The Nature Conservancy

Funding Trees
for Health

An Analysis of Finance and Policy Actions to
Enable Tree Planting for Public Health

Acknowledgments

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As city populations grow, urban trees cannot be viewed as a luxury: Trees are an essential component of a livable community and a core strategy for improving public health.

Executive Summary

The scientific case for the benefits of trees and urban nature has become more solid over the last few decades. Trees and other natural features in cities can help regulate water quality, water quantity, and the timing of water flow. They can help clean and cool the air, reducing harmful air pollutants and ambient air temperatures. They lend beauty to our streets, enhance citizens' lives, and significantly increase property values. When you consider all the benefits that street trees can provide to society, there is a strong business case for increased societal investment. One study in California, for instance, found that for every $1 spent on tree planting and maintenance, urban trees deliver $5.82 in benefits.

This report focuses on an area that has received a lot of attention recently, the links between trees and public health. Recent science has shown that the link is robust and economically significant. The central question of this report asks: *If trees are so important for health, how can cities use innovative finance and policy tools to enable tree planting for public health?*

This question is important, because despite the large literature on the many benefits provided by street trees and other natural features, most U.S. cities are experiencing declines in urban forest cover over time, with a net loss of 4 million urban trees every year, or about 1.3% of the total tree stock. New tree planting isn't keeping pace with the mortality of existing trees, either from natural causes or from clearing of trees for new development. If trees provide so many benefits, why are cities letting this natural resource dwindle away? We believe that there are four main barriers preventing cities from fully seizing the power of street trees and other natural features:

1. **Lack of knowledge:** Decision-makers and the public may lack knowledge of the benefits trees provide. We hope reports such as this one can play a role in closing this knowledge gap. For cities willing to invest time and resources, urban forestry science and tools have advanced enough that it is now quite possible to estimate the benefits that current (or future) street trees provide to residents. A first guide for U.S. cities looking to systematically planning urban forestry activities to achieve multiple ecosystem service objectives can be found in The Sustainable Urban Forest: A Step-by-Step Approach, a free handbook developed by the US Forest Service and The Davey Institute.

2. **Public concerns:** There are some public concerns about potential negative problems with trees, such as problems with fallen limbs causing power outages, or trees and untended parks providing spaces for criminal activity. In the report we address these concerns in detail and discuss possible solutions. Concerns can often be alleviated by better urban forestry practices or public education campaigns. Many of the past issues and concerns over street tree planting can be minimized in the future by following the Arbor Day Foundation's Right Tree, Right Place best practices.

3. **Silos:** The opportunity to advance tree planting in cities touches virtually every part of the urban landscape—from city streets and parks to private residential and commercial property. Yet the formally designated responsibility to advance tree planting often falls on just one municipal agency, such as a Forestry Office within a city's Department of Parks and Recreation. As a result, it can be difficult for cities to efficiently identify and harness all tree planting opportunities that might be presented by the on-the-ground work of different municipal agencies. We discuss in this report how cooperative planning processes are one way to overcome this barrier.

4. **Lack of financial resources:** Trees are often considered a "nice to have" item when compared to other critical municipal needs such as police and fire protection, education, roads, and other public services. This perspective, combined with the annual budget cycle of most cities (as opposed to longer-term planning considerations) leaves tree planting programs minimally funded, and often at risk of reductions. Finally, there is a persistent lack of funding for urban forestry, caused by constrained urban budgets and cities generally prioritizing urban forestry budgets relatively low compared with other priorities. Budgets to support a healthy tree canopy are further strained by a lack of funding for maintenance. Most cities spend less on trees than needed to maintain current stock, let alone enough to increase tree stock to achieve health gains. The last half of this report presents solutions that can help increase funding for urban forestry to benefit public health.

The investment gap: This report quantifies the investment gap—how much more investment in trees we would need to maintain our current urban canopy and then significantly expand it to seize greater potential health benefits. *We estimate that an additional investment of around $8 per person annually would be enough to create this green future in US cities*. We emphasize that this is an average figure, and the situation will vary greatly in different cities. Nevertheless, it is enough to show that a green urban future is not an impossible dream, but is quite affordable, if policymakers and others decide to make this investment.

Finance and policy solutions: The last section of the report describes some specific solutions that can enable tree planting for public health. *The solution that will work will vary by city, but what matters is giving value—financial and moral—to the benefits that trees provide to health*.

