



Urban Forests for Healthier Cities: Policy, Planning, Regulations, and Institutional Arrangements

Main Question:

What are some of the plans, policies, regulations, and institutional arrangements that cities can use to maintain, strengthen, and expand urban forests?

Who is this guide meant for?

City- and community-level leaders, urban planners, government and NGO officials, and other decision-makers and stakeholders involved in the planning, implementation, and management of urban forests.

What will you gain from reading this guide?

- **Define** urban forests
- **Understand** why urban forests are important to creating healthier, more livable cities
- **Identify** key stakeholders and interventions relevant to urban forests at multiple spatial scales and levels of government
- **Explain** the importance of integrated city planning and policy actions to conserve, manage, and expand the city's urban forests
- **Draw inspiration from** a sampling of international “good practices” to meet multiple goals and objectives across the city

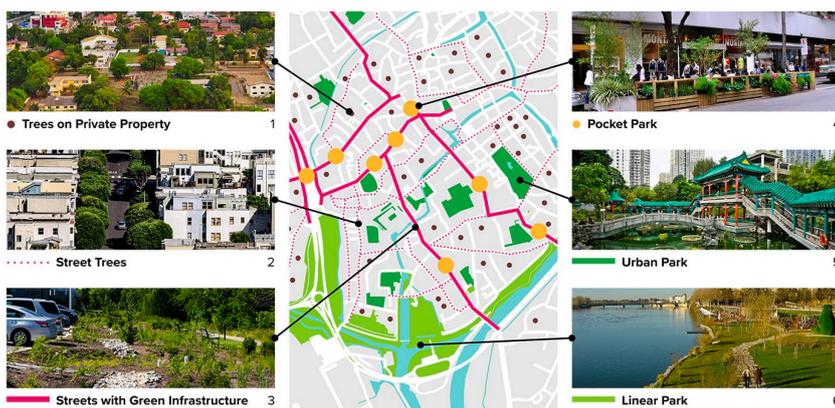
Course Content

What is an Urban Forest?

An urban forest encompasses the trees and shrubs in an urban area, including trees in yards, along streets and utility corridors, in protected areas, and in watersheds. ([Escobedo, Kroeger, & Wagner, 2011](#); [Miller, Hauer, & Werner, 2015](#))

This includes individual trees, street trees, green spaces with trees, and even the associated vegetation and the soil beneath the trees. ([Konijnendijk et al, 2006](#); [Escobedo, Kroeger, & Wagner, 2011](#))

In many regions, urban forests are the most extensive, functional, and visible form of [green infrastructure](#) in cities. Green infrastructure is the natural and semi-natural infrastructure within a city that provides ecosystem services like stormwater management or air pollution abatement. ([Lafortezza et al, 2017](#))

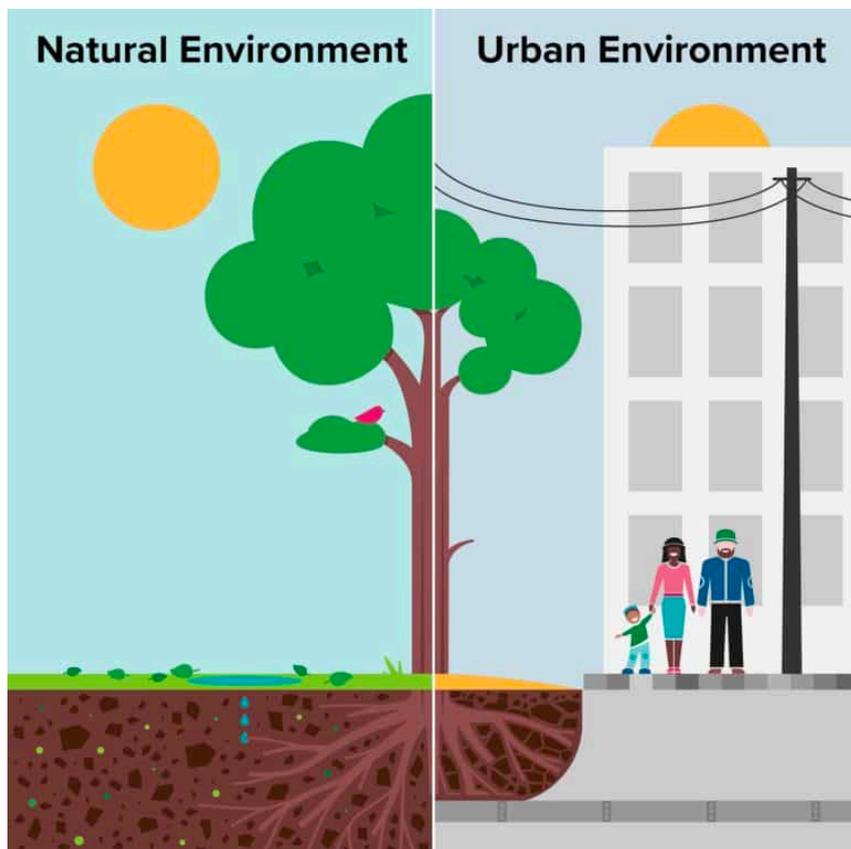


This image provides some examples of where the urban forest can exist in a city. It includes trees, understory plants, and the soil and subsurface area. NRDC Green Infrastructure.

Image: [Cities4Forests](#). Photos: 1. [Truba7113](#), 2. [Vladimir Kudinov](#), 3. [Chesapeake Bay Program](#), 4. [Luisa Zottis/EMBARQ Brasil](#), 5. [Pablo Gonzalez](#), 6. [Vitor Oliveira](#).

What Challenges Do Urban Forests Face?

1. **Difficult growing conditions.** Urban environments create challenging conditions for tree growth. Exposure to pollutants, high temperatures, extreme drought and inundation, and limited space above- and below-ground inhibit proper root and crown formation and increase susceptibility to insects and disease
2. **Insufficient resources for proper care.** Proper maintenance is critical to a thriving urban forest, but it demands time, resources, and coordination from municipal governments. It may also be difficult to prioritize for financially constrained private property owners. Limited resources also hinder efforts to inventory public and private green space. In some cases, the maintenance responsibility of trees and forests may be unclear due to limited details of land ownership or tenure.
3. **Encroachment from development.** Pressure from development—either as expansion or infill—often results in loss of urban forest canopy and other green spaces. ([Konijnendijk et al, 2017](#))
4. **Incomplete public understanding of the benefits provided by the urban forest.** Urban trees are often viewed as a financial burden or risk, but the benefits they provide may be poorly understood and undervalued by the public and by decision-makers. ([Escobedo, Kroeger, & Wagner, 2011](#))



Visualizing the challenges to urban tree growth and survival.
Image: [Cities4Forests](#). Adapted from [Barcelona's Trees for Life Strategic Plan](#).

All green infrastructure requires careful installation and plans for long-term maintenance, to avoid damage to roads, sidewalks, and property. ([Hewitt, Ashworth, & MacKenzie, 2020](#)) Along with regular care, the right **policies, regulations, and institutional arrangements** can help to sustain healthy urban forests and deliver important benefits to people.

Why Do Urban Forests Matter?

Urban forests provide city dwellers with many [ecosystem services](#), or benefits that humans derive from nature. ([Dialy, 1997](#))



Urban forests offer many benefits to residents, which are moderated by climate, geography, characteristics of the built environment, social and political conditions, and even individual or cultural identity. Image: [Cities4Forests](#).

