WORLD RESOURCES INSTITUTE

EXECUTIVE SUMMARY

Better Forests, Better Cities

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HIGHLIGHTS

- A growing body of scientific evidence shows that conserving, restoring, and sustainably managing forests can provide robust, low-cost infrastructure solutions to help cities and their leaders meet the myriad demands of growing urban populations, such as increased clean and reliable fresh water, safe and healthy environments, and protection from natural disasters.
- Cities around the world are responding to this evidence, increasingly using forests inside, near, and far away from cities to address their challenges and meet the aspirations of residents.
- Forests are particularly effective at providing cities and their residents with four benefits: human health and well-being, a clean and reliable water supply, climate regulation, and biodiversity conservation.
- This report evaluates the evidence base to show how and where these benefits are delivered and what immediate actions cities can take to better conserve, restore, and sustainably manage forests for the desired benefits.
- It presents a review of hundreds of synthesis papers, original research papers, and key reports and collectively shows how different forest types at different levels can deliver a diverse suite of benefits to cities.

BETTER FORESTS MAKE FOR BETTER CITIES

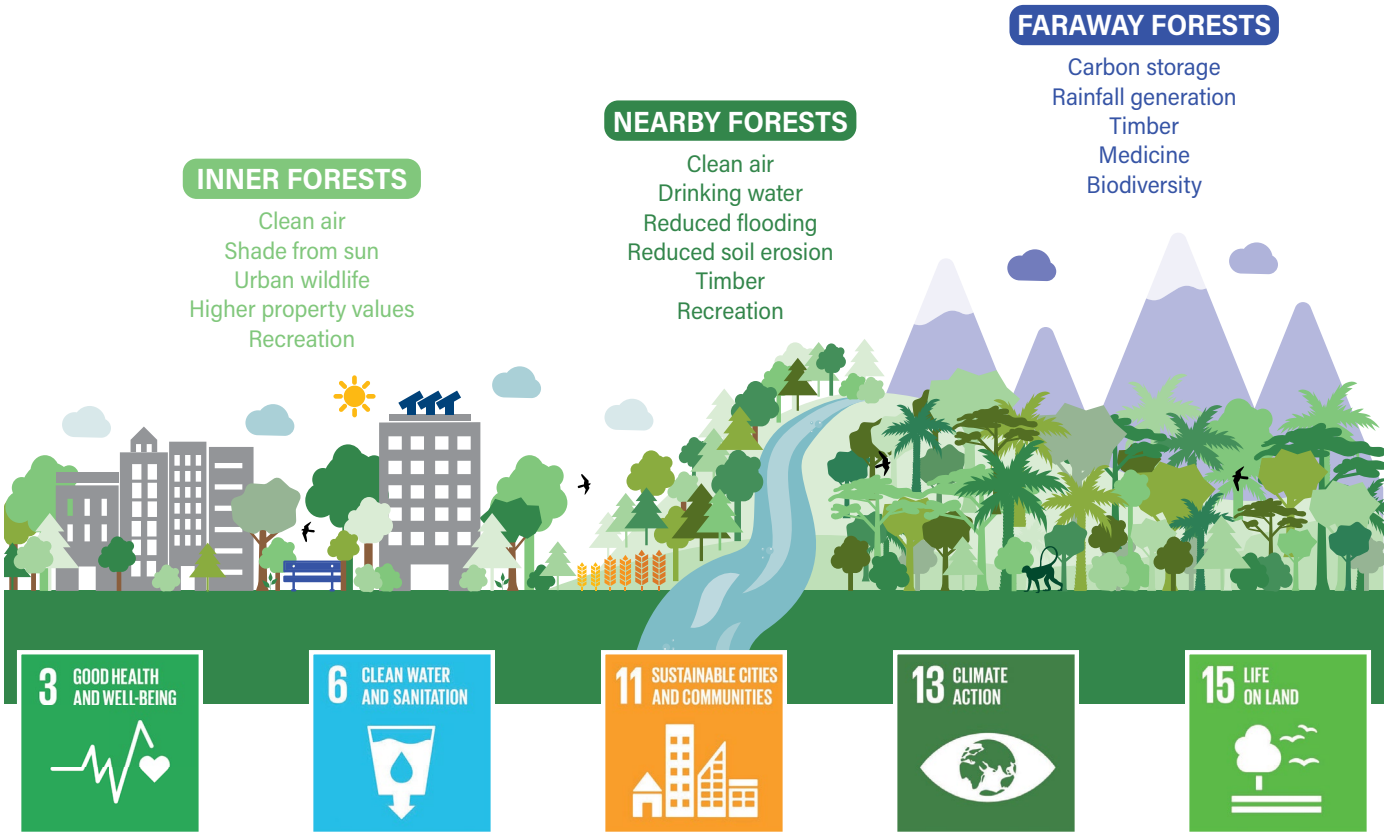
In the coming decade, city mayors and managers will face unprecedented demands from growing urban populations. Rapid urbanization and environmental changes are putting new pressures on burgeoning cities. City leaders are charged with providing urban residents with a safe place to live and work, environments that promote good health, clean and reliable freshwater, and protection from natural disasters. They will need to step up their climate action and meet other sustainability commitments—all of which are rising on political and media agendas. At the same time, city leaders will need to juggle these demands amidst dynamic conditions, often with tight financial resources.

Nature-based solutions[1] (NBS)—such as trees and forests—can help cities meet many of these needs. A growing body of scientific evidence shows that conserving, restoring, and sustainably managing forests can provide robust, low-cost infrastructure solutions to complement other traditionally built infrastructure. Cities around the world are responding to this evidence, increasingly using forests to address their challenges and meet the aspirations of residents.

