Is Smart Growth a smart adaptation strategy?

Examining Ontario's proposed growth under climate change

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Introduction

Urban planners and other municipal officials throughout North America, Europe and Australia have been grappling with the costs of urban sprawl. Amongst this community of professionals and others, the realization has dawned that urban sprawl has led to increased traffic congestion, with its attendant economic and health costs, loss of green space and impingement on watersheds, increased infrastructure requirements and costs and a loss of a unique sense of place that is found in the downtown neighborhoods of most cities. There have been several responses such as fixed boundaries for urban areas and green spaces and new urbanism, but the 1990s witnessed the birth of a new movement in planning called Smart Growth. Smart Growth proposes a number of initiatives to reduce or stop urban sprawl, to reduce traffic congestion and to increase the economic viability of cities.

The most common element in Smart Growth plans is delimiting the areas where cities can expand and encouraging higher densities on commercial and residential land use. These measures are accompanied by mixed land use areas to put people closer to work and closer to commercial activities to reduce the reliance on the automobile and increase social capital; investments in public transit; development in proximity to public transit; and the protection of green space. It is hoped that these measures will lead to more vibrant, pedestrian friendly communities, reduce the cost of new infrastructure by concentrating growth in existing areas, reduce the number of private automobile trips and provide more affordable housing. To one degree or another, these elements are found in Portland, Oregon, USA; Sydney, Australia; and in the Canadian Province of Ontario's new growth management strategy (MINISTRY OF PUBLIC INFRASTRUCTURE RENEWAL, 2004).

Smart growth initiatives should not be viewed solely as an environmental strategy to preserve green space or a rural strategy to preserve farmland. The Province of Ontario considers it to be a crucial step in maintaining and increasing the competitiveness of the Golden Horseshoe Region, which is the economic engine of the province and the country. It is not only driven by the need to maintain competitiveness, but to accommodate the future projected growth in the region in a manner that protects the region's watersheds, valuable green space including two UNESCO Heritage sites, preserve farmland and reduce the growth in traffic congestion.

Smart Growth stands on an economic, environmental and social pillar, but the emphasis differs from region to region. Thus,

- in Northern Ontario, the major concern is declining population and recommendations to the Provincial Government focus on new ideas in regional development, such as industrial clusters, and community building to keep people in the North and to draw new migrants to the area (MINISTRY OF PUBLIC INFRASTRUCTURE RENEWAL, 2003);
- The Smart Growth Panels in Western and Eastern Ontario have had a decidedly more rural flavor, although with cities such as Ottawa and London, they also reflected the land use concerns found in Central Ontario (MINISTRY OF PUBLIC INFRASTRUCTURE RENEWAL, 2003).

The benefits of Smart Growth initiatives are not being questioned in this paper. The question posed is whether a planning strategy that is supposed to lead to more compact development increases or decreases the vulnerability to climate change, particularly in Central Ontario. It will be argued that, in some ways, it increases and, in other ways, decreases the vulnerability to climate change. If a Smart Growth policy does increase our vulnerability, it should not be dismissed, due to the potential benefits of curbing urban sprawl in Central Ontario. Those components of the growth management plan that decrease Central Ontario's vulnerability to climate change should be noted and addressed as necessary.

How Smart Growth reduces vulnerability to climate change

Two specific impacts – increased storm water runoff and warmer summers – will be used as the focal point from which to assess the extent to which a Smart Growth strategy will decrease vulnerability to climate change and enhance adaptability to climate change in Central Ontario. An increase in runoff is expected to result from an increase in extreme precipitation events. It is expected that warmer summers will not be characterized so much by an increase in average temperature, but an increase in the severity, frequency and/or length of heat waves.

