

Climate Change and the Urban Forest

Toronto Workshop – Proceedings

March 9th, 2009



ACKNOWLEDGEMENTS

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About the Clean Air Partnership

The Clean Air Partnership (CAP) is a registered charity that works in partnership to promote and coordinate actions to improve local air quality and reduce greenhouse gases for healthy communities. Our applied research on municipal policies strives to broaden and improve access to public policy debate on air pollution and climate change issues. Our social marketing programs focus on energy conservation activities that motivate individuals, government, schools, utilities, businesses and communities to take action to clean the air.

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Background

On February 13th, 2009, the Clean Air Partnership hosted the first Climate Change and Urban Forestry Workshop. This event was made possible through support from the Ontario Ministry of Natural Resources. To ensure the agenda directly reflected the needs of urban foresters in Southern Ontario, an expert panel was consulted. This panel consisted of Dr. Andy Kenney (Faculty of Forestry, University of Toronto), Janet McKay (Executive Director, LEAF), Gary Nielsen (Climate Change Project Coordinator, Ontario Ministry of Natural Resources) and Richard Ubbens (Director, Urban Forestry, Parks, Forestry and Recreation, City of Toronto).

1 Welcome Address from Donna Cansfield, Minister of Natural Resources

Minister Donna Cansfield started the day with a welcome address, noting the vital job that urban forestry plays in making our cities and towns attractive, healthy, livable places. With 80% of the people in Ontario now living in cities, the Minister recognized how urban foresters need to play an increasingly vital role in making our growing cities healthier and better places to live. She observed that the job of growing urban forests, like every other aspect of resource management, has become that much more difficult as we have come to terms with the reality of climate change. Urban Foresters already face the usual problems of pests, dry weather and limited funds for tree maintenance. In addition, road widening, front-yard parking pads, renovations and additions that encroach on the roots of established trees, and some residents' preference for paved patios, more sunlight and less leaf cleanup all help make growing an urban forest a constant struggle. The anticipated changes in our climate are expected to increase the potential for serious damage to city trees. In the face of these challenges, healthy urban trees and forests are becoming ever more essential if we are to successfully defend cities against the effects of climate change.

Minister Cansfield spoke of Premier McGuinty's commitment to plant 50 million trees in southern Ontario by the year 2020 as the most ambitious project of its kind in North America, and the single largest commitment to the United Nations Billion Tree Campaign. She noted that the 50 million trees being planted must be of the right species and in the right places, including parks, conservation areas and private lands. She also noted that the Ministry cannot meet this commitment without the help of its many partners, such as Trees Ontario, Ontario Stewardship, conservation authorities and other agencies. To help support urban forests, the ministry is also partnering with Evergreen to deliver a Community Tree Planting program.

The Minister spoke to the issue of climate change being the biggest single challenge to global sustainability in the 21st century, and that it is the job of governments around the world to choose the best path forward, based on our understanding of what's happening to the climate. The Ontario government accepts this and has made climate change their number one environmental priority. The province's Action Plan on Climate Change sets firm targets and goals for reducing greenhouse gas emissions, investing in public transit, developing clean technologies, and helping homeowners conserve energy and adopt solar and other green power sources.

2 Climate Change in Southern Ontario: Implications for Urban Forestry

Joan Klaassen, Senior Climatologist within Environment Canada's Adaptation and Impacts Research Division, reviewed the changes that are already being observed in Southern Ontario's climate as well as those that are projected in the future and their potential effects on the urban forest. The presentation in its entirety can be viewed on the Clean Air Partnership website www.cleanairpartnership.org.