Forests inside, near, and far away from cities (Figure ES-1) can help cities both meet their needs and contribute to commitments to act on global challenges:

- *Inner forests* include street trees, trees and forests on private property, patches of native woodland, forested ravines and corridors, and so forth, found within city boundaries. Inner forests can improve air quality, reduce the heat island effect (leading to lower energy use and energy bills), reduce stormwater runoff and urban flooding, provide access to nature and respite from the built environment, and support human health and wildlife.
- *Nearby forests* are trees, woodlands, and forests in the watersheds surrounding cities. They contribute to cleaner air in cities, support stable supplies of clean drinking water, reduce flooding, provide wildlife habitat, and offer space for recreation.
- *Faraway forests* are substantial, intact, and remote forests that are most often located far outside a city's boundary. These forests—particularly those in the tropics—sequester large amounts of carbon, generate reliable rains for

FIGURE ES-1 | Inner, Nearby, and Faraway Forest Benefits



Note: Forests at three levels provide benefits to cities and contribute to the achievement of the UN Sustainable Development Goals.
Source: Cities4Forests n.d.a.

cities and the world's agriculture belts, provide a wealth of products used by cities every day (including medicines, food, and building materials), and host the majority of the world's land-based biodiversity.

Forests are particularly effective at providing cities and their residents with four benefits: human health and well-being, a clean and reliable water supply, climate regulation, and biodiversity conservation. *Better Forests, Better Cities* evaluates the evidence base to show how and where these benefits are delivered by forests and, in unique circumstances, when and where they are not. This report presents a review of hundreds of synthesis papers, original research papers, and key reports. Collectively, this research shows how different forest types at different levels can deliver a diverse suite of benefits to cities.

FINDINGS FROM THE SCIENTIFIC LITERATURE

Health and Well-Being

Cities afford their inhabitants many benefits, but they also create conditions that can have negative impacts on health and well-being (Kuddus et al. 2020). Forests and trees, particularly in the inner forest, can improve the health and well-being of urban residents by these actions:

- *Reducing extreme heat.* The urban heat island effect—in which urban areas experience higher temperatures than their rural surroundings—presents a number of risks to human health. These include increased risk of heat-related deaths, increased concentrations of urban smog and ground-level ozone, spikes in energy and water

demand, and power outages (Heaviside et al. 2017). Urban trees and forests can mitigate the urban heat island effect by providing shade and cooling the air via evapotranspiration. These processes reduce both the risk of heat-related illness or death and increase the livability of cities (Bowler et al. 2010a; Mohajerani et al. 2017; Wolf et al. 2020).

- *Enhancing urban air quality.* Ambient air pollution threatens the well-being of most urban residents. Nine out of 10 people breathe polluted air worldwide, leading to about 4.2 million deaths globally. Low- and middle-income countries are disproportionately affected (WHO 2016). Reducing emissions from the source is key, but carefully planned and managed inner forests can further improve air quality by removing and dispersing air pollutants (Nowak et al. 2014; Kumar et al. 2019; Hewitt et al. 2020).
- *Promoting mental and physical health.* Living in cities can take a toll on mental and physical health. Pollutants, being sedentary, and living close to other people can increase the prevalence of many kinds of diseases (Bai et al. 2012; Ventriglio et al. 2021). Forests and trees reduce noise, pollution, and other stressful conditions, and they provide opportunities for rest, relaxation, and recreation in nature (Hartig et al. 2014; Kuo 2015; Bratman et al. 2019; Wolf et al. 2020). Preventing deforestation and degradation of biodiverse forests outside cities may also reduce the spillover of infectious diseases, including novel viruses, from animal hosts to humans (Alimi et al. 2021).
- *Creating safe, walkable streets.* Cities around the world are working to increase biking and walking as ways to travel. Trees along streets and urban green spaces encourage active transport, providing shade, reducing localized air pollution, and making streets and pathways more beautiful and pleasurable (Wolf et al. 2020).
- *Supporting community connections.* Forests and other green spaces can build cohesion among urban residents by providing places for communities to gather, enhancing a "sense of place," and creating space for spirituality and reflection (Wolf et al. 2014; Jennings et al. 2016). Inner and nearby forests are desirable locations for social gatherings, recreation, tourism, and spiritual practice and contemplation (Kuo 2015; O'Brien et al. 2017; Irvine and Herrett 2018; Ngulani and Shackleton 2019).
- *Reducing inequity and empowering residents.* Social and economic inequality is a challenge facing most cities. Lower levels of urban tree canopy cover have been associated with relatively low-income and marginalized populations in some cities (Schwarz et al. 2015; Jennings et al. 2016; Gerrish and Watkins 2018; Watkins and Gerrish 2018). Unequal tree distribution can translate into unequal distribution of the important human health and well-being benefits trees provide (Jennings and Johnson Gaither 2015; Braubach et al. 2017). Engaging communities to plan and integrate more trees and natural areas into neighborhoods with marginalized and low-income residents can help to address systemic inequalities in urban areas (Wolch et al. 2014; Kondo et al. 2015; Jelks et al. 2021). Meaningful community engagement and leadership is essential to realize these benefits.

