Trees and Residents
An exploration of residents' role in growing Mississauga's urban forest

Tenley Conway and Tooba Shakeeel
Department of Geography, University of Toronto, Mississauga
2012

Executive Summary

Urban forests provide vital ecological services in our communities and are crucial for our mental, physical and emotional well-being. The distribution of the urban forest across many cities, including Mississauga, is uneven, which has led researchers to conclude that different groups have unequal access to the many benefits associated with trees. Recent research has also shown that neighbourhood socioeconomic conditions and built form are typically related to urban forest patterns. However, the role individual property-owners play in shaping those patterns has not been explored. Understanding patterns at the property-level is important because it is the scale where residents make decisions, with the cumulative impact of those relatively small-scale decisions shaping broader characteristics of the urban forest.

There are two objectives of this research. First, gain an understanding of residents' attitudes towards trees and tree-related policies, as well as documenting current vegetation conditions in residential yards. Second, identify property and household characteristics significantly related to canopy cover extent and tree density. The study area is four neighbourhoods in Mississauga (Ontario, Canada) that differ in terms of socioeconomic conditions, age of development, and characteristics of tree cover. Residents' attitudes and household demographic data were derived from a survey of households living in on-the-ground houses in the study area. Tree density and percent canopy cover per property were calculated using Geographical Information Systems (GIS) and remote sensing data. The first objective was addressed through simple summaries of survey responses. The second objective was addressed by comparing the two tree measures with household characteristics using regression analysis.

The results of the study show that most of the survey respondents prefer to have trees in their yards, and appreciate the environmental and aesthetic benefits of trees. However, residents indicated lower levels of support for municipal policies that would either encourage more planting or restrict tree removal on private property. Residents' attitudes towards trees, amount of available planting space and number of trees removed in the last year are statistically related to the amount of tree canopy and density of trees on their property. However, the nature of these relationships varies between canopy cover and tree density. For example, the amount of available planting space is positively related to percent canopy cover and negatively related to tree density.

The results of the study indicate that most people have positive feelings towards urban trees, while property-level conditions are significantly related to residents' attitudes and actions as well as space constraints.

1. Introduction

Trees and other vegetation in cities, collectively known as urban forests, are vital sources of services that keep our cities healthy, safe and vibrant (McPherson et al., 2005; Nowak et al., 1996; Smardon, 1988). Not only are urban forests appreciated for their aesthetic appeal, but also for their numerous ecological, environmental, and social services. However, in most cities trees are not evenly distributed across and within different neighourhoods. This uneven distribution raises concerns about unequal access to urban forest related benefits by residents. The distribution of the urban forest is related to a number of factors, including urban form, socioeconomic characteristics and government policy (Alberti, 2005; Grove et al., 2006; Conway & Urbani, 2007; Nowak et al., 1996).

Recent research has shown that the highest percent canopy cover in urban areas is present on residential land (Alberti, 2005; TRCA, 2011). Hence, studying human-forest relationships on this land-use represents a critical component of the urban forest. Additionally, residents of single-family homes control the use and content of their yards, meaning that small-scale (i.e. household-level) decisions likely shape the broader pattern we see across urban areas. Urban forest research has examined neighbourhood-level correlates of urban forest quantities and distribution. Variables such neighbourhood age, socioeconomic status and ethnic composition of residents are often related to percent canopy cover (Conway & Hackworth, 2007; Conway & Urbani, 2007; Grove et al., 2006; Heynen & Lindsey, 2003; Hitchmough & Bonugli, 1997; Landry & Chakraboty, 2009). To date, little work has examined property-level tree cover quantities, distributions, and its relationship to household-level characteristics.