Highlights included observations and findings that:

- Canadian temperature increases are larger than global averages, in part due to the dramatic warming in the arctic
- Canada is, on average, becoming wetter
- Southern Ontario temperatures are also warming, precipitation patterns are changing and there is evidence of increases in some weather extremes
- BUT the climatic changes are not linear, non uniform at the local/regional level
- Significant, interseasonal, interannual variability has also been exhibited (e.g. some years/seasons may be very dry, with others experiencing intense precipitation events or wetter than normal conditions)
- Growing season indicators imply a significant increase in the number of growing days. This is coupled with a lengthening of the frost-free season in most locations, which is a definite benefit to early growth in the urban forest. (but there are local exceptions, an obvious threat to the urban forest)
- Freeze / thaw cycles could increase, an increase in these cycles is of obvious importance to the urban forest (however, current trends are not spatially consistent in Southern Ontario)
- Although annual precipitation is expected to increase, the number of consecutive dry days and potential severity of drought, particularly in summer, is expected to increase. Drought is a health stressor to trees and can also affect insect populations
- Trees are more vulnerable to insect pathogens in a drought situation. With warmer winters, insects may be able to overwinter and thrive
- Variable precipitation patterns will also mean the potential for extended periods of rainfall, with more frequent and intense extreme rainfall events which again can be a stressor to trees
- Overall impacts will vary by region, site conditions, species and microclimate. Winter ice and storm impacts as well as wind storms can cause dramatic damage to the urban forest and are also perceived as a major threat
- Biodiversity, threatened by climate change, in turn, leaves the urban forest more vulnerable to other threats
- Adaptation strategies will be needed to reduce climate change risks to the urban forest

3 Climate Change and the Urban Forest – What the Research says

In this session, representatives from organizations that are currently undertaking research and programming relevant to climate change and the urban forest each provided a brief synopsis of their research activities, methodologies, resources and programs they've tapped. Key questions proposed by the facilitators included;

- Are there major gaps in the research?

- Who is available to do the needed research and program development?
- What resources are available to help organize and conduct needed research?
- Who is responsible and what are the best practices to conduct climate change risk assessment for the urban forest?
- Does the promotion of urban forests as protection against the impacts of climate change in urban environments provide another important argument in support of more resources to prioritize planting and maintaining trees in our communities?
- What are the governance and policy needs for a climate resilient urban forest?

A scan of research activities being undertaken by the participants revealed a broad scope of programs in silviculture, outreach and education, climate change resiliency building and policy areas.

Examples of Silvicultural Research

- Mapping of the natural heritage system within the urban landscape
- Examining new cultivars that may be drought resistant
- Programs to ensure the right trees are planted in the right place at the right time, strategic placement of trees in urban areas
- Pilot projects to examine tree seed diversity
- Temporal analyses through plot based sampling using international protocols, large scale inventories of forest stocks to track survival and forest health, the design of green spaces in commercial areas and UFORE Studies

Examples of Policy Research

- Alternative delivery models and estimating their success, the effectiveness of tree protection bylaws
- Studies looking at the real estate values of natural features, 3rd party verification systems for carbon offset programs and the development of a Canadian Urban Forest Protocol

Examples of Public Education and Outreach Research

- Application of scientific research in community based programs
- Educational programs and conferences
- Engaging the public and building networks
- Backyard tree planting programs and their successes

Examples of Urban Forestry and Climate Change Research

- Research that looked at urban forest health in the face of a changed climate included tools that examine species specific reactions to climate change models, ongoing tree species adaptation studies and a soil protection pilot study.
- Research focused on the urban forest as a resource to aid resiliency in urban areas included building resilience into natural spaces, stormwater runoff from sidewalks with trees planted in silva-cells, examining impervious surfaces and how they have changed, examining the ecological benefits of tree planting, the development of a

system that can track the carbon sequestration over time, carbon offsets through afforestation, the benefits of the canopy including heat island mitigation effects and

- Several specific programs including Meeting the Challenge of Climate Change program and the Grow Clean Air program.

Research Gaps Identified

The research gaps observed by the group fell into two key areas, policy, and education and outreach. Examples of research gaps identified include;

- A need for groups (e.g. the Clean Air Partnership) to bring information and collaboration to splintered groups and a need to engage planners, engineers, developers, politicians and legislators in the urban forest debate
- Funding was noted as a major gap, it was recognized that until this is resolved, the urban forest resource would be greatly constrained
- General outreach and representation was noted as a deficient area
- The need to engage politicians in the urban forest debate, (but they recognize that researchers are often not suited to this role, therefore, proper representation is required)
- Core groups that are not being properly targeted, for education and outreach, more specifically, new Canadians, who make up the majority of residents in some GTA regions
- The private home owner, on whose land the majority of the urban forest resource is grown, needs to be engaged in a more successful manner than has occurred to date

4 Taking Action to Protect the Urban Forest from Climate Change

This session asked participants to describe actions they are taking to create a resilient future forest as well as to protect the existing forest from climate change. Participants were asked what activities and programs they are already doing that will help provide protection of urban forests from climate change and what are the best practices and strategies to engage non-foresters, the community, and all levels of government in protecting the urban forest?