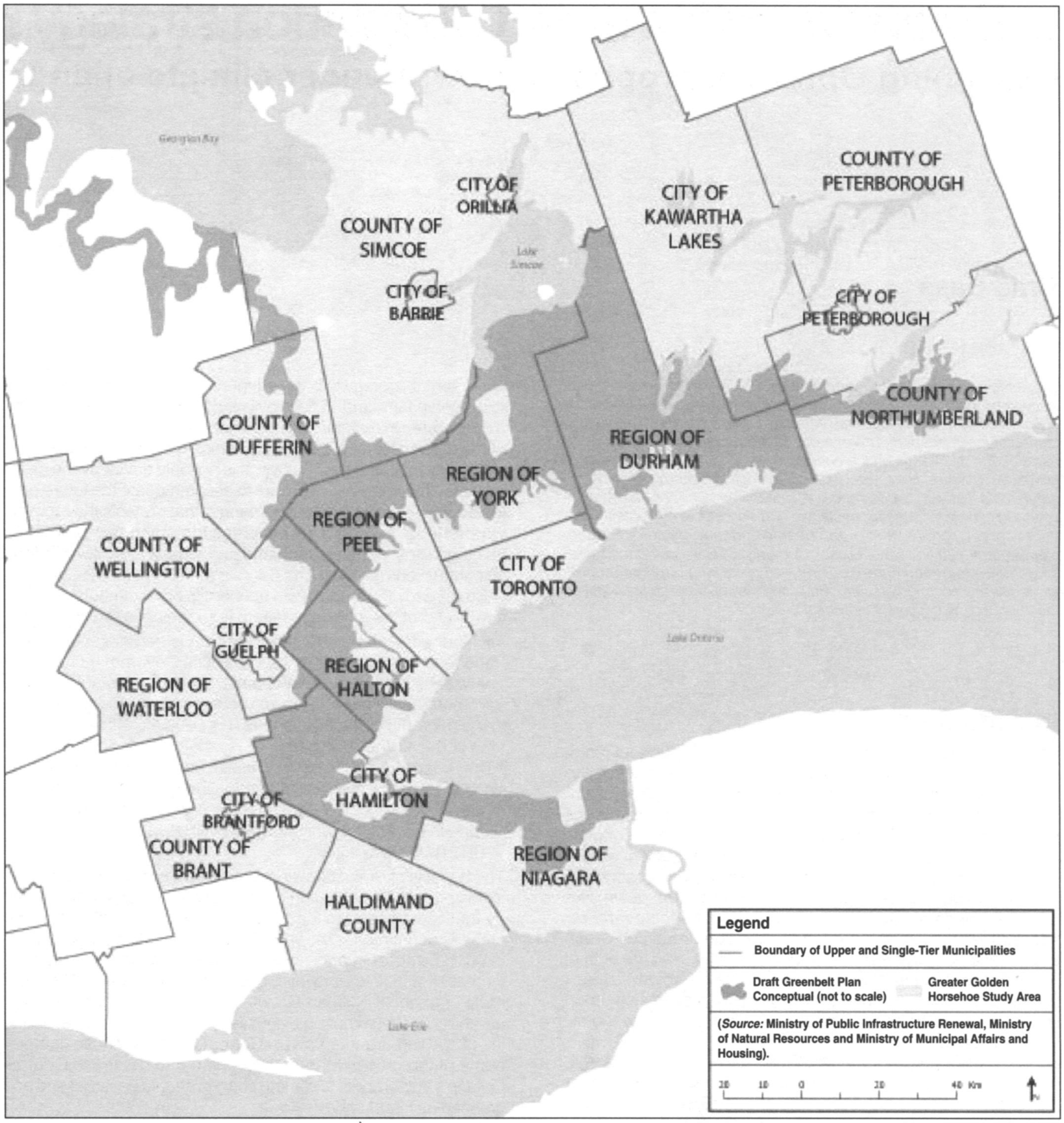

Fig. 1: The Greater Golden Horseshoe area, Ontario, Canada.

There are three objectives of Central Ontario's Smart Growth strategy, known as the Greater Golden Horseshoe Growth Plan (fig. 1) that would appear to reduce our vulnerability to both of these impacts:

- protecting green space;
- reducing congestion; and,
- compact development.

● **The designation of protected green spaces** and the restrictions on expanding urban boundaries suggest that the growth in impermeable surfaces, the root anthropogenic determinant of runoff, will be reduced or halted. Thus rain falling on these areas would not be expected to contribute to the total regional runoff and would not increase the risk of flooding due to higher spring stream flow, although this risk could be increased by other factors.