There are two objectives of this research:

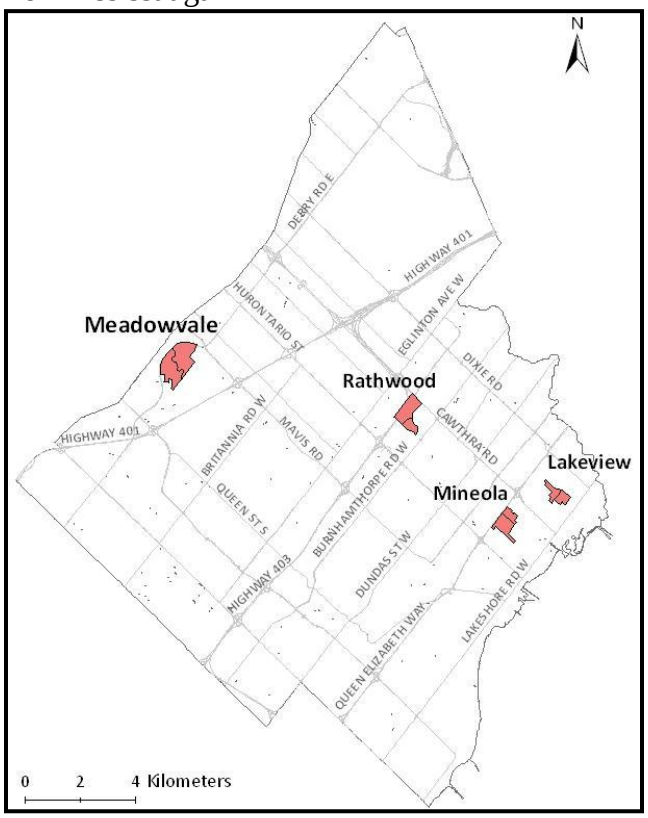
1. Obtain an understanding of residents' attitudes towards trees and support for tree-related municipal policies, as well as document current vegetation conditions in residential yards.
2. Identify property and household characteristics significantly related to canopy cover extent and tree density.

The purpose of this report is to describe the methods used to address these objectives and provide a summary of the results.

2. Study Area

The study area is located in Mississauga (Ontario, Canada), a city of 713,443 (Statistics Canada, 2011). Mississauga is just west of Toronto, Canada's largest city, while Lake Ontario forms the southern border (Figure 1). It contains a mix of residential neighborhoods (ranging from large apartment towers to fully detached homes), shopping complexes, employment centers, industrial areas, and historic town centers. Percent canopy cover across the entire city is 15%, but tree conditions are highly variable across Mississauga. Generally, highest canopy cover is present in residential areas, with low density residential land use having the most of any land-use type (Alberti, 2005; TRCA, 2011).

Figure 1: Map of four study areas in the City of Mississauga



The study area includes four neighbourhoods within Mississauga: Mineola, Lakeview, Meadowvale and Rathwood (Figure 1). Each neighbourhood was defined by two contiguous dissemination areas, delineated by Census Canada. Three variables from the 2006 census were used to determine which dissemination areas would be included: average household income, age of house construction and housing structure type. Studies have shown that in residential settings, these three variables commonly influence the level of tree cover seen on the ground (Conway & Urbani, 2007; Heynen & Lindsey, 2003; Hitchmough & Bonugli, 1997; Landry & Chakraborty, 2009), while allowing us to place temporal (age of housing) and socioeconomic (income) controls on our sample.

Initially, dissemination areas with at least 80% of homes located on-the-ground (i.e. fully-detached, semi-detached, townhomes) where identified to ensure most households had access to a yard where trees could potentially be located. Four neighbourhoods were then selected, each representing one combination of the following factors: either 20th percentile or 80th percentile of household income in Mississauga and over 80% of homes built either before 1970 or after. The number of properties per study neighbourhood was between 253 and 584.

The first neighborhood, Mineola, is classified as an older, higher-income neighborhood. It contains a large number of mature trees and has properties approximately double the size of the other neighborhoods in the study. The majority of the houses in Mineola were built prior to 1960, and mature trees are a common neighborhood feature. Lakeview is the other older neighborhood, consisting of relatively low income households. It also has a number of older trees, with overall density similar to Mineola. Meadowvale is the newer, high-income neighbourhood, with many young families living in the area. The neighborhood actually consists of two areas, separated by conservation land and an older settlement location in the center. The majority of houses in the two main sections of the neighborhood have small trees, mostly limited to the front of the house. The last neighborhood, Rathwood, has newer homes and households with relatively low income. It differs from the other neighborhoods in three ways: Rathwood has the greatest number of townhomes; many of the homes are part of a condo association, with 'street trees' the responsibility of the association, not the city; and it is the only neighbourhood where less than 50% of the residents are home-owners.

