



AMERICAN FORESTS  
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# Climate Change and Urban Forests: Executive Summary

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# Executive Summary

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Increasing levels of atmospheric carbon dioxide and other “greenhouse” gases (e.g., methane, chlorofluorocarbons, nitrous oxide) are contributing to an increase in atmospheric temperatures by the trapping of certain wavelengths of heat in the atmosphere. The projected changes in climate will affect human health and well-being through generally warmer temperatures, but also changes in precipitation patterns, rising sea levels and increased storm intensities and frequencies. As over 80% of the United States population resides in urban areas and many greenhouse gas emissions emanate from urban areas, managing urban areas to mitigate emissions and create resilient cities, given these projected changes, is of paramount importance.

One important attribute in urban areas that can both affect emissions and climate change impacts are urban forests. In 2010, U.S. urban areas occupied 27.4 million hectares (ha) — or 3.6% of land area of the conterminous U.S. — and are projected to increase to 66.0 million ha (8.6%) by 2060. Given that, on average, trees cover 39.4% of urban areas in the U.S., current urban tree cover equates to 10.8 million ha and will increase substantially in the coming years. These trees sequester carbon, but also alter building energy use, which consequently affects emissions from power plants. In addition, these trees alter air temperature and reduce storm water runoff, which can mitigate some of the projected impacts from climate change.

The purpose of this report is to aid in understanding the future impacts of urban forests on climate change mitigation at the county level across the conterminous U.S. This report combines projected changes (2010 to 2060) in urbanization and associated urban tree cover to better understand urban forest impacts related to climate changes.

The report estimates projected changes in urban forests related to carbon storage, building energy use and power plant emissions. Two types of projections were developed: Part 1 addresses projected changes in these effects given projected urban growth; Part 2 projects changes only within existing urban areas (no urban expansion).

## Projected Changes to Urban Forest Services Given Projected Urban Expansion

As urban forests and urban populations expand across the nation, urban forests will become increasingly valuable. Between 2010 and 2060, urban land in the conterminous U.S. is projected to grow by 38.5 million ha, with urban tree cover increasing by 10.8 million ha, doubling total urban tree cover to 21.6 million ha. While the amount of urban tree cover will increase as urban land expands, the average percent tree cover in urban is projected to decline from 39.4% in 2010 to 32.8% in 2060. This decline in percent tree cover is largely attributed to tree cover changes in areas of urban expansion and the recent trend in loss of urban tree cover and increase in impervious cover, which is projected to continue into the future.

Overall, total urban forest carbon storage value is projected to increase by \$175 billion; energy conservation by \$3.3 billion/year; and avoided pollutant emissions by \$1 billion/year (Table 1).

*Table 1. Summary of projected changes in urban area and forest values due to projected urban expansion. Results by county and state are detailed in Part 1 of the report.*

Urban Attribute	2010	2060	Change
Land area (ha)	27.5 million	66.0 million	+38.5 million
Tree cover (ha)	10.8 million	21.6 million	+10.8 million
Tree cover (%)	39.4	32.8	-6.6
Carbon storage (tonnes)	852 million	1.78 billion	+931 million
Carbon storage (\$)	160 billion	335 billion	+175 billion
Energy conservation (\$)	4.1 billion	7.4 billion	+3.3 billion
Avoided carbon emissions (t)	6.1 million	10.3 million	+4.2 million
Avoided total emissions (\$)	1.4 billion	2.5 billion	+1.0 billion

While urban forest carbon storage values will increase substantially, much of this increased value is due to conversion from rural forest storage. Thus, overall carbon storage in rural forests will decrease as urban areas expand, with urban forests gaining some carbon storage from the previously rural land. In addition, while savings from energy use and associated emissions will increase due to increased urban tree cover, overall energy use and emissions will increase as urban areas expand.

