the following:

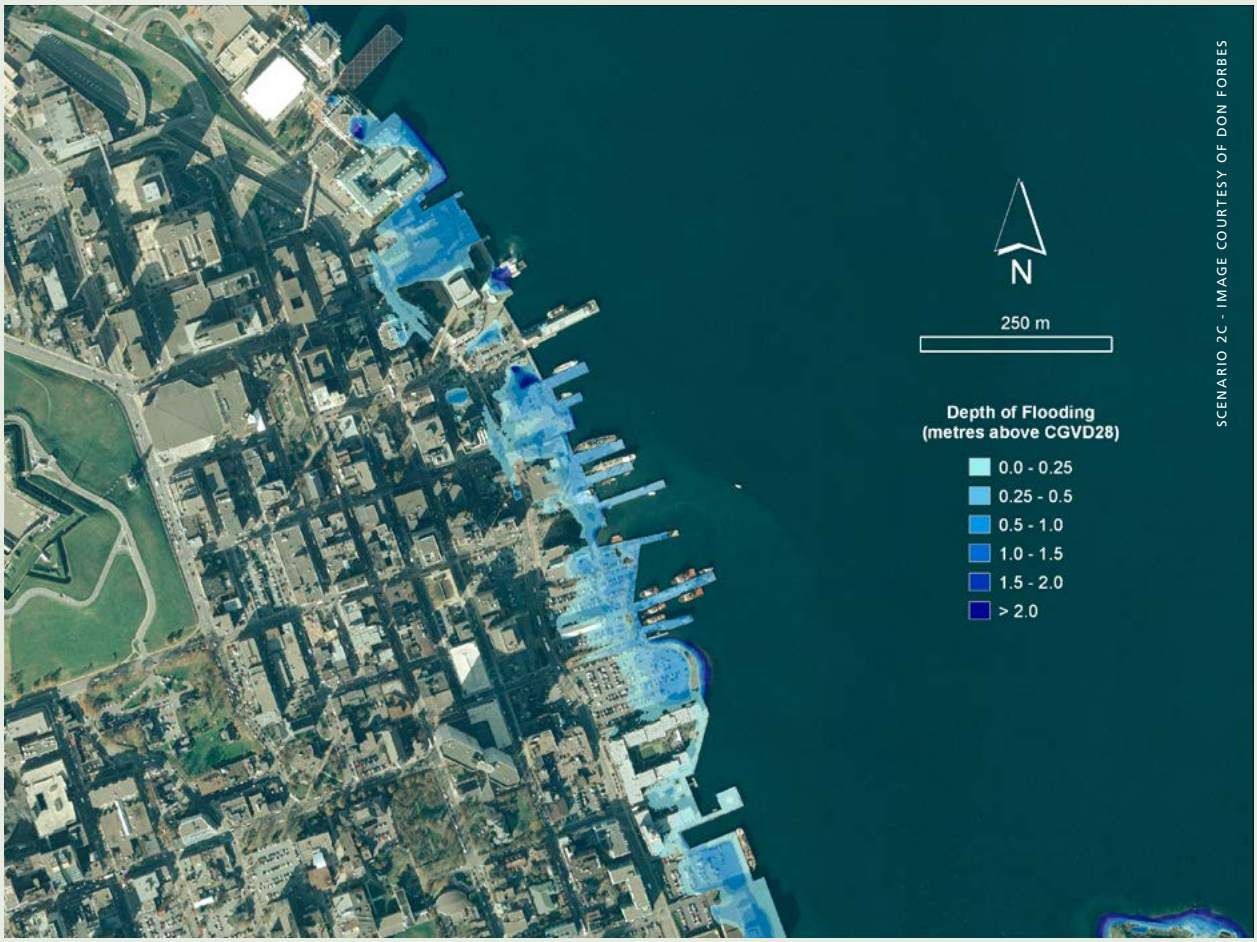
- **as tools for learning and public engagement**. Planners may present climate projections to stakeholders and the public to raise awareness about the nature and magnitude of possible changes to the local climate, thus stimulating discussion amongst stakeholders about potential impacts, local vulnerabilities, adaptive capacity and preferred approaches to adaptation.
- **as part of assessments of community vulnerabilities and risks**. In formulating adaptation plans, communities often utilize climate projections when studying the nature and extent of local risk and vulnerabilities, including the capacity of key stakeholders and residents to cope with and respond effectively to increased stress.
- **as parameters for setting the design tolerance of systems and structures**. For example, a municipality may, based on projected changes in the intensity of future rainfall events, change the design criteria for the diameter of storm-water pipes to accommodate greater flows.