● **Reducing traffic congestion**, particularly within the urban core areas, and more compact development, would appear to be good adaptations to a warmer summer. All machinery contributes waste heat to the atmosphere, increasing the urban temperatures. Reducing traffic congestion would reduce the waste heat generated by idling automobiles and should have some impact on summer temperatures, although how large an impact is not known. However, the severity of smog is also increased under warmer temperatures and traffic congestion. Reducing automobile emissions by reducing the use of automobiles would remove a source of pollutants for the formation of smog and is a logical adaptation to a warmer climate. Another benefit that might be expected from reducing the number of automobiles in the urban core is a decrease in traffic accidents, and their associated costs, due to inclement weather.

- **Compact development** would also appear to reduce our vulnerability to warmer summers as it allows for an optimization of infrastructure, particularly new infrastructure for delivering alternatives to electricity from Ontario's power grid. For example, providing air conditioning through a district approach, such as deep water cooling from a body of water, is more feasible with higher densities. This would reduce the dependency and the drain on the grid during periods of peak summer demand. Even without an alternative source for cooling, compact development should provide more opportunities for optimizing HVAC infrastructure, which should result in some energy savings during peak demand. Protecting green space would also reduce the geographic expansion of the urban heat island, an increase in urban temperatures as vegetation is replaced by hard, impermeable surfaces, typical of urban development. These surfaces absorb most of the incoming solar radiation, converting it to heat. On vegetation, a significant amount of incoming solar radiation is used for evapotranspiration and is bound up in the water molecules that are transported into the atmosphere. Hence, vegetated areas are cooler than non-vegetated areas.

Compact development also reduces the amount of new infrastructure required for drainage and sewage, thus freeing up additional funds that would otherwise have to be spent on maintenance and replacement of infrastructure. Although developers are responsible for installing the infrastructure for new developments, once the construction is complete, the responsibility for maintenance and replacement is turned over to the municipality. Low-density development on undeveloped green fields requires new infrastructure, which does not optimize the use of existing infrastructure, and requires more meters of pipe than higher density developments.

There are other ways in which the proposed regional growth management plan may decrease vulnerability to climate change. The designation and protection of greenbelts will provide corridors for biodiversity, which may be important as ecosystems adapt to a different climate. If this includes farmland as well (although only the tender fruit lands receive specific notice) it could provide an additional measure of food security. The Greenbelt Discussion paper also proposes to protect at least part of the urban forest, which is critical to reducing both runoff and the urban heat island (MINISTRY OF MUNICIPAL AFFAIRS AND HOUSING, 2004). The proposed plan also includes protection of watersheds. Without knowing if water supplies will remain at the current levels over the next 30 years, these watersheds may become increasingly important for supplying water throughout the region (figs. 1 and 2) and in maintaining the greenbelt around the Golden Horseshoe (MINISTRY OF MUNICIPAL AFFAIRS AND HOUSING, 2004).