Efforts to sustain percent tree cover in urban areas at current levels (39.4%) as urban areas expand are projected to require an annual planting of 25 million trees per year in urban areas, or about one new tree planted annually for every 2.0 ha (4.9 acres) of urban land. Sustaining current percent urban tree cover would retain 353 million tonnes of carbon storage, avoid the emission of an additional 3.3 million tonnes of carbon per year, save an additional \$1.9 billion in energy costs per year, and avoid pollutant emissions with an associated value of \$729 million per year in the year 2060. Sustaining

tree cover through time sustains multi-billion dollars in benefits annually that are otherwise projected to be lost by 2060 in urban areas as urban land expands. These values are conservative as numerous other benefits are not considered (e.g., air pollution removal, air temperature reduction, human health benefits). However, many rural forest values (e.g., carbon storage, timber production, wildlife habitat) will be lost due to urban expansion. Thus, the expansion of urban forests is likely not a net gain in overall forest values for the nation, but rather just a conversion of forests and other land from rural to urban as population expands. This conversion will likely lead to net loss in total forest values as overall forest cover will likely decline; in addition, emissions from urban areas will increase. More research is needed regarding the locally specific drivers and outcomes of changes in tree cover among rural and urban areas as urban areas expand. The information can be used to help develop specific management and policy actions to sustain tree cover and ecosystem services at desired levels.

## Projected Changes to Urban Forest Services in Existing Urban Areas

Given recent losses in urban tree cover in many areas, tree cover within existing urban areas is projected to decline in the coming years. Loss of urban trees is due to many reasons, including urban development (removal of healthy trees), storms, insects and diseases and old age (attrition). A net loss in tree cover indicates that the loss of existing tree canopies is greater than new canopy cover generated through tree growth, natural regeneration and tree planting. Between 2010 and 2060, urban tree cover in existing urban areas (2010) is projected to decrease 39.4% in 2010 to 31.0% in 2060. Overall, total urban forest carbon storage value is projected to decrease by \$34 billion; energy conservation by \$855 million/year; and avoided pollutant emissions by \$318 million/year (Table 2).

*Table 2. Summary of projected changes in urban area and forest values within existing urban areas. Results by county and state are detailed in Part 2 of the report.*

Urban Attribute	2010	2060	Change
Tree cover (ha)	10.8 million	8.5 million	-2.3 million
Tree cover (%)	39.4	31.1	-8.3
Carbon storage (tonnes)	852 million	671 million	-180 million
Carbon storage (\$)	160 billion	126 billion	-34 billion
Energy conservation (\$)	4.1 billion	3.3 billion	- 855 million
Avoided carbon emissions (t)	6.1 million	4.7 million	-1.4 million
Avoided total emissions (\$)	1.4 billion	1.1 billion	-318 million

To sustain urban tree cover through 2060, on average, 23 million trees would need to be planted annually. On average, this planting equates to a national rate of one new tree annually for every 1.2 ha (3.0 acres) of urban land. Planting 23 million trees per year also equates to each urban resident planting one tree every 11.5 years, or about seven trees during their lifetime, to sustain tree cover in existing urban areas. By reducing projected tree losses (i.e., enhancing preservation of existing canopy),

fewer trees would need to be planted to sustain tree cover. Canopy preservation is often a better option to sustain tree cover than planting as existing trees are already established and larger than planted trees. Sustaining current percent tree cover will prevent these losses by sustaining an additional 180 million tonnes of carbon storage and avoiding the emission of an additional 1.4 million tonnes of carbon (Table 2). Additional urban forest values (e.g., air pollution removal, air temperature reduction, human health benefits) would also be sustained.

## Projection Limitations

The projected changes in urban forest ecosystem services are uncertain, with uncertainty increasing as one projects farther into the future. As these projections are often based on current trends, numerous factors in the future could change these projections (e.g., environmental changes, economic changes, urban forest management and urban development policies and patterns). However, the projections illustrate potential changes in urban forest cover and associated ecosystem services given current patterns of change.

As projections are based on recent trends, some estimates are likely overestimates (e.g., loss of urban tree cover in Central Plains states). All estimates will be subject to fluctuations due to numerous factors. As the environment changes so will the forces that affect urban forest health and productivity. Some factors will enhance, and others will decrease health and productivity. In context with the limitations, projected changes can be used as a starting point for discussion on where to direct policies and management to protect future urban forests and populations. Human decisions related to implementing policies and management actions will ultimately guide urban forest change in the coming years.