

SPECIAL REPORT

TD Economics



June 9, 2014

URBAN FORESTS: THE VALUE OF TREES IN THE CITY OF TORONTO

Highlights

- Urban forests are made up of the trees, shrubs and other flora and fauna that line the streets, parks and ravines of our cities.
- Urban forests do more than beautify the scenery. They represent an important investment in environmental condition, human health and the overall quality of life.
- The trees in the City of Toronto's urban forest are worth an estimated \$7 billion, or about \$700 per-tree.
- Toronto's urban forest provides residents with over \$80 million, or about \$8 per-tree, worth of environmental benefits and cost savings each year. For the average single family household, this works out to \$125 of savings per annum.
- For every dollar spent on annual maintenance, Toronto's urban forest returns anywhere from \$1.35 – \$3.20 worth of benefits and cost savings each year.
- Maintaining the health of our urban forests is the best way to protect the value of our green investment.

Urban forests are made up of the trees, shrubs and other flora and fauna that line the streets, parks and ravines of our cities. Urban forests play a much greater role than just beautifying the scenery. The green space provided by Toronto's urban forest is a critical factor in environmental condition, human health and the overall quality of life. Using the City of Toronto's urban forest as an example, we demonstrate how an investment in urban forests is an investment in the overall economic and environmental well-being of urban society.

Toronto's urban forest

"Forest" might not be the first word that comes to mind when we think of a bustling urban centre like Toronto – the most populous city in Canada. However, beyond the business and condo towers lie 10 million trees comprised of at least 116 different species that make up Toronto's urban forest. From a bird's-eye view, these trees appear as a lush green canopy that covers nearly 30% (190 km²) of the City of Toronto. The density of Toronto's urban forest is on average 16,000 trees per square kilometre or about four trees per person in the city. The majority of Toronto's urban forest is located in its ravines and river valleys, such as the Don Valley, Highland Creek and Rouge River watersheds (see Chart 1), which have been largely undisturbed by the city's expansion.

There has been increasing recognition of the environmental

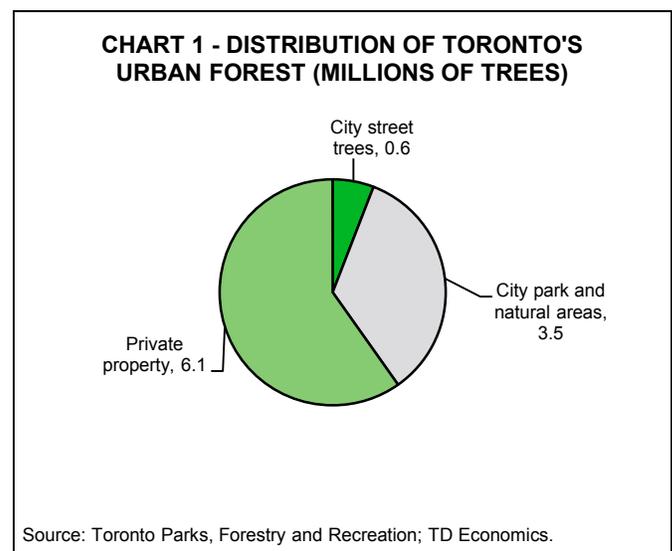


Table 1 - Annual benefits provided by Toronto's urban forest

| Benefit | Description | Tangible benefit | \$ value (millions) | \$/tree |
|---------------------------|--|--|---------------------|-----------------|
| Wet-weather flow | Reduced strain on water transportation and processing infrastructure from rain and wet-weather flow intercepted. | 25,112,500 cubic metres | \$53.95 | \$5.28 |
| Air quality | Air pollutants absorbed removed and avoided by street trees. | 1,905 tonnes | \$19.09 | \$1.87 |
| Energy savings | Energy saved through shading and climate moderation. | 749,900 MBTU of natural gas 41,200 MWH of electricity | \$6.42 | \$0.63 |
| Carbon sequestration | Carbon sequestered from the atmosphere and emissions avoided through energy savings.* | 36,500 tonnes | \$1.24 | \$0.12 |
| Energy emission abatement | Carbon emissions from fossil fuel power generation avoided through climate moderation. | 17,000 tonnes | \$0.58 | \$0.06 |
| Total benefit | Sum of economic benefits provided by urban forests. | - | \$81.29 | \$7.95 |
| Cost benefit ratio | Benefits to citizens for every \$ spent on maintenance. | - | - | \$1.35 - \$3.20 |

* Carbon avoided and sequestered is net of the emissions from the decomposition and maintenance of trees.

