The Power of Urban Trees



CLIMATE CO CENTRAL

Around 80% of the U.S. population lives in urban areas—and faces particular climate risks. Cities are dominated by pavement, buildings, and dense infrastructure that hold heat and are prone to stormwater runoff. These built environments can amplify the risks associated with extreme heat and heavy rainfall events made more likely in our warming climate.

Alongside buildings and pavement, U.S. urban areas also contain an estimated 5.5 billion trees that provide important benefits to people (see Box 1). A growing body of research shows that urban trees and greenspaces support healthy, equitable, and resilient cities. At the same time, urban forests are themselves vulnerable to urbanization and climate change; they require adequate stewardship to continue benefiting communities.

Box 1. Quantifying benefits from urban trees

Healthy urban forests provide many and varied benefits to humans, known as <u>ecosystem services</u>. These services range from providing food and fiber, to filtering air and water, to supporting wildlife habitat and natural beauty.

Estimates have shown U.S. urban forests provide <u>billions of</u> <u>dollars</u> in benefits each year. Some benefits are localized, such as providing shade along a street. But others are far reaching, such as scrubbing air pollution and sequestering carbon.

The U.S. Forest Service and partner organizations developed i-Tree to quantify and map ecosystem services from trees. i-Tree is a series of <u>free tools</u> that assess and measure urban forests at different scales, from individual trees to canopy cover across an area.

Five benefits of urban trees in a changing climate

The number of Americans that live in urban areas grew by more than 6% from 2010 to 2020. This upward trend is expected to continue. Around 90% of Americans could live in urban areas by 2050 (up from 80% in 2020). Urban land area has been projected to expand by more than 163 million acres by 2060 to accommodate this growing population.

As urban populations continue to expand, there is increasing awareness and concern about the effects from urbanization—including land-use changes, pollution, and, ultimately, increased vulnerability to climate change.

Cities across the country (and world) are incorporating nature into urban landscapes to mitigate urbanization impacts and help communities adapt to climate change.

Urban forests (sometimes called community forests) are the dynamic ecosystems of trees and other vegetation in cities and surrounding communities that can vary greatly in size, layout, and diversity. Urban or community forests can consist of individual yard or street trees; or greenways, nature preserves, and landscaped gardens.

1. PROVIDE SHADE, REDUCE HEAT

Cities are generally warmer than surrounding areas, in part due to the urban heat island effect, through which pavement and buildings retain heat and reflect it back into the surrounding air.

Climate Central applied an index (developed by Sangiorgio et al, 2020) based on albedo (reflected light), greenery, and urban design to evaluate the intensity of urban heat islands in 159 locations across the U.S. The cities with the five most intense urban heat islands are New Orleans, Newark, N.J., New York City, Houston, and San Francisco.

Vegetation is a key factor in the urban heat island index. Trees and greenery help reduce urban heat by lowering surface and air temperatures. Mid-afternoon temperatures can be as much as 20°F hotter in highly developed urban areas compared to nearby areas with vegetation.

Shade trees provide immediate heat relief to people exercising or working outdoors. A wellplaced shade tree near a house can reduce indoor temperatures and, therefore, the energy needed to keep a home cool.

Trees help people save money and stay comfortable—but they can also reduce serious risks from heat exposure. Extreme heat can be dangerous and is the leading weather-related cause of death. One study across 97 U.S. cities suggests that the current urban tree cover might help prevent an average of nearly 300 heat-related deaths annually by reducing air temperatures. Urban heat risks will likely climb alongside warming trends, especially during the summer making urban trees increasingly important for the health and well-being of people in cities.

Box 2. Inequitable distribution of trees and their benefits

Urban trees and their benefits aren't <u>equally distributed</u> across cities and communities, and the disparities are often connected to <u>income and race</u>. One study of more than 5,700 U.S. communities found that low-income areas had <u>15% less tree cover</u> and were more than 2.7°F hotter in the summer compared to high-income areas.

The non-profit organization American Forests developed <u>Tree Equity Score maps</u> to quantify tree equity in cities across the U.S. and inform community planning. City planners and community groups can use tools like i-Tree or Tree Equity Score to prioritize greenspace and tree planting initiatives. <u>Research suggests</u> that tree plantings are best implemented through community partnerships and with meaningful engagement of local residents.

2. PREVENT STORMWATER RUNOFF

A warmer atmosphere can hold more moisture—which increases the chances that rain falls in heavier downpours. As the U.S. has warmed (by approximately 2.5°F) since 1970, 136 locations across the country (out of the 150 locations analyzed) have experienced an increase in hourly rainfall intensity. Extreme rainfall events bring an amount of rain well above normal for the time and location, at a heavier, faster rate—which can elevate local risks of flooding.

Heavy rainfall can be especially problematic in urban areas, which have extensive impervious cover, such as pavement and rooftops, that prevent water from soaking into the ground.

Rainwater instead flows over these impervious surfaces, resulting in stormwater runoff that picks up pollutants and debris before ultimately ending up in local waterways.

High volumes of stormwater runoff can result in flooding—which can be costly and dangerous. Flooding caused \$28 billion in damages during the past five years (2018-2022). Floodwaters also pose risks to public health and safety through exposure to contaminants, water-borne diseases, and debris.

Urban tree canopy can intercept, slow, and temporarily store rainfall to minimize the amount of water that hits pavement and contributes to runoff and flooding. Leaf litter and soil around the base of a tree allow rain to absorb into the ground. Roots stabilize the soil to prevent erosion during heavy rain, and filter rainwater to remove pollutants. In highly developed areas, trees can play an important role in minimizing the amount of stormwater that flushes through a city. Some studies estimate this ecosystem service from trees is valued at millions of dollars annually in cities and watersheds across the U.S.