The report discusses some methods commonly used by cities to try to break silos by linking urban forestry to other municipal goals. These can include planning processes such as sustainability or comprehensive plans, heat action planning (where multiple agencies are planning how to mitigate risks from urban heat waves), or planning related to compliance with the Clean Water Act (e.g., stormwater plans).

We also discuss some common financial mechanisms for urban forestry, such as funding from public revenues, municipal codes and policies, and partnerships with companies and NGOs.

We propose in this report that one novel way to overcome the funding barrier may be to more closely link the goals and funding of the health sector with the goals and funding of urban forestry agencies. If trees have significant benefits to physical and mental health, as is increasingly clear from the scientific literature, then why not consider a link between health funding and urban forestry?
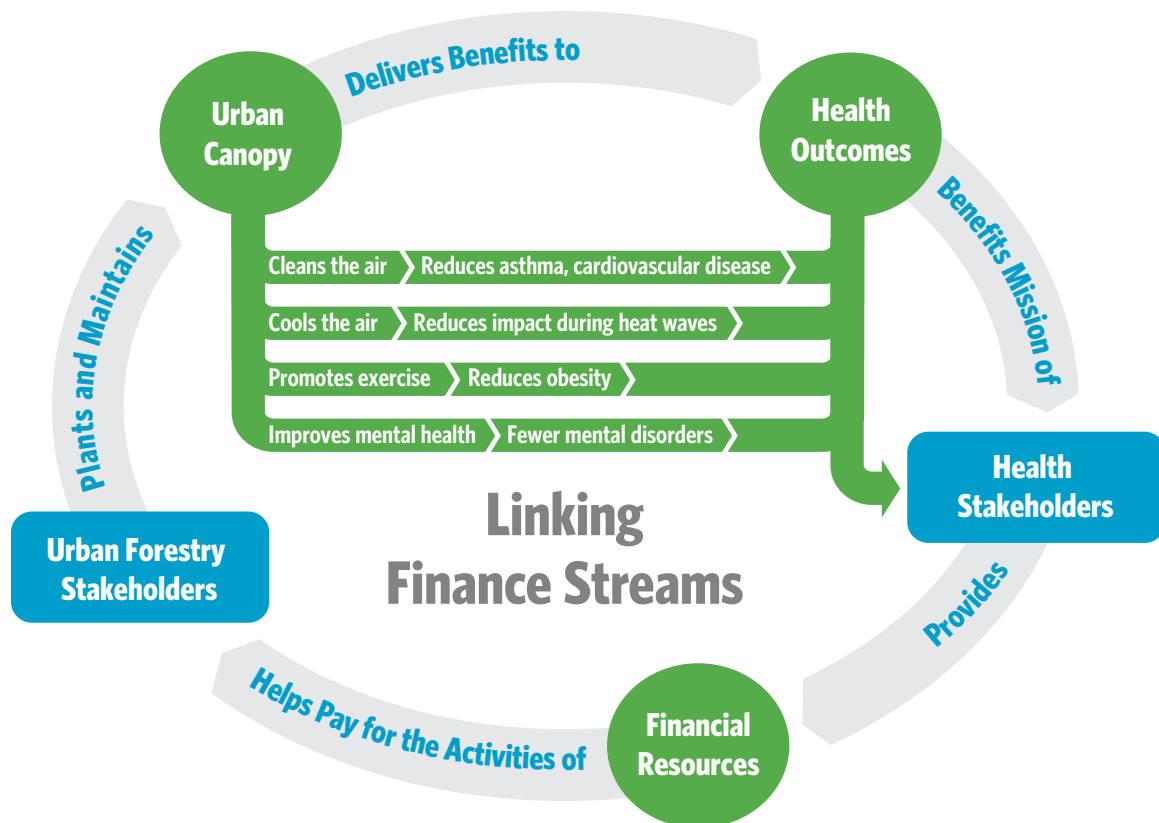
Figure E1. Conceptual model of the linkage between urban forestry funding and health funding.

The concept of linking finance streams for nature and health seems simple (Figure E1). Those whose mission it is to plant and maintain trees and other urban vegetation spend money and resources to make urban areas greener, which delivers significant benefits for mental health. This helps those in the health sector better achieve their mission of improving people's health and well-being. To complete the circle, therefore, the health sector (whether public or private institutions) could supply some financial resources that help partially pay for the activities of those in the urban forestry sector.