3. Objective 1: Residents' Attitudes and Yard Characteristics

3.1 Methods

In order to obtain information about residents' attitudes and yard characteristics in our study neighborhoods, a mail-based survey was conducted during the summer of 2011. The survey asks residents to provide information regarding their attitudes towards tree functions, support for municipal policy, number of trees currently present in their yards, as well as information regarding household demographics. This allowed household specific information to be compared with property-level measures of tree presence.

Initially, every non-apartment dwelling household within the four neighbourhoods was contacted, totalling 1,399 households. Households received up to four contacts, including reminders and second questionnaires to ensure acceptable participation rates (Dillman, 2007). Once returned, the survey responses were entered into a database. Each survey had a unique code allowing us to link responses to a specific address. Simple summaries of the survey responses were then calculated to address objective 1.

Additional property-level information was derived from existing data, using Geographic Information Systems (GIS) and remote sensing methods. Tree density was determined based on the number of trees in each yard, gathered from survey responses, per 1,000 m^2 of available planting space. Available planting space was calculated as the area of each property not occupied by a house or other building. The percent of each property covered by tree canopy was also calculated from classified satellite imagery (Shakeel, 2012).

3.2 Results

The overall response rate to the survey was 43% (Table 1), with the survey participants generally reflective of the broader population in each neighborhood (Table 2).

Table 1: Survey response rate by each of the four neighbourhoods.

Neighbourhood	Number of Participating households (percent)
Mineola	126 (49%)
Lakeview	220 (38%)
Meadowvale	136 (54%)
Rathwood	118 (39%)
All	600 (43%)

Table 2: A comparison of census data and survey responses.

	Census Data (2006)			Residents Survey (2011)		
Neighborhood	Household Income (CAD)	University Degree (%)	Home Ownership (%)	Household Income (CAD)	University Degree (%)	Home Ownership (%)
Mineola	138,103	28	92	90,000-119,000	30	92
Lakeview	66,447	13	95	60,000-89,000	14	95
Meadowvale	152,765	40	90	90,000-119,000	40	94
Rathwood	63,520	16	44	30,000-59,000	16	59

The number of respondents who agreed or strongly agreed to statements related to wanting trees where they live was nearly always above 80%, with only small variations between neighborhoods (Table 3). The exception was for the statement 'I would like my neighborhood to have more trees, which had an overall agreement level of 52%.

In terms of benefits and costs, the number of respondents who indicated agreement with statements highlighting potential benefits of trees was generally above 80%, and the level of agreement for the statements highlighting cost was below 15% (Table 4). The exception here was in response to the statement 'trees attract wildlife I like to see in my yard', where respondents in all but Lakeview indicated agreement less than 80% of the time. Across the four neighborhoods, statements focused on non-specific aspects of attractiveness and environmental benefits had the highest levels of agreement, while root problems was the potential cost with the greatest agreement.

When considering respondents' attitudes towards municipal urban forestry policy, the level of agreement indicated by respondents was much lower than for general attitudes towards trees (Table 5). The highest number of respondents agreed with or strongly agreed with policy statements 2 and 3, which focused on the municipality providing information or reduced cost planting material to residents as a way to encourage planting on private property. The lowest level of support was for policy 4, which restricts tree removal on private property (Table 4). It was somewhat surprising that only about 60% of survey respondents indicated agreement with the municipal policies even when those policies were simply supporting voluntary planting.

Table 3: Percentage of respondents who indicated agreement with statements related to presence of trees.