Although projections are a useful decision-support tool, there are adaptation measures that communities can take without having to use or commission climate projections. Communities can, for example, base their adaptation planning decisions on an analysis of current vulnerabilities or on information gleaned from reliable regional, national or international assessments (which make use of climate projections). It is important that planners are cognizant of the inherent uncertainties embedded in projections and communicate them accurately to decision makers and the public.

Halifax Harbour plan for sea level rise[68,69]

Halifax (population 390 000), the capital of Nova Scotia, is a major seaport with significant industrial, military and municipal infrastructure on the coast. Rising sea level, along with increased storm intensity and associated waves and storm surges, presents risks to residents, property and infrastructure in coastal areas of the city. To respond to these impacts, in 2006 the city recognized the need to gather scientific data on sea level rise, storm surges and vulnerability to inform development of an area-specific land use plan for Halifax Harbour.

City planners partnered with a team of scientists to develop projections of future sea levels and storm water levels in Halifax Harbour under three climate scenarios for 2100: (1) a continuation of the historical rate of change, (2) the upper-limit projection for mean sea level rise from the fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC) and (3) a projection based on more recent scientific literature. High-resolution mapping of possible future flood levels was then produced for each scenario. Following a presentation by scientists and city staff, Halifax Regional Municipality (HRM) Council in 2010 chose scenario 2c as a policy reference point from which to develop the adaptation strategy. HRM is also committed to re-examining this choice when additional scientific information becomes available. This example demonstrates that credible climate projections, based on best available science that are communicated to the public and decision makers in a format that is easily understandable, provide a helpful foundation for adaptation action at the municipal level.



Climate projections informing adaptation planning in Prince George

The City of Prince George (population 77 000) is situated at the confluence of the Nechako and upper Fraser rivers in central British Columbia. Flooding and the devastation of the region's forests by the mountain pine beetle are the climate-related impacts of greatest concern to the community. In 2008, the City partnered with the University of Northern British Columbia (UNBC)[70] to mainstream climate change adaptation into the city's policies and programs.

The City and UNBC partnered with the Pacific Climate Impacts Consortium at the University of Victoria to produce a climate trends and projections report specific to the Prince George region.[71] The report assessed historical trends (1918 to 2006) for precipitation, temperature and stream flow as well as projected changes (for the 2020s, 2050s and 2080s) in temperature and precipitation using global climate models. UNBC and the City organized two adaptation workshops and other information events that brought together city staff, the public and key stakeholders to discuss approaches to dealing with climate change impacts. Climate experts from PCIC presented a summary of the projections at the workshops. Participants were asked to discuss the potential social, economic and environmental implications of the projected changes for Prince George and define key impacts for the city. The climate change projections were a useful tool for establishing a credible baseline from which workshop participants could engage and discuss impacts and adaptation actions. Prince George has since integrated the findings from the workshops, including recommended measures to reduce risks from forest fires and flooding, into the Integrated Community Sustainability Plan[72] and draft Official Community Plan.

PHOTO COURTESY OF CITY OF PRINCE GEORGE

3.3 SCENARIO PLANNING

A scenario is a plausible, simplified description of how the future may develop. Scenario planning is a strategic medium- to long-term planning tool in which planners develop multiple scenarios describing potential social, economic and environmental conditions in a community and then formulate strategies and measures to achieve planning goals under one or more of those scenarios.[73] Long used by government and the private sector for managing uncertainty, scenario planning is now being applied by some communities to prepare for climate change.