- *Providing food, medicine, and raw materials.* Although city residents rely heavily on imported goods sold in formal markets (e.g., stores), inner and nearby forests can help improve food access, especially for lower-income or marginalized groups in cities. These forests can provide food, medicines, and raw materials for subsistence or can provide income (Pramova et al. 2012; Shackleton et al. 2015).
- *Enhancing economic well-being.* Inner forests can provide multiple economic benefits to cities and city residents (Nesbitt et al. 2017). Trees can increase property values for residents and associated property tax revenues for municipal governments (Roy et al. 2012). They can serve as a form of "green infrastructure" that can lower the costs of stormwater management, reduce flooding risks, lower energy costs, and provide other cost-saving measures.

Water

Forests and trees at all three levels can be a cost-effective way to help improve and stabilize city water resources. Many cities struggle to provide ample clean water (water is "too dirty"), address flooding and erosion (there is "too much" water), plan for droughts (there is "too little" water), and deal with new levels of inconsistency in once-reliable rain patterns (water is "too erratic").

***Too dirty*: Many cities find it difficult to provide residents with a reliable supply of clean drinking water.** Contaminated drinking water causes severe health issues in many regions, and water treatment facilities can be costly to establish and maintain. Forests in watersheds can prevent soil erosion and filter sediment and pollutants (Kuehler et al. 2017), keeping surface waters and aquifers cleaner and reducing costs to cities. For example, recent analysis finds that upstream forest protection and restoration can reduce costs for water utilities in the world's 534 largest cities collectively by US$890 million per year (McDonald and Shemie 2014). Mature native forests provide these benefits more reliably than plantations.

***Too much*: By 2030, riverine flooding will impact around 130 million people and $535 billion in urban property, and coastal flooding will impact another 15 million people and $177 billion in urban property.**[2] Forests—especially nearby forests—can prevent or reduce the severity of flooding. Forests intercept and store rainwater, reducing stormwater runoff. They improve the ability of soil to hold water, increasing both infiltration (entry) and percolation (downward movement) of rainwater (Berland et al. 2017; Kuehler et al. 2017). They increase the amount of water returned to the atmosphere by evapotranspiration. And they can store excess runoff, holding and slowing the release of water much like a sponge. Forested watersheds (near cities) regulate water flows and help prevent flooding and landslides. Trees and other vegetation in bioretention areas, green roofs, and bioswales can also complement traditional, engineered water infrastructure solutions for stormwater management in urban areas.

***Too little*: Water scarcity can be caused by drought, groundwater depletion, or reduced river flows. Many cities around the world—especially in arid regions—face seasonal or year-round issues with water supply.** The "Day Zero" drought-induced water crisis in Cape Town of 2017–18 drew worldwide attention to the risks of too little water: thousands of people lost their jobs, food security decreased, and a political crisis ensued. Preventing deforestation and restoring forests can help sustain water availability (Brauman et al. 2007; Filoso et al. 2017; van Dijk and Keenan 2007; Zhang et al. 2017) by increasing the infiltration capacity of soils, which promotes groundwater recharge, although benefits may lag in reforested areas and water yields may decline initially in the years immediately following restoration or reforestation (Filoso et al. 2017). Forests also affect rainfall patterns at regional and even global levels. By capturing and recycling precipitation, evapotranspiration sends water into the atmosphere, creating "flying rivers" that transport water to fall as rain in downwind regions far from the forest.

***Too erratic*: Urban residents are vulnerable to increasingly erratic weather patterns, including longer and more intense droughts and heavy rainfall, linked to climate change.** Variability and unpredictability in precipitation and water supply create additional challenges for municipal leaders, such as providing a reliable water supply to residents or preparing for unpredictable water highs and lows. Because of their role in the global water cycle, forests can help reduce this variability. Forests, especially large tracts of intact forests and rain forests, recharge atmospheric water supplies and thereby influence rainfall patterns hundreds to thousands of miles away. Forests also can reduce local water variability by enabling a slow release of water over time. Conserving and

restoring forests are important strategies for stabilizing precipitation levels and groundwater availability in a changing climate (Melo et al. 2021).

Climate

The effects of climate change—including heat waves, flooding, rising sea levels, and droughts—threaten both the well-being of urban residents and the costs of operating a city. Not surprisingly, urban residents' concerns about climate change are growing rapidly. Forests are good for both climate change adaptation and mitigation, and some of the adaptation benefits (for example, flooding reduction) have previously been mentioned. This section focuses on how forests can mitigate climate change. Cities around the world are committing to bold action to reduce their greenhouse gas (GHG) emissions and tackle climate change. C40 Cities Climate Leadership Group (an international network of megacities that have committed to take action on climate change), ICLEI—Local Governments for Sustainability, and the Carbon Neutral Cities Alliance are all examples of city networks committed to reducing GHG emissions. The first important step is to reduce GHG emissions from sources within cities and from city consumption, but forests can help cities go further.

Forests and trees in cities can reduce energy-related GHG emissions by modulating temperature. Inner forests reduce extreme heat in summer and shade buildings (Mullaney et al. 2015; Ko 2018). These trees can help residents and businesses adapt to rising temperatures while simultaneously reducing emissions generated by cooling and heating buildings with fossil fuels. In the United States alone, urban forests reduce electricity use by 38.8 million megawatt-hours at a savings of $4.7 billion annually, with reductions in heating use estimated at 246 million British thermal units at a savings of $3.1 billion annually, and avoided emissions valued at $3.9 billion annually (Nowak et al. 2017).