Examples of Action being taken to protect the Urban Forest

- Pursuing the green development standards where possible
- Bylaws and bylaw enforcement.
- Engaging and educating engineering and planning/legal departments
- Greater community engagement which allow for greater resiliency building
- Using UFORE to develop business cases
- Getting council support for urban forest initiatives
- Educating the public about the cash values of trees to foster resiliency
- Using proper planting and tree care practices to aid resiliency
- Lobbying for provincial and federal support
- Using the media coverage generated by pest outbreaks to promote the cause
- Incorporating understory shrubs and groundcover
- Examining species from more southern ranges and assessing their suitability
- Experimenting with other foreign species, from Europe etc.

- Engaging the media
- Using documented scientific experiments to get robust information
- Engaging the public through web based mapping systems focused on the community level informing the public about the tree and soil types in their local parks

5 Future Direction and Recommendations

Workshop participants were asked to develop recommendations for the best strategies moving forward to protect the urban forest in the face of climate change. The total list of recommendations is presented in Appendix 1. Participants then voted to determine what four strategies would be chosen moving forward. These recommendations are described below. The discussion is summarized in the table in Appendix 3.

5.1 Engage all levels of government in funding and support

The barriers included the fact that currently there is no business case to acquire additional funding, that the impact on climate change from the urban forest is not enough to warrant additional funding and the issue of communications. Right now there is no real communications / lobbying presence working on behalf of urban foresters. This ties in with another observed barrier, questionable public support and awareness. Other barriers to the engagement of all levels of government funding and support included jurisdictional overlap, competing priorities and a perceived lack of middle management bureaucratic buy-in at the provincial and federal levels of government.

Recommendations

1. Connect to keystone provincial priorities (climate change adaptation / infrastructure programs).
2. Build on existing partnerships such as that which exists between OMNR and Evergreen.
3. Expand support beyond planting and into urban forestry stewardship.
4. Connect to federal interests such as emergency preparedness, water and public health.
5. Connect urban forest to invasive species such as the ash borer or longhorn beetle to engage public conscience.
6. Reinforce the adaptive benefits of the urban forest in the context of climate change.
7. Connect with professional organizations – planners / Federation of Canadian Municipalities / Engineers etc

5.2 Develop a business case for urban forestry in the context of climate change

Obstacles in the way of realizing this recommendation include responsibility, who would be responsible for this? The complexity of the issue, for example, varied definitions of sustainability. Reliable data on forest values and inventory are lacking, and this presents another challenge. Also, the varied viewpoints of the landowner present a key challenge where we see a complexity/multiplicity of landowner values. Other barriers noted include a convincing message, how can we get help those individuals that do not understand the message being presented to them. Lack of expertise is an issue; the economics of developing a business case for the urban forest is complex and requires expert input. The final barrier to the development of a business case for urban forestry in the context

of climate change is a lack of context i.e. how can we achieve a sustainable urban forest without sustainable development? To this end, it was noted that engaging planners and politicians is essential.

Recommendations

1. A literature review of existing business cases.
2. Define the scope and terms of reference.
3. Policy changes identified through dialogue between foresters, planners and all levels of government.
4. Sharing responsibility, OMNR could play a coordinating role, CUFN could also play a key role.

5.3 Develop and promote best urban forest management practices

The group recognized multiple barriers to the development and promotion of best urban forest practices. Inadequate human resources were recognized as a key barrier. Again, inadequate financial resources were also noted as being an obstacle. Similar to Recommendation 5.2, responsibility was observed as a barrier. The absence of any umbrella group representing urban foresters in lobbying, communications and best practices development was recognized as an issue. Lack of flexibility was the final barrier cited by the group.