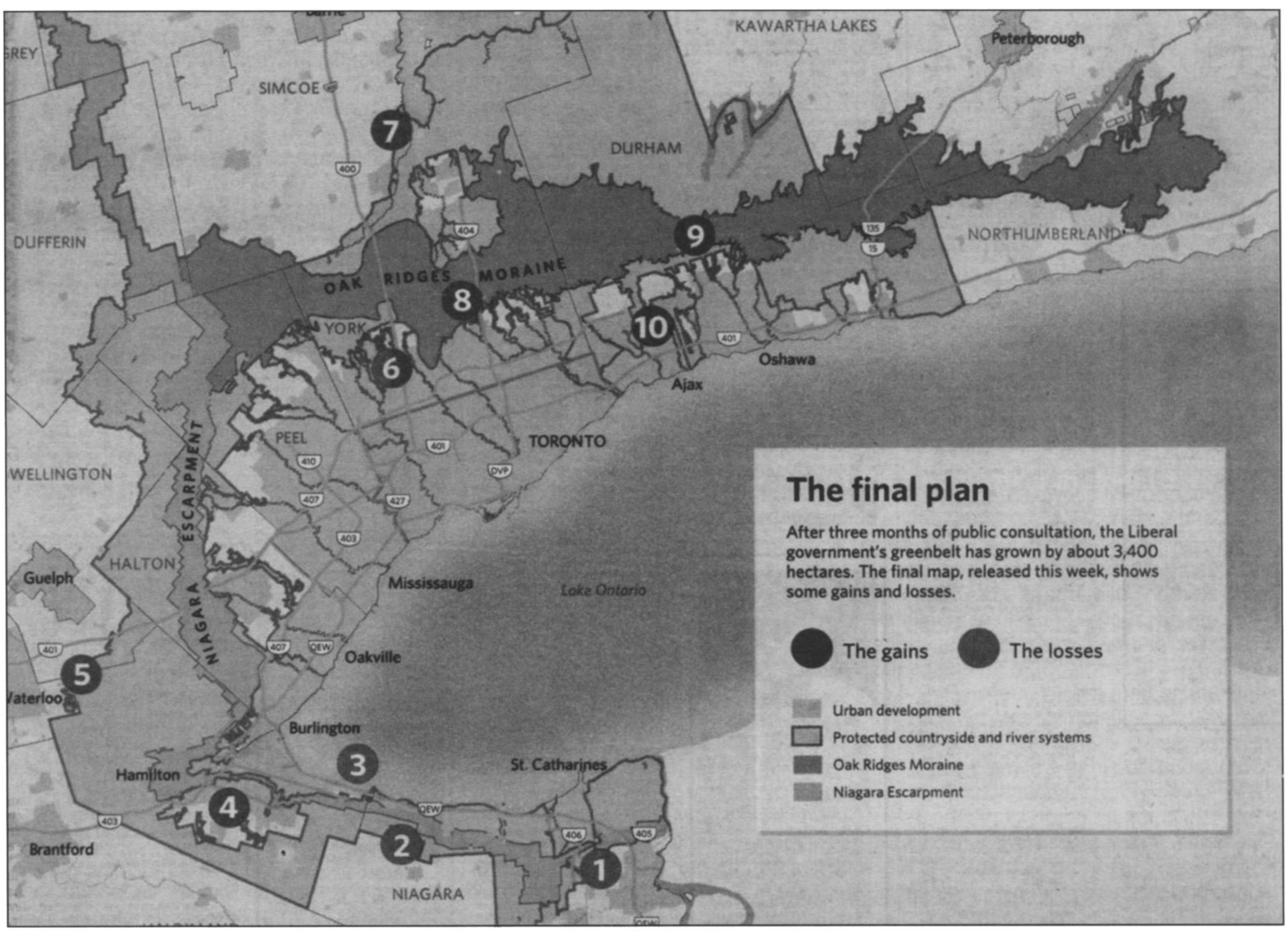

Fig. 2: Golden Horseshoe – The final plan.

How Smart Growth increases vulnerability to climate change

Just as Smart Growth may decrease the Golden Horseshoe's vulnerability to climate change, it may also increase its vulnerability. The discussion will be confined primarily to storm water runoff and warmer summer temperatures. In fact, many of the very features that were cited in the previous section are the very same features that have a deleterious effect on the region's ability to reduce the impacts of climate change.

Storm water runoff results from an inability of the surface to absorb the precipitation as it falls. Thus it runs overland, and in cities, into a drainage system. During a heavy precipitation event, the drainage system's capacity is often exceeded, which leads to other problems. In parts of the Golden Horseshoe region, the drainage and the sewage systems are combined. During a heavy rainfall event, the excess storm water is flushed through the sewage system, and without adequate storage, the sewage will be flushed out of the system before it can be treated, an event called combined sewer overflow (CSO). In other systems, and even in combined systems, the sheer amount of water leads to excess runoff and even floods.

In an urban environment, roads, sidewalks, driveways and parking lots generate a large amount of runoff, but a great deal is also generated by rooftops. One strategy for reducing storm water runoff is to reduce the amount of impermeable surface, and this is often done with vegetation. Typically, urban vegetation is reduced with higher commercial and residential densities. Thus higher densities will tend to increase storm water runoff, not only by squeezing out space for vegetation, but also by increasing the percentage of area in rooftops.

