Urban trees can provide numerous benefits to society
Photo by David Lorenz Winston
(Provided courtesy of USFS)

# Taking Stock: The First Step to Creating Healthier Cities with Trees

## By David Nowak, USDA Forest Service

With 55% of the world's population living in urban areas, which average 26.5% tree cover, trees are important landscape elements in most cities. Globally, tree cover varies from around 31% in forested regions, to 19% in grassland regions, to 13% in desert areas. Thus, because they are a significant component of all city landscapes to varying degrees, trees are important elements that will affect the health and well-being of local city residents.

City trees provide numerous benefits to society that include cooling air temperatures, reducing building energy use and atmospheric carbon dioxide ($CO_2$), improving air and water quality, mitigating rainfall runoff and flooding, enhancing human health and social well-being and lowering noise impacts. In the United States, urban areas contain an estimated 5.5 billion trees that cover 39.4% of urban areas. These trees conservatively produce over $18.3 billion in value annually due to air pollution removal ($5.4 billion), reduced building energy use ($5.4 billion), carbon sequestration ($4.8 billion) and avoided pollutant emissions ($2.7 billion). Numerous other benefits (e.g., improved psychological health, higher real estate values, noise reduction, etc.) remain to be quantified.

Urban forests also have various costs associated with tree planting, maintenance and removal, and other indirect costs such as allergies from tree pollen, increases in winter building energy use due to tree shade from both evergreen and deciduous trees, and changes in local biodiversity due to invasive or exotic plants. While urban trees remove air pollution and reduce pollution concentrations overall, in some cases tree cover that overarches roadways can limit pollution dispersion and increase local pollution concentrations. Understanding the cost and benefits related to urban trees can lead to better designs to improve the urban environment with trees.