Recommendations

1. Define the scope and terms of reference.
2. Complete a literature review of best practices.
3. The development of policy changes to allow for the development and promotion of best urban forest management practices.
4. Better division of responsibilities. It was suggested that OMNR could develop best practices and provide and roles in coordination, facilitation and support whilst municipalities could be responsible for implementation, enforcement and incentives.

5.4 Public education and engagement

The issue of public education and engagement was a recurring theme throughout the day. Difficulties recognized in achieving this goal include the lack of a consistent message, inadequate funding to get the message out. Another issue is that of lingual and cultural barriers, especially profound in the Greater Toronto Area. Concurrent with this obstacle are the varied values and beliefs of the general public. The overuse of technical jargon was recognized as an issue, as was competition from other causes. The final barrier observed is that those who know the most about the urban forest are not necessarily the best communicators, again pointing to the issue whereby a separate group may be required to represent urban foresters.

Recommendations

1. The enrolment of a high profile public figure to champion the cause of urban forestry.
2. Increased funding for groups like LEAF, Evergreen and ACER to do what they already do best, public education and outreach.
3. Promote increased collaboration among groups like LEAF and Evergreen.
4. Capitalize on existing opportunities.

5. Nurture creative partnerships with non-environmental groups, for example, an urban forest group working with a community group that assists new immigrants etc.
6. Take the stewardship role out of the urban forestry community and into other communities, the educational community (schools, colleges, universities) for example.
7. Build greater trust of government and government programs, especially among immigrants and in lower income neighborhoods

6 Next steps

Moving forward, to act on the recommendations, it was decided that an advisory group would advise on the next meeting of the group and that the day would be divided between meeting with planners and a strategy session.

The following have agreed to participate in an advisory group.

Ian Buchanan	Manager, Natural heritage and forestry services section, York region
Andy Kenney	Faculty of Forestry, University of Toronto
Peter Simon	Urban Forestry Services, Parks Forestry and Recreation, City of Toronto
Rike Burghardt	Urban Forestry Services, Parks Forestry and Recreation, City of Toronto

Appendix 1 Workshop Participants

Alice Castleman	ACER
Andrew Pickett	City of Toronto (Parks, Forestry and Recreation)
Andrew Millward	Ryerson University
Andy Kenney	Univeristy of Toronto
Anne Koven	Ontario Professional Foresters Association
Arnold Mostert	City of Pickering
Arthur Beauregard	City of Toronto (Parks, Forestry and Recreation)
Barb Boysen	Ontario Ministry of Natural Resources
Bodhan Kowalyk	Ontario Ministry of Natural Resources
Brenlee Robinson	Ontario Urban Forest Council
Carol Walker-Gayle	City of Toronto (Parks, Forestry and Recreation)
Carole Berry	ACER
Colin Lacey	Evergreen
Danijela Puric-Mladenovic	Ontario Ministry of Natural Resources
Dave MecLeod	City of Toronto (Toronto Environment Office)
David Orsini	Sunarts Design
Donna Cansfield	Ontario Ministry of Natural Resources
Edith George	Ontario Urban Forest Council
Eva Ligeti	Clean Air Partnership
Fran Moscall	O UFC / Ontario Heritage Tree Alliance
Gary Nielsen	Ontario Ministry of Natural Resources
Ian Buchanan	York Regional Municipality
Jack Radecki	Ontario Urban Forest Council
Jalil Hashemi	Town of Oakville
James Lane	York Regional Municipality
Jane Hanlon	St. Catharines Climate Action Now
Janet McKay	LEAF
Jenny Gleeson	Ontario Ministry of Natural Resources
Joan Klaassen	Environment Canada
John Simmons	Halifax Regional Municipality
John Cary	Trees Ontario
Kevin Behan	Clean Air Partnership
Kristina Pauk	Tree Canada
Liat Podolsky	Ecojustice
Lionel Normand	Toronto and Region Conservation Authority
Meaghan Eastwood	Toronto and Region Conservation Authority
Mike Puddister	Credit Valley Conservation
Noah Gaetz	Toronto and Region Conservation Authority
Paul Grey	Ontario Ministry of Natural Resources
Peter Simon	City of Toronto (Parks, Forestry and Recreation)
Rike Burkhardt	City of Toronto (Parks, Forestry and Recreation)
Ron Wu-Winter	Toronto and Region Conservation Authority
Stephen Smith	Urban Forest Associates Inc
Stewart Chisolm	Evergreen
Sue Arndt	Evergreen
Tara Tchir	Thames River Conservation Authority
Todd Irvine	LEAF
Uyen Dias	City of Toronto (Parks, Forestry and Recreation)
Wendy Strickland	City of Toronto (Parks, Forestry and Recreation)