Inner forests provide modest opportunities to sequester and store carbon in wood and soils (Nowak et al. 2002; Roy et al. 2012; Nowak and Greenfield 2018b). However, total carbon storage is limited by the cost and availability of space in cities, and both total storage and sequestration rates in urban forests vary with climatic and other biophysical factors (Nowak et al. 2013; Dobbs et al. 2014; Chen 2015). Cities with favorable growing seasons, ample water supplies for vegetation, and robust urban forest management programs tend to store more carbon. Although inner forests do store carbon (and provide many cobenefits), planting trees and expanding the urban tree canopy will never be a sufficient way for cities to meaningfully compensate for their energy and transportation emissions. The number of trees that can fit within an urban area (and thus their stored carbon) is very small relative to a city's annual carbon emissions (Pataki et al. 2011). Urban forests can only sequester a tiny fraction—often less than 1 percent—of overall city emissions. Urban forests can also be carbon neutral or carbon positive in some cases, meaning that they may emit as much or more carbon as they sequester. Throughout China, for example, the annual carbon sequestration of urban vegetation in 35 of its largest cities could offset only 0.33 percent of these cities' total annual emissions (Chen 2015). Importantly and in all instances, urban forests will always sequester more carbon than they would if the forests were converted to other land uses.

Protecting and restoring faraway forests is critical to reduce emissions and mitigate global climate change. Often underappreciated by city climate action planners, faraway forests provide large-scale carbon sequestration for climate change mitigation. Forests, especially tropical forests, are large reservoirs of carbon that are released if the forest is cleared. But if forests are conserved, those stores are protected, and standing or restored forests continue to sequester even more carbon. Cities can play a big role in realizing this carbon opportunity and can help meet their own carbon reduction or neutrality commitments in the process. For instance, cities can lower their forest-carbon footprint by ensuring that the commodities they purchase for city infrastructure and operations—such as timber, paper, and food—come from deforestation-free supply chains or by reducing food loss and waste or shifting the diets of their residents towards more plant-based foods. Cities can partner with selected faraway forests that have a social or economic link to the city, offering programs that support the conservation and/or restoration of that faraway forest. Moreover, cities can financially support reductions in tropical forest-related emissions by participating in jurisdictional REDD+ (reducing emissions through deforestation and degradation, plus the sustainable management of forest and the conservation and enhancement of forest carbon stocks) programs verified by a credible standard.

Biodiversity

Biodiversity—global and local—provides many direct and indirect benefits to cities, and cities can play a key role in protecting biodiversity at regional and global levels. The biodiversity of plants, animals, fungi, and other life forms is declining rapidly because of human activities, both in and outside of cities (Tilman et al. 2017; Mazor et al. 2018). Maintaining—or even increasing—biodiversity in inner forests is increasingly appearing on municipal agendas (Brende and Duque 2021). Yet municipal policies and practices can support forest biodiversity in nearby and faraway forests too. Supporting forest-based biodiversity is important to cities for a number of reasons, including providing direct benefits and supporting many of the benefits in the other three sections of this report.

- *Biodiverse forests often provide more—and more reliable—goods and services* (Fischer et al. 2006; Flynn et al. 2011; Cardinale et al. 2012; Oliver et al. 2015). To provide the myriad benefits of trees to urban residents, forests must be able to persist and recover from changes in the environment, including storms, droughts, and a changing climate. High levels of biodiversity can serve as biological "insurance"—when an ecosystem has many species fulfilling similar roles, it can continue to function even if some of those organisms are lost or if a disease (e.g., Dutch elm disease; chestnut blight) wipes out an entire species from an area (Yachi and Loreau 1999; Brandon 2014).
- *Biodiverse forests store more carbon, more reliably.* Undisturbed native forests sequester more carbon and store it for longer than degraded forest or monoculture plantations (Holl and Brancalion 2020; Watson et al. 2020). Biodiverse forests have higher resilience to fluctuations in climate, pest outbreaks, and diseases than tree monocultures. This higher resilience makes them a more reliable carbon sink (Turner et al. 2009; Brandon 2014; Seddon et al. 2019).
- *Biodiverse forests protect watersheds.* Native, biodiverse forests in watersheds are more effective than planted monocultures at supplying water resources to downstream cities (Alvarez-Garreton et al. 2019; Bonnesoeur et al. 2019; Yu et al. 2019). This is due to the structure, impact on soils, and greater resilience of native forests creating better conditions for storing and filtering water.
- *Biodiversity provides blueprints for new medicines.* Biodiversity within forests has provided compounds and genetic material for making antibiotics, anticancer agents, anti-inflammatory compounds, and analgesics used around the world (Chivian and Bernstein 2010; Sen and Samanta 2014). In developing countries, 70–95 percent of the population, including those living in cities, rely on traditional remedies such as herbal medicines derived from forests for primary care (Robinson and Zhang 2011).
- *Biodiverse forests support urban food supplies* (Krishnan et al. 2020). Thirty-five percent of food produced globally comes from 800 plants that rely on pollination by insects and other animals (Klein et al. 2007). Forests provide critical habitat for many of these pollinators (Öckinger and Smith 2007; Nicholls and Altieri 2013; Bailey et al. 2014; Hipólito et al. 2019).
- *Protecting biodiverse forests can reduce risks of zoonotic and vector-borne diseases.* Deforestation, forest degradation, and the associated wildlife trade has been linked with the spread of diseases that jump from animals to humans—which cause immense health and economic damages (Wolfe et al. 2007; Karesh et al. 2012; Jones et al. 2013; Borremans et al. 2019). Examples include the Ebola virus, yellow fever, malaria, Zika virus, and coronaviruses (Guerra et al. 2006; Wilcox and Ellis 2006; Karjalainen et al. 2010; Monath and Vasconcelos 2015; Olivero et al. 2017). Evidence suggests that conserving tropical

forests and sustaining their high levels of biodiversity can decrease transmission of some infectious diseases (Evans et al. 2020; UNEP 2020).