The argument that compacting urban growth reduces the impermeable surface on a regional level may not be relevant in the Golden Horseshoe. The region already features a large settlement area. The plan is to increase densities within this settlement envelope with no mention made about preserving a fixed amount of vegetation or reducing the impact of density on runoff. In fact, development will be allowed to proceed in areas within the settlement area that have already been designated, further reducing the amount of vegetation and replacing it with impermeable surfaces. In addition, the proposed growth plan does not prohibit future greenfield expansion. It will be allowed under certain conditions, and it will also be at higher densities, thus increasing the amount of impermeable surface, thus increasing the amount of storm water runoff. The protection of "municipal forests" is proposed solely in the context of recreation and culture (MINISTRY OF MUNICIPAL AFFAIRS AND HOUSING, 2004). Furthermore, it is not clear whether it applies to those urban forests that are only part of a network of green spaces or all trees.

The proposed growth management plan for the Golden Horseshoe region will also increase the vulnerability to warmer summers and heat waves. Typically, because of a reduction in vegetation, dense urban areas are warmer than their suburban and ex-urban counterparts – the phenomenon known as the urban heat island. The urban heat island has many ancillary costs, in addition to a decrease in thermal comfort. Every one degree Celsius rise in temperature increases electricity demand by at least 3.8 percent (LIU, 2003), which is a provincial average and may be higher within the Golden Horseshoe. This increase in demand places additional strain on Ontario's power grid leading to more pollution from Ontario's or US coal-fired generators (although this would be reduced upon the phase-out of coal-fired power in Ontario) and an increased risk of brown or blackouts. The higher temperature also increases the risk of morbidity and mortality for vulnerable populations, the severity of smog episodes and increased strain on the health care system (BASUR, 2000).

Increasing the density within the current settlement boundaries will increase the amount of surface area that creates waste heat. Further, high-density expansions beyond the envelope will only increase this surface area. Typically, an urban heat island may augment temperatures by 2-4 degrees Celsius, but in Toronto, urban heat islands of 6 and 10 degrees Celsius have been measured in transects from downtown Toronto through York Region (KOREN, 1997). If the proposed growth management plan creates higher densities within the existing settlement boundaries as well as additional higher density development outside the current boundaries, with no plan for preserving vegetation or mitigating the urban heat island, then cities in the Golden Horseshoe will experience even higher temperatures than expected under any scenario of future climate change.

There are other vulnerabilities related to climate change that have not been addressed in the Growth Management Plan at this stage, and are typically not addressed in Smart Growth. The plan for the Golden Horseshoe has identified priority nodes for infrastructure investment that will serve as "anchors" for high-density residential and commercial development. As these areas tend to be urban centers, there are opportunities to optimize the use of infrastructure and minimize the costs of new infrastructure. However, the plan provides no further discussion as to whether the existing infrastructure is adequate to cope with additional storm water runoff. Some of these nodes will also require additional infrastructure to meet the water and sewage needs of the projected growth. As this plan will take the region through the 2030s, it is surprisingly silent on future water supplies in the region under climate change; adaptations to cope with future uncertainties in the regional water supply; and potential conflicts between industrial, municipal, agricultural, recreational, shipping and energy stakeholders.

Discussions in the natural hazards area have also suggested that concentrating population in urban areas tends to increase societal vulnerability to extreme weather events, albeit with the recognition that cities tend to be better equipped to respond to emergencies (MILETI, 1999). This vulnerability has been highlighted with the 1998 ice storm in Montreal and Ottawa and the 2004 summer floods in Edmonton and Peterborough. There are also concerns about the construction standards for infrastructure under climate change. For example, it is expected that climatic design values will require updating, perhaps more frequently than in the past 50 years in order to ensure that the margins of safety are adequate. The climate variables that are the most important are winds, snow loads or snow packs, rainfall intensities, accumulated or antecedent rainfalls, cold and warm temperatures, wet bulb temperatures or other humidity variables, accumulated temperatures, and combinations of these variables with daily outputs as a minimum (AULD, 2004). The uncertainties of most of these elements in a climate change scenario are still high and the uncertainty of all elements increases at smaller time steps.