	Mineola	Lakeview	Meadowvale	Rathwood
Ideally, I would like to live in a neighbourhood with large trees.	96	85	89	83
Ideally, I would like live in a neighbourhood with a tree in front of most houses.	89	82	91	85
Ideally, I would like to see at least one tree when I look out my window.	96	94	97	96
Having at least one tree at on my property is important to me	93	92	92	89
My ideal front yard would have at least one tree (including publicly owned street trees)	87	87	92	83
My ideal back yard would have at least one tree	93	88	86	79
I would like my current neighbourhood to have more trees	39	40	66	55

The survey also asked respondents to indicate the types of vegetation located in their front and back yards. Only ten households reported having no front yard, with most of these located in Rathwood. Overall, 94% of residents have grass in their front yard and 91% have grass in their backyard (Table 6). Presence of shrubs and flowers beds is also quite common in both front and back yards, however, only 2% of survey respondents grew fruits and vegetable in their front yard, while 43% have fruits or vegetables growing in their backyard. While there are few differences in grass presence between neighborhoods, the older neighborhood (Lakeview and Mineola) properties are more likely to have shrubs and flower beds.

There is a range of tree densities present on respondents' properties across the neighbourhoods (Table 7). The highest density is located in Rathwood, while the lowest levels are in the older neighborhoods (Lakeview and Mineola). It is important to remember that tree density does not account for canopy size; in Rathwood and Meadowvale the trees are typically much smaller than in Lakeview and Mineola, translating into lower canopy cover in the two

Table 4: Percent of respondents who indicated agreement with statements about possible benefits and costs of trees.

Property Statements	Mineola	Lakeview	Meadowvale	Rathwood
Neighbourhoods with trees are more attractive than those without trees.	94	98	97	93
Trees provide environmental benefits that I want in my neighbourhood.	98	98	98	95
I like the cooling benefits trees provide by shading my house in the summer.	86	92	83	87
Trees attract wildlife I like to see in my yard.	72	84	62	63
I do not want trees in my neighbourhood because they create a physical hazard (i.e. falling branches).	9	9	8	11
Trees make a neighbourhood look less tidy.	7	3	7	5
I do not want trees in my neighbourhood because they make the neighbourhood less safe (i.e. block views, create hiding places).	9	7	8	8
I do not want trees in my neighbourhood because they contribute to my allergies.	3	1	2	4
Trees require more work than they are worth.	7	3	4	10
I do not like trees in my yard because their roots cause problems (i.e. interfere with pipes, crack sidewalks)	14	4	12	15

newer neighbourhoods. Just over 15% of respondents removed a tree from their yard in the last year, while fewer planted new trees, indicating that tree densities may have slightly declined. However, just over half of respondents have planted at least one tree since residing in their house, with planting numbers highest in the higher income neighborhoods (Mineola & Meadowvale), and lowest in renter-dominated Rathwood.

Table 5. The percent of respondents who indicated agreement with the policy statements.

Policy	Mineola	Lakeview	Meadowvale	Rathwood
1: More municipal planting	33	36	58	47
2: Information for residents	65	46	73	57
3: Low cost trees for residents	63	50	75	61
4: Tree removal by-law	43	33	43	51

Table 6. Percent of respondents with non-tree vegetation types in the front and back yard.

Vegetation Types Present	*Mineola*	*Lakeview*	*Meadowvale*	*Rathwood*
		Front Yard		
No Front Yard	0	1	2	6
Grass	96	97	95	90
Flowers	92	98	82	77
Shrubs	90	82	67	60
Fruits & Vegetables	2	4	1	3
		Back and Side Yard		
No Back/Side Yard	0	1	0	1
Grass	93	92	97	80
Flowers	88	84	77	71
Shrubs	91	79	68	49
Fruits & Vegetables	46	51	41	36

Table 7. Trees conditions and management on properties.

	Mineola	Lakeview	Meadowvale	Rathwood
Tree Density (per 1000m^2)	14.6	13.2	18.8	28.3
Canopy Cover	39%	26%	21%	24%
Removed one or more trees in the last year	18%	16%	15%	16%
Planted 1 or more trees in the last year	9%	16%	10%	9%
Planted a tree since moving into house	58%	47%	62%	31%

4. Objective 2: Property and Household Characteristics Related to Tree Conditions

4.1 Methods

The relationship between the two tree measures and potential property-level explanatory variables was then explored. The tree measures are percent canopy cover and tree density. Percent canopy cover is important in assessing urban forest benefits, as the amount and quality of services provided by trees increases with the amount of leaf cover. Tree density captures trees of all sizes, including younger trees that do not contribute significantly to percent canopy cover but are still a vital part of the urban forest structure. From a management perspective, tree density is easier to alter over a short period, through tree planting or removal, while increases in canopy cover tend to occur more slowly.