In planning for adaptation to climate change, planners devise scenarios that demonstrate how changes in climate may affect the community under different development trajectories (see the diagram in the following Whitehorse example). The development trajectories are based on a few key variables expected to drive change, such as population growth, technological shifts or energy demand. Different narratives about how climate change may unfold in the community are derived from scientific projections, expert assessments and other sources.[74]

Planning scenarios assist adaptation planning and policy-making in several ways. The process of constructing the scenarios educates stakeholders about the nature and extent of future climate-related risks and opportunities. Scenarios may provide information that helps to identify emerging vulnerabilities (for example, potential conflict over access to water) and support efforts to prioritize climate change risks. They also assist in devising adaptation strategies and actions to address vulnerabilities. The most robust measures are those effective across different scenarios. For example, in communities at risk from wildfires, proper firebreak maintenance can be a useful adaptation measure regardless of the magnitude of climate change experienced and the rate of development. In other cases, planners may develop contingent adaptation strategies that would be implemented in the event a particular scenario begins to unfold.[75]

Whitehorse Community Climate Change Adaptation Project

Whitehorse (population 25 690) is the capital of Yukon and, like other northern communities, already faces many climate-related impacts, including forest fires, flooding and ecosystem changes. To help the community prepare for future climate changes, a scenario planning project was conducted in 2009, led by a local college in collaboration with the territorial government, local and First Nations governments, private sector firms and community groups.[76,77]

In a series of meetings, members of the community identified local vulnerabilities under four possible "future histories" of Whitehorse. To create those histories, two climate change scenarios and two development scenarios were generated. For instance, Scenario 4, entitled City of Crossroads, envisions a high degree of climate change (median temperature rise of 4°C) as well as significant population growth (24 000 new residents). The other future histories have different assumptions regarding climate change and development. Participants brainstormed on the social, economic and environmental consequences associated with each scenario. Certain impacts or concerns that were common across the four histories were deemed to be consequences most likely to occur and therefore became priorities for developing adaptation actions. The priorities included increased risk of forest fire, shifts in the availability of water, infrastructure decline, energy and food security, and potential land use conflicts. The study also allowed planners to identify the range of impacts that any one adaptation measure could address and how these measures may fit with other planning initiatives.

		Climate changes (e.g. extent of temperature rise and increase in snow)	
		some climate change	lots of climate change
Development trajectory (e.g. population growth)	low	Scenario 1: City of Wilderness	Scenario 2: City of People
	high	Scenario 3: City of Mettle	Scenario 4: City of Crossroads

3.4 VISUALIZING CLIMATE CHANGE IMPACTS

Maps and other landscape visualizations can illustrate, in a simple and effective manner,[78] the nature and extent of the changes expected in the local climate, the severity of possible impacts, and what proposed adaptation responses might look like. Such visualizations support decision making by translating scientific concepts into maps or images that have clear and practical meaning to non-scientists and the public. They can facilitate dialogue during the planning process.

MAPS

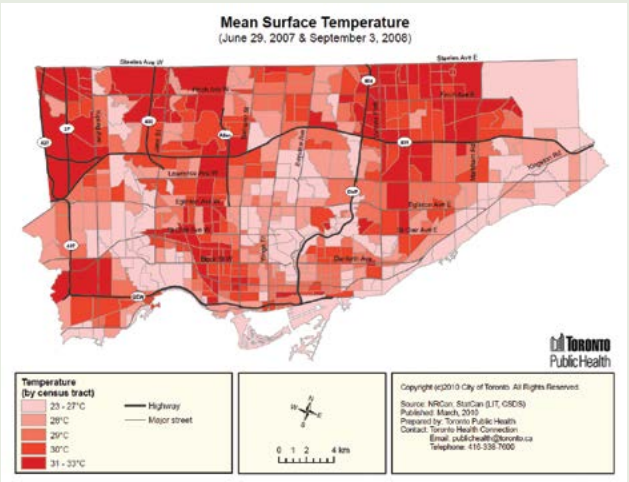
Maps are one of the most common adaptation decision-support tools used by planners. They can range from simple hand-drawn maps to those developed by using sophisticated computer software. Maps have been used to identify geographic areas of the municipality at risk from climate-related impacts, the location of vulnerable infrastructure and populations, or to demarcate places where certain adaptation-related policies apply. For example, the potential extent of shoreline erosion or storm surge flooding under various climate change scenarios can be mapped. Maps can also be readily referenced or incorporated into land use planning tools, such as zoning bylaws, official plans and policy documents.