We urge all cities to begin exploring ways to create this vital link between the health sector and urban forestry agencies, using one of the potential models discussed in this report. Working together, the health sector and the urban forestry sector can achieve a healthier, more verdant world.

The Business Case for Trees

The humble street tree is an ecological powerhouse. Study after study has shown multiple benefits to people and society.[1] Trees and other natural features in cities can help regulate water quality, quantity, and timing. They can help clean and cool the air, reducing harmful air pollutants and ambient air temperatures. They lend beauty to our streets, enhance citizens' lives, and significantly increase property values. This whole list of benefits, and more, comes from trees and parks in cities and towns.[2]

Photo: © iStock/benedek

Photo A: Street trees in a typical suburban U.S. neighborhood.

When you consider all the benefits that street trees can provide to society, there is a strong business case for increased societal investment. A study in California by U.S. Forest Service and University of California, Davis researchers found that for every $1 spent in California cities on tree planting and maintenance, there were $5.82 in benefits.[3] Another study looked at five cities across the U.S. (Fort Collins, Colorado; Cheyenne, Wyoming; Bismarck, North Dakota; Berkeley, California; and Glendale, Arizona), and found that for each dollar invested in tree planting and maintenance, annual benefits returned ranged from $1.37 to $3.09.[4] Street trees can have phenomenal rates of return, exceeding in many cases the return on investment typical in many for-profit business sectors.[5]

This report focuses on an area that has received a lot attention recently, the links between trees and public health. Until recently, it wasn't clear how important this

link was, but recent science has shown that the link is robust and economically significant.[6-8] In the remainder of this section, we briefly describe the links between trees and health. Interested readers will find much more detail in other sources.[2, 9-13] Then the bulk of this report describes how cities can overcome finance and policy barriers to more fully take advantage of the power of trees and natural features to improve public health.

The benefits that trees and other natural features provide to people are often called ecosystem services.[14] There are myriad different ecosystem services that are important to human well-being, and many of them directly relate to human health. A short list of ecosystem services most relevant to cities is shown in Table 1.

ECOSYSTEM SERVICE
Provisioning services:
Agriculture (crops, livestock, aquaculture, etc.)
Water (quantity)
Cultural services:
Aesthetic Benefits
Recreation & Tourism
Physical Health
Mental Health
Spiritual value and sense of place
Biodiversity
Regulating services:
Drinking water protection (water quality)
Stormwater mitigation
Flood risk mitigation
Coastal protection
Air purification (particulates, ozone)
Shade and heat wave mitigation

Table 1. Ecosystem services of greatest relevance to cities, classified according to the scheme of the Millennium Ecosystem Assessment.

One important link between trees and health is the way street trees and other vegetation can improve air quality. Trees can help reduce concentrations of particulate matter, the most damaging type of air pollution globally, which kills more than 3 million people each year.[15] The surfaces of leaves can serve as filters, removing particles as they pass through a process called dry deposition, which can reduce particulate matter concentrations by more than 10% downwind of plantings.[16] One study of 10 U.S. cities found that urban trees remove enough particulate matter to reduce annual health impacts significantly, with reductions in health impacts ranging of $1.1 million (Syracuse) to $60.1 million (New York).[10] Trees can also reduce ground-level ozone concentrations, by directly absorbing ozone and decreasing ozone formation. However, the interaction is complicated, and in some situations the Volatile Organic Compounds (VOCs) released by trees can actually increase ozone formation.[17]

Photo: © City of Louisville, KY
Louisville Mayor Greg Fisher's Twitter, @louisvillemayor, https://twitter.com/louisvillemayor

Green for Good

Louisville, KY's urban laboratory is testing the theory that a greener neighborhood is a healthier neighborhood. Starting in 2016, a research team built a vegetative buffer designed to filter fine particulate air pollution coming from a nearby heavily trafficked roadway. The site was the front yard of Louisville's St. Margaret Mary Elementary School. This innovative health research project is designed to address the growing science linking the environmental with the health of citizens living in densely populated areas.

"The execution of the Green For Good project is important because it could not only improve the health of St. Margaret Mary students but it also serves as a pilot that could be repeated in any neighborhood," Mayor Greg Fischer said. "This research has the potential to make our neighborhoods greener and healthier."

