Residents' Experiences and Reactions to the December 2013 Ice Storm

Vivian Yip, supervised by Dr. Tenley Conway

Abstract

With the recent increased interest in protecting and growing the urban forest, it is important to understand residents' perceptions of urban trees in order to create successful and efficient urban forest programs and policies. A written survey was mailed to 400 randomly-selected households in five neighbourhoods in the Greater Toronto Area. This survey examined perceptions about urban trees and levels of support for municipal actions that could reduce future tree damage, quantified damage from the ice storm, and collected household-level socioeconomic factors. Consistent patterns of perceived benefits and risks, and municipal actions emerged from the results of the survey. From the results of this survey, significant relationships with demographic variables are discussed. Canopy cover, ice storm severity in different neighbourhoods and limitations introduced by the study area criteria may have affected the survey responses. Further study is recommended to address some of this study's uncertainties and limitations.

Introduction

Urban trees perform a number of ecosystem services and provide social and financial benefits, including storm water management, air quality improvement, temperature regulation, habitat for wildlife, recreation opportunities and increased property values (Hostetler et al. 2013; Zhang et al. 2007). Recently the importance of the urban forest has received increased recognition, leading to a greater push to grow and protect urban forests (Conway and Bang 2014). Since the majority of urban trees are located on private property (McPherson 1998), residents play an important role in managing the urban forest. As a result, many municipalities have implemented urban forestry programs and tree protection legislation to increase canopy cover and protect pre-existing trees from removal (Conway and Bang 2014).

In addition to planting trees, it is also important to maintain tree health to prevent damage from lack of maintenance, pollution and natural disturbance events (such as disease and extreme weather events) (Hostetler et al. 2013). The ice storm that occurred in December 2013 in Southern Ontario is an example of a natural disturbance event. A thick layer of ice from the storm accumulated on tree limbs and caused them to snap and fall onto other structures and utility lines (Armenakis and Nirupama 2014; Hauer et al. 2011). The weather event resulted in major damage to the canopy cover, as well as a power outage for over a million customers in southern Ontario lasting for more than three days (Armenakis and Nirupama 2014). Damages for the city of Toronto were estimated to cost at $106 million (Armenakis and Nirupama 2014).

While the benefits of urban trees have become widely known to the point where almost all residents are aware of their positive effects (Zhang et al. 2007), there has been relatively less research on the perception of risks associated with urban trees and residential support for municipal actions regarding damage mitigation. Determining which demographic groups are

more likely to support municipal actions or dislike a certain aspect of tree ownership will help inform future urban forest management programs and policies.

The objectives of this study are to: (1) investigate the perceived benefits and risks associated with urban trees, (2) explore levels of residential support for municipal actions after damaging events, and (3) determine if the two aforementioned topics vary based on household-level socioeconomic factors. The study is set in the Greater Toronto Area (Ontario, Canada).

Background Information

Services and disservices

There is a growing recognition of the importance of the many benefits associated with urban trees (Lorenzo et al. 2000; Landry and Chakraborty 2009; Hostetler et al. 2013; Conway and Bang 2014). These benefits are often represented as a monetary value. For example Pothier and Millward (2013) estimated that each tree on the Ryerson University campus contributes benefits equivalent to $27 per tree for a total of $15 752, while maintenance costs are approximately $11 680.

In many cities the benefits provided by urban trees justify significant investments to plant more trees. The urban forestry literature tends to promote the positive effects of trees (Bolund and Hunhammar 1999; Zhang et al. 2007; Landry and Chakraborty 2009; Hostetler et al. 2013; Pothier and Millward, 2013), but few articles discuss possible disservices (Lyytimaki et al. 2008; Lyytimaki and Sipila 2009; Escobedo et al. 2011). While ecosystem services are considered beneficial end products of ecosystems, Escobedo et al. (2011) defines ecosystem disservices as the costly, risky end products of ecosystems. Ecosystem disservices include maintenance costs, damage to infrastructure, fear of crime and allergies, among others (Lyytimaki et al. 2008;

Escobedo et al. 2011). Several articles argue that the very definition of ecosystem services only embraces benefits and ignores the "bads" that are associated with urban trees (Lyytimaki et al. 2008; Lyytimaki and Sipila 2009). Lyytimaki et al. (2008) and Lyytimaki and Sipila (2009) suggest that the only way to create efficient management policies is to understand both the benefits and potential harm that ecosystems can produce and consequently incorporate them into the planning process.

Unsurprisingly, residents have a wide variety of preferences and opinions about urban trees on private property. While some may state that they love trees, others are not necessarily willing to deal with the disservices that come with tree ownership (i.e. requiring time and money, possible hazards) (Conway and Bang 2014). Other limitations may include lack of planting space, and the cost of tree maintenance (Landry and Chakraborty 2009; Conway and Bang 2014). Therefore it is important to separate the idea being supportive of urban trees and the reality of participation when it comes to creating initiatives to grow and protect urban forests (Conway and Bang 2014).

Defining ice storms and recent events

Ice storms are one of the many natural disturbances that can cause urban forest-based disservices. There are costs associated with cleaning up fallen trees and branches, costs to replace lost trees and costs associated with damages attributed to falling trees and branches. Ice storms are a type of winter storm characterized by freezing rain and subsequent ice (or glaze) accumulation exceeding 6 mm (Bragg et al. 2003; Amenakis and Nirupama 2014). There is some disagreement in the ice storm literature about their reoccurrence interval that may be attributed to varying interpretations of what a "major" ice storm. According to Luley and Bond (2006), major

events tend to reoccur approximately every 8 years in the Northeast U.S., while Hauer et al. (2011) claim that major ice storms reoccur every 20-100 years depending on the location. The characteristic ice layer that forms during ice storms can cause severe damage to urban areas through direct and indirect damage, including damage to trees. Tree damage can range from minor branch breakage to snapped or uprooted trees, and may cause residual damage for years afterwards (Zipperer et al. 2004; Hauer et al. 2011). The extent of tree damage depends on many factors, including amount of ice accumulation, wind speeds, tree species, branch architecture, structural defects, tree size and tree density (Luley and Bond 2006; Hauer et al. 2011). As well, dormant trees (and therefore having "cold" or "green" wood) tend to be less resistant in the winter than they would in the summer (Bragg et al. 2003). In addition to direct damage to trees, falling tree branches may also damage other structures, vegetation, and power lines (Armenakis and Nirupama 2014).

Several notable glaze events include: major ice storms that occurred in March 1991 in western New York, resulting in $40 million in damage (Zipperer et al. 2004) and another that occurred in January 1998 in Canada and the northeastern U.S. (Bragg et al. 2003; Lautenschlager and Nielsen 2007). The latter is associated with damage costs of $2.5 billion and ice accumulation was up to16.5 cm thick (Bragg et al. 2003). A more recent ice storm occurred in December 2013, covering Southern Ontario, Quebec and the Maritimes (Armenakis and Nirupama 2014). According to Armenakis and Nirupama (2014), the storm left a 30 mm layer of ice accretion on all surfaces, causing major damage to the urban forest. Downed tree branches also broke power lines and left 300 000 customers without power for three days (Armenakis and Nirupama, 2014). Armenakis and Nirupama (2014) estimate that damages associated with the ice storm cost the city of Toronto $106 million alone and incurred insured losses of $200 million.