VISUALIZATIONS

Increasingly, municipalities employ computer animation software to create three-dimensional visualizations at the street and neighbourhood scales. The software combines images of the existing features of the community (for example, roads, buildings and trees near the shore) with climate-related impacts projected for the area (for example, higher sea level). The animations help people visualize the losses that may be incurred under such conditions and illustrate the consequences of a particular adaptation measure. For example, planners may want to create an image showing how raising a dike or levee would affect views of the ocean from various waterfront properties. The resulting images may be useful in engaging the affected land owners and the public when evaluating the merits of a proposed adaptation measure, such as raising a sea dike.

Toronto's heat vulnerability mapping tool[79]

As the climate changes, Toronto is expected to experience more intense and prolonged heat waves. Extreme heat is a public health issue of particular concern to the city's senior citizens, to persons suffering from respiratory illnesses and to other vulnerable populations. Toronto Public Health (TPH) has developed a mapping tool to visualize areas of elevated human vulnerability to extreme heat. The maps incorporate numerous indicators of vulnerability, including surface temperatures, green space coverage, housing and social characteristics of at-risk populations, access to air conditioning, and the location of cool places. The tool helps TPH and community partners identify and prioritize geographic hot spots for delivering resources during a heat alert. The City also plans to use the tool for long-term climate adaptation planning.



MAP COURTESY OF TORONTO PUBLIC HEALTH

Delta's visualization of climate change impacts[80,81]

Delta, British Columbia (population 99 863), is 17 kilometres south of Vancouver, at the mouth of the Fraser River. The low-lying community is at risk of flooding from sea level rise and increased intensity and frequency of storm surges.[82] Since 2005, Delta has partnered with the Collaborative for Advanced Landscape Planning (CALP) at the University of British Columbia (UBC) to develop visualizations of the flooding risk to Delta. CALP and UBC's Okanagan campus developed a 3D virtual environment where Delta residents could see what adaptation actions would look like. For example, the following image shows a typical residential street inundated by flood waters following a major storm surge event. Delta officials found the visualization process useful in engaging local residents. Since the public consultations in 2007, Delta has integrated adaptation into various infrastructure and operational decisions.

3.5 ADAPTATION PLANNING GUIDEBOOKS

Several Canadian guidebooks have been produced that describe the steps a community can take to formulate an adaptation strategy and action plan (see Appendix B). Several of these guidebooks outline a standard planning process that is then tailored with information that is relevant to preparing for the impacts of climate change.

The guidebooks are typically based on the experience and insights of pilot communities and may include case studies and prepared worksheets, as well as tips and practical information. The other decision-support tools described in this document – visualizations, vulnerability and risk assessments, and scenario planning – may be included within the adaptation planning process described in the guidebooks.

Windsor's Climate Change Adaptation Plan

Windsor (population 216 000) is located in southwestern Ontario on the south shore of the Detroit River and Lake St. Clair. Climate change impacts of concern include an expected increase in the frequency and intensity of heavy rain storms and heat waves (a doubling of the number of 30°C days has been projected by 2050).[83] These changes could pose serious problems for the city. In 2010, for example, a significant rainstorm that delivered 90 mm of rain in a 24-hour period led to widespread basement flooding throughout the city.[84]

Windsor began developing its adaptation plan in 2010. The City is working through the five-step adaptation planning process outlined in *Changing Climate, Changing Communities*, a guidebook published by ICLEI Canada.[85] The steps are initiate, research, plan, implement and monitor. The City is midway through that planning process. The development of Windsor's adaptation plan builds on existing initiatives, including a heat alert and emergency response system, the expansion of a waste water treatment facility, various initiatives aimed at reducing basement flooding, and the construction of a new retention treatment basin to reduce combined sewer overflows. City officials intend to integrate the actions identified in the adaptation plan into existing policies, programs and operations.