- *Access to biodiverse nature in cities can provide more reliable and richer benefits to residents, including an important list of mental and restorative health benefits* (Fuller et al. 2007; Lai et al. 2018; Wood et al. 2018; Marselle et al. 2019; Ngheim et al. 2021). Urban trees and forests are one of the main ways urban residents experience nature (Pregitzer et al. 2019). Biodiversity in the urban forest also contributes to the distinctive character of cities around the world (Hausmann et al. 2016).
- *Inner forests can house high biodiversity.* Urban forests can be highly biodiverse and can serve as corridors for some species. But they also tend to have more invasive species, "generalist" species, and fewer endemics (species with very limited ranges) than rural forests in the same habitat type (Concepción et al. 2015; Ducatez et al. 2018; Borges et al. 2021). Managing urban forests for biodiversity can provide access to nature within cities and create more resilient urban forests, essential for delivering other forest benefits.
- *Tropical forests hold most—up to 90 percent—of the planet's terrestrial biodiversity and thus are essential to urban well-being* (Wilson 1988; Reid and Miller 1989; WRI et al. 1992). Tropical forests continue to be lost at alarming rates.

Cities around the world are responsible for the lion's share of deforestation via their consumption. This also puts them in a strong position to improve their own biodiversity impacts through local policies that reduce negative impacts on tropical forests.

Right Trees, Right Place

Forests can provide the many benefits described in this report. But sometimes, the wrong trees in the wrong places can result in unintended and negative consequences. For example, monocultures of trees along city streets are vulnerable to pest and disease outbreaks (such as Dutch elm disease and the emerald ash borer). Our research found that some tree species emit volatile organic compounds and bioparticles (such as pollen) that can worsen urban air quality. In some situations, trees planted in urban street "canyons" formed by tall buildings can trap polluted air near the ground, preventing air currents from dispersing the pollution. Invasive tree species planted in cities can reduce native biodiversity and can even damage neighboring forests if they spread beyond city limits. Some species of tree also fail to thrive in harsh urban environments where air pollution, wind, and harsh temperatures can damage trees. In nearby and faraway forests, monoculture tree plantations can decrease biodiversity and sometimes even reduce carbon stores, especially if they replace native forests. In certain circumstances, upstream tree planting or forest restoration will decrease downstream water availability. For example, in Quito, Ecuador, millions of eucalyptus trees planted throughout the city and in nearby watersheds now diminish urban biodiversity, create forest fire risks, and can lead to soil erosion (compared to native tree species). Thus, ensuring the "right trees" are in the "right place" is critical for receiving the full benefits of forests at all levels.

Recommendations for Policy and Action

What can city leaders do to realize the myriad benefits forests provide to their cities and residents? Our analysis has identified actions cities can take, and our synthesis of the literature and interviews categorized these under five thematic categories:

1. Measurement and monitoring

2. Planning

3. Partnerships

4. Finance

5. Markets

The following are a suite of "no regrets" measures that allow a city to take immediate action to capture the potential of inner, nearby, and faraway forests to help meet their goals (Figure ES-2). While not exhaustive, they provide directions towards tangible actions. Underpinning these measures are a set of guiding principles that apply to all recommendations (Box ES-1). Suggested policy actions are divided by level—inner, nearby, and faraway forests—and the thematic category that each action addresses.

FIGURE ES-2 | Forest-Positive Actions across Five City Action Categories and Three Forest Levels

	INNER FORESTS	NEARBY FORESTS	FARAWAY FORESTS
1. Measurement 	1. Map, inventory, and monitor your city's urban forest 2. Quantify the benefits of urban trees 3. Align forest monitoring metrics with city goals 4. Articulate clear forest-related goals	1. Map peri-urban and watershed forests and identify where forests are being lost 2. Quantify the benefits of trees in areas around the city	1. Conduct an analysis of city-wide consumption linked to tropical deforestation 2. Identify and track local attitudes and initiatives towards promoting deforestation-free commodities 3. Articulate clear goals to guide action
2. Planning 	5. Develop an urban forest management plan 6. Designate land specifically for natural areas 7. Create connectivity	3. Support the development of "nearby forest" management plans 4. Articulate clear forest-related goals	4. Calculate and develop an action plan to reduce the consumption of forest-risk commodities and city-driven carbon dioxide emissions associated with deforestation
3. Partnerships 	8. Seek out organizations conducting innovative work on inner forests 9. Cultivate interagency and cross-jurisdictional collaboration	5. Articulate and amplify shared goals	5. Establish a "partner forest" 6. Establish relationships with organizations involved in forest conservation, restoration, and sustainable management to help implement faraway forest programs 7. Call on subnational and national governments as well as businesses and financiers to conserve, restore, and better manage tropical forests 8. Incentivize the use of responsibly sourced forest-risk products
4. Finance 	10. Explore diverse, long-term financing mechanisms	6. Clarify that forest protection and management are eligible infrastructure expenses 7. Make the economic and business case for action on forests 8. Establish upstream-downstream partnerships to finance watershed management	9. Compensate for urban emissions by funding tropical forest conservation 10. Match conservation and restoration efforts in the city with conservation in faraway forests
5. Markets 	11. Develop wood waste reuse programs	9. Implement a robust procurement policy for local, sustainably sourced wood 10. Explore the role of carbon markets to finance forest conservation or restoration	11. Establish ecotourism ventures to conserve and sustainably manage forests threatened by competing land-use pressures 12. Initiate tropical forest-positive procurement policies and campaigns

Source: Authors.