Much of the urban forest literature emphasizes the need to assess damages after natural disturbance events (Zipperer et al. 2004; Lautenschlager and Nielsen 2007; Hauer et al. 2011; Hostetler et al. 2013). Damage assessment is typically done through several techniques: GIS or remote sensing (Hauer et al. 2011; Hostetler et al. 2013), questionnaires (Hauer et al. 2011) and urban forest inventories (Zipperer et al. 2004; Lautenschlager and Nielsen 2007). Multiple techniques can be combined (Hauer et al. 2011; Hostetler et al. 2013) and used to study certain parameters that approximate tree damage, including: ice thickness, debris volume, wind speed, canopy cover (Hauer et al. 2011; Hostetler et al. 2013) and canopy loss (Zipperer et al. 2004).

Ideally, risk management strategies should be planned before ice storm occurrences in order to minimize damage to and by trees (Bragg et al. 2003; Hauer et al. 2011). Despite the frequency of ice storm occurrences and the extensive damage that they can cause, there is still no standard procedure for managing damaged trees in urban areas, although some exist for rural forests (Zipperer et al. 2004; Luley and Bond 2006). Planting more resistant tress may be a possible strategy to reduce ice storm damage. Different tree species have different susceptibilities; for example Luley and Bond (2006) note that sugar maples are rated as 'susceptible' to ice damage while Norway maples are hardier and rated as 'resistant'. Planting more resistant trees (especially when replacing previously damaged trees) may reduce damage during future natural disturbances. A second potential response is reducing the impact from falling limbs by reducing infrastructure they can damage (Armenakis and Nirupama 2014). Armenakis and Nirupama (2014) suggest that moving Toronto utilities underground would make them less vulnerable to damage from falling tree limbs. However due to the city's extensive network of overhead power lines this management strategy is estimated to cost $1.5 billion and raise electricity rates by 300% (Armenakis and Nirupama 2014). Buried utilities would also be

vulnerable to floods (Armenakis and Nirupama 2014). This study explores residents' support for trees and other risk reduction measures.

The importance of residential attitudes on urban forest programs and policy

Urban tree programs are a relatively new concept in many municipalities and thus citizens may not be aware of its need for constant budgetary support (Zhang et al. 2007). As well, individuals often lack incentive to contribute to programs that will benefit everyone regardless of the amount of financial contribution that they provide (Zhang et al. 2007). In response to the increasing acceptance of urban trees, many municipalities have created urban forestry goals- either defined by canopy cover or number of trees planted (Conway and Bang 2014). Most of the urban forest is located on private properties, giving residents an important role to play through tree planting and maintenance (Conway and Bang 2014). Many municipal urban forestry programs target residents by framing it as part of a resident's civic duty (Conway and Bang 2014). Recent research has also examined the effect of residents' attitudes and socioeconomic factors on willingness to participate in urban forestry initiatives (Lorenzo et al. 2000; Conway and Urbani 2007; Zhang et al. 2007; Conway and Bang 2014) through surveys or qualitative interviews. Understanding the relationship between residents and their level of support is very important when developing effective management plans.

Generally respondents who have university or college educations, are relatively young (approximately 30-50 years), have higher annual incomes (greater than $40 000 or $75 000 USD) and are knowledgeable about urban tree benefits and programs are more likely to participate or contribute to urban tree programs, as well as live in areas with higher canopy cover (Lorenzo et al. 2000; Conway and Urbani 2007; Zhang et al. 2007; Landry and Chakraborty

2009; Conway and Bang 2014). Individuals who are 50+ years of age, earn less than $25000 annually, have less education (i.e. high school) and do not appreciate urban tree benefits are least likely to support urban forestry programs (Lorenzo et al. 2000). Studies found that ethnicity and gender were not significant factors when it came to contributing to urban tree programs (Zhang et al. 2007). Lorenzo et al. (2000) concluded that type of home ownership, age, and levels of education were not statistically significant when considering willingness to contribute financially. From the results of these studies, we can conclude that assessing levels of support and participation is a complex, multi-faceted issue that changes depending on the program or policy in question. For example, Conway and Bang (2014) found variations depending on the type of policy; residents tended to respond neutrally or positively to municipal policies that encouraged planting, but were less supportive of policies that would restrict tree removal.

Managing tree damage after ice storms

A major gap in the literature exists at the intersection of the previously mentioned topics. While there has been research on tree damage caused by ice storms, municipal policies, and residential attitudes, there has been very little work examining municipal management strategies in response to ice storm damage in urban areas, especially in terms of citizen support. There are brief mentions of some potential management strategies; Lautenschlager and Nielsen (2007) note that training technicians to ensure that consistent damage assessments are made and thus creating better management guidelines is an option, and Armenakis and Nirupama (2014) note that moving utilities underground would minimize damage to power lines. However, it seems that the main focus thus far has been on damage assessment (Zipperer et al. 2004; Lautenschlager and Nielsen 2007). This seems to be more of an attempt at repairing damage after an event rather than mitigating future damage. Damage assessments and tree inventories are important, but more

emphasis should be placed on minimizing damage before the event occurs, as this is the more sustainable approach. Given the volume of urban forest on residential property an understanding of residents' support for different management approaches are needed.

Methodology

Through a written survey of several Greater Toronto Area (GTA) neighbourhoods after a major ice storm, I examined residents' attitudes towards urban trees and their support for actions that the city should take in order to mitigate damage from future ice storms. Five neighbourhoods across the GTA were examined to gain a sense of the variety of opinions and experiences (Figure 1). All neighbourhoods had high canopy cover and representing the places that experience not only the most benefits but also the most disservices from the urban forest.

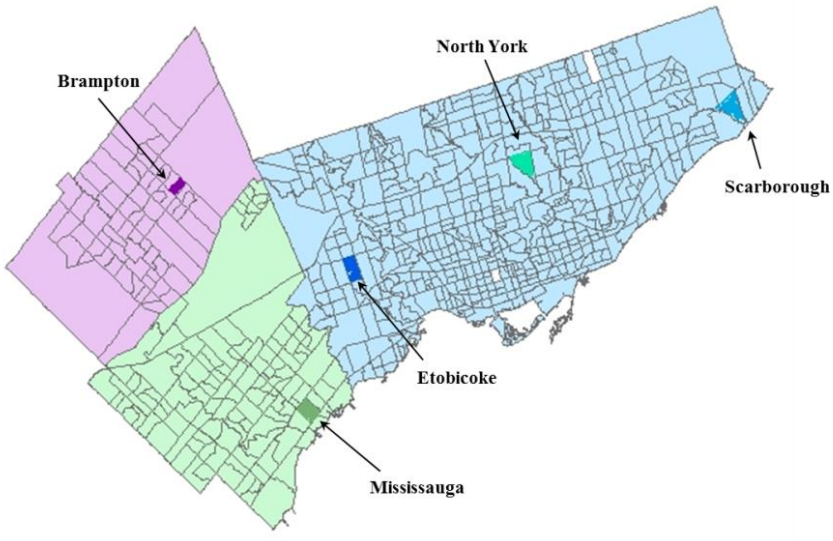

Figure 1: Study areas within the GTA. Surveys were sent to the selected neighbourhood within each of the five municipalities.