Modifying Smart Growth with green roofs

Smart Growth has emerged as a response to a real problem and its antecedent costs. The proposed Growth Management Plan for Central Ontario has the potential to both decrease and increase the region's vulnerability to climate change in different ways. The suggested modifications in this section provide the means to mitigate the increasing vulnerability by reducing the urban heat island and storm water runoff, without requiring major changes to the plan or the Government's policy directions. The simplest modification to deal with both storm water runoff and warmer summers is to add an urban vegetation component to the plan. The benefits of vegetation in an urban environment have been widely recognized and include reducing the urban heat island and storm water runoff, but extend to increasing biodiversity and improving mental well being (KAPLAN, 1995;

McPHERSON, 1994; McPHERSON et al., 1989; TERJUNG and O'ROURK, 1981).

One of the most important vegetative features in the urban environment is a tree. Being the largest piece of vegetation, trees magnify most of the benefits associated with vegetation as well as providing shade for people, animals and buildings. Being the largest also requires the most space. This requirement is under threat in many urban areas in the Golden Horseshoe, due to zoning restrictions in some areas and building densities in other areas. Although we tend to expect to minimize tree cover in a commercial high-density area, in some communities, the zoning restrictions have reduced the space in low-residential areas by two-thirds and even moderate zoning restrictions have reduced the available space by 25-30 percent (DUFFY, 1999: VRECANAK et al., 1989). Without any provisions for urban vegetation, we can reasonably expect that space for trees will be further reduced under a plan that will use a variety of incentives to encourage more compact development.

In addition to trees, parks are another important green space in urban environments. The demand at certain times of the day already taxes the existing supply in the GTA and exceeds it in the City of Toronto. For example, there are insufficient parks in downtown Toronto to support the enrolment in soccer leagues that is supported throughout the region. A recent survey of downtown residents in a University of Toronto married student residence highlighted the lack of recreational amenity space for families in the downtown core (SMIRNAKIS, 2003). It does not appear that parkland will increase in downtown Toronto under a Smart Growth policy.

There are several ways the plan could be modified, without sacrificing the requisite densities, to incorporate vegetation. The plan already ties future expansion beyond the existing settlement boundaries to several criteria, including the protection of natural heritage systems. The Greenbelt Taskforce Discussion Paper mentions the identification of existing and potential public parks and open spaces, and the task force is considering the protection of a network of public open spaces, including municipal parks and forests. These could be strengthened to provide for parkland, but it is important not to restrict urban vegetation solely to parks, but to incorporate it into all parts of the urban fabric to reap the full benefits. The City of Toronto's Wet Weather Flow Plan is also a model for incorporating storm water runoff reduction features into medium and higher density areas (WORKS AND EMERGENCY SERVICES, 2003).

Incorporating spaces for full-grown, mature trees is difficult in high-density areas, but this has been done in other cities such as Portland, Oregon, USA. It requires recognition of the importance of trees; planning for trees; and designing roads and walkways to allow the requisite space. In some urban areas, this is no longer possible, but there are other options. Shrubs provide many of the same benefits as trees and require less space. Rooftops and walls provide another option. Although they are similar to desert environments and contribute to the urban heat island, this effect can be mitigated through covering these surfaces with vegetation.

Green roofs are a thriving industry in Germany and other European countries, often backed up by legislation that requires the conservation or restoration of vegetation in urban areas. Green roofs in particular have been shown to reduce the urban heat island and to reduce storm water runoff. Green roofs and walls reduce the urban heat island by utilizing incoming solar energy for evapotranspiration, thereby cooling rooftop temperatures from 60 degrees Celsius or more to as low as 25 degrees Celsius. Green roofs also provide additional shade and insulation to a building, which, in combination with the evaporative cooling, reduces the requirements for air conditioning, more so in smaller buildings than large, multi-storey buildings. However, green walls can be designed to achieve significant reductions in summer electricity demand, even on multi-storey buildings. Green roofs store water in the growth medium, but include a drainage layer to store excess water, thus providing means to store rainfall or at least delay its entry into the drainage system during a storm. They can be designed to minimize runoff with deeper drainage layers, and increase depth of growing medium and broad, leafy plants that intercept most of the vegetation.