BOX ES-1 | Guiding Principles

- *Conserve first, restore second*. Conserving native forests is a more effective and cost-effective way of sequestering carbon, conserving biodiversity, and maintaining water resources than planting new forests.
- *Protect large, old trees*. Old trees support biodiversity and provide benefits that cannot be replaced by planting new trees.
- *Define forests as essential infrastructure*. Forests are often seen as a luxury or amenity, but given the benefits they provide, they should be viewed in policy and practice as essential infrastructure for cities alongside traditional built or "gray" infrastructure.
- *Create a clear vision for the role of forests*. Forests and trees can serve multiple city goals and also imply trade-offs. It is important to collaboratively develop a vision for the role that forests can play in reaching success.
- *Give voice to communities.* Empower and engage community members, including a diversity of voices to ensure benefits are equitably distributed and suit residents' needs.
- *Emphasize equity*. For low-income and marginalized populations, the benefits of forests and trees may hold disproportionate value.
- *Collaborate across jurisdictions and city agencies*. Collaboration across agencies, sectors, and jurisdictions (including both other municipalities and regional and national governments) is crucial for capturing synergies in data, expertise, and resources.
- *Use forests to complement measures to reduce greenhouse gas emissions*. As a climate change mitigation strategy, forest conservation and restoration should complement city efforts to reduce urban emissions from energy generation, industry, and transportation. Reducing emissions will help keep forests healthy—a double win for climate change mitigation.
- *Prioritize biodiverse, native forests*. Biodiverse forests and native tree species, as opposed to monoculture plantations or non-native species, are more resilient to stress and provide a broader suite of benefits.
- *Use the "right tree, right place" approach*. The species and placement of forest planting and regrowth should be aligned with the specific goals, adapted to local conditions, and resilient to a changing climate.

Recommendations for Inner Forests: Urban Trees, Parks, Green Infrastructure, and Natural Areas

The following options can help city leaders advance the quantity and quality of inner forests—and thus the benefits those forests provide to urban residents. Since most inner forests fall within a city's jurisdiction, cities often have full authority to pursue these recommendations.

Measurement and Monitoring: Inner Forests

- *Map, inventory, and monitor your city's urban forest*. Develop an urban tree cover baseline and land cover map as a first step towards planning and monitoring urban forests. Include an inventory of large, old, and culturally relevant trees. Evaluate key urban environmental challenges that could be improved through better forest management, such as heat islands, urban flooding, and inequities in access to green space (WRI Mexico 2016; Singapore-ETH Centre n.d.).
- *Quantify the benefits of urban trees, especially iconic and mature ones.* Such an analysis is critical for informing policies and investments in urban trees and can garner political and resident support. For example, following

its success in the United States, i-Tree Eco[3]—an online tool developed by the U.S. Forest Service to quantify and value ecosystem services provided by trees—was recently adapted, translated, and launched for Mexican cities, allowing cities across Mexico to quantify the extent and composition of urban forests and calculate ecosystem services and monetary values.

- *Align forest monitoring metrics with city goals.* Although canopy cover is often measured to assess urban forests, this single metric does not provide comprehensive information on all forest benefits. Use other metrics that improve forest function, such as forest types, species diversity, carbon density, proximity to residents, and distribution (Pregitzer et al. 2019).
- *Articulate clear goals.* These are a few examples:
  - *Increase forest canopy by* X *percent.* The appropriate canopy cover targets will depend on what is appropriate for local conditions (e.g., climate, natural tree canopy cover outside the city) and should be used with additional targets—such as species diversity or a mix of stand ages—to ensure forest diversity and health.
  - *Ensure every resident has green space within a half mile of home.* This addresses the increasing appetite of cities to achieve equitable access to green space for their residents.
  - *Reduce heat island or stormwater threats by* X *percent.* In the face of climate change, cities are increasingly looking to establish targets that address climate risks, such as flooding, drought, and heat

Planning: Inner Forests

- *Develop an urban forest management plan.* The plan should be scientifically informed, inclusively developed, and climate resilient. The plan should inform and be informed by other citywide plans, such as transportation, housing, land use, parks, and economic development.
- *Designate land specifically for natural areas.* These include parks, vacant lots, and along roadways. For example, the Miyawaki method—in which diverse plantings of native trees and shrubs are used to create "microforests"—has been used to improve local access to nature and increase urban biodiversity in many cities around the world (Nargi 2019). Be explicit about the use of these natural areas to promote community gathering and better access to nature for all residents.
- *Create connectivity.* Corridors of tree-covered green space can facilitate the spread of pollinators, support wildlife, alleviate stress, increase foot and bike commuting, and reduce exposure to pollution for residents. Successful examples of green corridor projects include the Medellín Green Corridors (UNEP 2019) and the Barcelona Green Corridor Network (O'Sullivan 2017).

Partnerships: Inner Forests

- *Seek out organizations conducting innovative work on inner forests.* For example, the Natural Areas Conservancy in New York City is a formalized partnership that focuses on maintaining and improving the city's vast natural areas network, integrating the city's needs with the conservation benefits these areas provide.[4]
- *Cultivate interagency and cross-jurisdictional collaboration.* Managing forests for multiple benefits spans different city agencies, including health, water, land use, transportation, economic development, climate, air pollution/quality, and parks/recreation. The Joint Benefits Authority[5], which is being pioneered in San Francisco, is an example of a new mechanism that allows multiple departments within a city to jointly plan, implement, and finance projects to increase the quantity and quality of inner forests.