PHOTO COURTESY OF TOURISM WINDSOR ESSEX PELEE ISLAND

Nova Scotia's *Municipal Climate Change Action Plan Guidebook*: Yarmouth pilot project

The Town of Yarmouth (population 6761) is on the Gulf of Maine in southwestern Nova Scotia. The town is vulnerable to sea level rise and storm surge flooding. In 2010, the Government of Nova Scotia required municipalities to prepare and submit a climate change action plan by 2013 as a condition for receiving federal gas-tax funds. In November 2011, the Province published the *Municipal Climate Change Action Plan Guidebook* to help municipalities prepare their action plans.[86] Yarmouth was one of three pilot communities to work through the Guidebook. The lessons learned were used to assist other municipalities in undertaking similar initiatives.

Steps to develop an action plan

1. Build an adaptation team/committee.
2. Assess impacts and hazards.
3. Identify affected locations.
4. Identify and evaluate the impacts to affected facilities, infrastructure and services.
5. Identify local social, economic and environment considerations.
6. Determine priorities for adaptive actions.

Yarmouth is developing a long-term strategic approach for managing climate change hazards. Between October 2011 and February 2012, with assistance from the Dalhousie School of Planning, Yarmouth worked through the six steps in the Guidebook. Before submitting its Plan to the Province in 2013, the Town intends to host a public consultation session and continue to refine its Action Plan. Despite some challenges, town staff found it to be a useful process. In particular, the formation of the steering committee, composed of staff from different departments, has allowed colleagues to work together across functional areas.

PHOTO COURTESY OF MICHAEL BLASER

Appendix A
Provincial and territorial role in local adaptation planning

PROVINCES

Under the Canadian constitution, provinces have jurisdiction over many matters of local concern including land use planning.[87,88] Accordingly, Provinces play a role in land use planning for local adaptation to climate change through

- **enabling legislation** – Provinces enact and revise laws that guide planning by local and regional authorities. Those laws establish the regulatory and policy tools that control land use at the local level and define how and when they may be used. For example, provincial planning acts prescribe the kinds of zoning bylaws a municipality may adopt. The provinces define the suite of tools available to local government to design and implement adaptation plans and measures.
- **provincial planning policies** – Provinces adopt regulations and policies, to which local and regional plans generally must conform, on planning issues of concern across the province. Those policies may address topics relevant to local adaptation efforts. For instance, a province may prescribe planning standards designed to protect agricultural land and contain urbanization at the fringes of a metropolitan area. Those standards may facilitate enhanced regional food security and the design of more resilient urban communities.
- **provincial adaptation plans and programs** – Many provinces have their own formal plans for adapting to climate change. Typically, such plans specify provincial goals and objectives; identify the impacts of climate change on government programs, operations and infrastructure; and suggest specific actions. For example, a plan may call for more high-definition aerial mapping or enhanced monitoring of water quality. Provinces also disseminate guidelines and technical information and can act as facilitators and conveners to assist local governments, the private sector and civic organizations in adapting to climate change. Finally, provinces fund programs that can support local adaptation (for example, subsidies for an urban tree planting program to reduce the urban heat island effect).
- **direct involvement in development decisions** – In most local planning matters, the provincial government plays an indirect, oversight role (for instance, as appellate bodies on a zoning dispute or as the final approving authority on local official plans). In some circumstances, provincial officials are directly involved in local development decisions. This may be the case for sites and issues that fall under direct provincial jurisdiction, such as highway construction, unincorporated communities, local projects on crown land, projects affecting heritage properties, and environmental assessments of large infrastructure projects. In such cases, provincial officials may contribute directly to decisions on the design and implementation of local adaptation measures.
- **intergovernmental relations** – Provinces negotiate agreements, collaborate on programs and projects, and manage their relations with other provinces and the federal government. In that capacity, a province can help set the conditions for participation by local governments in programs that support or complement adaptation. An example is the set of agreements between the Government of Canada and various provinces governing the allocation of federal gas-tax funds.

The nature and extent of provincial involvement in local adaptation planning varies between provinces, depending on legal and institutional frameworks, the planning culture and practice of each location, and many other factors.