For example, **well-planned, well-managed** urban forests have the potential to:

- **Contribute to the physical and mental health of urban dwellers** by buffering stress, creating inviting places for physical activity, and more ([Braubach et al, 2017](#); [Sanesi, Gallis, & Kasperidus, 2011](#); [Wolf & Robbins, 2015](#))
- **Mitigate the heat island effect** by reducing temperatures through shading and evapotranspiration ([Lai et al, 2019](#); [Nowak, Dwyer, 2007](#); [Sanesi, Gallis, & Kasperidus, 2011](#))
- **Reduce burdens on traditional water infrastructure and reduce run-off** by absorbing and filtering stormwater ([Kuehler, Hathaway, & Tirpak, 2017](#))
- **Calm traffic and reduce driver speeds** when properly incorporated along roads and rights-of-way ([Mok, Landphair, & Naderia, 2006](#); [Wolf, 2010](#))
- **Improve air quality** by removing harmful pollutants, like particulate matter, ozone, and smog, in certain contexts; however, trees may also trap air pollution in urban canyons, create allergenic pollen or even emit pollutant precursors ([Kumar et al, 2019](#); [Sicard et al, 2018](#))
- **Reduce noise** ([Nowak & Dwyer, 2007](#); [Sicard et al, 2018](#))
- **Improve scenic quality and aesthetic appeal** ([Nowak & Dwyer, 2007](#))
- **Support local livelihoods** and provide fuelwood, medicine, and other goods ([Sanesi, Gallis, & Kasperidus, 2011](#))

- **Enhance community cohesion** by fostering social interaction, building environmental consciousness, and establishing a shared sense of place ([Sanesi, Gallis, and Kasperidus, 2011](#); [Weinstein et al, 2015](#); [Wolf, 2017](#))
- **Increase food security for marginalized populations** in both developed and developing contexts ([Braubach et al, 2017](#); [Konijnendijk & Gauthier, 2006](#); [Kowalski & Conway, 2018](#))
- **Enhance agricultural productivity** in peri-urban agroforestry by improving site conditions and diversifying production for smallholder farmers ([Konijnendijk & Gauthier, 2006](#))
- **Sequester carbon**; however, pruning, fertilization, and irrigation of street trees may also result in CO2 emissions ([Nowak et al, 2002](#))
- **Increase property values** and thus increase municipal tax revenue. In some cases, trees may also impose financial burdens on landowners related to tree care or removal or taxes related to property value or contribute to displacement of vulnerable groups ([Nowak & Dwyer, 2007](#); [Aguelovski et al, 2019](#))
- **Increase residents' connection to nature** during resident engagement activities such as tree plantings, which may promote other pro-environmental behavior ([Whitburn, Linklater, & Milfont, 2019](#))
- **Increase equity**, as benefits from urban greening can be most impactful for disadvantaged groups ([Braubach et al, 2017](#); [Wolf, 2017](#))
- **Intercept rainfall and surface runoff to reduce erosion and sedimentation** in urban areas and along coasts and streams ([Berland et al, 2017](#))

Consider Context

The type and amount of ecosystem services urban forests provide depend on many factors. Climate, geography, and even cultural or individual preferences can affect whether these services are considered benefits or dis-benefits (costs). ([Escobedo, Kroeger, & Wagner, 2011](#))



Medellin, Colombia. Photo: [Reg Natarajan, Flickr](#).



Manila, Philippines. Photo: [David Stanley, Flickr](#).



Victoria Peak, Hong Kong. Photo: [Mikel Santamaria](#), Flickr.



Bangalore, India. Photo: [vhines200](#), Flickr.

This learning guide focuses primarily on urban forest-related policy, planning, and regulatory interventions at the city and local level. However, these interventions can manifest in many forms, extending from the national to the household level. The guide is intended to explore a handful of such plans, policies, regulations, and institutional arrangements from cities around the world. Because every city exists in a different political, economic, environmental, and cultural context, policies and plans should be tailored to the local situation.

Multiple Stakeholders, Multiple Scales

Who should care? Many different stakeholders may be affected by urban forests. The list below describes some of the actors to be consulted in the development and implementation of urban forest-related policies and plans:

- **Federal/ National Policy Administration**

- Political leaders

- **State/ Provincial Departments**

- Forestry
- Horticulture
- Agriculture
- Highway/roads
- Irrigation
- Utilities

- **Municipal Councils**

- Parks and gardens
- Town/urban planners
- Landscape architects
- Legal advisors
- Mayors and city leaders
- Policymakers
- Waste managers
- Transportation planners
- Environmental protection departments
- Public works departments
- Hospitals and public health departments

Environmental NGO's

- Local
- International

Donor Agencies

- Bi-lateral (government to government)
- Multi-lateral

Corporate Business

- Multi-national
- National
- Local

Academic Institutions

- Schools
- Universities
- Other research bodies

Local Groups of Residents

- Associated with the local school
- Associated with local church/temple
- Environmental groups
- Harvesters of tree products
- Neighborhood organizations

Individuals

- Residents of all ages
- Owners/managers of private tree nurseries
- Private tree growers
- Tree wardens
- Urban foragers and gatherers
- Visitors/tourists
- Arborists
- Foresters (both rural and urban)
- Private businesses

(Adapted from [Carter, 1995](#), with additions by authors)

Multiple scales for interventions:

- **Micro/local** — including site specific considerations related to the air, ground, and soil
- **Neighborhood**

- **City**
- **Regional**
- **State/provincial**
- **National**

Urban Forests may support larger city goals, such as:

- **Resiliency** — Utilizing trees to position a city and its residents to withstand or recover faster from risks related to climate change and natural disasters such as heat waves, flooding, or drought.
- **Sustainability** — Integrating trees into urban landscapes to deliver environmental, social, and economic benefits, such as tree-lined pedestrian walkways along business districts that cool ambient temperatures, promote walking and social interaction, and boost property values and local business revenues.
- **Public Health** — Supporting tree-related policies and plans that increase public contact with nature, encourage physical activity, and reduce exposure to harmful vehicle emissions.
- **Safer and more sustainable transportation** — Incorporating trees into transportation projects to improve “last mile” connectivity to public transit by reducing vehicle speeds in low speed areas, altering microclimates to promote walking and cycling, and reducing flooding along transportation infrastructure



Scales, stakeholders, goals, and interventions to consider when working on urban forests. Image: [Cities4Forests](#).

Introduction to Policy for Urban Forests

Policies are instruments that provide guidelines and principles to shape the decisions, actions, and laws the city might adopt in the future to meet goals or objectives. ([Salbitano et al, 2016](#))

Municipal policies that affect urban forests can be developed by and incorporated into many parts of city government, from parks and recreation departments to utilities departments. Policies can also outline the

creation or management of urban forests directly. Even those intended to meet broader, city-wide objectives—such as increased resilience to climate change—may affect urban forests indirectly.

Policies may also negatively affect urban forests. For example, policies related to [design of roads](#) and [sidewalks](#) that fail to provide adequate space for roots or tree canopy may make it difficult for trees to thrive.

Finally, national or regional policies, such as those that guide urban expansion and development, may affect urban forests. For example, “Sponge City” guidelines and policies developed by China’s national government aim to create flood-resilient cities. ([Chan et al, 2018](#)) To accomplish this, it provides direction for urban planning, land use, and the design of urban green spaces, including those with trees. ([Chan et al, 2018](#))

Policy	Focus or Objective
Forest Conservation	Describes strategies for conservation, often applies to rural and wild land but can also encompass urban and peri-urban forests
Green Space	Targets protection and expansion of green areas
Agroforestry & urban agriculture	Encourages agroforestry and agriculture in urban and peri-urban areas
“Complete Streets”	Establishes streets and rights-of-ways as public spaces and places emphasis on improving conditions for all users (not just cars) and can include trees and vegetation for stormwater management and heat mitigation
Biodiversity	Sets goals for habitat conservation, connectivity of green space, and improved water and air quality



In the Rwanda National Forestry Policy 2018 document, Policy Statement 7 encouraged the adoption of agroforestry and the protection of other urban and peri-urban trees in cities. ([Republic of Rwanda, 2018](#))

Photo: [Francisco Anzola, Flickr](#).



In the Netherlands, the Structural Vision Amsterdam 2040 describes the city's policy goals related to green space, including the protection and expansion of the urban forest in city parks. ([City of Amsterdam, n.d.](#)) Photo: [Leandro Neumann Ciuffo, Flickr](#).

Public Space Interventions

Street trees make up a significant portion of the urban forest. Strategically planted street trees can assist planners in goals related to transportation and public spaces.