On the ground research for "Green For Good" launched in September 2016 with baseline air monitoring and health data collection. Then the team planted three rows of more than 80 mature trees. The buffer was built with pine trees, cypress, serviceberries and cedar trees. After the buffer was in place, the project team conducted a second round of air monitoring and health studies. Sixty students and 20 adults joined the study to show the impact of increasing greenness levels.

The project is a public/private collaboration between the Diabetes and Obesity Center at the University of Louisville, the Institute of Healthy, Air, Water and Soil, University of Louisville, Washington University of St. Louis, Hyphae Design Laboratory, and Metro Louisville Government. Funding was provided by a grant from the Funders' Network for Smart Growth and Livable Communities and its partner the Urban Sustainability Directors Network, and local philanthropies.

Initial analysis of the air monitoring data and blood and urine samples showed that the vegetative buffer had an impact. Under certain conditions, levels of particulate matter were 60% lower behind the buffer than in the open side of the front yard. Among the health study participants, immune system function increased and inflammation levels decreased after planting.

Another important link is the way trees can mitigate summer air temperatures.[18-20] High air temperatures during heat waves can significantly increase mortality, and heat waves kill more people on average than other weather-related sources of mortality in the United States. Globally, heat waves are estimated to kill around 12,000 people per year, but this figure may rise sharply with climate change to more than 250,000 people per year, unless cities begin to adapt to the increased frequency and severity of heat waves. Trees help cool the air by shading impervious surfaces that otherwise would absorb the sun's energy and then reradiate it out as heat, increasing air temperatures. Trees also cool the air as the water that they transpire goes into the atmosphere, through evaporative cooling. Urban trees on average reduce air temperatures on summer days by 2-4˚F, although in some circumstances the cooling effect can be even larger.[16] The cooling effect of trees can extend beyond their immediate vicinity, as cool air currents move toward hotter urban neighborhoods.[20]

Photo: © iStock/ImageSource

Photo B: Street trees reduce pollutants that can exacerbate asthma and other illnesses, New York, NY.

Trees and parks play an important role in increasing mental and physical health as well. By increasing the opportunities for recreation and exercise, parks have been shown to reduce obesity and increase cardiovascular health.[21-23] In Los Angeles, for instance, Jennifer Wolch and her colleagues found that the more parks were within 500m of a home, the lower children's Body Mass Index (BMI) was at age 18.[23] There is also a growing body of evidence that exposure to nature provides significant mental health benefits. More time spent in nature decreases levels of stress and increases mental focus. Urban parks are, then, truly a respite from the hustle and bustle of urban life.[9, 12, 24]

Climate change gives fresh urgency to urban forestry. Climate change will increase the risks and hazards facing urban populations in numerous ways, from increasing heat waves to more intense rainfall to rising sea levels. For some of these risks, trees and

other natural features can be a way to reduce the threat, in effect serving as part of the climate adaptation strategy of the city[2] As discussed above, trees can offer a way to reduce temperatures during urban heat waves, potentially helping to offset the increased frequency and intensity of heat waves under climate change. More intense rainfall under climate change may be partially offset by green infrastructure like constructed wetlands that help manage stormwater. Coastal habitats like mangroves and barrier dunes can help reduce the risks associated with coastal storms and erosion, which will worsen with climate change. If trees were important before, they will be even more important in a climate-altered world.

Barriers

Given the large literature on the many benefits provided by street trees and other natural features, one might expect that cities would be maintaining or expanding these natural features over time. In fact, most U.S. cities are experiencing declines in urban forest cover over time, with a net loss of 4 million urban trees every year, or about 1.3% of the total tree stock.[25] New tree planting isn't keeping pace with the mortality of existing trees, either from natural causes or from clearing of trees for new development. If trees provide so many benefits, why are cities letting this natural resource dwindle away? We believe that there are four main barriers preventing cities from fully seizing the power of street trees and other natural features. In this section, we discuss these four barriers, paying attention to finance and policy barriers as the focus of this report.

Photo: © iStock/Jay Lazarin

Photo C. Hurricane Sandy aftermath, Fallen tree on power line, Bronx, NYC.