Source: Toronto Parks, Forestry & Recreation, TD Economics.

and economic benefits urban forests provide in recent years. As a result, Toronto's urban forest is viewed as an investment in the economic and environmental wellbeing of the city. In the following, we describe the dollar value of some of the benefits provided by Toronto's urban forest. It's important to keep in mind that these values only quantify a portion of the overall value provided by urban forests. Many of the benefits that are important to communities – aesthetic values, recreational spaces, community importance – are difficult to quantify and are not included in our valuation.

Valuing Toronto's urban forest

With urban forests abundantly lining city streets, parks and ravines all around us, it's easy to forget that these trees have a monetary value. The replacement value (what it would cost to remove a tree and replant a similar one) of the 10 million trees that make up Toronto's urban forest is valued at over \$7 billion, or about \$700 per tree.

Beyond their value as a commodity, our urban forests provide a range of important environmental benefits that improve living standards, while also providing major cost savings to households.

Wet-weather flow reduction

Urban forests help ease the burden of managing snow, rain and other wet-weather flow by intercepting falling precipitation in their canopy, increasing the amount of water absorbed into the ground, and reducing soil erosion. Wet-weather runoff carries pollutants into the city's water supply and, in situations of heavy rainfall, can overburden processing infrastructure, which strains equipment and

shortens its lifespan. This is ultimately very costly.

Each year, Toronto's urban forest intercepts an estimated 25 million cubic metres of wet-weather flow. The annual cost savings this provides through reducing burdens on processing infrastructure and mitigating property damage is valued at over \$50 million (see Table 1) – although differences in land use and the distribution of trees in Toronto mean that the benefits of slowing wet-weather flow are more pronounced in some areas than others.

Air quality

Urban forests produce oxygen, absorb air pollutants, and capture particulate matter like dust, ash, dirt and pollen in their canopy. Toronto's urban forest removes about one-quarter of the annual emissions produced by industry within the city – that's about 19,000 metric tons of air pollution removed from the atmosphere annually. Comparatively speaking, the amount of particulate matter removed by Toronto's urban forest each year is equivalent to the amount released by over one million automobiles or 100,000 single family homes (See Table 2).

It is possible to place a monetary value on the indirect benefits provided by pollution removal provided by urban forests. The value of pollution removal is based on the externality costs of pollution, which are the avoided economic damages that air pollution would place on society through its impact on the population. Moreover, we can place a price on the pollution captured by urban forests relative to what it would cost to remove the same amount using technology. By using these techniques, we can estimate that the amount of air pollution abated by Toronto's urban forest generates

Table 2 - Air pollution removed by Toronto's urban forest

| Pollutant removed | Tonnes per-year | Equivalent annual automobile emissions | Equivalent annual single family home emissions |
|--------------------|-----------------|--|--|
| Carbon stored | 1.1 million* | 733,000 | 367,900 |
| Carbon sequestered | 10 | 30,900 | 15,500 |
| Carbon monoxide | 10 | 44 | 180 |
| Nitrogen oxides | 297 | 20,700 | 13,800 |
| Sulfur dioxide | 62 | 99,900 | 1,700 |
| Particulate matter | 357 | 1,047,000 | 101,100 |

* Refers to the total amount carbon stored in woody tissues of Toronto's urban forest - not an annual value.

Source: Toronto Parks, Forestry & Recreation; TD Economics.

an annual savings of \$19 million – just under \$2 per tree (see Table 1).