TERRITORIES

Like provincial governments, the governments of the territories of Nunavut, the Northwest Territories and Yukon have jurisdiction over land use planning and many other local matters. However, these legislative powers do not spring directly from the Constitution but instead are delegated to the territories by the Government of Canada under various laws.[89,90,91] Territorial governments in turn enact legislation and adopt policies to guide planning by local and regional authorities within their borders.[92,93]

While the legal framework for land use planning in the territories differs from that in the provinces, the roles that territorial governments play in adaptation to climate change roughly correspond to those described in the Provinces section of this appendix. For example, territorial governments also adopt climate change strategies and actions plans.[94,95,96] Territorial land-use planning practices and territorial government involvement in local adaptation planning vary by territory, depending on the enabling federal legislation and other factors.

British Columbia's Climate Action Plan[97]

British Columbia released its Climate Action Plan in June 2008. Chapter 5 describes the Province's vision, strategies and activities as it prepares for climate change. In responding to the increased likelihood of severe weather events, the provincial government is taking action to (1) ensure that new development on flood plains will be flood-proofed to provincial standards, (2) consider the impacts of climate change when awarding provincial infrastructure grants, (3) develop a comprehensive plan for green community development and (4) ensure that community development strategies recognize the importance of streams and rivers. The Province is currently updating its planning policy statements and guidelines, including the Guidelines for Management of Coastal Flood Hazard Land Use. The Guidelines describe new land use tools that local governments may adopt, including sea level rise planning areas and risk-based zoning.[98]

Prince Edward Island's Climate Change Strategy[99]

Prince Edward Island's Climate Change Strategy outlines measures to both reduce greenhouse gas emissions and to deal with the impacts of climate change. The strategy adopts a risk-based approach to adaptation as it "is the most practical way to ensure that adaptation responses are socially acceptable, cost-effective and consistent with the community's wider social, environmental and economic goals." The impacts of climate change on coasts – such as sea level rise, increased storm surge flooding and erosion – are highlighted as issues of concern. The strategy identifies five overarching adaptation objectives and actions, all of which have direct implications at the municipal level. For example, the Province committed to reviewing all provincial land use and development policies to encourage more sustainable options for future land development and to better adapt to changing climate conditions.

Manitoba's *Provincial Planning Regulation*

Manitoba's *Provincial Planning Regulation*[100] (the Regulation) identifies both climate change mitigation and adaptation as strategic priorities, along with other key concerns such as clean water and public safety. Community resilience is recognized as a key principle of sound land use planning.

The Regulation identifies issues of provincial interest to be addressed in local development plans and goals to be pursued in various policy areas. For instance, with respect to general development policy, the provincial interest includes directing development toward areas where risk can be minimized and taking into account climate change vulnerabilities. With regard to water, provincial interest includes the development of strategies to prioritize allocation and implementation of conservation measures to build community resilience. The Regulation prohibits certain kinds of development in or near water bodies and prescribes minimum setbacks for new development. The policy on planning for agriculture recognizes the potential increased demand for food production in response to climate change and encourages local authorities to promote food security. At a strategic level, the Regulation requires that each local planning authority assess local vulnerabilities to climate change and consider existing climate change action plans when preparing, amending or replacing the local development plan.

Appendix B

Additional resources on select decision-support tools

RISK ASSESSMENT

Adapting to Climate Change: A Risk-based Guide for Local Governments **(Black et al., 2010)**

This guide, based on risk-management guidelines from the International and Canadian standards associations, uses a simple, practical approach for identifying and ranking risks.

http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca.earth-sciences/files/pdf/projdb/pdf/ris_e.pdf

Climate Change Adaptation Framework Manual **(Ministry of Sustainable Resource Development, Alberta, 2010)**

This risk management manual helps government and non-government organizations anticipate and prepare for the economic and ecological impacts of climate change in a comprehensive and consistent manner.

http://www.srd.alberta.ca/MapsPhotosPublications/Publications/ClimateChangeAdaptationFramework.aspx

Managing the Risks of Climate Change – A Guide for Arctic and Northern Communities **(Centre for Indigenous Environmental Resources, 2009).**

This guide provides northern communities with a simple and practical risk management process.

http://ccrm.cier.ca

CLIMATE PROJECTIONS

Plan2Adapt (Pacific Climate Impacts Consortium)