Barrier #1: Lack of knowledge

One potential problem may simply be that decision-makers may not be aware of the multifaceted value of street trees to society. For many members of the public or even town council members, street trees can seem like mere ornamentation.[26] If people are not aware of the value of street trees to health, for instance, it is impossible for that value to appear in decision-making. Few public health departments, for example, think of urban forestry as relating to the missions of their department. There have been a number of reports over time on the benefits nature provides to people (ecosystem services), beginning with the landmark Millennium Ecosystem Assessment.[27] We believe that these reports have increased knowledge of decision-makers about the value of street trees, and thus have made this barrier less severe than in the past. More and more, urban decision-makers recognize the value of urban forestry.

A suite of relatively new models and tools exist for quantifying the value of urban forests to people. Foremost among these is i-Tree (parts of which were previously known as UFORE) , which is a package of models that allow for surveying urban forests and estimating ecosystem service values for, among others, temperature mitigation, air quality improvement, reduced energy use, increases in property values, and carbon sequestration.[28] For stormwater mitigation, there are now quite detailed models such as the EPA's Storm Water Management Model and the National Stormwater Calculator.[2] Finally, maps are available for many cities of the return on investment of tree planting to reduce air temperatures and particulate matter concentrations.[16] For cities willing to invest a little time and resources, it is now quite possible to estimate the benefits that current (or future) street trees provide to residents. A first guide for U.S. cities looking to systematically planning urban forestry activities to achieve multiple ecosystem service objectives can be found in The Sustainable Urban Forest: A Step-by-Step Approach.[29]

Barrier #2: Public concerns

Although trees provide many benefits to people in cities, the public may not understand these benefits or how cities prioritize the planting and maintenance of trees. Several studies have explored residents' concerns about city street tree planting and maintenance programs.[30] There can be concerns with the planting and establishment of new trees, or concerns about the maintenance and stewardship of the exiting tree canopy.[31]

Concerns about new tree plantings vary. Street tree planting policies and processes can be controversial, particularly the decision of what species of trees to plant and where to plant them. This is particularly the case when there is a lack of notification or inclusion in the process by residents, or concerns that newly planted trees will not be properly maintained. In some localities, such as Denver, CO, maintenance of street trees is the responsibility of the adjacent property owner. In such cases for residents of more limited means, the expansion of street trees in their neighborhood may be viewed as a financial burden.

One of the challenges with maintaining existing urban trees is that communities have inherited an urban forest resulting from decisions made decades ago.

This has often resulted in an urban forest that lacks species diversity, plantings that may interfere with infrastructure, such as utility lines, or may require on-going maintenance costs that are excessive. Many communities have an aging urban forest with many trees reaching the end of their life span. Add to this the increased mortality from the introduction of non-native forest insects and diseases that are killing millions of trees across the country. Many city trees have historically been planted in public rights of way, where multiple agencies are responsible for maintenance of the different features (trees, sidewalks, sewer lines, and utility lines).[32] In particular, electric utility companies often prune trees in ways that do not always successfully balance the goals of encouraging tree health while minimizing interference with utility lines.[33]

While the above concerns are legitimate, they can be addressed by involving community residents in the decision about which tree species are planted where, while educating them about which species and practices are ecologically appropriate and cost effective. Many of the past issues and concerns over street tree planting can be minimized in the future by following Right Tree, Right Place best practices.[34] Residents can also be trained to properly care for trees near their house, and urban forestry officials can follow up with residents every few years to offer support and provide assistance as necessary. This can be part of a program of preventative maintenance. Finally, increasing budgets for maintenance and pruning, as well as improving the coordination between agencies and utility companies, can reduce the conflict between utility wires and tree plantings.[32, 33] This will lead over the long-term to a less costly procedure for maintenance of overhead utility lines and fewer disruptions of service to community residents.

Barrier #3: Silos

The opportunity to advance tree planting in cities touches virtually every part of the urban landscape—from city streets and parks to private residential and commercial property. Yet the formally designated responsibility to advance tree planting often falls on just one municipal agency, such as a forestry office within a city's Department of Parks and Recreation, which might not be part of a centralized or coordinated planning structure with other relevant agencies. As a result, it can be difficult for cities to efficiently identify and harness all tree planting opportunities that might be presented by the on-the-ground work of different municipal agencies, such as the transportation department and water department. Even where an agency not formally charged with tree planting responsibilities can identify opportunities, that agency's metrics and financial structure might not support the extra cost increment of tree planting and maintenance above agency mandates (e.g., a water agency integrating tree planning into a stormwater control feature to aid with heat island mitigation). This is often called the "wrong pocket" problem – the agency that might benefit from urban tree canopy may not be the one who is responsible for paying for tree planting and maintenance.