Specifically, the study area was determined by overlaying household types and canopy covers over Brampton, Mississauga, Etobicoke, North York and Scarborough. Specific census tracts were identified where greater than 80% of homes were single family homes and also had canopy cover levels that fell into the municipality's top quartile. This represents the areas that

have the highest likelihood of households with a private yard containing sizeable canopy cover. The specific canopy cover criteria are listed in Table 1. From there, potential census tracts that had minimal public land and the most even distribution of canopy cover were chosen as the five study neighbourhoods (Figure 1).

Table 1: Canopy cover criteria for study area selection.

Municipality	Census Tract ID	Canopy Cover Criteria	Actual Canopy Cover
Brampton	5350562.09	15% or above	17%
Mississauga	5350507	24% or above	44%
Toronto- Etobicoke	5350232	38% or above	44%
Toronto- North York	5350267	38% or above	50%
Toronto- Scarborough	5350361.01	38% or above	49%

Surveys were sent to 400 randomly selected households in each census tract. First, a letter of invitation was sent out to all respondents detailing the research project in June 2014. Approximately a week later, written surveys were sent. The survey asked questions about attitudes towards urban trees, damage inflicted by the ice storm, support for possible municipal management actions, and demographic information. A reminder letter and second survey were sent in July 2014, if necessary. The mailing took place approximately six months after the ice storm. All surveys were given a unique ID to help track responses. Completed surveys were entered into a dataset, and then checked to eliminate error.

Average and overall response rates were calculated for the entire survey and specific municipalities, respectively. Summary statistics were also calculated for relevant questions. Averages were compared to data obtained from the 2006 Canadian census to assess the respondents' representativeness.

In order to address the research objectives, this thesis primarily focused on survey questions about residents' perceptions of urban tree benefits and risks, and levels of support for

municipal actions that could reduce tree damage in future events. Several questions (such as those that quantified ice storm damage) were also examined to provide context about residents' experiences. Responses to questions associated with the most important benefits and risks of trees and support for municipal actions were compared with the socio-economic demographic variables in order to determine if respondents belonging to a certain demographic group were more likely to choose specific benefits or risks or have a certain level of support for municipal action. This was done using a cross-tabulation analysis with the Cramer's V test statistic. All comparisons with a p-value of 0.05 or less were considered 'significant'.

Results

The overall survey response rate was 56% (Table 2). Brampton had the lowest response rate at 49%, and Etobicoke had the highest response rate at 64%.

Table 2: Survey count and response rate for each neighbourhood and the Greater Toronto Area.

Municipality	Received	Response Rate
Brampton	188	49%
Mississauga	208	54%
Etobicoke	245	64%
North York	197	52%
Scarborough	237	61%
Overall (GTA):	**1075**	**56%**

A comparison of the data collected in the 2006 census and the survey responses showed differences in almost all demographic variables (Table 3). This included a lower average household income and percentage of row houses, while the percentage of single detached houses, semi detached houses and percentage of individuals with a university degree or higher had increased (Table 3). In particular, the percentage of individuals with a university degree or higher increased quite significantly, by at least 24% (Brampton), ranging up to 43% (North York).

However, this last variable likely reflects differences in the way this information was collected. Although there was a more recent Canadian Census conducted in 2011, the 2006 census is generally thought to be more thorough and accurate (Statistics Canada 2015). But the comparison indicates the sample may not be representative of the broader census tract population.

Table 3: A comparison of 2006 census data and the 2014 survey responses.

	2006 Census Data					2014 Survey Responses				
	Average Household Income (CAD)	**Single Detached Houses**	**Semi Detached Houses**	**Row Houses**	**University Degree or Higher**	**Average Household Income (CAD)**	**Single Detached Houses**	**Semi Detached Houses**	**Row Houses**	**University Degree or Higher**
Brampton	96362	47%	29%	16%	14%	60 000 - 89 000	58%	34%	7%	39%
Mississauga	142989	84%	0%	11%	20%	90 000 -119 000	99%	0%	0%	55%
Etobicoke	342031	95%	0%	3%	36%	150 000 - 179 000	100%	0%	0%	72%
North York	254758	85%	0%	2%	40%	120 000 - 149 000	98%	1%	1%	83%
Scarborough	156484	88%	0%	10%	25%	90 000 - 119 000	97%	0%	2%	51%

Results from the socio-economic section of the survey show that the average age of all respondents is around 60 years old, and that most (55-81%) respondents are born in Canada, are homeowners (96-99%), live in single detached houses (58-100%), have resided at their current address for over 20 years (48-64%) (Table 4). Generally both genders were well-represented, ranging from an approximately even division between male and female (Brampton, Etobicoke and Scarborough) to skewing in favour of males (Mississauga, North York). Education and average household income varied between neighbourhoods; both factors tended to be lower in Brampton and Mississauga when compared to the neighbourhoods in Toronto. The most common reported ethnicities were British Isles, European, and Canadian, but also included South Asian, East and Southeast Asian, Caribbean and others. North York had the lowest reported British Isles ethnicity (24%) when compared with all other neighbourhoods, where approximately half of all respondents reported being of British Isles ethnicity. The ages of

members in households varied between age groups and neighbourhoods; most neighbourhoods reported that they had at least one member that was 18 to 44, 45 to 64 and 65+ years of age. Fewer respondents reported having at least one member that was under 18 years of age.

Table 4: Summary of socio-economic variables across all neighbourhoods. Several categories have been combined and condensed in this table. University Degree or Higher includes all respondents who selected the options "University Bachelors degree" and "Masters or Doctorate degree". British Isles, European and Canadian were the 3 most common ethnicities- note that respondents were instructed to choose all options that apply. 1-4 Members in Household Ages 65+, Ages 45-64, Ages 18-44 and Ages under 18 include all respondents who selected any number from 1-4 when asked about members in their household.

	Brampton	Mississauga	Etobicoke	North York	Scarborough
Average Respondent Age (years)	58	59	62	63	64
Male	55%	63%	56%	63%	53%
Female	44%	37%	44%	37%	47%
University Degree or Higher	39%	55%	72%	83%	51%
British Isles Ethnicity	43%	51%	46%	24%	48%
European Ethnicity	25%	43%	48%	42%	32%
Canadian Ethnicity	14%	11%	6%	8%	13%
Born in Canada	56%	81%	75%	55%	62%
Resided at address for 20+ years	57%	53%	48%	64%	56%
House owner	97%	96%	99%	96%	99%
Single detached house	58%	99%	100%	98%	97%
Average Household Income (CAD)	60 000 – 89 000	90 000 – 119 000	150 000 – 179 000	120 000 – 149 000	90 000 – 119 000
1-4 Members in Household Ages 65+	59%	44%	52%	57%	55%
1-4 Members in Household Ages 45-64	74%	62%	62%	54%	60%
1-4 Members in Household Ages18-44	63%	46%	42%	39%	41%
1-4 Members in Household Ages under 18	40%	35%	26%	20%	20%

In general, about half of the respondents' had some property damage in all neighbourhoods during the December 2013 ice storm (Table 5). Trees or shrubs were the most commonly damaged items in all municipalities, with the exception of Etobicoke, where the most commonly damaged item was hydro or wires. However around half of the respondents in all municipalities also reported that their properties did not suffer any damages.