Appendix 2 Participating Organizations

ACER
Clean Air Partnership
City of Ottawa
City of Toronto (Parks, Forestry and Recreation)
City of Toronto (Toronto Environment Office)
Credit Valley Conservation
Ecojustice
Environment Canada
Evergreen
Halifax Regional Municipality
LEAF
Ontario Ministry of Natural Resources
Ontario Heritage Tree Alliance
Ontario Professional Foresters Association
Ontario Urban Forest Council
City of Pickering
Ryerson University
St. Catharines Climate Action Now
Sunarts Design
Thames River Conservation Authority
Toronto and Region Conservation Authority
Town of Oakville
Trees Ontario
Tree Canada
Urban Forest Associates Inc
University of Toronto
York Regional Municipality

Appendix 3 List of all recommendations developed by the group

Recommendations	Votes
1. Engage all tiers of government in funding and support	19
2. Develop a business case for a sustainable urban forest in the context of climate change	12
3. Develop and promote best urban forest management practices	11
4. Educating / engaging the general public	4
5. Resource assessment	3
6. Enlarge the CUFN to include Southern Ontario	3
7. Interactive mapping / data sharing network	3
8. Provincial policy statements	1
9. Engage relevant stakeholders in an urban forestry discussion regarding climate change	1
10. International collaboration	1
11. Funding (Non-gov / other)	0
12. Study / report tracking system	0
13. Consistent messaging for specific stakeholders	0
14. Positive spin on the urban forest message	0
15. Green infrastructure = urban forest	0
16. Interprovincial collaboration	0

Appendix 4 Workshop Agenda

Urban Forestry and Climate Change Workshop

February 9th, 2009

Metro Hall, Room 309,
55 John St, Toronto, Ontario



Overview

This one-day workshop is organized by the Clean Air Partnership with the support of the Ontario Ministry of Natural Resources. It will facilitate a discussion among urban forestry experts about:

- Research and research gaps pertaining to the effects of climate change on urban forests and how the urban canopy will help communities adapt to climate change
- The resources and policy supports needed by urban forest parishioners to respond to climate change
- Ways to strengthen networking, information and the development of strategic directions

8:15 – 8:30 a.m. Welcome and Opening Remarks

Welcome and opening remarks from the Honourable Donna Cansfield, Minister of Natural Resources and Eva Ligeti, Executive Director of the Clean Air Partnership.

8:30 – 9:00 a.m. Update on How Climate is changing in Southern Ontario

A presentation by Joan Klaassen, Senior Climatologist with Environment Canada will set the stage for the discussions to follow.

Presentation - Climate Change in Southern Ontario, Now and in the Future

This presentation will provide details about weather trends in Southern Ontario and future climate projections, including information about changes in average, seasonal and extreme temperatures; precipitation levels and variability; freeze-thaw cycles; increases in frequency and intensity of storms; shift in climatic zones, etc.

9:00 – 10:30 a.m. Climate Change and the Urban Forest - What the Research Says

Roundtable Presentations – Research Currently Underway

Representatives from organizations that are currently undertaking research and programming relevant to climate change and the urban forest will each provide a brief comment (2-3 minutes) of their research activities, methodologies, resources and programs they've tapped. Topics will include; how and to what extent urban trees can reduce climate change impacts such as heat, air pollution and flooding in urban environments, as well as the practical, governance and policy challenges of growing trees where they are most needed (e.g. on city streets).