This Web site generates maps, plots and data describing projected future climate conditions for British Columbia.

http://www.plan2adapt.ca/

Localizer (Canadian Climate Change Scenarios Network)

On this Web site developed by Environment Canada, when users enter a postal code, the site provides climate change projections for future temperature and precipitation for that location.

http://www.cccsn.ec.gc.ca/?page=viz-localizer

VISUALIZING CLIMATE CHANGE IMPACTS

Local Climate Change Visioning and Landscape Visualizations: Guidance Manual **(2010).**

This manual, published by the Centre for Advanced Landscape Planning at the University of British Columbia, assists communities in developing climate change visioning processes.

http://www.calp.forestry.ubc.ca/news/viz-guidance-manual/

ADAPTATION PLANNING GUIDANCE

Climate Change Adaptation Planning: A Handbook for Small Canadian Communities **(Canadian Institute of Planners, 2011)**

The handbook helps small Canadian communities prepare and implement a climate change adaptation plan. The handbook details the key steps that municipal planners and decision makers can take to plan for climate change adaptation and determine what strategic actions need to be taken.

www.planningforclimatechange.ca/wwwroot/Docs/Library/CIPReports/RURAL%20HANDBOOK%20FINAL%20COPY.PDF

Changing Climate, Changing Communities: Municipal Climate Adaptation Guide and Workbook **(ICLEI Canada, 2010)**

This guide provides a Canadian-based framework that helps local governments develop an adaptation plan that addresses the most significant climate risks and opportunities for their community. The accompanying workbook includes practical tools and exercises to support practitioners during the planning process.

www.iclei.org/index.php?id=11710

***A Guide for Quebec Municipalities for Developing a Climate Change Adaption Plan* (Élaborer un plan d'adaptation aux changements climatiques. Guide destiné au milieu municipal québécois [Ouranos, 2010])**

This French-language guide uses five steps to help municipalities identify climate risk, set adaptation priorities and implement effective adaptation strategies.

http://ouranos.ca/media/publication/111_PlanadaptationCC-Guidemunicipalites-Ouranos.pdf

Climate Change Adaptation Resource Kit (Columbia Basin Trust, ongoing)

The Columbia Basin Trust and partners developed this Web site to share experiences and lessons learned from year-long adaptation planning processes in Elkford and Kimberley, British Columbia. The text focuses on the communities' experiences, resources dedicated, timelines and lessons learned.

adaptationresourcekit.squarespace.com

***Climate Change Planning Tools for First Nations* (Centre for Indigenous Environmental Resources, 2006)**

The six guidebooks provide user-friendly and culturally appropriate climate change and adaptation manuals to guide First Nations through the planning process. They outline a framework for decision making applicable to a variety of contexts and permitting on-going modification.

www.cier.ca/information-and-resources/publications-and-products.aspx?id=412

***Model Standard of Practice for Climate Change Planning* (Canadian Institute of Planners, 2011)**

The standard includes two elements: (1) a statement that establishes principles of responsible professional practice for addressing climate change and (2) a framework to serve as a model to planners as they consider climate change in their professional practice.

http://www.planningforclimatechange.ca/wwwroot/Docs/Library/CIPReports/CIP%20STANDARD%20OF%20PRACTICE%28ENGLISH%29.PDF

***Planning Resource Guide: Climate Change Adaptation through Land Use Planning* (Manitoba government, 2011)**

This resource guide was developed to help inform land use planning and ensure that communities will be adaptable to the most likely effects of climate change.

www.gov.mb.ca/ia/plups/pdf/cca.pdf

***Canadian Communities' Guidebook for Adaptation to Climate Change* (Bizikova et al., 2008)**

The guidebook "provides a process closely tied to on-going planning cycles to help decision makers incorporate climate change science, impacts, adaptation and mitigation solutions into their sustainable development initiatives."

http://fcm.ca/documents/tools/PCP/canadian_communities_guidebook_for_adaptation_to_climate_change_EN.pdf

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APPENDIX A: PROVINCIAL AND TERRITORIAL ROLE IN LOCAL ADAPTATION PLANNING

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