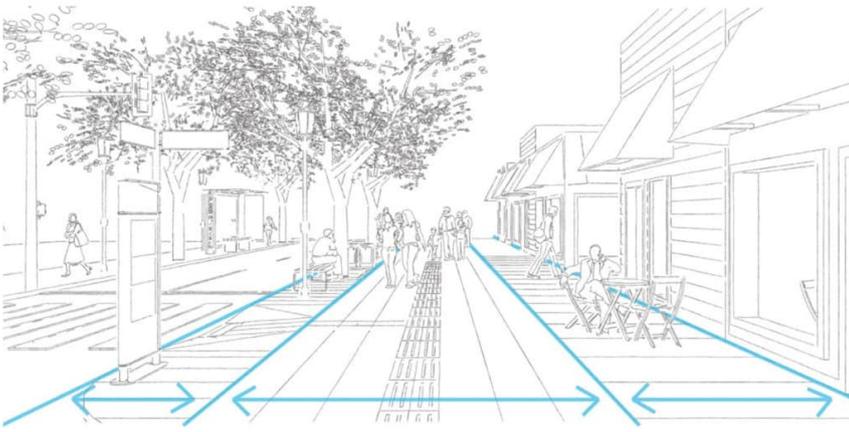
When small parcels of land are repurposed into [pocket parks](#) with trees and seating, they augment the green infrastructure network of a city and can become spaces for social interaction.

Some cities are adopting "[complete streets](#)" policies to create integrated networks of streets that facilitate safe and accessible travel for all people—regardless of age, socio-economic status, ethnicity, ability, or preferred mode of travel. ([Seskin, 2013](#)) When well-planned and well-maintained, urban forests can serve a role in the complete streets movement by reducing air temperatures, providing shade, slowing traffic, and in some instances protecting commuters from some environmental and safety hazards such as air pollutants. ([McPherson, 1994](#); [Nowak, Crane, & Stevens, 2006](#))

Trees can be incorporated into complete streets and transportation plans by:

- Allocating sufficient space in [sidewalk design](#) for the growth of their roots and canopy.
- Incorporating appropriately sized and placed trees as a traffic calming measure. ([Wolf, 2006](#))

However, tree placement must be designed to avoid impeding pedestrian movement, creating obstacles for the disabled, or damaging above-and-below-ground utilities. Improperly placed or sized trees can also block drivers' line of sight. ([Wolf, 2006](#))



WRI's [The 8 Principles of Sidewalks](#), 2019.

Mexico City recently implemented a complete streets design on its Avenida Eduardo Molina, including dedicated bus lanes, renovated sidewalks, and a green central median. ([WRI, 2015](#))

The city of Medellín, Colombia is using trees and other plants to improve commuters' conditions. To address the urban heat island (UHI) effect and promote biodiversity, the city has expanded greenspace along 18 roads and 12 waterways. To accomplish this, the city's botanical gardens hired and trained more than 70 botanists—many of whom were from vulnerable or displaced populations. ([Ashden, 2019](#))

More than 8,000 trees and nearly 350,000 shrubs have been planted since the program's inception. The new trees and other vegetation reduce the temperature of the corridors by 2-3°C. More than 1 million people travel through downtown Medellín daily—either for work, for school, or as tourists. Pedestrians, cyclists, local businesses, community members and vulnerable populations alike are benefiting from the shade. ([Ashden, 2019](#))

Please see the [Selected Resources slide](#) for more information on public space interventions.

Case Study: Greening Kuala Lumpur

In Malaysia's largest city, Kuala Lumpur, rapid urban growth resulted in significant loss of greenspace from 2001-2013. ([Kanniah, 2017](#)) To slow this trend, the city instituted a program called "Greening KL," which aimed to plant 100,000 trees by 2020. ([Kanniah, 2017](#)) This bold goal was achieved in 2014, and planting efforts still continue. ([Ismail et al, 2018](#))

In this tropical capital, trees moderate the microclimate and increase thermal comfort for residents. In a recent study, roadside trees in Kuala Lumpur with dense canopies reduced the mean radiant temperature - a holistic measure of thermal comfort - by 35% and reduced the perceived ambient temperatures to pedestrians. ([Zaki et al, 2020](#)) Overall, beneath tall trees, the average surface temperatures decreased by 5.4°C and average air temperatures decreased by 1.3°C. ([Zaki et al, 2020](#))



Kuala Lumpur, Malaysia. Photo: [Khalzuri Yazid, Flickr](#).

To create broad support for its forest, Kuala Lumpur is also exploring public-private partnerships with pocket park sponsorship. These partnerships leverage funding from the private sector for public development. Corporations interested in social responsibility programs fund maintenance and upgrades for the park, but the benefits of these public greenspaces extend to the community. At least five financial institutions, including the Standard Chartered Bank, have participated so far. ([Kanniah, 2017](#))

Introduction to Planning for Urban Forests

Planning is the coordinated, organized, and ongoing process that guides decision-making, change, and growth in a community, city, region, or nation. ([Elmendorf, 2007](#)) A lack of planning risks misaligned efforts from various partners working on these issues in silos. When planning is not participatory or inclusive, policies and laws may be perceived as incohesive or arbitrary.

A few sound principles for planning include. ([Schwab, 2009](#))

- **Ensuring consistency between plans and codes related to trees and other green infrastructure across agencies.** Plans should be simple and clear. They should be aligned with national or regional policies, and urban forest-related goals established in one plan should be cross-referenced with other plans that impact urban forests.
- **Collaborating with a diverse team when drafting codes and ordinances.** Urban planners, developers, arborists, landscape architects, environmentalists, public works officials, community members, and others will each provide a unique perspective.
- Effective planning also **incorporates feedback** and uses new data to inform future strategies and goals. ([Miller, Hauer, & Werner, 2015](#))

Urban trees and forests may be included in several city plans and documents. The table below shows some examples of relevant plans and typical content.

Plan or document type	Common contents and distinguishing features
Comprehensive or master plan	Community plan, often extends decades into the future
Strategic plan	Outlines actions related to key issue(s), over shorter time frame than comprehensive plan

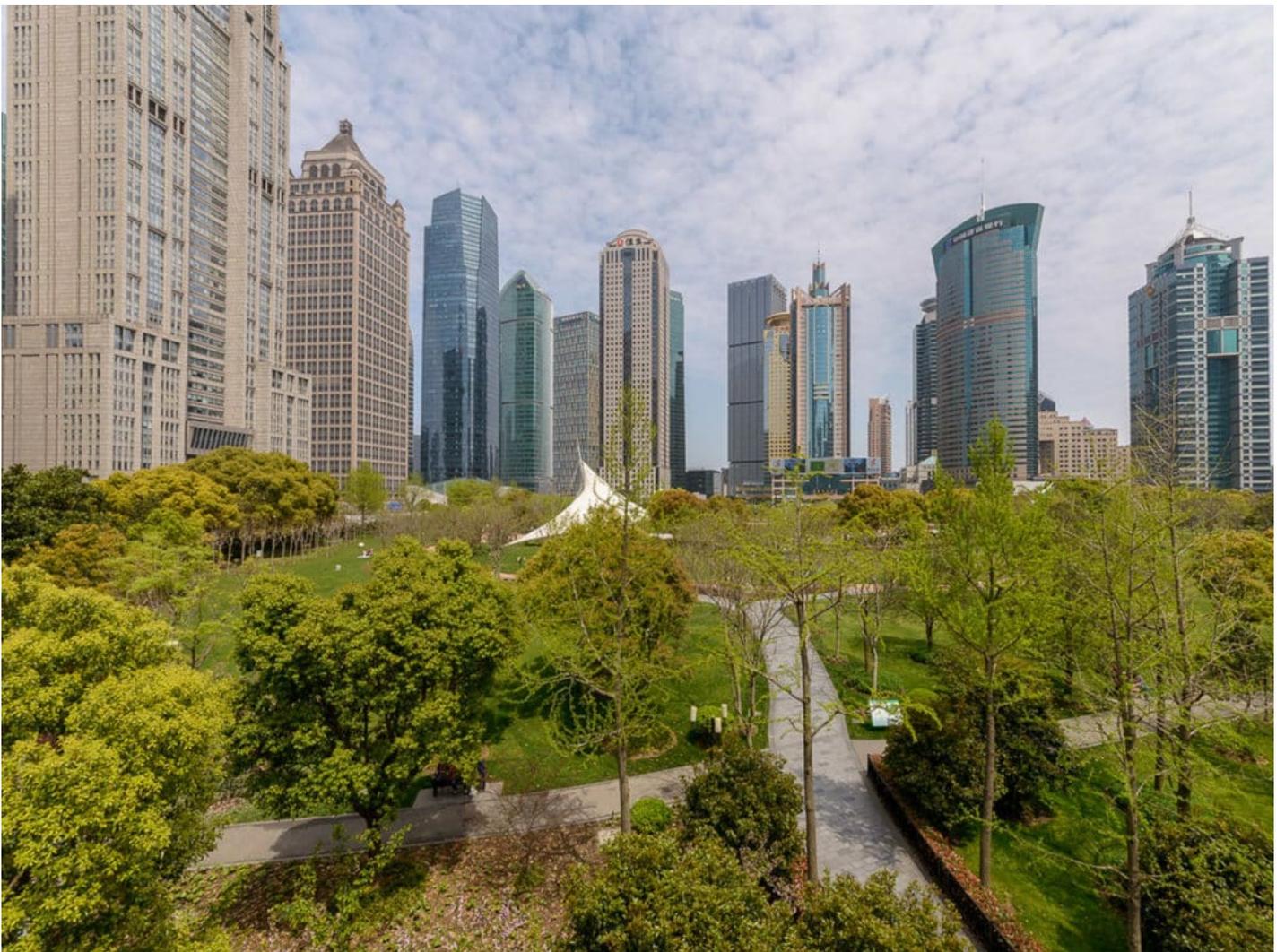
Plan or document type	Common contents and distinguishing features
Climate action plan	Roadmap to help city reduce greenhouse gas emissions
Local or partial plan	Neighborhood-scale plan, establishes vision and land-use guidance
Site development plan	Guidelines for construction and development
Utility plan	Provides guidance on planning related to utility function, such as powerlines for energy supply
Urban forest management plan	Roadmap for urban forest design, management, and more
Transportation or mobility plan	Provides guidance for public transportation system and priority improvements
Green infrastructure plan	Plan related to nature-based solutions, typically with emphasis on stormwater management
Design and engineering manual	Plan that includes specifications for roads, bridges, and other infrastructure
Parks plan	Guides development and maintenance of park and recreational space