Green roofs can be designed to accommodate a variety of uses and building conditions and capacity for increased loading on the roof. For example, the residents of the aforementioned University of Toronto residence now have access to recreational green space on one of the roofs that is accessible from a Parent Drop-in Centre, a meeting room and the laundry room. It provides a safe and secure environment for children to play and ride tricycles. Green roofs can support a wide range of biodiversity or they can resemble other less-diverse landscapes, such as turf grass; they can support food production; and they can be designed to be used as parkland.

One element of the proposed growth management plan is the protection of employment lands in urban areas. Employment lands are often characterized by large, one-storey buildings on large lots of land as the design is adaptable to changing use and access is often required for trucks. Protecting employment lands is a difficult task for municipalities and not a popular political issue. Yet, these are the very buildings that could benefit the most from, and are the most amenable to, green roofs, and in some areas they have enough space to support substantial tree growth. Thus the employment lands – which are difficult to defend given the increased demand for housing, their apparent negative environmental connotations and the fact that they often sit vacant for long periods of time – can become the environmental heart of an urban area by providing green space to cool the city; reducing the impact on the drainage grid, perhaps using the roofs to recycle water; and providing an option for rooftop parkland.

There are other measures that can be used to cope with both increasing runoff and the urban heat island. The worst effects of runoff, flooding, could be dealt with reactively, using a series of low-cost barriers that can be wrapped around the lowest levels of buildings, preventing some of the damage associated with high water levels. The polluting effects of combined sewer overflow can also be mitigated by building large storage tanks to hold the overflow until it can be treated, or separate sewage and drainage systems, both of which represent significant infrastructure investments. Inlet control devices can be installed over sewer grates. These act to delay the flow of runoff into the drainage system, turning the street into a storage tank, although the local residents have to adapt to what appears to be a small flood during each rain event, and the risk of local floods may be increased during severe storms. Even roof runoff can be contained by using roofs as storage reservoirs or using holding tanks within buildings.

The urban heat island can be reduced through the use of reflective or white surfaces, and various demand management strategies or technologies can be used to reduce the demand for electricity from the grid during peak demand times. However, urban vegetation provides a range of benefits, some of which cannot be easily replicated by other approaches. It is also the simplest and least-cost strategy to reduce the vulnerability to runoff and the urban heat island in Central Ontario, while maintaining the benefits of Smart Growth. However, the other areas of climate change vulnerability, such as the uncertainty of future water supplies or the standards required for new infrastructure need to be addressed through other means.

Planning for urban expansion could also be conditioned on projected water supplies over the next 30 years. Although these future supplies cannot be predicted with certainty, the Growth Management Plan could be modified to include at least two climate scenarios in planning the expansion of any particular urban area in order to increase the certainty about future water supplies. The model for this is Bill 160, The Emergency Management Act, in Ontario that mandates that each municipality develop a plan for emergencies. Environment Canada currently provides climate information for municipalities to assess the risks of meteorological hazards on a website devoted to supporting this bill (ENVIRONMENT CANADA, 2004). Environment Canada's Climate Impact Scenarios website could be used for the same purpose.

Conclusions

The Growth Management Plan for Central Ontario will increase and decrease vulnerability to climate change in different ways. At this point, it is not clear which trend is stronger. However, a strategy to increase urban vegetation will confer many benefits that are currently inadequately addressed in the Growth Management and Greenbelt Taskforce Discussion Papers. An urban vegetation strategy will also reinforce those elements of the Growth Management Plan that reduce the region's vulnerability to climate change. Reducing energy consumption due to the urban heat island will increase the effectiveness of energy infrastructure that can take advantage of compact development and will reinforce the benefits of reducing traffic congestion. Reducing the additional storm water runoff from increased roof area will reinforce the reductions of the potential regional runoff that would follow a business-as-usual development scenario.

The introduction of an urban vegetation strategy would complement the proposed Green Belt protection legislation and build on the specific proposal for protecting the municipal forests in the Green Belt Discussion paper. The Province of Ontario is currently reviewing the Planning Act, the Provincial Policy Statements and developing the Growth Management Strategy for the Greater Golden Horseshoe. These policy initiatives provide the vehicles for developing an urban vegetation strategy, and beyond. In addition, a policy that specified vegetation, including green roofs, could be used to increase the marketability of Growth Management Plan in Ontario, as demonstrated in several other case studies (LODER, 2004).

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