A statistical method known as multiple regression was employed to determine the best combination of property-level variables that can predict variations in the tree measures at the individual property-level. The property-level variables are a variety of property and household characteristics, selected based on a review of the literature. The variables can be grouped into four categories: neighbourhood, attitudes, characteristics of individual property, and household characteristics (Table 8).

4.2 Results

The regression analysis, with percent canopy cover as the dependent variable, highlighted a number of significant explanatory variables (Table 9). The three variables with the strongest relationship to percent canopy cover are the Mineola neighborhood, the amount of available planting space and the Lakeview neighborhood. According to this model, properties in older neighborhoods (Mineola, Lakeview), households with positive attitudes towards trees, and properties with more available planting space tend to have higher percent canopy cover.

Households who have removed trees, identify as South Asian, and live further from a park tend to have lower canopy cover. The overall fit for this model was an R^2 of 0.225, indicating almost a quarter of the variation in canopy cover can be account for in this model.

Table 8: Potential property and household explanatory variables used in the multiple regression analysis.

Category	Variables
Neighbourhood	Lakeview Meadowvale Mineola Rathwood
Attitudes	PCA_Municipality: a composite variable of policy support PCA_Trees: a composite variable of attitudes
Characteristics of Individual Property	Type of house: fully detached, semi, townhouse Amount of available plantable space Number of trees removed last year Distance to nearest park Growing fruits and/or vegetables Household income Education (university degree)
Household Characteristics	Number of years at current home (length) Ownership status Household members: Under 18 18 to 64 65 and over Ethnic Background(s): British Isles European South Asian East and South East Asian Caribbean Latin American Other

Table 9: Percent canopy cover multiple regression results. Variables are listed in order from most to least significant (p-value < 0.05 = significant).

Variables	Standardized Coefficient (β)	p-value
Mineola	0.349	0.000
Plantable space	0.271	0.000
Lakeview	0.161	0.001
Rathwood	0.148	0.003
PCA_Trees	0.112	0.012
Number of trees removed last year	-0.096	0.028
South Asian	-0.095	0.032
Distance to nearest park	-0.126	0.058
R^2	**0.225**	

When tree density is the dependent variable, six explanatory variables are significant. The three most significantly variables are the amount of available plantable space, the Rathwood neighbourhood and the number of trees removed in the last year. Here, we see properties with less planting space available tends to have higher trees densities, opposite the relationship with percent canopy cover. Further, properties that have higher tree densities were more likely to have had a recent tree removed, perhaps an indication that those who are actively managing their yard are removing and planting higher number of trees. These new trees are likely relatively small, accounting for the opposite relationship that tree removal has with percent canopy cover. The overall fit for this model was an R^2 of 0.141, indicating that about 14% of the variation in tree density can be by this model.

Table 10: Summary of tree density multiple regression results. Variables are listed in order from most to least significant (p-value < 0.05 = significant).

Variable	Standardized Coefficient (β)	p-value
Plantable space	-0.282	0.000
Rathwood	0.228	0.001
Number of trees removed last year	0.144	0.002
PCA_Trees	0.124	0.007
Lakeview	-0.123	0.012
Type of House	-0.127	0.083
R^2	**0.141**	

5. Conclusions

The vast majority of respondents in our four Mississauga neighbourhoods prefer to have trees present in their neighbourhoods and yards, and appreciate the environmental benefits that trees can provide. On the other hand, residents show weaker support for municipal urban forest policies, indicating that residents prefer greater control over the trees on their properties. Overall, tree presence calculations show that all neighbourhoods have moderate to high quantities of trees and canopy cover present.