Around half of all respondents from Brampton and Mississauga lost hydro, telephone and cable TV services during the ice storm. However, hydro was commonly lost for less than 1 day. In particular, the majority of respondents from Etobicoke and Scarborough (71% and 79%,

respectively) reported loss of hydro for 4 or more days. Around half of the respondents from the same neighbourhood reported loss of telephone and cable TV services for at least 4 days. Residents from North York reported slightly lower percentages of loss for all utilities and generally for a shorter period of time.

Table 5: Summary of damage to respondents' property during the December 2013 ice storm. Note: percentages may not total to 100 because respondents were instructed to select all that apply.

	Damaged house	Damaged car(s)	Damaged fencing	Damaged deck(s)	Damaged hydro, wires	Damaged trees or shrubs	Damaged other landscaping	No damage	Other damage
Brampton	7%	8%	15%	3%	5%	32%	9%	45%	11%
Mississauga	5%	5%	14%	1%	15%	28%	9%	52%	5%
Etobicoke	8%	2%	11%	3%	31%	28%	13%	44%	6%
North York	8%	3%	11%	4%	8%	30%	15%	50%	8%
Scarborough	4%	5%	19%	2%	13%	24%	9%	46%	10%

Almost all respondents reported damage to the small branches (<10 feet in length) of trees on their property (Table 6). In terms of damage to larger branches (>10 feet), just under half of the respondents reported that 1 to 5 large branches fell on their property, and around a third of the respondents reported no damage to large branches. Finally, most respondents did not report any felled trees from the ice storm.

Table 6: Summary of tree damage on respondents' property during the December 2013 ice storm.

	Did any small branches fall on your property?	How many larger branches fell down on your property?				How many trees fell down on your property?		
	Yes	None	1 to 5	5 to 10	More than 10	None	1 to 2	3 to 4
Brampton	86%	21%	49%	14%	16%	86%	14%	1%
Mississauga	89%	39%	41%	14%	6%	90%	10%	0%
Etobicoke	94%	33%	45%	11%	10%	91%	9%	0%
North York	87%	37%	44%	11%	7%	89%	9%	2%
Scarborough	85%	33%	43%	14%	11%	90%	10%	0%

Benefits of Urban Trees

In general, shade provision and oxygen provision were by far the most commonly identified urban tree benefits by respondents (Table 7). These responses were chosen more often

in Brampton than in any other municipality. Other popular answers included providing food and shelter for animals (Brampton) and tree attractiveness in the 4 other neighbourhoods. More respondents from Mississauga chose lowering heating or cooling costs and soil stabilization as a benefit than any other municipality. Very few respondents chose 'other' benefits or 'no benefits' as a response. In Etobicoke, respondents were less likely to think that trees' providing food and shelter for animals was a benefit, and more slightly more likely to think that trees did not provide any benefits to trees, as compared to the other neighbourhoods. Respondents from North York were more likely to choose shade as a benefit than any other municipality and less likely to choose providing food and shelter for animals. Respondents from Scarborough were less likely to choose combating global warming and creating a calming effect as benefits.

Table 7: Percentages of respondents for urban tree benefits in five neighbourhoods.

	Provide shade in yard or garden	Provide food and shelter for animals	Lower heating or cooling costs	Trees look attractive	Combat global warming effects	Stabilize the soil	Provide oxygen	Create a calming effect	Increase property value	Reduce noise or sight lines	Other	There are no benefits
Brampton	75%	45%	32%	32%	21%	31%	69%	24%	20%	28%	1%	3%
Mississauga	65%	30%	34%	41%	14%	38%	54%	28%	27%	31%	0%	2%
Etobicoke	66%	16%	19%	42%	15%	24%	60%	21%	24%	26%	0%	4%
North York	62%	24%	16%	44%	20%	30%	60%	19%	13%	22%	0%	3%
Scarborough	66%	29%	23%	41%	12%	28%	61%	16%	12%	22%	0%	2%

When considering the most important benefits and sociodemographic patterns, the number of residents of a certain age (over 65, and 45 to 64 years old) in a household was often a significant factor in determining which benefits were identified in Brampton (Table 11). British, Canadian, other and European ethnicities were also found to be significantly related in responses to a variety of other potential benefits. In Mississauga, income was found to be a significantly related to several benefits, as well as the number of members ages 65 and over and ages 45-64. In Etobicoke, the number of residents of a certain age in a household (over 65 and 45-64 years)

was significantly related to urban tree benefits. Additionally gender and ownership were the most common significant demographics in Etobicoke. Responses for tree benefits from North York showed very few significant demographics, unlike other municipalities. This was also the only municipality where combating global warming had differential support based on a demographic factor (age and ethnicity). There were few significant demographic factors in Scarborough as well. The number of members over the age of 65 years or under 18 years in a household, British and European ethnicity, education, house type, and being born in Canada were all found to be significantly-related to perceived benefits. There were no particular trends or groupings of demographics, unlike the other four municipalities.

Risks of Urban Trees

Tree roots causing damage to drains or foundations was the most common risk identified across all municipalities included problems with utility wires and high costs for pruning/removal (Table 8). According to residents in Brampton, the most common risks were: root damage to drains or foundation, damage from falling branches, utility wire problems and root damage to hard landscape surfaces. The most common responses for tree risks from Mississauga included harm from falling branches, root damage to drains and foundation, high costs for pruning/removal and problems with utility wires. Root damage to drains and foundations, problems with utility wires and harm from falling branches were the most common responses from participants in Etobicoke. Although root damage to hard landscape surfaces was one of the most common responses amongst most municipalities, Etobicoke had the lowest selection rate (20%) for this risk. Root damage to drains or foundation was by far the most common response for North York, followed by problems with utility wires and harm from falling branches.

Respondents in Scarborough often chose root damage to drains or foundation; Scarborough had the highest response rate when compared with other municipalities (80%).

Table 8: Percentages of respondents for urban tree risks in five neighbourhoods.

	Root damage to drains or foundation	Root damage to hard landscape surfaces causing uneven or broken surfaces	Harm from falling branches to people and property	Problems with utility wires	Create unsafe areas for criminal activity	High costs for pruning/removal	Tree leaves/flowers create a mess on ground	Attract unwanted animals/insects	Creates shade in yard or garden	Other	There are no risks
Brampton	78%	46%	64%	46%	13%	33%	28%	19%	14%	8%	3%
Mississauga	64%	25%	70%	49%	10%	50%	24%	11%	13%	10%	2%
Etobicoke	67%	20%	61%	64%	4%	32%	18%	9%	2%	6%	2%
North York	71%	30%	56%	49%	2%	36%	14%	7%	3%	10%	2%
Scarborough	80%	34%	60%	54%	1%	40%	13%	8%	4%	3%	1%

Out of all five neighbourhoods, Brampton had the greatest number of significant results when socio-economic factors are compared to the selection of risks. In Brampton, various ethnicities (including British, European, Caribbean, East and Southeast Asian, and other), number of members over 65 years, 45-64 years, and under 18 years were all found to be significantly related to selection of all urban tree risks (Table 12). Being born in Canada and gender were also found to be significantly related in several responses. Income was found to be a common significant factor in determining most responses to tree risks in Mississauga. The number of members under 18 and over 65 years of age were also significantly related for a few responses. There were many different significant factors in determining respondents' choices in Etobicoke. Respondent age, the number of members 18 to 44 and 45 to 64 years of age, education, gender, ethnicity and house ownership were found to be significant. There were a wide range of demographics that were significant for respondents in North York. Ethnicity was the most common significant factor across most responses. These ethnicities included British Isles, European, Caribbean, East and Southeast Asian, Southern ethnicity, and others. Respondents in Scarborough with various ethnicities, house types, and number of members

under 18 or over 65 years of age were the most common significant factors when it came to choosing responses.