The City of San Francisco’s Urban Forest Plan draws from many other city plans.



Image: [Cities4Forests](https://www.cities4forests.org/). Adapted from San Francisco Urban Forest Plan (2014)

Case Studies: Urban Planning



In 2004, the government of China instituted its National Forest City program to encourage the establishment and maintenance of urban forests across the nation. To earn the distinction of “National Forest City,” a city must submit a 10-year urban development plan that explicitly includes forests. ([Xiao, 2016](#)) Photo: [Stefan Wagener, Flickr](#).



In Ethiopia, the Addis Ababa City Structure Plan 2017-2027 Draft outlines goals to protect riparian areas with 50 meter buffer zones and to prevent erosion on slopes with an incline greater than 30% by creating conservation forests. ([City of Addis Ababa, 2017](#)) Photo: [Natasha Elkington/CIFOR, Flickr](#).

Comprehensive and Strategic Plans

Many cities incorporate urban forests into broader, community-wide plans such as comprehensive and strategic plans. Using these general urban plans, city governments can require or incentivize the expansion and protection of urban forests or other green infrastructure on public and private lands alike.

Comprehensive plans, or master plans, are urban growth management plans that use community input and historical context to shape goals for development, transportation, land use, and parks and recreation, often extending decades into the future.

Trees may be incorporated into comprehensive plans when cities:

- Identify zones of protection (such as riparian buffers)
- Establish “green corridors” that connect parks
- Embed goals that recognize the contribution of trees to social equity, transportation, and more.

Strategic plans serve a similar function to comprehensive plans but operate over shorter time spans. For example, the City of Vancouver, Canada has adopted a **strategic action plan** called “Greenest City” to address the threats posed by climate change. The plan outlines the policies, actions, and partnerships needed to achieve this ambitious goal. ([City of Vancouver, 2015](#))

The City of Vancouver's strategic action plan outlines a goal and quantifies targets.

5/ ACCESS TO NATURE

GOAL: VANCOUVER RESIDENTS ENJOY INCOMPARABLE ACCESS TO GREEN SPACES, INCLUDING THE WORLD'S MOST SPECTACULAR URBAN FOREST.

2020 TARGETS:

1. ALL VANCOUVER RESIDENTS LIVE WITHIN A FIVE-MINUTE WALK OF A PARK, GREENWAY OR OTHER GREEN SPACE.

Indicator: Percent of city's land base within a five minute walk to a green space.

Baseline (2010): 92.6%

Actual (2014): 92.7% (+0.1%)

2. PLANT 150,000 NEW TREES.

Indicator: Total number of additional trees planted.

Baseline (2010): 0

Actual (2014): 37,000

2050 TARGET:

INCREASE CANOPY COVER TO 22%.

Baseline (2013): 18%

Note: Development of a biodiversity target is currently underway.

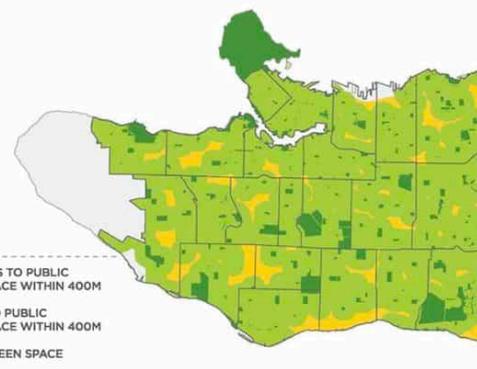
INTRODUCTION

Just over a hundred years ago, Vancouver had western redcedar and Douglas-fir forests growing hundreds of feet tall.

Anyone who has walked through a park on the first sunny day of spring has experienced the importance of green spaces to the health of individuals and communities. Whether they take the form of a community garden, a city park, a greenway along your block, or the seawall, green spaces have been shown to benefit our physical and emotional health by reducing blood pressure, cholesterol, and stress.

These spaces also contribute to our sense of community by creating places for recreational activities, for children to play, and for neighbours to meet and socialize.

VANCOUVER ACCESS TO PUBLIC GREEN SPACE





People enjoying an urban park in Vancouver, Canada. Photo: [Peter Guo, Flickr](#).

Urban Forest Management Plans

To synthesize the visions, policies, codes, and other information from different government agencies and to provide historical context for urban forests, some cities choose to develop [urban forest management plans](#). These plans may outline the vision for the forest's future, contain inventories of city trees, and quantify forest benefits. Integrating various plans and policies under one overarching plan can help to centralize information, establish a clear and cohesive vision, and serve as a roadmap for the management of the urban forest.

Typically, “high-quality” urban forest management plans contain:

- A visionary statement for the city's canopy
- An inventory or other assessment of the urban forest
- A description of goals, objectives, measurable targets, and actions
- An implementation plan describing dates and responsibilities
- An ongoing monitoring plan

(Sources: [Gibbons & Ryan, 2015](#); [California Urban Forest Council, 2018](#); [Ordóñez and Duinker 2013](#))

These plans also often provide historical background on the region and quantification of benefits. They may offer guidelines on species selection or planting practices.

The Urban Forest Plan of San Francisco effectively cross-references other codes and policies.

STRATEGY 1.1

Pursue an expanded and equitable distribution of trees and greening throughout the City.

1.1.1 Continue to enforce existing requirements for street tree planting (Planning Code & Public Works Code).

- **Planning Code: Section 138.1 requires street trees to be planted as part of new development projects.** The Code requires street trees for every 20' of building frontage for new construction projects, significant building expansions, paving of front setbacks or addition of a dwelling unit, garage or parking space. When trees are required but not permitted due to underground utilities or other conditions, in-lieu fees will be collected to fund tree planting in other areas.
- **Section 428 requires payment of in-lieu fees for tree planting to DPW's Adopt-A-Tree Fund in cases where planting requirements of Sec. 138.1 are waived by the Zoning Administrator.**
- **Public Works Code: Article 16 (Urban Forestry Ordinance) outlines City requirements related to street tree procedures and care.** The Code describes DPW's jurisdiction and oversight responsibilities of trees in the public right-of-way and other trees protected under DPW's jurisdiction, including:

1.1.2 Pursue an expanded City sponsored street tree planting program. As recommended in the MANAGE and FUND chapters, increased resources should be made available that would expand the existing limited capacity of the Department of Public Works to engage in larger scale street tree planting.

1.1.3 Support Friends of Urban Forest's tree planting, stewardship and sidewalk garden programs. Friends of the Urban Forest (FUF) is largely responsible for the planting and care of many of San Francisco's street trees. This important organization has excelled at involving communities in greening their neighborhoods. FUF's strong programs should continue to be supported by the City.