Finance: Inner Forests

- *Explore diverse, long-term financing mechanisms to manage, protect, and expand urban forests.* Innovative financing tools include the following:
  - Green bonds and climate bonds, which fund projects that have positive environmental and/or climate impacts through the use of proceeds or asset-linked bonds
  - Pay for performance environmental impact bonds (also known as pay for success bonds and social benefit bonds), which allow private investors to fund specific interventions and earn a return based on performance (i.e., paying for results rather than services)
  - Community-based public-private partnerships between local governments and private entities, which align the interests of public, private, and community stakeholders around common goals
  - Tree-planting funds from taxes and stormwater fees
  - Tree banks, which collect funds when trees are removed and their replacement value cannot be achieved and support replacements in other places throughout the city
  - Mitigation fees, which require that development activities mitigate their impacts by planting trees on sites where disturbance occurs or pay the equivalent fees into the city's tree canopy conservation account
  - Integration of forests into compliance plans for environmental requirements
  - Incentives for city residents to support trees and forests through tax reductions

Markets: Inner Forests

- *Develop wood waste reuse programs.* Rather than disposing of wood from urban trees in landfills, municipalities can develop wood waste reuse programs. Dead trees can become timber for local industry and construction and a variety of other energy-saving products. These programs help defer costs, create employment, store carbon, and foster integrative thinking and charismatic sustainable policies centered on trees in cities.

Recommendations for Nearby Forests: Watershed and Recreation Areas around Cities

The following options can help city leaders advance the quantity and quality of their nearby forests—and thus the benefits those forests provide to urban residents. Since most nearby forests fall outside city agency jurisdiction, partnership, and collaboration with other government agencies (e.g., state, provincial, federal), landowners, and managers will be necessary for implementation.

Measurement and Monitoring: Nearby Forests

- *Map peri-urban and watershed forests and identify where forests are being lost around the city.* Understanding where forests are, where loss is occurring, where risk of loss from fire or land-use change are high, and where restoration opportunities exist is essential for planning engagement with nearby forests.
- *Quantify the benefits of trees in areas around the city.* This can help garner support from residents and partners to support watershed management for city water supply.

Planning: Nearby Forests

- *Support the development of "nearby forest" management plans with measurable goals and success metrics.* A city could provide resources, such as funding, administrative support, and staff participation, and promote collaborative planning between government jurisdictions.
- *Articulate clear goals.* These are a few examples:
  - Restore *X* hectares by 2030.
  - Remove invasive species from key watersheds.

Partnerships: Nearby Forests

- *Articulate and amplify shared goals.* Forming collaboratives between city agencies, other government agencies, and landowners can be an effective way to do this. For example, the city of Denver collaborates with the National Forest System and state agencies in the Forests to Faucets initiative[6], which has the shared aim of reducing wildfire risks and improving watershed services across Colorado's Front Range (CSU n.d.).

Finance: Nearby Forests

- *Clarify that forest protection and management are eligible infrastructure expenses.* Many existing funds for infrastructure have not clearly stated their ability or priority for funding NBS, such as forests. Explicitly making NBS eligible for funds can open new funding sources for forest protection and management.
- *Make the economic and business case.* A "Green-Gray Assessment"[7] (Gray et al. 2019) assesses the costs and benefits of using green infrastructure (i.e., forests and trees) or green and gray infrastructure versus relying solely on traditional gray infrastructure for securing stable and clean water supplies.
- *Establish upstream–downstream partnerships to finance watershed management.* Identifying the downstream beneficiaries (e.g., water utility, beverage company) of forest watershed services is a key first step to securing performance-based arrangements with the upstream land managers. Types of financing mechanisms being pioneered by cities include green bonds, forest resilience bonds, water funds, and water utility rate surcharges.

Markets: Nearby Forests

- *Implement a robust procurement policy for local, sustainably sourced wood.* Sourcing wood from sustainably certified managed forests within a city's "woodshed" can help keep forests from being converted to other land uses.
- *Explore the role of carbon markets to finance forest conservation or restoration.* King County in the U.S. state of Washington established the Forest Carbon Program[8]; it provides the opportunity for local companies to compensate a portion of their own carbon emissions and support healthy forests within the county (King County 2020).

Recommendations for Faraway Forests: Intact and Remote Forests, Especially in the Tropics

City leaders can advance the quantity and quality of faraway forests—and thus the benefits those forests provide to urban residents. Because faraway forests fall outside a city agency's jurisdiction, partnership and collaboration with other governments and stakeholders will be necessary for implementing the following actions. Given the critical role of tropical forests in mitigating climate change and the current threats they face, cities should allocate special attention to conserving and restoring tropical forests.

Measurement and Monitoring: Faraway Forests

- *Conduct an analysis of city consumption linked to tropical deforestation.* Tools such as the Forest Footprint[9] can estimate a city's impact on tropical deforestation driven by urban consumption of commodities (e.g., beef, soybeans, timber) associated with tropical deforestation (Cities-4Forests n.d.b).

- *Identify and track local attitudes and initiatives towards promoting deforestation-free commodities.* This can help gauge levels of political support a city may have in taking steps to drive deforestation-free commodity procurement policies.
- *Articulate clear goals to guide action.* This is an example:
  - *X* percent of tropical wood and forest-risk commodities will be sustainably procured by *X* date.

Planning: Faraway Forests

- *Calculate and develop an action plan to reduce the consumption of forest-risk commodities and city-driven carbon dioxide emissions associated with deforestation.* The Forest Footprint tool can help cities to identify the size of their forest impact and the key commodities driving deforestation, which can help them plan their mitigative actions.