Levels of Support for Municipal Actions

With some small variations, respondents in all municipalities agreed that better pruning of street trees are needed, that the city should plant trees that are more structurally sound, that the city should provide subsidies for residents to remove damaged trees and that utilities should be buried (Table 9). Most respondents disagreed that the city should plant fewer street trees, and were generally neutral regarding the statements: the city should plant smaller trees, the city should plant native trees, and that subsidies should be available for residents to prune their trees.

Respondents from Brampton were more likely to 'agree' and 'strongly agree' that subsidies should be available to remove dead/damaged/diseased trees (Table 9). Mississauga had a lower response rate for agreement for better pruning and tree care; more respondents chose 'neither agree nor disagree' for this option than other municipalities. As well, a greater proportion of respondents 'strongly disagreed' that fewer street trees should be planted in Mississauga than other municipalities. Respondents in Etobicoke were more likely to 'strongly agree' that utilities should be buried than respondents from other municipalities. Although the responses were still split, respondents in Scarborough were more likely than other municipalities to 'agree' and 'strongly agree' that subsidies should be available for residents to prune trees.

Table 9: Percentages of respondents for municipal actions in Brampton, Mississauga, Etobicoke, North York and Scarborough.

	Better pruning and care of street trees by the city is needed	The city should plant fewer street trees	The city should plant trees that are more structurally sound	The city should plant smaller trees	The city should plant native trees	Utilities should be buried	Subsidies should be available to residents to remove diseased/dead/damaged trees	Subsidies should be available to residents to prune trees on their property
Brampton								

Strongly disagree	5%	42%	5%	11%	2%	0%	4%	7%
Disagree	9%	41%	7%	31%	6%	3%	8%	25%
Neither Agree nor Disagree	9%	11%	28%	39%	34%	17%	11%	20%
Agree	39%	4%	39%	14%	40%	31%	35%	22%
Strongly Agree	38%	1%	21%	5%	18%	49%	42%	26%
Mississauga								
Strongly disagree	2%	51%	4%	13%	4%	4%	9%	12%
Disagree	9%	35%	8%	35%	4%	2%	14%	21%
Neither Agree nor Disagree	20%	9%	29%	36%	29%	19%	14%	21%
Agree	45%	2%	49%	12%	50%	42%	38%	28%
Strongly Agree	23%	2%	11%	3%	14%	32%	25%	17%
Etobicoke								
Strongly disagree	5%	42%	2%	7%	1%	2%	5%	10%
Disagree	3%	36%	4%	27%	4%	2%	15%	23%
Neither Agree nor Disagree	12%	15%	29%	47%	49%	10%	12%	18%
Agree	40%	4%	51%	15%	35%	28%	38%	26%
Strongly Agree	41%	3%	14%	3%	12%	57%	30%	23%
North York								
Strongly disagree	1%	42%	2%	8%	2%	3%	7%	11%
Disagree	5%	36%	8%	32%	7%	2%	13%	26%
Neither Agree nor Disagree	9%	16%	29%	41%	39%	9%	14%	19%
Agree	42%	3%	46%	15%	40%	38%	36%	21%
Strongly Agree	44%	3%	15%	5%	12%	48%	30%	22%
Scarborough								
Strongly disagree	1%	42%	3%	9%	2%	2%	5%	11%
Disagree	4%	34%	7%	35%	4%	1%	9%	16%
Neither Agree nor Disagree	17%	14%	26%	32%	33%	10%	9%	19%
Agree	36%	7%	41%	16%	40%	34%	34%	27%
Strongly Agree	42%	3%	23%	8%	21%	53%	43%	27%

Many factors were found to be significantly related to all policy responses in Brampton; house type, ownership, gender and being born in Canada were the most common significant factors across all policy statements (Table 10). Respondents with British, Caribbean and South Asian ethnicities were also significantly different in their responses to four policy statements.

The most common significant demographic in Mississauga for different levels of support for municipal actions was the number of members over 65 and 18 to 44 years of age present in a household. Gender, British, and East and Southeast Asian ethnicity were also significantly related to some policies. In Etobicoke, being born in Canada, gender, house type, ownership and income were consistently found to be significantly related to levels of support for various municipal tree care actions. The results from North York showed that being born in Canada, gender, house type and ownership were significantly correlated with levels of support for municipal actions for nearly every response. Being of European, East and Southeast Asian and South Asian ethnicity was also found to be a significant factor for some policy statements. Respondent age, house type, being born in Canada, house type, gender and ownership were found to be important factors for levels of support for municipal actions in Scarborough.

Table 10: Cross-tabulations between municipal actions and household-level sociodemographic variables for the neighbourhoods of Brampton, Mississauga, Etobicoke, North York and Scarborough. Significant p-values (<0.05) are shown. P-values <0.01 have been bolded. Responses where the majority of respondents "agreed" or "disagreed" with the statements have been highlighted in green and red respectively, and neutral or divergent responses are in yellow. Results corresponding to respondent age have not been colour coded due to the continuous nature of the responses. Results that are too divergent (i.e. if the most common answers are both neutral and strongly agree) have also not been colour coded.

	Better pruning and care of street trees by the city is needed	**The city should plant fewer street trees**	**The city should plant trees that are more structurally sound**	**The city should plant smaller trees**	**The city should plant more native trees**	**Utilities should be buried**	**Subsidies should be available to residents to remove diseased/dead/ damaged trees**	**Subsidies should be available to residents to prune trees on their property**
Brampton								
Respondent age								
Number of members under 18 years of age in household								
Number of members 18-44 years of age in household						0.013		
Number of members 45-64 years of age in household								
Number of members over 65 years of age in household								
British Ethnicity						0.049		
European Ethnicity								
South Asian Ethnicity						**0.007**		
East and Southeast Asian Ethnicity								