1.1.4 Increase the number of street trees by half (50,000 new trees). The Plan proposes increasing the number of street trees by half (50%) over the next 20 years. Planting an additional 50,000 new street trees (2,500 trees/year plus replacement trees) will grow our street tree population from 105,000 to 155,000 trees. Currently, an estimated 1,500 trees are planted each year by Friends of the Urban Forest (1,200 trees) and the Department of Public Works (375 trees). However, these include a portion of replacement plantings for trees removed or that have died and so do not represent a significant increase in forest canopy. Additional street trees are planted by property owners and through development requirements. A concentrated effort to add new street trees will help stem the decline of the urban forest while

[City of San Francisco Urban Forest Plan, 2014.](#)

Case Study: San Francisco, CA, USA

The city of San Francisco has one of the lowest measures of canopy cover of any major US city (less than 15% and shrinking). Unlike many cities, San Francisco also placed the burden of street tree maintenance on property owners.

In 2014, it developed the [San Francisco Urban Forest Plan](#) (SF UFP), which described the other city plans that provided a foundation for the document and effectively **cross-referenced** other plans. But the plan was also a catalyst for change: it made the case that fragmented maintenance responsibilities were detrimental to the health of the urban forest. In 2016, 79% of San Francisco voters supported a ballot initiative to transfer responsibility of street trees from residents to the Department of Public Works, which even allocated \$19 million from the City's general fund to cover tree maintenance and infrastructure repair. ([San Francisco Public Works, 2017](#))



San Francisco, USA. Photo: [Sandrine Neel, Flickr](#).

Case Study: Greening for Resilience in Melbourne, Australia

Climate change threatens the way of life for residents of Melbourne, Australia. To contribute to city resilience against the threats of drought, heat, and extreme weather, the City of Melbourne developed an [Urban Forest Strategy Plan](#). The plan draws from and informs many other municipal plans and strategies.



Image: [Cities4Forests](#). Adapted from [City of Melbourne Urban Forest Strategy, 2014](#).

The plan highlights **six strategies** for the urban forest, as well as **targets** for each:

1. Increase canopy cover to 40% by 2040
2. [City's evidence-based tree selection guidelines](#)
3. Increase urban forest diversity, using the City's evidence-based tree selection guidelines ([City of Melbourne, 2011](#))

4. Improve vegetation health, with 90% of the City's trees in good health by 2040
5. Improve soil moisture and water quality, to allow for healthy growth of vegetation
6. Improve urban ecology by protecting urban biodiversity
7. Inform and consult the community.



Leaves, South Yarra, Melbourne. Photo: [a.canvas.of.light, Flickr](#).

The Urban Forest Strategy Plan presents specific actions to achieve each target: for example, to improve vegetation health, it recommends annual health checks for every municipal tree. ([City of Melbourne, 2014](#))

Introduction to Regulations for Urban Forests

Cities can enact laws and regulations, such as ordinances or codes, to enforce the broader vision or strategy behind urban-forest-related policies and plans.

Ordinances, by-laws, codes, and other regulations can regulate the activity of residents,

government agencies, and private entities related to trees. They are typically enforced by city authorities, and may be associated with permits, fines, or incentives.



“Heritage tree” designation protocol can protect old or culturally significant trees, as in Washington, D.C. (DDOT, n.d.) Large trees may have social or cultural value. (Jim, 2005; O’Brien et al, 2017) Photo: John Brighenti, Flickr.

Even cities without comprehensive urban forest strategies often have tree ordinances developed by relevant city agencies, such as the department of parks and recreation, public works, or even transportation.

The table below presents some of the types of regulations that cities utilize to manage urban forests.

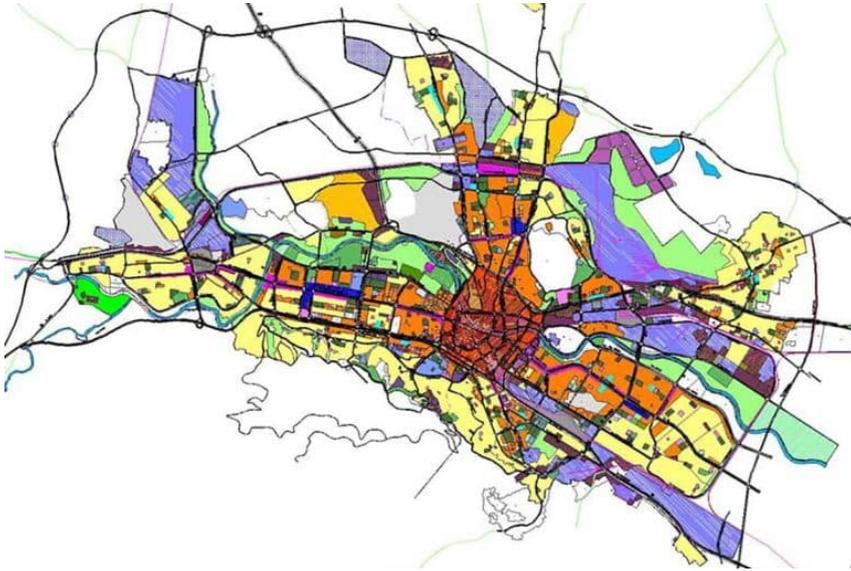
Regulation	Enforcement
Tree preservation ordinance	Establishes protections of specific trees based on criteria such as species, size, or location (e.g. trees along riverbanks or steep slopes). Can also regulate maintenance, removal, and replacement of trees on public and private land.
Tree protection ordinance/ standard	Implements tree protection measures to be taken during and after construction to ensure tree roots, base, crown, and the surrounding soil structure are not disturbed.
Tree planting guidance	Defines approved species, sizes, and locations, as well as timing of planting and permitting process.
Zoning	Can place limits on the amount of impervious surface, establish open or green spaces, and utilization of green infrastructure for stormwater management in new developments.
Stormwater management ordinance	Can include trees and other green infrastructure as part of an integrated approach to stormwater management.
Landscaping ordinance	Defines tree and vegetation planting requirements such as spacing, species, variety, and placement (e.g. to screen, block noise from, and/or shade parking lots).
Public space design manual	Summary of regulations for designing public spaces.

To be effective, regulations must be enforced. Thus, many cities also define enforcement authorities in

their tree-related policies.

Zoning

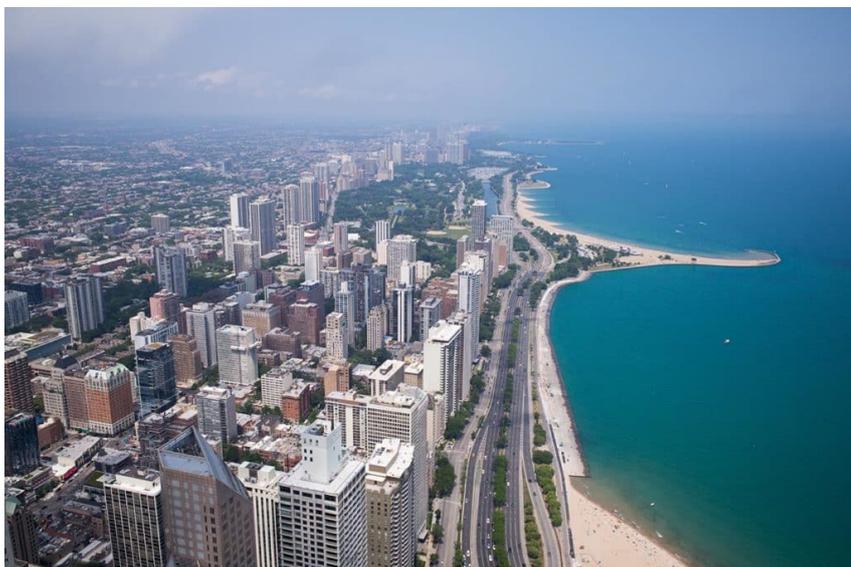
Zoning (or development control regulation) is a tool that can be used to enact ordinances used to define and delineate development and land-use. ([O'Brien et al, 2017](#); [Miller, Hauer, & Werner, 2015](#))



Zoning scheme of city of [Skopje, North Macedonia](#). Different colors represent designated zoning regulations.