The lack of internal coordination and alignment across municipal government can also lead to additional missed opportunities to advance tree planting through municipal regulation of development. Ideally, this regulatory process would be used to create conditions for development approvals that include advancement of city's overall tree planting strategy.

The barrier of fragmented decision making also extends to how cities can efficiently engage with private sector partners, such as non-profit organizations and community-based organizations that share a city's tree planting goals. These private sector partners can bring complementary opportunities for tree planting that supplement municipal agency efforts, such as tree planting and stewardship programs for homeowners in underserved neighborhoods. To fully capture this opportunity and to create alignment with a city's own efforts, municipal agencies must be able to effectively coordinate planning with these private sector efforts, and ideally would be able to provide technical assistance. Yet in many cities this capacity to provide cross-sector coordination and technical assistance is lacking.

Barrier #4: Lack of financial resources

As noted above, US cities overall are losing tree cover, even as they carry out new plantings each year. Trees are often a "nice to have" item when compared to other municipal needs such as police and fire protection, education, roads, and other public services. This perspective, combined with the annual budget cycle of most cities (as opposed to longer term considerations) leaves tree planting programs minimally funded, and always at risk of reductions. As just one example, Gary, IN cut its entire municipal tree program in response to hardships associated with the 2009 financial crisis.[35]

One study of city officials across Alabama found that over 65% of city officials had a desire for more knowledge about the cost of trees, while fewer than 40% had a desire for more knowledge about tree benefits.[36] This underscores that while many city officials may have a generally positive attitude towards increasing tree cover, they are also primarily focused on the costs of trees, as opposed to the benefits, which includes public health benefits that may justify increased spending. And of course, insufficient resources for urban forestry, as well as different neighborhood histories of investment in tree planting and different levels of political power, can result in very large inequities in urban forest canopy distribution.[37] In major cities across the U.S., these inequities have strong correlations with income and, in some cases, with race.[38]

Budgets to support a healthy tree canopy are further strained by a lack of funding for maintenance. Most cities spend less on trees than needed to maintain current stock, let alone enough to increase tree stock to achieve health gains. For municipal decision makers, trees are largely viewed as a capital cost, with associated maintained requirements, divorced from the totality of the benefits trees provide. While most cities do have a budget for tree maintenance, it is often inadequate. Despite a growing body of research documenting the benefits of trees, a 2015 review [35] of relevant literature found that there remains a deficit of research about the true full cost of trees, as well as research about costs associated with under-maintenance of existing trees. Without this additional information, it is difficult to make the case to city decision makers that the full suite of benefits, including public health benefits, provided by trees is worth the full cost.

Photo D: Planting trees in Lousivlle, KY to address urban heat issues.

It is difficult to estimate the needed extra funds that cities would require just to maintain their current tree canopy, as optimal maintenance schedules depend on local conditions. However, the average U.S. municipal spending on urban forestry, measured as investment per tree, has fallen more than 25% since 1980.[35] Average annual per-capita municipal expenditures fell substantially in real terms, from $7.70 in 1974 to $6.19 in 1980 to $5.53 in 1986,[35] and have been relatively constant since then, averaging $5.83 today.[39] Note that there is a lot of variation within this average among cities. In general, smaller cities tend to have higher per-capita costs, since the fixed costs of an urban forest program are spread over a smaller population. For this white paper, we will assume arbitrarily that an increase to the levels of per-capita municipal investment that occurred in 1974 would be sufficient to maintain current tree canopy cover. This amounts to a 24% increase in annual municipal forestry budgets (an extra $1.87 per person on average) needed just to fully cover current tree maintenance needs.

Of course, additional trees would be needed to fully capture all potential benefits to society. Many cities have set goals for expansion of their urban canopy, recognizing that there is space for more trees in their urban landscape and that increased trees would bring more benefits. In this section, we present one scenario of additional tree planting for health. We acknowledge, however, that there are other possible scenarios of additional tree planting.