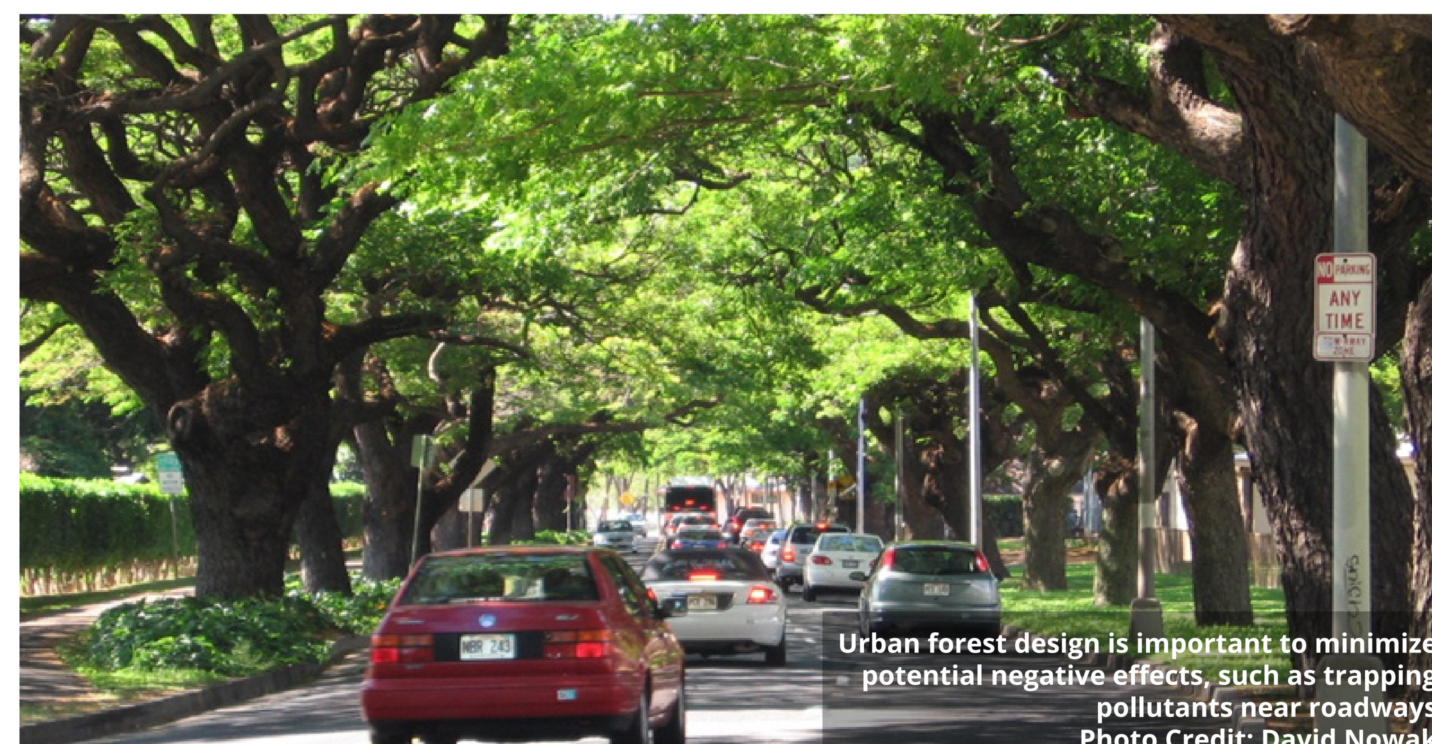
**Changing City Tree Populations**

The importance of urban trees and forests will increase in the coming years as urban populations increase and urban land expands. Global urban populations are expected to increase another 2.5 billion by 2050, increasing the proportion of the global urban population to 68%. Urban land in the United States is projected to increase from 3.6% (67.6 million acres) in 2010 to 8.6% (163.1 million acres) in 2060. This projected increase of 95.5 million acres is an increase in urban land larger than the state of Montana. While urban land and populations are expanding, the percent tree cover within existing urban areas is on the decline in recent years. Within existing urban areas, the average global urban tree cover had a slight, but statistically significant decline from 26.7% to 26.5% (c. 2012-2017), or a loss of about 100,000 acres per year. Concurrent with tree loss on urban land was an increase in impervious cover among all continents, which globally had a statistically significant increase from 24.3% to 25.9% (800,000 ac/year). In the United States, urban tree cover dropped by one percent between 2009-2014 (40.4% to 39.4%), which equates to a loss of about 28.5 million trees per year. Estimated loss of benefits from trees in urban areas is conservatively valued at $96 million per year. Urban impervious cover in the U.S. had a statistically significant increase from 25.6 percent to 26.6 percent (+1.0 percent), which equates to an annual increase of 131,000 acres of impervious cover per year.

**Factors Influencing Urban Tree Populations**

Various factors affect the amount, type and changes in tree cover within cities. Numerous forces can decrease tree cover, including development, insects and diseases, fire, climate change, storms, old age (natural tree attrition) and tree removal due to perceived risks to humans. Various factors can also increase tree cover, including tree planting, but more importantly natural regeneration. As 75% of the world's urban population lives in forested regions that have ample precipitation and seed sources, natural regeneration can dominate the influx of new trees. In the US and Canada, about 2 in 3 trees in cities come from natural regeneration. The percentage of the tree population planted is greater in managed land uses (e.g., residential) and in cities developed in grassland vs. forested areas; the percentage of trees planted also tends to increase with increased population density and percent impervious cover in cities.

Dominant factors affecting the amount of urban tree cover are the surrounding natural environment (i.e., water availability, seed sources), population density and associated impervious surfaces that limit regeneration, and




Urban forest design is important to minimize potential negative effects, such as trapping pollutants near roadways
Photo Credit: David Nowak

management activities (e.g., mowing, which limits natural regeneration, and tree planting).

**Assessing Local Urban Tree Populations and Values**

Given the numerous factors that affect and change urban forests, it is important to understand local urban forest composition and impacts to effectively manage this resource to improve human health and well-being in cities. Although city managers know they have trees, without rudimentary information about this resource, it cannot be adequately managed and sustained. City managers often know how many people, cars, buildings, light poles, etc., that they have, but have limited to no information on their vegetation resource. As these forests provide millions of dollars of benefits at the local scale, investment in a better understanding of this resource is paramount. The first step to understand this resource is taking stock of the current resource and its values. Managing a city without understanding its tree resource, which on average occupies one-quarter of the city area, is like managing a grocery store without knowing what is on one-quarter of the grocery store shelves. Basic stock, or inventory, information is essential to better management and developing plans to optimize forest values for current and future generations.