Cities may use zoning to create, expand, or maintain urban forests. For example, zoning may provide a mechanism to:

- Mandate the amount of open space in a city, leaving room for trees to grow
- Designate protected or sensitive areas such as riparian buffer strips or steep slopes
- Regulate patterns of development in a way that leaves room for urban forests
- Provide tree planting requirements for new projects



Since 1991, the city of Chicago's [landscape ordinance](#) has required installation of trees during development. Planting of trees is required following the construction or rehabilitation of

many buildings. Developers must plant one tree for approximately every 8 meters of development frontage. ([City of Chicago, 2000](#)) Photo: [Roman Boed, Flickr](#).



In the 1990's, the city of Quito, Ecuador took actions to dedicate space for and protect its urban forests. The city put in place extensive ordinances outlining regulations related to land use, zoning, subdivision of land, and more. For example, every new housing development must set aside 10% of its land to create public open space, which dedicates land for trees to be planted and thrive. ([Murray, 1997](#)) Photo: [putneymark, Flickr](#).

Institutional Arrangements: Part I

Plans and policies are important tools for cities to define the needs and vision for their urban forests. But implementation requires collaboration between those planning and managing public and private lands, as well as dedicated funding for management and growth.

A variety of possible **institutional arrangements**, or governance structures and processes, exist. **Governance** can be thought of as the shared decision-making and rule-setting process by government actors, technical practitioners, civil society, and private businesses. ([Sheppard et al, 2017](#))



Singapore. Photo: [Aleksandr Zykov, Flickr](#).

Equitable and inclusive governance provides a foundation for sustainable and resilient cities. ([Nesbitt et al, 2018](#)) **Public participation** can build trust, reduce conflict, streamline operating costs, increase legitimacy of decisions, and foster knowledge building. ([Beckley, Parkins, & Sheppard, 2006](#)) Failure to engage communities in planning and decision-making may exacerbate existing disparities in access to the benefits of urban forests and other green infrastructure. ([Nesbitt et al, 2018](#))

Because urban forests are complex and affect so many stakeholders, collaboration across multiple sectors and agencies can reduce redundancy in efforts and leverage limited resources effectively. However, the most successful arrangements in one city may not be suitable or feasible in another.

Institutional Arrangements: Part II

In many cities, urban forests fall primarily under the jurisdiction of the **local government**. ([Knuth, 2005](#)) For example, in India, “municipal corporations” may centralize many city management responsibilities, from waste management to green infrastructure maintenance. In other regions, urban forests may be managed by the department of public works, the department of parks and recreation, or a combination of governmental agencies. In Johannesburg, South Africa, urban forestry responsibilities were once scattered throughout several city agencies. But in 2013, several entities merged to form the Johannesburg City Parks & Zoo department, which consolidated and unified the city’s urban forestry activities. ([Johannesburg City Parks, n.d.](#))

Forest management may also be fragmented *across* a metropolitan region, as in Santiago, Chile, where it is divided between 36 *comunas*, or municipalities, each with their own mayor, council, and budget. ([Escobedo et al, 2006](#)) In such situations, a shared inventory of green spaces can be a useful mechanism for understanding ownership and establishing management and accountability. Under a less centralized system, **regional collaboration** and **resource-sharing** across municipal boundaries can be used to increase governance capacity for forest management. ([Sheppard et al, 2017](#))

In some cities, dedicated **urban forestry commissions**, or elected legislative bodies, are created to spearhead forest activities. Other cities use **citizen advisory boards** to systematically include local perspectives. ([Nesbitt et al, 2018](#))

Finally, many cities co-manage their forests with **non-profit partners**. These types of partnerships may require special institutional arrangements and explicit establishment of roles, responsibilities, and permissions. Non-profit organizations can provide technical expertise on topics such as forest management and community outreach, as well as opportunities for public participation. They can also provide funding and labor to keep programs going when municipal budgets are tight. For example, Washington, D.C. partners closely with a non-profit called [Casey Trees](#) to engage volunteers and generate “report cards” to monitor forest health and management efficacy. ([Casey Trees, n.d.](#))

Case Study: Evolving Urban Forest Management in Seattle, WA, USA

Urban forest management in the City of Seattle, WA unites the efforts of many different entities. In 2007, the City released its first Urban Forest Management Plan, which outlined its goal to increase canopy cover to 30% by 2037 as well as its overarching vision and guiding principles. ([City of Seattle, 2013](#))

In 2009, the mayor and city council established a “Core Team” of representatives from seven municipal agencies involved in managing the urban forest to support its urban forestry commission in decision-making (*see image below*). But Seattle also works closely with the Green Seattle Partnership (GSP), a collaborative public-private organization, and Trees for Seattle, the city’s interdepartmental outreach and education program. ([City of Seattle, 2019](#))

Core Team



Additional Support By



Image: [Cities4Forests](#). Based on information from [City of Seattle, 2019](#).

To guide the development of the next iteration of its forest management plan, the City commissioned an assessment of its existing urban forestry activities and its Urban Forest Management Plan. This assessment revealed areas of opportunity and provided recommendations for improvement. ([Davey Resource Group, Inc., 2019](#))

Seattle is also seeking to create a more inclusive and equitable program. In 2018 and 2019, the city conducted community listening sessions and other engagement activities in under-represented communities. The concerns and perspectives expressed will be incorporated into the Seattle's revised 2020 Urban Forest Management Plan. ([Trees for Seattle, 2020](#))



Seattle Skyline, USA. Photo: [Jerry Meadan, Flickr](#).

Funding and Valuation

Because trees can live for decades, funding for urban forests requires long-term planning. It should incorporate the costs of tree care and staffing. ([Vibrant Cities Lab, n.d.](#)) Successful cities combine multiple funding and financing tools to support the urban forest. ([Knuth, 2005](#); [Young, 2011](#))

Municipal funding for urban forests can come from diverse sources, such as:

- **Municipal budget allocation.** For example, some cities choose to allocate a portion of tax

proceeds from real estate taxes to tree management. The cost of tree planting can also be included in municipal bonds for specific improvement projects, like street repairs. ([Ellmendorf, 2016](#))

- **Regulatory fees.** Cities can apply proceeds from the enforcement of municipal codes or policies related to zoning or tree protection (such as permits outlining tree removal and replacement). When landowners fail to comply, the permit holder may be required to pay a fine. ([Knuth, 2005](#))
- **Partnerships.** Both public-private and intergovernmental partners can pool resources for a common goal. Private donations, sponsorships, and endowments may also provide supplemental resources. ([Salbitano et al, 2016](#))

(Source: [McDonald et al, 2017](#); [VCL, n.d.](#); [Knuth, 2005](#))

Incentives can motivate residents, the private sector, NGOs, and communities to protect, manage, or expand the urban forest. Examples of such incentives include:

- Fast-tracking of permits for development
- Exemption from taxes or refunds/ waivers for private landowners to reward tree planting or protection of standing trees
- Provision of grants and loans for forest projects on private lands, when funding is available

(Source: [Knuth, 2005](#))

Some cities utilize business improvement districts (BIDs), areas in which businesses voluntarily pay a levy in order to fund supplemental services such as landscaping, street cleaning, and safety, in the BID. The services are implemented by a non-profit partner, designed to retain businesses and attract people to the area. ([Vibrant Cities Lab, n.d.](#)) Such a program could provide funding for street tree plantings and maintenance.

It may be possible to recoup some costs of urban forest management. For example, reutilization and sale of waste wood from urban trees can create a revenue stream while diverting materials from landfills. ([Nowak, Greenfield, & Ash, 2019](#)) Damaged or dying trees may be turned into commercial lumber or mulch. ([Nowak, Greenfield, & Ash, 2019](#))

The importance of assessing value

Urban forests are often considered a type of **natural capital**, or element of nature that generates value for humans either directly or indirectly. ([Willis & Petrokofsky, 2017](#)) Natural capital can be valued in both monetary and non-monetary terms. ([Haase et al, 2014](#))

Economic valuation of urban forests may help decision-makers, city leaders, businesses, private property owners, and others to understand their benefits and costs. ([Wolf, 2017](#)) When the benefits of urban forests are not valued or understood by decision-makers, businesses, and residents, it may be difficult to prioritize their funding or management, especially in low- or middle-income countries with many urgent planning priorities. ([Cilliers et al, 2013](#))

Case Study: Expanding Urban Forests in Curitiba, Brazil

The city of Curitiba, Brazil has been lauded as one of the greenest cities in Latin America. Recently, Curitiba successfully executed a large-scale tree planting initiative. From 2013-2016, the city planted 139,000 trees. This required technical expertise, coordination across departments, and careful planning.