Caribbean Ethnicity		0.014		**0.006**				
Canadian Ethnicity								
Other Ethnicity			0.010					
Born in Canada		0.030		**0.000**		**0.001**	**0.001**	0.034
Education	0.010						**0.001**	
Gender		0.017	**0.004**		0.030	**0.000**	**0.002**	**0.005**
House Type	0.019	**0.005**		**0.001**		**0.004**	**0.005**	0.026
Income								
Lived at current address		0.025						
House Ownership	**0.003**	**0.000**	0.010	**0.000**		**0.000**	**0.000**	**0.000**
Mississauga								
Respondent age	0.010							
Number of members under 18 years of age in household		**0.006**	**0.006**	0.027	**0.002**	0.049		
Number of members 18-44 years of age in household								
Number of members 45-64 years of age in household						0.036		
Number of members over 65 years of age in household								
British Ethnicity	0.025						0.048	
European Ethnicity								
South Asian Ethnicity								
East and Southeast Asian Ethnicity		0.014						
Caribbean Ethnicity								
Canadian Ethnicity								
Other Ethnicity								
Born in Canada								
Education		**0.005**				**0.007**		
Gender	**0.006**			0.032		**0.002**	**0.001**	0.038
House Type		**0.000**		**0.001**				
Income								
Lived at current address		0.037						
House Ownership								
Etobicoke								
Respondent age		**0.000**		**0.000**	**0.000**			
Number of members under 18 years of age in household								
Number of members 18-44 years of age in household				0.043	0.027			0.011
Number of members 45-64 years of age in household				**0.000**				
Number of members over 65 years of age in household								
British Ethnicity	**0.003**						**0.002**	**0.000**
European Ethnicity								**0.009**
South Asian Ethnicity						0.029		
East and Southeast Asian Ethnicity								
Caribbean Ethnicity								
Canadian Ethnicity						**0.000**		

Other Ethnicity								
Born in Canada	**0.000**	**0.000**	**0.009**	**0.009**		**0.000**	**0.003**	**0.000**
Education		0.032	0.013					
Gender	**0.001**	**0.006**	0.015	**0.000**		**0.000**	**0.006**	**0.000**
House Type	**0.000**	**0.000**	**0.000**	**0.000**	**0.002**	**0.000**	**0.000**	**0.000**
Income			**0.001**				0.014	**0.009**
Lived at current address	0.024						0.042	
House Ownership	**0.000**	**0.000**	**0.001**	**0.001**	0.027	**0.000**	**0.001**	**0.000**
North York								
Respondent age						**0.003**		
Number of members under 18 years of age in household								
Number of members 18-44 years of age in household								
Number of members 45-64 years of age in household								
Number of members over 65 years of age in household								
British Ethnicity								
European Ethnicity		**0.000**						
South Asian Ethnicity					0.018			
East and Southeast Asian Ethnicity		**0.001**		**0.000**				
Caribbean Ethnicity								
Canadian Ethnicity						0.028		
Other Ethnicity								
Born in Canada	**0.000**	**0.002**	**0.004**	**0.000**		**0.000**	**0.000**	**0.000**
Education		0.041						
Gender	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
House Type	**0.002**	0.018	0.010	0.023	**0.004**	**0.000**	**0.000**	**0.000**
Income								
Lived at current address						0.014		
House Ownership	**0.000**	**0.000**	0.013	**0.004**	**0.005**	**0.000**	**0.000**	**0.000**
Scarborough								
Respondent age		**0.001**	0.041	**0.000**	0.010	**0.000**		
Number of members under 18 years of age in household		0.029	0.019					
Number of members 18-44 years of age in household	**0.005**							
Number of members 45-64 years of age in household								
Number of members over 65 years of age in household								
British Ethnicity		0.037						
European Ethnicity								
South Asian Ethnicity								
East and Southeast Asian Ethnicity				0.025				0.017
Caribbean Ethnicity								
Canadian Ethnicity								
Other Ethnicity		0.022		0.036				
Born in Canada	0.036	**0.009**	**0.003**	**0.001**	**0.002**		0.038	**0.002**

Education								
Gender	0.047	**0.001**	**0.000**	**0.002**	**0.000**	0.011	**0.000**	**0.000**
House Type	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Income				0.014	0.037			
Lived at current address								
House Ownership	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**

Discussion

This study examined residents' experiences and policy support after a major ice storm. Survey were sent out in the summer of 2014 to randomly-selected households in the study neighbourhoods located in Brampton, Mississauga, Etobicoke, North York and Scarborough (Figure 1). Trees and shrubs were the most commonly damaged property, followed by hydro and wires and fencing; however nearly half of the respondents did not report any damage to their property (Table 5). In terms of tree damage, nearly all respondents reported damage to small branches and about half reported damage to their trees' larger branches (Table 6). The most common perceived benefits was providing shade in the yard or garden and providing oxygen (Table 7). The most common responses for risks was root damage to drains or foundation and harm from falling branches (Table 8). Consistent trends emerged when examining levels of support for municipal actions, with respondents generally expressing agreement that better care of street trees by the city, that trees that are more structurally sound should be planted, and that utilities should be buried (Table 9). Respondents generally disagreed that fewer trees should be planted, and were neutral about the city planting native trees and providing subsidies for tree removal and pruning (Table 9).

Although the response rate varied between neighbourhoods, the overall response rate for the GTA was quite high (Table 2). This would suggest that residents are sufficiently interested in urban forest management to take the time to complete our survey. This is surprising, considering property and tree damage caused by the ice storm was relatively minor (Tables 5, 6). Response

rates were high in Toronto neighbourhoods, with the highest response rate occurring in Etobicoke (Table 2). More respondents from Etobicoke also reported damage to hydro and wire and small branches (Tables 5, 6). Etobicoke and Scarborough also had the highest reported proportion of utility loss and for the longest period of time. Therefore while the results from our survey shows that the ice storm did not cause severe damage, certain neighbourhoods sustained more damage than others and this may have contributed slightly to the increased response rate.

Respondent age and the number of members within certain age groups were often found to be significantly related to residents' perceived benefits and risks (Tables 11, 12). We would suggest that this may be due to generational differences between different age groups, as well as their difference in experience and physical ability to care for and manage urban trees on their property. Gender was a common demographic variable that found to be significantly related to respondents' selection of policy statements (Table 10). This may be reflective of tree and yard care responsibilities in households.

Summary statistics showed that a greater proportion of respondents in Brampton often chose different tree benefits and risks when compared to the other four municipalities (Tables 7, 8). These respondents were more likely to consider shade provision for the yard or garden, and food and shelter provision for animals as benefits (Table 7). They are also more likely to consider root damage to drains, foundation and hard landscape surfaces as risks (Table 8). Brampton has the lowest overall canopy cover of all the municipalities, which may cause the functional aspects of trees to become more evident (i.e. providing shade). This is emphasized by the fact that Brampton had the lowest response rate for tree attractiveness (Table 7). Any risks caused by urban trees "malfunctioning" is also more likely to be noticed, as respondents have

grown accustomed to their functional aspects, therefore a greater proportion of respondents in Brampton chose root damage to property as their top choices for risks.

Our methodology may have contributed to a tendency for our results to be skewed in several socioeconomic factors. This is due to the presence (or absence) of certain demographics in our study areas. For example, Caribbean ethnicity was often found to be a significant factor; however very few Caribbean respondents (11 households) resided within the surveyed neighbourhoods (Table 4). This is also the case for many other factors (i.e. house owners). Furthermore, results from our cross-tabulations show that many demographic variables that were found to be significantly related to respondents' answers are comprised of many small groups. Therefore it is unclear whether some of these results are socio-economic patterns or whether they are the result of a few individuals' preferences.