Participant Discussion

Workshop participants will be encouraged to speak to the following questions:

- Are there major gaps in the research? What more do we need to know?
- Who is available to do the needed research and program development? What resources are available to help organize and conduct needed research?
- Who is responsible and what are the best practices to conduct climate change risk assessment for the urban forest?
- Is it realistic to plan for urban forests to mature and be made resilient enough to provide protection from climate change?
- Does the promotion of urban forests as protection against the impacts of climate change in urban environments provide another important argument in support of more resources to prioritize planting and maintaining trees in our communities?
- What are the governance and policy needs for a climate resilient urban forest?

10:30 – 10:45 a.m. Coffee Break

10:45 a.m. – 12:00 p.m. The Urban Forest in the Face of Climate Change

Roundtable Presentations – Taking Action to Protect the Urban Forest from Climate Change

This session will ask urban foresters from a variety of organizations to describe actions they are taking to create a resilient future forest as well as to protect the existing forest from climate change. The presentations may include information on: technical issues such as care and maintenance of existing trees under more variable precipitation regimes; species and seed selection, pest and disease control; and policy issues such as engaging the community to tend its own trees, working across municipal silos to both protect and enhance the urban forest, working with provincial priorities such as the PPS and the Greenbelt and engaging with all political levels.

Participant Discussion

Participants will be encouraged to speak to the following questions:

- What activities and programs are you already doing that will help provide protection of urban forests from climate change?
- What can be done about emerging issues such as potential conflicts between solar rooftop programs and the urban tree canopy?

- What are the best practices and strategies to engage non-foresters, the community, and all levels of government in protecting the urban forest?

12:00 – 1:00 p.m. Lunch to be provided

1.00 – 3.00 p.m. What Next?

This session will involve facilitated discussion by workshop participants who will be asked to discuss and make recommendations about:

1. What are the most urgent actions that should be taken to better respond to the threats of climate change to the urban forest? What can foresters do, what can federal and provincial forestry departments do, what can academic institutions do?
2. What are the major barriers to these needed actions?
3. What research and programmatic supports are needed to ensure the resilience of the urban forest under climate change and where should they come from?
4. How best to continue the discussion among urban foresters, forest researchers and climate scientists about climate change and the urban forest in Southern Ontario.
5. What are the next steps to continue this dialogue and build support and recognition of the value of the urban forest for both climate change adaptation and mitigation?

3:00 – 3:15 p.m. Break

3.15– 4.00 p.m. Conclusion

This session will summarize the day's discussions, prioritize needed action and identify the next steps for continuing the dialogue. If time permits the participants will consider a set of recommendations for future action.

Climate Change and the Urban Forest

A Backgrounder

February 9th, 2009



ACKNOWLEDGEMENTS

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Andy Kenney, Associate Professor, Faculty of Forestry, University of Toronto

Janet McKay, Executive Director, LEAF

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Backgrounder – Climate Change and the Urban Forest

This backgrounder seeks to provide an opportunity for workshop participants to familiarize themselves with recent research regarding climate change and the urban forest. This will allow the workshop to focus more precisely on key questions such as,

- What are the governance and policy needs for a climate resilient urban forest?
- What are the best practices and strategies to engage non-foresters, the community, and all levels of government in protecting the urban forest?
- What are the most urgent actions that should be taken to better respond to the threats of climate change to the urban forest? What can foresters do, what can federal and provincial forestry departments do, what can academic institutions do?

I. Introduction – The Nature of Climate Change in Southern Ontario

Over the past half-century, average annual temperatures in Ontario have increased by as much as 1.4 °C. This warming is projected to continue, with the most pronounced temperature increases occurring in winter. It is anticipated that intense rainfall events, heat waves and smog episodes are likely to become more frequent. The hotter summers associated with climate change are expected to have major impacts on urban areas including increased concentrations of ground-level ozone. Extreme weather, in combination with a host of existing urban stressors, has the potential to seriously diminish our urban forest resource.

Climate change in Southern Ontario – what can we expect?

- Changes in average, seasonal and extreme temperatures
- Increased precipitation levels and variability
- More freeze-thaw cycles
- Changes in the frequency and intensity of storms
- Shifts in climatic zones

Some key research papers in this area include:

Bruce, J.P. and Haites, E. (2008) *Canada in an International Context*; in *From Impacts to Adaptation: Canada in a Changing Climate 2007*, edited by D.S. Lemmen, F.J.Warren, J. Lacroix and E. Bush; Government of Canada, Ottawa, ON, p. 387-424.