In urban parks, large native species like *araucaria* were planted to provide shade and habitat for other species. Experts also designed and planted ten “mini forests” in 500 square meters of formerly degraded

land spread throughout the city. The city considered several criteria for planting of street trees, including:

- Size at maturity (avoided large trees along streets)
- Root system and canopy shape
- Ability to produce flowers or edible fruit
- Ability to produce large fruits or toxic substances (avoided)
- Native vs. introduced status (planted 80% native)
- Resistance to pests and disease
- Adaptability to climate extremes



An araucaria tree in Curitiba. Photo: [Galante 86, Flickr](#).

But Curitiba's efforts haven't stopped since the trees have been planted. To protect existing trees, the city's Plant Production Department issues permits for removal within the city. The Municipal Forest Code even states that when a hazardous tree is removed it must be replaced with two new trees, which may either be planted on one's own property or in other specially designated areas. Curitiba's holistic planning and implementation efforts set the stage for a healthy urban forest, capable of delivering desired benefits.

(Source: [Curitiba City Hall, 2016](#))

Challenges

What are some of the barriers to sustaining healthy urban forests, capable of delivering ecosystem services to many residents? ([FAO, 2014](#); [Salbitano et al, 2016](#))

- **Multiple urgent priorities** — Cities strive to provide clean water, safe transportation, food security, affordable housing, employment opportunities, and many other services to their residents. These urgent issues often define the urban policy agenda.
- **Harsh urban conditions** — As described on card 2, exposure to pollutants, extreme temperatures, and physical constraints challenge tree growth and survival.
- **Lack of technical skills, knowledge of “best practices,” or expertise** — Municipal agencies may not have the knowledge or resources they need to manage urban forests, or even know where to turn for external assistance.
- **Tight budgets and limited investment interest**— Despite the potential for economic and social benefits, cities often fail to value urban forests as more than an amenity, or to include them in cost-benefit assessments, which reduces incentive to invest. Urban forests also require maintenance. Management of the urban forest may present yet another demand on limited municipal resources.

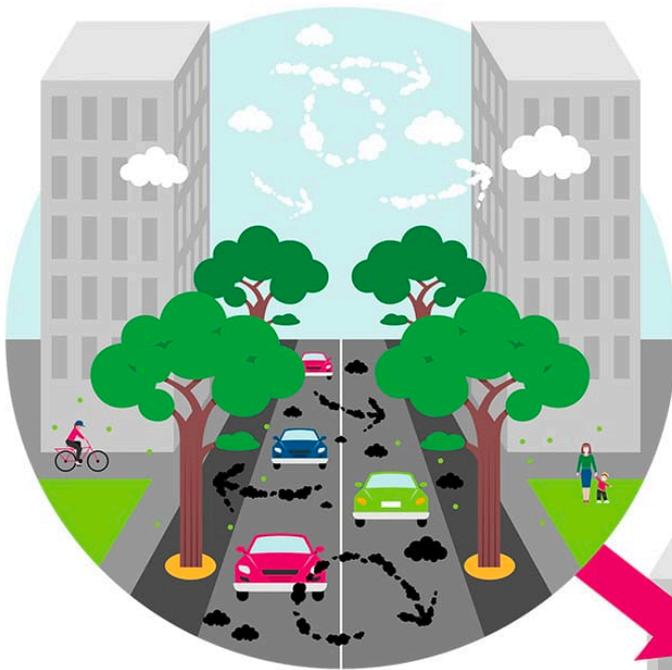
What are some key aspects to consider during planning, implementation, and management of urban forests?

- **Equity** — Without integrated planning, urban greening projects run the risk of contributing to the displacement of vulnerable, low-income, or marginalized groups. ([Wolch, Byrne, & Newell, 2014](#)) This may be direct, as individuals are told to leave in order to create green space, or indirect, as rising property values following urban greening cause “ecological gentrification”. ([Wolch, Byrne, & Newell, 2014](#)) Urban greening can thus create greater disparities in social, health, and economic risks between groups. Meaningful engagement with residents and communities may prevent these unintended outcomes. Municipal policies should be transparent, inclusive, and evidence based on Social Equity.
- **Fear of crime** — Urban forests with dense shrubs may create fear of crime or reduce perceived safety, especially for women and minority groups. ([Jansson et al, 2013](#)) Poor lighting, litter, and graffiti in these spaces may reinforce this fear. ([Jansson et al, 2013](#); [Wolf, 2017](#)) However, maintenance and management of these spaces to maintain lines of sight and tidy appearances may increase the perception of safety. ([Jansson et al, 2013](#); [Wolf, 2017](#))
- **Air pollution** — Although urban forests can remove pollutants, tree canopies in urban “street canyons” may also trap air polluted by vehicle emissions near ground level and reduce the circulation of cleaner air from the atmosphere. ([Abhijith et al, 2017](#), [Kumar et al, 2019](#)) In these situations, planting dense rows of low hedges or smaller trees to create a barrier between pollutants and people may be preferable. ([Abhijith et al, 2017](#), [Kumar et al, 2019](#)) Guidelines for planting for clean air exist (see [Selected Resources card](#)).
- **Safety and conflicts with infrastructure** — Urban trees may fall and injure people or damage

property. They may also damage sidewalks or other infrastructure, which can also cause injury or conflict with overhead or underground utilities or solar panels. ([Randrup, McPherson, & Costello, 2001](#)) Careful site selection and proper maintenance may reduce these risks. Many urban forests are planted with trees that produce allergenic pollen, which causes discomfort and lowers quality of life for urban residents. ([Eisenman et al, 2019](#); [Cariñanos & Casares-Porcel, 2011](#)) Trees that produce large amounts of pollen can be avoided, especially during large-scale tree planting initiatives. ([Cariñanos & Casares-Porcel, 2011](#))

- **Disease exposure** — Urban forests and other green spaces may expose residents to disease vectors like ticks or mosquitos. ([Karjalainen, Sarjala, & Raitio, 2010](#); [Lõhmus & Balbus, 2015](#))

Air Pollution in "Street Canyons"



Dense tree canopies can trap polluted air (black) and allergens (green dots) at ground level and prevent dilution with clean air from atmosphere (white).

Hedges may reduce exposure to polluted air (black) and allergens (green dots) for pedestrians but still allow for mixing with clean air from atmosphere (white).



Fear of Crime



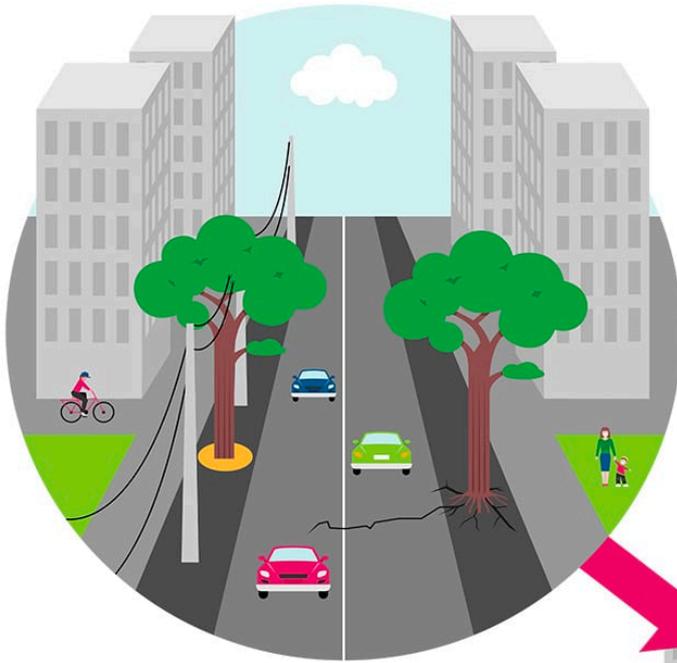
Dark, dense forests may be perceived as a place for criminals to hide, and may cause psychological distress due to fear of crime, in women, the elderly, and other groups.

Regular maintenance, removal of litter, and the addition of lights may reduce fear of crime. Removal of dense shrubs at eye-level near trails may also help.