Climate moderation and energy savings

Depending on where they are planted, trees can reduce the energy consumption of buildings by providing shade, evaporative cooling and blocking winter winds. Properly situating trees around a structure can reduce air-conditioning needs in warm seasons by one third and heating requirements in cooler seasons by one quarter. In fact, the annual net cooling effect of a young healthy tree is equivalent to ten room-sized air conditioners operating twenty hours a day. Climate moderation provided by urban forests lowers energy demand for cooling and heating, which can translate into a cost savings for households and businesses. Energy savings provided by climate moderation can also improve air quality by reducing reliance on some emission intensive energy sources.

Every year, Toronto's urban forest abates 750,000 MBTU of natural gas consumption and over 40,000 MWH of electricity. That works out to a \$6.5 million/year energy savings for businesses and households (see Table 1). Reduced energy consumption also avoids 17,000 tonnes of greenhouse gas emissions from emission intensive energy sources each year, providing an additional annual savings of \$400,000 to \$600,000. On their own, these effects might seem small, but over the long term, these benefits make a significant contribution to environmental wellbeing.

Carbon storage and sequestration

Urban forests play an important role in mitigating the effects of climate change through the storage and sequestration of carbon. As trees grow, they naturally remove carbon

from the atmosphere and store it within their woody tissues. The total amount of carbon currently stored in Toronto's urban forest is estimated at 1.1 million tonnes. To put this in perspective, this is equivalent to the amount of carbon emitted by 700,000 automobiles each year (see Table 2). In addition to carbon storage within woody tissue, urban forests also sequester carbon from the atmosphere through the photosynthesis process. Every year, the City of Toronto's urban forest sequesters over 46,000 tonnes of carbon, which is equivalent to the annual carbon emissions from 31,000 automobiles or 16,000 single family homes (see Table 2).

The value of carbon stored within the woody tissues of Toronto's urban forest is estimated to be between \$27 and \$37 million – to put this in perspective, that's about \$160,000 – \$230,000 per square kilometre. In addition, the total amount of carbon sequestered by Toronto's urban forest through photosynthesis is valued at \$1 to \$1.5 million per annum.

Property values

An additional benefit of urban forests is that they increase the property values of land, support higher rents and generate more property tax revenue. In some locations, rental rates of commercial office properties are about 7% higher on sites having a high quality landscape that includes trees. A study of New York City also reported that having trees on, or near, property generates an additional US\$90 in property taxes. While it's hard to pin down the exact amount our urban forests contribute to property values in Toronto, there is a clear correlation between residential property values and proximity to trees and green space.

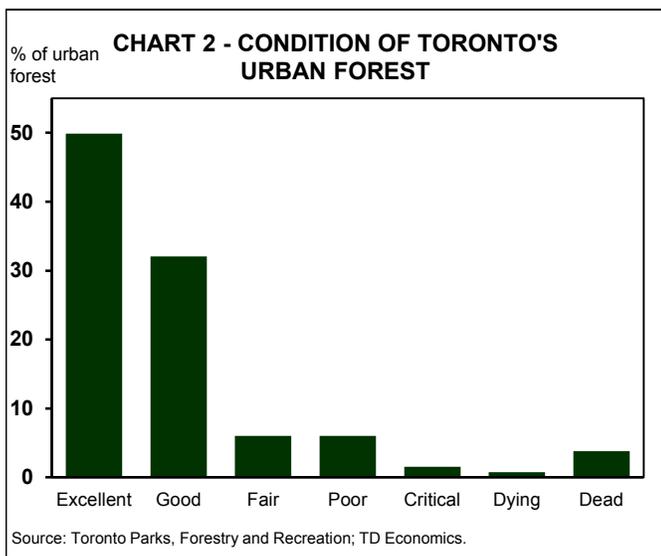
Maintaining our urban forests

Not all trees are created equal, and the benefits they provide vary, depending on size and species. But, as a general rule of thumb, we can say bigger is better. Large, healthy