Our additional tree planting scenarios are based on the work described in the global Planting Healthy Air report,[16, 40] which looked in detail at 27 cities in the United States. Current canopy cover was mapped using 2m resolution imagery, as well as future places where tree planting was feasible (e.g., sites that were not already impervious surfaces). The study assembled city-specific information on planting and maintenance costs. The study also prioritized sites for planting based on where there

would be the biggest benefit to public health in terms of reductions in particulate matter concentrations or ambient air temperatures. Planting in the sites with the greatest health benefits (top 20% of all potentially plantable sites in a city) would cost an additional $201 million per year across these 27 cities (Table 2). This is the annualized figure, and includes one-time planting costs ($1.6 billion) plus additional average annual maintenance costs ($160.9 million). Given the population of these 27 cities, this extra urban greening works out to an annual increase of $5.87 per person in urban forestry budgets.

The total investment gap for urban forestry in the United States is the need for additional money for adequate maintenance of existing canopy ($1.87 per person per year), *plus* additional investment to expand urban forest canopy to seize the kind of potential health benefits outlined in the *Planting Healthy Air* report ($5.87 per person per year). We estimate the total investment gap is in the ballpark of $7.74 per person annually. This amount of additional investment on top of current budgets would more than double the average big city (> 100,000) urban forestry budget.[39] Note, however, that urban forestry activities would still make up less than 1% of the average municipal budget.

One of our goals in writing this report is to convince decision-makers that urban forestry can be thought of as (in part) an investment in health. Public health budgets, of course, are also stretched in many cities and countries, and we are not calling for raiding those budgets to provide for more tree planting. Rather, we simply note that current health expenditures are (appropriately) a much larger budgetary expenditure than urban tree planting. In the United States, total expenditures on health care were roughly $3.0 trillion in 2014, or roughly $9,500 per person.[41] Around a quarter (28%) of this spending was by the federal government, with state and local governments accounting for an additional 17% of spending. Around $248 billion of this spending is on public health, broadly construed. If there are health benefits to tree planting, then it may make sense for health agencies to be involved with planning and funding urban forestry activities. A modest 0.10% increase in overall health spending amounts to an extra $10 per person per year, which would close the investment gap in urban forestry.

An Example of How Increased Urban Greening Could Benefit Health

In this section, we examine in more detail the scenario of increased urban greening from, the Planting Healthy Air report,[16, 40] also introduced in the preceding section, presenting such a scenario's benefits and return on investment in terms of air quality improvement. We just consider the benefits in terms of particulate matter reduction. A more thorough analysis would consider all the potential benefits to society, rather than just the air quality benefits. Our goal in this section is to simply provide one example of why additional tree planting might provide significant gains to health.

Under this scenario of increased urban greening, a prioritized investment in planting in the top 20% of sites with the greatest health benefits would reduce particulate matter (PM) concentrations. Increased leaf surface area would increase the dry deposition of PM, thus decreasing atmospheric concentrations of PM. Increased tree planting at these priority sites would benefit millions of people who would receive a meaningful reduction in PM concentrations. In the low ecological impact scenario (where dry deposition rates are at the low end of what has been empirically observed), 3.4 million people were estimated to have a reduction in PM_{10} concentrations of greater than 2 $\mu g/m^3$, whereas in the high ecological impact scenario (where dry deposition rates are at the high end of what has been empirically observed) 11 million people would experience a reduction in PM_{10} concentrations of greater than 2 $\mu g/m^3$.[16, 40]

PM concentrations reductions of this magnitude for large urban populations could have a meaningful impact on the incidence of respiratory disease exacerbations such as asthma attacks and cardiovascular events (e.g., acute myocardial infarctions), which are all impacted by PM.[11] The costs of these health events are born by patients, employers, and insurers in the form of medical costs paid for beneficiary health care provider visits and services and by employers well as society in the form of lost or restricted work days.

Previous studies have estimated the benefits of reduced health care costs at the national level [42] or municipal levels.[10] However, in practice today most urban forestry investment decisions are made without considering the potential health benefits of planting. We believe estimates of avoidable health related costs at the local level may help address local barriers to funding, particularly when urban forestry programs must compete with other budget needs. To address this gap, and in collaboration with Analysis Group AG, the current research used a standard industry model to estimate avoidable costs associated with reductions in pollution at the city level for two components: 1) health care resource use and 2) work loss.

Photo: © iStock/urbancow

Photo E: Trees make cities more livable.