To this end, the USDA Forest Service, the Davey Tree Expert Company and several partners have developed i-Tree (www.itreetools.org), a suite of free tools that aid in easily quantifying local urban forest structure and values. These tools provide information on forest structure that aids managers by revealing species composition, sizes, locations and potential forest risks (e.g. insects and diseases) as well as information on numerous services, costs and values (Table 1). Assessments can be conducted using field or aerial-based data. i-Tree is based on peer-reviewed science and has more than 410,000 users in 130 countries.


Color enhanced aerial image of New York City illustrating variations in vegetation cover. Image Credit: USFS

The core program of the i-Tree suite is i-Tree Eco. This model, which can be used globally, uses field-based sample or inventory data and local environmental data to assess and forecast forest structure, benefits, threats and values for any tree population. i-Tree Eco includes: plot selection tools; mobile data entry applications; tabular and graphic reporting and exporting; and automatic written report generation.

Remeasuring field and aerial data through time also provides a means to monitor changes in local urban forest resources and values. In the United States, the USDA Forest Service Forest's Urban Forest Inventory and Analysis Program is measuring urban forest data annually and uses i-Tree to assess current stock and changes in structure, services and values through time. Thirty-five cities were monitored in 2019 with new cities to be added to the monitoring program annually. Assessing both current stock and changes in stock through time are essential to sustaining adequate and healthy urban forests in the future.

The i-Tree tools have been used to aid forest management plans, assess risks, justify tree planting programs, protect urban tree resources, and justify financial support for urban forestry programs. These tools make it easy for everyone to assess their local urban forest resource and its value, which is the key first step to creating healthier cities with trees.

i-Tree™

### Other i-Tree tools include:

- **i-Tree Species** – selects the most appropriate tree species based on desired environmental functions and geographic area;
- **i-Tree Hydro*** – simulates the effects of changes in tree cover and impervious cover on runoff, stream flow and water quality;
- **i-Tree Canopy*** – allows users to easily photo-interpret Google aerial images to produce statistical estimates of land cover types (historical imagery in Google Earth can also be used in analyzing changes in land-cover types);
- **i-Tree Design** – links to Google Maps and enables users to quantify the current and future benefits of trees on their properties;
- **MyTree –** easily assesses the benefits of one to a few trees using a phone via a mobile web browser; and
- **i-Tree Landscape** – allows users to explore tree canopy, land cover, tree benefits, forest and health risks, and basic demographic information anywhere in the United States and to prioritize areas for tree planting and protection.

* Indicates that the tool can be used globally.

**Table 1.** Benefits and costs of trees currently quantified and in development in i-Tree

| Ecosystem Effect | Attribute | Quantified | Valued |
|---|---|---|---|
| Atmosphere | Air Temperature | ● | O |
| | Avoided emissions | ● | ● |
| | Building energy use | ● | ● |
| | Carbon sequestration | ● | ● |
| | Carbon storage | ● | ● |
| | Human comfort | O | |
| | Pollen | O | |
| | Pollution removal | ● | ● |
| | Transpiration | ● | |
| | Ultraviolet radiation | ● | O |
| | Volatile organic compound emissions | ● | |
| Community/Social | Aesthetics/property value | O | O |
| | Food/medicine | O | |
| | Health index | O | |
| | Forest products | O | O |
| | Underserved areas | ● | |
| Terrestrial | Biodiversity | O | |
| | Invasive plants | ● | |
| | Nutrient cycling | O | |
| | Wildlife habitat | ● | |
| Water | Avoided runoff | ● | ● |
| | Flooding | O | O |
| | Rainfall interception | ● | |
| | Stream temperature | ● | |
| | Water quality | ● | ● |

●= attribute currently quntified or valued in i-Tree
O = attribute in development in i-Tree

**Disclaimer**: The use of trade names in this article is for the information and convenience of readers. Such use does not constitute official endorsement or approval by the United States Department of Agriculture or the United States Forest Service of any product or service to the exclusion of others that may be suitable.

**Resources**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*David J. Nowak is a Senior Scientist and i-Tree Team Leader with the USDA Forest Servic*e



**Liberty Hill, San Francisco**
**Image Credit: Friends of the Urban Forest**