Image: [Cities4Forests](https://www.cities4forests.com/).

Interference with Infrastructure



Tall trees may conflict with utilities and infrastructure below and above ground (shown). When planted close to sidewalks or when soil is compacted, tree roots can cause damage.

Selection of shorter species near utilities with desirable canopy and root structures can prevent conflict with utility lines. Planting street trees in tree boxes and providing adequate space for root growth can minimize conflict with sidewalks and underground utilities.

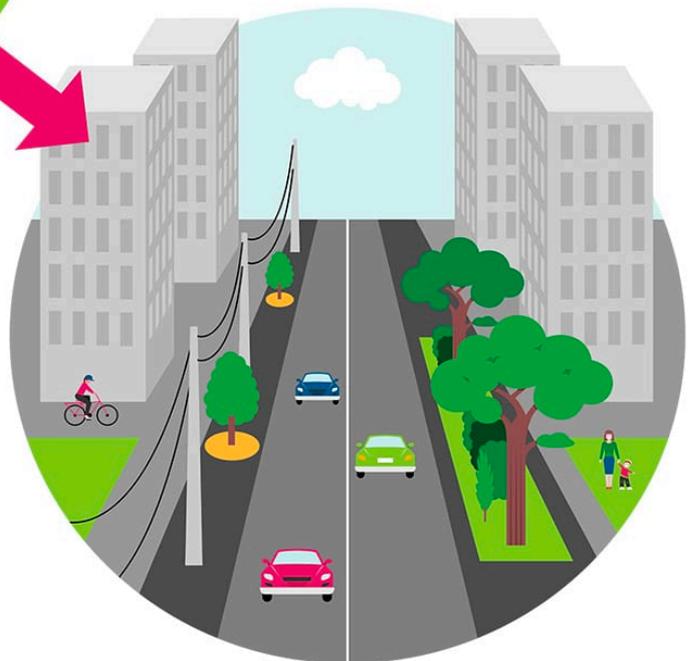


Image: [Cities4Forests](#).

In general, however, **many of the possible dis-benefits of urban forests can be avoided with proper planning, management, maintenance, and community input** — especially when these concerns are explicitly incorporated into planning and decision-making. ([Löhmus & Balbus, 2015](#); [Wolf, 2017](#)) **Participatory planning** and research that incorporates local knowledge and perspectives can create equitable solutions that empower local communities. ([Anguelovski et al, 2019](#))

Please see the [Selected Resources card](#) for more information on green infrastructure for air quality.

Gaps in Knowledge

- **What are the impacts of policies, regulations, and plans on urban forests, in both the near-term and the long-term?**
- **How can we best assess the effectiveness of these plans?**
- **Which plans, policies, or regulations are most necessary?**

For example, urban forest management plans are the “defining documents” of many urban forest programs, but not all cities have the capacity to develop such plans. ([Ordóñez & Duinker, 2013](#)) For those that do, formal assessment methods of urban forest management plans are lacking. ([Ordóñez & Duinker, 2013](#))



Mumbai, India. Photo: [Edwin, Flickr](#).

- How do benefits and dis-benefits differ in various social, political, climatic, geographic, and economic contexts? Much of the research has been conducted in North America, Europe, China, and Australia. ([Roy, Byrne, & Pickering, 2012](#)) It is important to remember that in other contexts, benefits and dis-benefits may change. ([Dobbs, Escobedo, & Zipperer, 2011](#))
- How do the services provided by “natural” or remnant forest patches differ from those of street trees or non-native planted trees?
- How can city officials best assess the value of urban forests, considering local environmental and economic conditions, in order to incorporate this value into decision-making? ([Roy, Byrne, & Pickering, 2012](#))
- How can city officials best assess the intangible social value of urban forests?
- How will rising global temperatures due to climate change and increasingly frequent extreme weather affect the ability of urban forests to provide benefits?
- What are the best ways to engage local communities, especially disadvantaged communities, when both parties have only limited time and resources? Some cities have taken innovative approaches, such as creating phone-lines to increase resident input, or creating community advisory boards? ([Nesbitt et al, 2018](#))

Summary

- The urban forest encompasses the trees and associated vegetation in an urban area. The urban forest is part of a larger network of green infrastructure.
- Urban forests can help to create more livable cities by providing ecosystem services, or benefits. They also create some dis-benefits, or costs, which should be considered during policymaking, planning, management, and consultation with stakeholders.
- Cities are challenging environments for trees, and development pressure continues to increase with the growth of urban populations. In different contexts, trees may provide benefits or dis-benefits to urban dwellers.

- Plans, policies, regulations, and institutional arrangements can support urban forests—either directly or indirectly. Interventions to influence planning and management of urban forests could be included in comprehensive or strategic plans, ordinances, by-laws or codes, urban forest management plans, and zoning for the city and local context.
- Cities around the world have taken different approaches to managing their urban forests. Many successful cities have taken steps to coordinate the activities of the government, the private sector, civic organizations, and residents themselves.
- Integrated planning and policy can support funding streams to manage, restore, and grow urban forests.
- Understanding and including the various stakeholders involved in the governance of urban forests typically reduces conflict and helps to ensure equitable distribution of urban forest ecosystem services.

Selected Resources

General Urban Forest Resources:

- [Cities4Forests Toolbox](#)
- [Guidelines on Urban and Peri-urban Forestry \(FAO\)](#)
- [Urban Forest Management Plan Toolkit](#)
- [Routledge Handbook of Urban Forestry \(2017\)](#)
- [Urban Forestry: Planning and Managing urban Greenspaces \(Miller, Hauer, and Werner, 2015\)](#)
- [Legal and Institutional Aspects of Urban and Peri-urban Forestry and Greening \(FAO\)](#)
- [Planning for Urban Forests, American Planning Association \(2009\)](#)

Resources for Public Space Interventions:

- [Cities Safer by Design \(WRI\)](#)
- [Toolkit for Community Participation in Pocket Parks \(EMBARQ\)](#)
- [Complete Streets Local Policy Workbook \(Smart Growth America\)](#)
- [The 8 Principles of the Sidewalk: Building More Active Cities](#)

General Green Infrastructure Resources:

- [Green Infrastructure: How to Manage Water in a Sustainable Way \(NRDC\)](#)
- [Integrating Green and Gray: Creating Next Generation Infrastructure \(WRI\)](#)

Social Equity Resources:

- [Cities4Forests Social Equity Learning Guide](#)
- [Roadmap for Inclusive Planning \(C40\)](#)
- [Mapping Social Landscapes Guide \(WRI\)](#)
- [Meaningful Stakeholder Consultation \(IDB\)](#)

Guidelines and Literature on Urban Trees/ Green Infrastructure and Air Quality:

- [Using Green Infrastructure to Protect People from Air Pollution \(Greater London Authority\)](#)
- [Implementing Green Infrastructure for Air Pollution Abatement: General Recommendations for Management and Plant Species Selection \(University of Surrey\)](#)
- [Using Green Infrastructure to Improve Urban Air Quality \(GI4AQ\) \(Hewitt, Ashworth, and MacKenzie, 2020\)](#)

Definitions

- **Equity:** The absence of avoidable or remediable differences among groups of people, whether those people are defined socially, economically, demographically, or geographically. ([WHO, n.d.](#))
- **Participatory Planning:** Joint actions of local people and project staff with the objective of formulating development plans and selecting the best available alternatives for their implementation. It should be a two-way learning process of dialogue, negotiation and decision-making between insiders and outsiders, concerning activities to be undertaken by the insiders and supported by the outsiders. It is thus conceptualized in terms of what can be called a “negotiating dialogue” between local people and project staff, aimed at conforming project support to local needs, constraints and opportunities. Simply stated, participatory planning is an effort of the parties involved to elaborate a common agenda for future development actions.
- **Resiliency:** “cities that have the ability to absorb, recover and prepare for future shocks (economic, environmental, social & institutional). Resilient cities promote sustainable development, well-being and inclusive growth” ([OECD, 2019](#))

Credits

Edith Juno, Author

Terra Virsilas, Author

James Anderson, Editor

Lisa Beyer, Reviewer

Jaya Dhindaw, Reviewer

Robin King, Reviewer

Gabriela Morales, Reviewer

Sebastian Varela Contador, Reviewer

Benjamin Welle, Reviewer

Sarah Wilson, Reviewer

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