Similarly, the criteria used for selecting study areas may have affected our demographics in respondents as well. Selecting for areas that are located in the top quartile of canopy cover may have resulted in selecting neighbourhoods that are older with more valuable properties, therefore our respondents may be more likely to have higher household incomes and perhaps even possess higher levels of education. As well, since one of the criteria was to select 80% or greater of single family houses, most of our respondents reside in single family houses compared to semi-detached houses or row houses (Table 4). Generally, by selecting for certain neighbourhoods, we have surveyed respondents that may not be representative of the typical demographics that exist within the greater area of the municipality, as seen in Table 3. In order to address some of the uncertainties and limitations, we would suggest that further study is needed to investigate the meaningfulness of some of these socio-economic patterns.

Conclusion

Urban trees perform many important services, including ecosystem services, economic and social benefits (Bolund and Hunhammar 1999; Zhang et al. 2007). Most urban trees are located on private property (McPherson 1998), giving residents an important role to play in managing and protecting the urban forest. Although there has been a push to protect the urban forest (Conway and Bang 2014), they are often exposed to many threats, including severe weather events (Hostetler et al. 2013). The December 2013 ice storm is an example of an extreme weather event that caused massive damage to the Greater Toronto Area. We sent out a written survey in summer 2014 to study neighbourhoods in Brampton, Mississauga, Etobicoke, North York and Scarborough. The objectives of this study were to examine: (1) residents' perceived benefits and risks (2) levels of support for municipal actions, and (3) whether household-level socioeconomic factors are significantly related to support for municipal actions.

Consistent patterns between neighbourhoods emerged from the results. Common benefits included providing shade and oxygen, while common risks included root damage to hard landscape surfaces and harm from falling branches. Respondents thought that the city should plant trees that are more structurally sound, that the city should take better care of street trees and that utilities should be buried. Respondents also disagreed with the policy statement that fewer trees should be planted, and were conflicted about the city planting urban trees and providing subsidies for tree pruning and removal. A number of factors were found to be significantly related to urban tree benefits, risks and management actions, including age for benefits and risks and gender for policy statements.

The significant relationship between respondent and household members' age may be due to generational differences in knowledge and ability to care for trees, and the significance of

gender was attributed to household responsibilities for tree management. Some of the factors that were found to be significantly related to survey responses may not be indicative of meaningful relationships, as some demographic groups were small. Therefore it is unclear whether these are socio-economic patterns or the result of several individual's opinions. As well, the criteria for selecting study area may have skewed the respondent demographics. We also suggest that canopy cover may affect residents' perceptions of tree benefits and risks. Further study is needed to specifically consider perceptions of urban forest disservices and to determine whether the results from the cross-tabulation analysis are substantial and valid.

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References

Armenakis, C., Nirupama, N. (2014). Urban impacts of ice storms: Toronto December 2013. *Natural Hazards*, 7(2): 1291-1298.

Bolund, P., Hunhammar, S. (1999). Ecosystem services in urban areas. *Ecological Economics*, 29: 293-301.

Bragg, D. C., Shelton, M. G., Zeide, B. (2003). Impacts and management implications of ice storms on forests in the southern United States. *Forest Ecology and Management*, 186: 99-123.

Conway, T. M., Bang, E. (2014). Willing partners? Residential support for municipal urban forestry policies. *Urban Forestry & Urban Greening*, 13: 234-243.

Conway, T. M., Urbani, L. (2007). Variations in municipal urban forestry policies: a case study of Toronto, Canada. *Urban Forestry & Urban Greening*, 6: 181-192.

Escobedo, F. J., Kroeger, T., Wagner, J. E. (2011). Urban forests and pollution mitigation: analyzing ecosystem services and disservices. *Environmental Pollution*, 159: 2078-2087.

Hauer, R. J., Hauer, A. J., Hartel, D. R., Johnson, J. R. (2011). Rapid assessment of tree debris following urban forest ice storms. *International Society of Arboriculture*, 37(5): 236-246.

Hostetler, A. E., Rogan, J., Martin, D., Delauer, V., O'Neil-Dunne, J. (2013). Characterizing tree canopy loss using multi-source GIS data in Central Massachusetts, USA. *Remote Sensing Letters*, 4(12): 1137-1146.

Landry, S.M. and J. Chakraborty. (2009). Street trees and equity: Evaluating the spatial distribution of an urban amenity. *Environment and Planning A,* 41(11): 2651-2670.

Lautenschlager, R. A., Nielsen, C. (2007). Ontario's forest science research and extension efforts after the 1998 ice storm. *Journal of Forestry,* 105(1): 34-42.

Lorenzo, A. B., Blanche, C. A., Qi, Y., Guidry, M. M. (2000). Assessing residents' willingness to pay to preserve the community urban forest: a small-city case study. *Journal of Arboriculture and Urban Forestry*, 26(6): 319-325.

Luley, C. J., Bond, J. (2006). Evaluation of the fate of the ice storm-damaged urban maple (*Acer)* trees. *Arboriculture & Urban Forestry,* 32(5): 214-220.

Lyytimaki, J., Petersen, L. K., Normander, B., Bezak, P. (2008). Nature as a nuisance? Ecosystem services and disservices to urban lifestyle. *Environmental Sciences*, 5(3): 161-172.

Lyytimaki, J., Sipila, M. (2009). Hopping on one leg- the challenge of ecosystem disservices for urban green management. *Urban Forestry & Urban Greening,* 8: 309-315.

McPherson, E. G. (1998). Structure and sustainability of Sacramento's urban forest. *Journal of Arboriculture*, 24(4):174-190.

Pothier, A. J., Millward, A. A. (2013). Valuing trees on city-centre institutional land: an opportunity for urban forest management. *Journal of Environmental Planning and Management*, 56(9):1380-1402.

Statistics Canada. (2015). NHS: Data quality. Retrieved from http://www12.statcan.gc.ca/NHS-ENM/2011/ref/about-apropos/nhs-enm_r005-eng.cfm

Zhang, Y., Hussain, A., Deng, J., Letson, N. (2007). Public attitudes toward urban trees and supporting urban tree programs. *Environment and Behaviour,* 39(6): 797-814.

Zipperer, W. C., Sisinni, S. M., Bond, J., Luley, C., Pleninger, A. G. (2004). An assessment of management history of damaged and undamaged trees 8 years after the ice storm in Rochester, New York, U.S. *Journal of Arboriculture,* 30(2): 92-100.

Appendix A

Table 11: Cross-tabulations between perceived benefits and household-level sociodemographic variables for the neighbourhoods in Brampton, Mississauga, Etobicoke, North York and Scarborough. Significant p-values (<0.05) are shown. P-values <0.01 have been bolded. Responses where the majority of respondents "agreed" or "disagreed" with the statements have been highlighted in green and red respectively, and divergent responses (where there was more than one prevalent response) are in yellow. Results corresponding to respondent age have not been colour coded due to the continuous nature of the responses.