Table 3 - Air effects of average tree in Toronto by size

| Diameter of tree | Carbon stored (kg) | Carbon sequestered (kg/yr) | Pollutants removed (kg/yr) |
|------------------|--------------------|----------------------------|----------------------------|
| 0cm - 15cm | 9 | 1 | 0.1 |
| 15cm - 30cm | 89 | 6 | 0.3 |
| 30cm - 45 cm | 283 | 12 | 0.5 |
| 45cm - 60 cm | 655 | 19 | 0.7 |
| 60cm - 75cm | 1176 | 29 | 1.0 |
| > 75 cm | 2709 | 52 | 1.8 |

Source: United States Department of Agriculture, TD Economics.



trees absorb up to 10 times more air pollutants, 90 times more carbon, and contribute up to 100 times more leaf area to our urban forest canopy relative to smaller trees (see Table 3). That's not to say smaller plants don't do their fair share. The shrubs in Toronto's urban forest contribute about a quarter of the air quality benefits that trees do.

Maintaining the health of our existing urban forests is the best way to secure larger trees, grow the value of our natural capital and ensure they continue to provide environmental benefits. Maintenance is important, as there are serious threats to the health of our urban forests. Invasive species, such as the European Gypsy Moth and the Emerald Ash Borer, pose a significant threat to almost 10% (\$570 million) of Toronto's urban tree population. The Asian Long Horned Beetle – which poses a threat to \$4 billion worth of Canadian urban forests – was previously thought to be eradicated in Canada. However, it was re-discovered in western Toronto in October 2013. Efforts to maintain our urban forests make a world of difference, and the vast majority of Toronto's urban forest is in good or excellent condition (see Chart 2).

It's only natural to question if the benefits of maintaining an urban forest outweigh the costs, especially in heavily urbanized environments, where plant life has difficulty thriving naturally. Using the 2011 City of Toronto parks and forestry budget proposal as a reference point, we can say that the annual maintenance cost of a tree is roughly \$4.20. For every dollar spent on maintenance in Toronto's urban parks, trees return \$3.20 to the community, but this number can vary based on the type of land on which the trees are located. For example, trees located in areas where it is difficult for them to grow – such as street trees – return about \$1.35 of benefits for every dollar spent. Despite this variation it's clear that the benefits provided by Toronto's urban forest outweigh the cost of maintaining them.

Bottom line

Urban forests are made up of the trees, shrubs and plants that grow in our yards and parks and that line our streets. Torontonians recognize that their urban forest represents an important investment in the city's environmental condition, human health and societal wellbeing. Indeed, the 10 million trees that make up the City of Toronto's urban forest are valued at over \$7 billion and provide an additional \$80 million of environmental benefits and cost savings each year. Although it's important to keep in mind that the true value of our urban forests is much larger than is reflected in these figures, as they do not include some important benefits such as aesthetic and cultural value, and recreational. Maintaining our urban forests makes sense, as every dollar spent on maintenance returns \$1.35 – \$3.20 worth of benefits to residents of the City of Toronto. The cost savings produced by our urban forests make it clear that keeping the green on our streets, keeps the green in our wallets.

*Craig Alexander, SVP & Chief Economist
416-982-8064*

Connor McDonald, Economist

This report is provided by TD Economics. It is for informational and educational purposes only as of the date of writing, and may not be appropriate for other purposes. The views and opinions expressed may change at any time based on market or other conditions and may not come to pass. This material is not intended to be relied upon as investment advice or recommendations, does not constitute a solicitation to buy or sell securities and should not be considered specific legal, investment or tax advice. The report does not provide material information about the business and affairs of TD Bank Group and the members of TD Economics are not spokespersons for TD Bank Group with respect to its business and affairs. The information contained in this report has been drawn from sources believed to be reliable, but is not guaranteed to be accurate or complete. This report contains economic analysis and views, including about future economic and financial markets performance. These are based on certain assumptions and other factors, and are subject to inherent risks and uncertainties. The actual outcome may be materially different. The Toronto-Dominion Bank and its affiliates and related entities that comprise the TD Bank Group are not liable for any errors or omissions in the information, analysis or views contained in this report, or for any loss or damage suffered.