3. REDUCE AIR POLLUTION

Burning fossil fuels releases harmful greenhouse gases and particulates into the air. The effect on air quality is most acute in urban centers, where the U.S. population is concentrated. Traffic, industrial activity, and heating or cooling buildings are some of the human activities that contribute to urban air pollution.

Air pollution can worsen respiratory disease



and increase risks of cardiovascular disease, and may also increase risks of dementia. Most severely, air pollution can even cause premature death. Children and people with certain preexisting conditions may be more at risk from the health effects of air pollution.

Urban trees can help improve air quality and protect human health. Leaves absorb gaseous pollutants, such as ozone and nitrogen dioxide, and intercept hazardous particulate matter.

4. SEQUESTER CARBON

Carbon pollution is the primary contributor to Earth's rapid warming since the pre-industrial era. Sequestering (removing and storing) carbon from the atmosphere can reduce the planetwarming effects.

Trees use carbon dioxide from the atmosphere during photosynthesis to make food and build new growth. This carbon is stored in every part of a tree's biomass—from roots to trunk to leaves. Trees release some CO2 back into the atmosphere through natural processes; and when a tree eventually dies, its stored carbon is released back into the ecosystem. The amount of carbon a tree can remove, or sequester, each year is related to its species, size, and health.

By removing heat-trapping greenhouse gases from the atmosphere, trees help slow warming and contribute to efforts to meet global climate targets. But humans are emitting carbon into the atmosphere faster than it is absorbed by trees and other terrestrial ecosystems. Naturebased climate solutions such as afforestation must therefore also be paired with substantial cuts in carbon pollution from human activities to combat climate change.



Figure 2: Benefits of trees

5. HEALTH, WELLNESS, AND CONNECTION TO NATURE

Some ecosystem services from trees are challenging to quantify. For example, urban forests provide habitat for wildlife, support biodiversity, and provide access to nature—all of which can help people feel healthy and connected.

Trees have been linked to a number of physical and mental health benefits. Numerous studies have shown that spending time in nature can boost mood, improve

cognition, and reduce stress. The mental health benefits of trees may be more important than ever, since a growing body of research suggests that climate change can worsen mental health and well-being.

Stewardship of urban forests

Planting trees and expanding canopy cover could provide more benefits to more communities. Urban and neighboring areas averaged 42% tree cover circa 2014. In

Box 3. Life cycle of an urban tree

When an urban tree meets the end of its life—whether from natural causes or because it needs to be removed—it can continue storing carbon for many years as urban wood products. Rather than sending a downed street or yard tree to a landfill, some woodworkers harvest and mill the wood. Urban wood is used for lumber or firewood, or creatively transformed into unique furniture or even <u>guitars</u>.

addition to establishing new growth, protecting and enhancing existing urban tree canopy through tree care and stewardship is essential for established trees to continue providing benefits to America's large and growing urban population.

HOW CLIMATE CHANGE AFFECTS TREES

To effectively manage urban forests, it's necessary to understand how they are potentially affect

by climate change. Research suggests elevated atmospheric CO2 increases tree growth and wood volume—meaning there could be more available forest biomass to store carbon. But environmental shifts driven by climate change are broadly putting pressure on trees and forest ecosystems. Changes in temperature and precipitation trends may have critical implications for urban trees.

One study of urban forests across 164 global cities showed that 70% and 76% of urban tree species could be at risk by 2050 due to projected changes in mean annual precipitation and temperature, respectively.

Some fruit and nut trees that inhabit urban food forests could be affected by reduced winter chill—annual periods of chilling temperatures necessary for the trees to produce fruit or flowers in the spring. According to a Climate Central analysis, 181 U.S. locations saw chill decrease since 1980.

In a changing climate, the geographic zones in which particular tree species can survive or thrive is shifting. Climate Central's analysis of 242 U.S. locations showed that 50% (121) experienced an increase in their plant hardiness zone (e.g., from Zone 5 to Zone 6) at some point over the period of analysis (1951-2022). The U.S. Forest Service developed a Climate Change Tree Atlas that summarizes how habitat suitability could continue to shift for common tree species—and describes their adaptability under different warming scenarios for 185 urban areas.

Box 4. Restoring trees after the storm

Extreme weather events driven by climate change can cause severe damage to urban trees, resulting in significant loss for communities. In the aftermath of some major storms, the U.S. Forest Service has deployed <u>Urban Forest</u> <u>Strike Teams</u>—crews of specially trained arborists who can assess hazards and identify salvageable trees. These teams can help communities stay safe after a storm and protect tree canopy. The <u>RETREET program</u> with Keep America Beautiful helps communities replant after disasters, thereby restoring urban ecosystems and building resilience to future extreme weather events.

LIMITS OF URBAN TREES

Globally, cities contribute up to 60% of total greenhouse gas emissions, despite making up only about 2% of land area. Three major U.S. cities—New York, Los Angeles, and Chicago—are among the largest carbon emitters in the world.

Urban trees can support the health and safety of growing urban populations in a warming world, but they are not a

complete solution to the problem. Cutting emissions is the most effective way to slow the rate of warming—in cities and beyond—and protect both human and tree health.

Communities across the country—from major cities to hundreds of local entities—have demonstrated commitments to climate action. Pathways to net-zero differ among cities, but key actions include decarbonizing buildings; improving public transportation and electric vehicle infrastructure; and optimizing waste management.