Chiotti, Q. and Lavender, B. (2008) *Ontario*; in *From Impacts to Adaptation: Canada in a Changing Climate 2007*, edited by D.S. Lemmen, F.J.Warren, J. Lacroix and E. Bush; Government of Canada, Ottawa, ON, p. 227-274.

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K.B. Averyt, M. Tignor and H.L. Miller; Cambridge University Press, Cambridge, United Kingdom and New York, New York, 18 p.

Intergovernmental Panel on Climate Change (2007b) *Summary for policymakers; in Climate Change 2007: Impacts, Adaptation and Vulnerability* (Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change); (ed.) M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson; Cambridge University Press, Cambridge, United Kingdom, p. 7-22.

McKenney, D.E.W., Hutchinson, M.F., Kesteven, J.L., Venier, L.A., (2001) Canada's plant hardiness zones revisited using modern climate interpolation techniques. *Can. J. Plant Sci.* 47, 351–357.

Government of Ontario (2007) *Go Green: Ontario's Action Plan on Climate Change*. Unpublished report. August 2007.
<http://www.gogreenontario.ca/docs/actionplanonclimatechange.pdf>.

II. The urban forest and climate change

Urban trees and forests form an important element in the defense of cities against climate change: providing shade, cooling nearby buildings and ambient air, reducing stormwater runoff, erosion and surface water pollution, and minimizing smog formation. Conversely, climate change exacerbates existing stressors on urban trees and hastens the need for additional resources to protect and expand the urban forest. Urban environments present numerous impediments to healthy tree growth. As a consequence, many trees fail to live long enough to provide mitigation against the effects of climate change. This presents a conundrum to urban foresters, who face external climatic constraints on top of an already constrained resource.

Urban forest vulnerabilities in the face of climate change include:

- Heat stress and drought
- Air pollution stress
- Increased pest / disease outbreaks
- Flooding / erosion
- Changes in biodiversity
- Practical challenges to growing trees on city streets
- Increased vulnerabilities due to longer growing seasons
- Erratic precipitation patterns

Urban forests can mitigate climate change through:

- Shade provision – cooling
- Evapotranspiration - cooling
- Prevention of soil erosion
- Storm water catchment
- Carbon sequestration

Some key research papers in this area include:

- Akbari, H., Konopacki, S. (2004) Energy effects of heat-island reduction strategies in Toronto, Canada. *Energy* 29 (2004) 191–210.
- Davies, C., (2005) *Green infrastructure: integrating urban forestry with city regions undergoing urban expansion*. In: Hostnik, R. (Ed.), *Urban Forests – A Different Trademark for Cities and Forestry*. Proceedings – Book of Summaries, Eighth IUFRO European Forum on Urban Forestry, 10–12 May 2005, Celje, Slovenia. Slovenian Forest Service, Celje, pp. 62.
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III. Policy Actions and Urban Forest Health in a Changing Climate

In Southern Ontario to date, urban forest policy and funding have been the responsibility of the municipalities in the region. These municipalities are not the majority landowners of the urban forest. With the majority of urban trees located on private properties, effective policies must consider and engage private land owners to become custodians of the urban forest resource. Municipalities have limited knowledge about the number and conditions of trees held on private lands and have limited influence over their conditions and care. It is essential that future policies addressing the urban forest in the context of climate change consider this.

What resources and policy supports are needed by urban foresters to respond to climate change?

- Methods to strengthen networking and information sharing
- Policy challenges to growing trees where they are most needed
- Review of climate change risk assessments for the urban forest
- Review of governance and policy needs for a climate resilient urban forest
- Examples of community urban forest stewardship
- Scan of US/Canadian examples of State/Provincial/Federal urban forestry policies and support structures
- Determination of how to we engage provincial and federal governments to become champions of the urban forest
- Establishing what barriers have prevented this from happening thus far
- Scan of emerging issues such as potential conflicts (e.g. rooftop solar)
- Contingency funding for storms

Some key research papers in this area include:

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