Partnerships: Faraway Forests

- *Establish a "partner forest."* A partner forest[10] is a faraway (usually tropical) forest connected to a city through a meaningful and mutually beneficial exchange. The city supports the partner forest by directing its purchasing power towards a product or service that the forest provides (e.g., shade-grown coffee, climate benefits, ecotourism). The goal of a partner forest program is to visibly support a tropical forest that provides direct benefits to the city and raise awareness of those benefits among city residents (Cities4Forests n.d.c).
- *Establish relationships with organizations involved in forest conservation, restoration, and sustainable management to help implement faraway forest programs*. Instead of trying to develop in-house expertise, cities can partner with one or more nonprofit organizations with on-the-ground experience in the forests of interest to help scope, design, and implement a faraway forest program.
- *Call on subnational and national governments as well as businesses and financiers to conserve, restore, and better manage tropical forests.* Being home to the majority of voters in many countries, cities can flex their political muscle by being vocal with state and national government leaders about the importance of faraway forests for city resident well-being. If faraway forests are to remain, the voice of cities needs to be heard.
- *Incentivize the use of responsibly sourced forest-risk products*. For example, the UK city of Chester, led by the Chester Zoo and the local member of Parliament, worked to encourage local businesses to use and sell products with palm oil certified by the Roundtable on Sustainable Palm Oil. Chester was recently certified as the first sustainable palm oil city worldwide (Chester Zoo 2019).

Finance: Faraway Forests

- *Compensate for urban emissions by funding tropical forest conservation.* Cities will have difficulty reaching carbon neutrality by cutting their direct emissions alone. Financing tropical forest conservation and restoration, certified by credible jurisdictional REDD+ programs, may offer ways to compensate for remaining urban emissions. A "climate co-op" could be created where cities purchase high-quality forest carbon credits via the voluntary carbon market to finance long-term forest conservation with associated carbon benefits.
- *Match conservation and restoration efforts in the city with conservation in faraway forests.* For example, for every tree planted within the city, a city could support parallel restoration efforts in a tropical forest. The London Enfield Council woodland restoration project is developing such a partnership on restoration with the city of Port Moresby (Papua New Guinea).

Markets: Faraway Forests

- *Establish ecotourism ventures to conserve and sustainably manage forests threatened by competing land-use pressures.* Cities can support the implementation of community owned and operated sustainable tourism programs by promoting these amongst their residents to develop a steady clientele pipeline, thereby bolstering the efforts of regional governments to boost local economies while also conserving faraway forests (Fitzgerald n.d.).
- *Initiate tropical forest-positive procurement policies and campaigns.* Cities can implement policies that discourage purchasing commodities implicated in deforestation and provide incentives for purchasing better-sourced commodities (or alternatives with lower tropical forest impacts). Tropical timber, coffee, chocolate, soy, and beef are commodities that are especially amenable to this approach.

For all of these measures—for inner, nearby, and faraway forests—healthy communications and engagement with city residents will be important (Box ES-2).

BOX ES-2 | The Importance of Communications and Resident Engagement

To achieve forest-related goals, city leaders will need to communicate with city residents to raise awareness, generate a shared vision, and mobilize political support and individual action. These are some of the key features of an effective communications program:

- Educate residents about the value of inner, nearby, and faraway forests.
- Engage youth through classroom education and field trips.
- Cultivate trusted messengers.
- Articulate clear city goals with respect to inner, nearby, and faraway forests.
- Use storytelling and highly visible demonstration projects to garner local support and make forest benefits "real," such as how the city of Glasgow is doing through the Every Tree Tells a Story program.

CONCLUDING THOUGHTS

Home to more than half of the world's population, cities are growing in their size, power, and impact on the natural environment. They face pressing challenges to provide their residents with essential services, including healthy, livable neighborhoods, clean and reliable water, action on climate change, and access to nature and biodiversity. Cities can use trees and forests to help meet these challenges.

Within cities, trees and forests—inner forests—can reduce extreme temperatures, reduce stormwater runoff, promote mental health, and provide shared spaces for recreation and relaxation. Forests around cities—nearby forests—can improve water resources, provide many forest goods, and offer access to nature. And faraway forests around the world are key to mitigating climate change, conserving biodiversity, and maintaining global rainfall patterns. Cities have many options available to support forests at all three levels and make the best use of the benefits they provide. Forests can also help cities reduce operating costs and pay long-term dividends that often increase over time. *The best time to plant a tree was fifty years ago. The second-best time is today.*

ENDNOTES

1. Nature-based solutions are defined as actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits (IUCN n.d.)
2. Flooding data are from Aqueduct Floods (database), World Resources Institute, https://www.wri.org/applications/aqueduct/floods/.
3. For more information, see i-Tree Eco, https://www.itreetools.org/tools/i-tree-eco.
4. See the Natural Areas Conservancy, https://naturalareasnyc.org/.
5. See WRI (n.d.b).
6. See the Forests to Faucets initiative, https://cfri.colostate.edu/projects/forests-to-faucets/.
7. The Green-Gray Assessment (GGA) method of World Resources Institute (WRI) allows stakeholders to value the costs and benefits of integrating green or natural infrastructure into water supply systems to improve performance. It has been applied by WRI in multiple watershed systems in the United States, Mexico, Brazil, and Colombia (see Gray et al. 2019).
8. See the Forest Carbon Program, https://kingcounty.gov/services/environment/water-and-land/forestry/forest-carbon.aspx.
9. Read more about the Cities4Forests Forest Footprint tool here: https://cities4forests.com/forest-footprint/.
10. Read more about the Cities4Forests Partner Forest Program here: https://www.partnerforests.org/.

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