	Provide shade in yard or garden	Provide food and shelter for animals	Lower heating or cooling costs	Trees look attractive	Combat global warming effects	Stabilize the soil	Provide oxygen	Create a calming effect	Increase property value	Reduce noise or sight lines	Other	There are no benefits
Brampton												
Respondent age				0.014								
Number of members under 18 years of age in household				**0.007**	0.037			**0.008**	**0.001**			
Number of members 18-44 years of age in household				**0.005**					0.024	0.01		
Number of members 45-64 years of age in household												
Number of members over 65 years of age in household												
British Ethnicity					**0.003**							
European Ethnicity									**0.001**			
South Asian Ethnicity												
East and Southeast Asian Ethnicity												
Caribbean Ethnicity	0.048											
Canadian Ethnicity							0.036					
Other Ethnicity								0.015				
Born in Canada											0.020	
Education												
Gender												
House Type											0.025	
Income												
Lived at current address												
House Ownership											**0.006**	
Mississauga												
Respondent age												
Number of members under 18 years of age in household					**0.004**				0.020			
Number of members 18-44 years of age in household					0.025							
Number of members 45-64 years of age in household												
Number of members over 65 years of age in household												

British Ethnicity												
European Ethnicity												
South Asian Ethnicity												
East and Southeast Asian Ethnicity												
Caribbean Ethnicity												
Canadian Ethnicity		0.010										
Other Ethnicity												
Born in Canada												
Education												
Gender				0.038								
House Type												
Income		**0.001**			**0.001**		**0.001**		**0.001**			0.019
Lived at current address												
House Ownership								0.036				
Etobicoke												
Respondent age												
Number of members under 18 years of age in household									0.022			
Number of members 18-44 years of age in household												
Number of members 45-64 years of age in household						0.031		**0.005**	0.035			
Number of members over 65 years of age in household		0.046							0.015			
British Ethnicity												
European Ethnicity												
South Asian Ethnicity												
East and Southeast Asian Ethnicity												
Caribbean Ethnicity												
Canadian Ethnicity		0.032										
Other Ethnicity							0.039					
Born in Canada							**0.007**					
Education												
Gender		0.026		0.025		0.022						
House Type												
Income												
Lived at current address												
House Ownership		0.042							0.019			
North York												
Respondent age												
Number of members under 18 years of age in household												
Number of members 18-44 years of age in household				0.026	0.019							
Number of members 45-64												

years of age in household												
Number of members over 65 years of age in household												
British Ethnicity					0.048							
European Ethnicity												
South Asian Ethnicity												
East and Southeast Asian Ethnicity					0.04							
Caribbean Ethnicity												
Canadian Ethnicity												
Other Ethnicity												
Born in Canada												
Education												
Gender												
House Type												
Income												
Lived at current address												
House Ownership												
Scarborough												
Respondent age												
Number of members under 18 years of age in household										0.032		
Number of members 18-44 years of age in household												
Number of members 45-64 years of age in household												
Number of members over 65 years of age in household						0.043	0.035					
British Ethnicity												
European Ethnicity									**0.002**			
South Asian Ethnicity												
East and Southeast Asian Ethnicity												
Caribbean Ethnicity												
Canadian Ethnicity												
Other Ethnicity												
Born in Canada							0.033					
Education							0.018					
Gender												
House Type											0.016	
Income												
Lived at current address												
House Ownership												

Table 12: Cross-tabulations between perceived risks and household-level sociodemographic variables for the neighbourhoods in Brampton, Mississauga, Etobicoke, North York and Scarborough. Significant p-values (<0.05) are shown. P-values <0.01 have been bolded. Responses where the majority of respondents "agreed" or "disagreed" with the statements have been highlighted in green and red respectively, and divergent responses (where there was more than one prevalent response) are in yellow. Results corresponding to respondent age have not been colour coded due to the continuous nature of the responses.

	Root damage to drains or foundation	Root damage to hard landscape surfaces causing uneven or broken surfaces	Harm from falling branches to people and property	Problems with utility wires	Create unsafe areas for criminal activity	High costs for pruning/ removal	Tree leaves/ flowers create a mess on ground	Attract unwanted animals/ insects	Creates shade in yard or garden	Other	There are no risks
Brampton											
Respondent age									**0.007**		
Number of members under 18 years of age in household			0.012								
Number of members 18-44 years of age in household											
Number of members 45-64 years of age in household			**0.005**			**0.005**	0.038		0.017		
Number of members over 65 years of age in household			0.021		0.003	0.047	**0.005**	0.026	0.029		
British Ethnicity					0.019			0.013			
European Ethnicity							0.009				
South Asian Ethnicity											
East and Southeast Asian Ethnicity			0.041								
Caribbean Ethnicity							0.041		0.026		
Canadian Ethnicity											
Other Ethnicity					0.016	0.027		0.019	0.026		
Born in Canada			0.047		0.010			0.049			
Education											
Gender					**0.004**			**0.000**	0.017		
House Type											
Income			0.020								
Lived at current address											
House Ownership								0.041			
Mississauga											
Respondent age											
Number of members under 18 years of age in household		0.012									
Number of members 18-44 years of age in household											
Number of members 45-64 years of age in											

household											
Number of members over 65 years of age in household					0.020				**0.006**		
British Ethnicity											
European Ethnicity											
South Asian Ethnicity											
East and Southeast Asian Ethnicity											
Caribbean Ethnicity											
Canadian Ethnicity											
Other Ethnicity											
Born in Canada											
Education					0.014			0.024			
Gender											
House Type											
Income		0.032		0.011	**0.000**			**0.001**	**0.000**		
Lived at current address										0.048	
House Ownership							0.041		0.029		
Etobicoke											
Respondent age							0.011	**0.000**			
Number of members under 18 years of age in household											
Number of members 18-44 years of age in household											
Number of members 45-64 years of age in household					0.049						
Number of members over 65 years of age in household											
British Ethnicity											
European Ethnicity											
South Asian Ethnicity											
East and Southeast Asian Ethnicity											
Caribbean Ethnicity						0.040					
Canadian Ethnicity		0.028									
Other Ethnicity											
Born in Canada											
Education				0.047							
Gender					0.035						
House Type											
Income											
Lived at current address				0.035							
House Ownership			0.022								**0.000**

North York											
Respondent age					**0.000**			0.024			
Number of members under 18 years of age in household											
Number of members 18-44 years of age in household											
Number of members 45-64 years of age in household						0.033					
Number of members over 65 years of age in household											
British Ethnicity									**0.009**		
European Ethnicity							0.019				
South Asian Ethnicity					**0.005**						
East and Southeast Asian Ethnicity			**0.009**				**0.007**				
Caribbean Ethnicity		0.045			**0.000**						
Canadian Ethnicity											
Other Ethnicity			0.036						0.019		
Born in Canada									0.029		
Education							0.040				
Gender											
House Type											
Income	0.010										
Lived at current address								0.043			
House Ownership											
Scarborough											
Respondent age		0.040					0.047				
Number of members under 18 years of age in household				0.012				**0.009**	0.039		
Number of members 18-44 years of age in household											
Number of members 45-64 years of age in household											
Number of members over 65 years of age in household											
British Ethnicity											
European Ethnicity					0.028						
South Asian Ethnicity						0.044					
East and Southeast Asian Ethnicity											
Caribbean Ethnicity									0.003		
Canadian Ethnicity			0.039								
Other Ethnicity											

Born in Canada											
Education											
Gender	**0.008**		0.024								
House Type	0.010					0.018				**0.000**	
Income											
Lived at current address											
House Ownership	**0.003**										