According to the statistical analysis, there were three variables that were significant for both percent canopy cover and tree density: the amount of available planting space, number of trees removed in the past year and residents attitudes towards trees. Planting space is positively related to tree cover, highlighting the role of basic space limitations in determining the size and extent of tree cover. Number of trees removed in the past year is also significantly related to percent canopy cover (negatively) and tree density (positively), suggests that people are replacing older, mature canopy trees with younger trees that have smaller canopies. The positive relationship between people's attitudes towards trees and higher tree measures confirms the hypothesis that if people like trees, they are more likely to plant and care for them. At the individual property-scale, household income appears to be not important in predicting tree cover variations. Additionally, the combined neighbourhood results do not show that wealthier neighbourhoods have high percent canopy cover or tree density. Income has been linked to tree cover in the past, however, it seems to have little or no effect on tree cover for the samples in this study.

The overall results of this study demonstrate that residents of single-family properties are actively managing local urban forests, with their attitudes and activities related to property-level tree conditions. The analysis also shows that space constraints have an important relationship to tree characteristics. Future research and management should focus on the actions and motivations of residents, given their direct role in shaping the urban forest.

6. Acknowledgements

We would like to thank Lionel Nelson (TRCA), Janet McKay (LEAF), Leah Birnbaum, and Charles Keenan for providing comments on an earlier version of the survey. Elizabeth Bang, Kyle Brannen and Ray Ziemba helped disseminate and analyze the survey. This work would not have been possible without the many willing survey participants. Funding provided by the Social Science and Humanities Research Council (SSHRC).

7. References

Alberti, M. (2005). The effects of urban patterns on ecosystem function. *International Regional Science Review,* 28(2), 168-192.

Conway, T. & Hackworth, J. (2007). Urban pattern and land cover variation in the Greater Toronto Area. *Canadian Geographer / Le Géographe Canadien,* 51(1), 43-57.

Conway, T. & Urbani, L. (2007). Variations in municipal urban forestry policies: A case study of Toronto, Canada. *Urban Forestry and Urban Greening,* 6(3), 181-182.

Dillman, D.A. (2007). *Mail and Internet surveys: The tailored design method*. 2nd edition. New York: John Wiley.

Grove, J.M., Cadenasso, M.L., & Burch, W.R. (2006). Data and methods comparing social structure and vegetation structure of urban neighborhoods in Baltimore, Maryland. *Society and Natural Resources,* 19(2), 117-136.

Heynen, N. & Lindsey, G. (2003). Correlates of urban forest canopy cover. *Public Works Management & Policy,* 8(1), 33-47.

Hitchmough, J.D., & Bonugli, A.M.. (1997). Attitudes of a medium sized town in south west Scotland to street trees. *Landscape Research,* 22,327–337.

Landry, S.M., & Chakraborty, J. (2009). Street trees and equity: evaluating the spatial distribution of an urban amenity. *Environ. Plann A,* 41, 2651–2670.

McPherson, E.G. & Muchnick, J. (2005). Effects of street tree shade on asphalt concrete pavement performance. *Journal of Arboriculture,* 31(6), 303-309.

Nowak, D.J., Rowntree, R.A., McPherson, E.G., Sisinni, S.M., Kerkmann, E.R., & Stevens, J.C. (1996). Measuring and analyzing urban tree cover. *Landscape and Urban Planning,* 36(1), 49-57.

Shakeel, T. (2012). *Homeowners as Urban Forest Managers: Examining the Role of Property-level Variables in Predicting Variations in Urban Forest Quantity Using Advanced Remote Sensing and GIS Methodologies*. Unpublished Master's Thesis. Department of Geography, University of Toronto.

Smardon, R.C. (1988). Perception and aesthetics of the urban-environment: Review of the role of vegetation. *Landscape and Urban Planning,* 15(1-2), 85-106.

Statistics Canada. (2011). Census profile, Mississauga, Ontario, Census Division. http://tinyurl.com/dytvvqq.

TRCA (2011). *Peel Region Urban Forest Strategy*. Toronto: Toronto and Region Conservation Authority.