The Co-Benefits Risk Assessment (COBRA) model is a peer reviewed screening tool used by the U.S. Environmental Protection Agency to provide a "first-order" estimate for the associated economic impacts of state- and county-level emission reduction scenarios. The COBRA model combines demographic data (including background incidence rates of air pollution-induced illnesses) with epidemiological dose-response relationships and health care costs to estimate the avoidable health related costs associated with reductions in health care services from meaningful reductions in air pollution. Avoidable health related costs were calculated using county-level estimates from the COBRA model, inflated to 2015 dollars, scaled to city-level populations, and averaged across low and high estimates. Avoidable health care costs in the COBRA model were calculated for acute myocardial infarctions, other cardiovascular diseases, asthma, and respiratory conditions.

Avoidable health care and work loss costs in the 27 cities of interest could be substantial. Based on the medium ecological impact scenario discussed above, we estimated that lower-bound avoidable annual health care costs from urban tree planting in these 27 cities could be $13.2 million ($2015), and avoidable annual

City	City Population	TNC Tree Planting and Maintenance Cost ($)	Health Care Cost ($)		Work Loss Cost ($)
			High	Low	
Atlanta	464,000	5,785,000	221,000	57,000	120,000
Austin	932,000	5,411,000	533,000	138,000	450,000
Baltimore	621,000	3,987,000	458,000	139,000	188,000
Boston	667,000	2,336,000	229,000	56,000	123,000
Bridgeport	144,000	821,000	44,000	11,000	15,000
Chicago	2,696,000	11,592,000	875,000	219,000	353,000
Dallas	1,300,000	8,871,000	1,172,000	306,000	727,000
Denver	600,000	4,382,000	111,000	28,000	81,000
Detroit	677,000	9,568,000	373,000	88,000	108,000
Houston	2,099,000	15,320,000	1,844,000	488,000	1,177,000
Los Angeles	3,972,000	20,340,000	3,034,000	797,000	1,973,000
Louisville/Jefferson County	760,000	10,111,000	937,000	223,000	288,000
Miami	399,000	1,885,000	564,000	136,000	223,000
Minneapolis	383,000	3,389,000	182,000	44,000	118,000
Nashville-Davidson	679,000	16,433,000	384,000	88,000	165,000
New Orleans	390,000	2,261,000	147,000	37,000	72,000
New York	8,550,000	34,047,000	6,268,000	1,807,000	3,713,000
Philadelphia	1,567,000	6,858,000	990,000	276,000	434,000
Phoenix	1,446,000	5,297,000	68,000	18,000	40,000
Pittsburgh	304,000	4,185,000	194,000	48,000	76,000
Portland	584,000	4,416,000	238,000	53,000	154,000
Sacramento	466,000	3,375,000	345,000	77,000	179,000
San Diego	1,395,000	6,228,000	677,000	174,000	470,000
San Francisco	865,000	5,967,000	295,000	77,000	254,000
San Jose	1,027,000	2,011,000	255,000	60,000	174,000
Seattle	609,000	3,365,000	149,000	37,000	120,000
Washington DC	681,000	3,217,000	274,000	70,000	148,000
Overall	**34,278,000**	**201,460,000**	**20,860,000**	**5,554,000**	**11,941,000**
Overall (mid-range estimate)	**34,278,000**	**$201,460,000**	**$13,207,000**		**$11,941,000**
(% of tree planting cost)			(63%)		(57%)

Table 2. Annual Avoidable Health Related Costs Associated with Tree Planting and Maintenance. Source: Analysis Group

work loss costs could be $11.9 million (Table 2). These avoidable health related costs could account for approximately 12.5% of the estimated annual cost for tree planting and maintenance.

Even using the lower bound avoidable health related costs, the offset of tree planting and maintenance costs by avoidable health related costs could be as high as 30% in Miami, 23% in New York, and 19% in Los Angeles with differences driven by a wide set of factors. These could include specific conditions within each neighborhood and city, including the demographics and background health profiles of affected individuals, population density, initial air quality, and initial urban tree density. All else being equal, cities with greater initial levels of health problems that could be attributed to poor air quality would show higher health benefits from tree planting. Additionally, neighborhoods with higher population densities that still have space for additional tree planting were prioritized for tree planting in our tree planting scenario. All else being equal, cities with higher population density in their neighborhoods will show a higher return on investment from tree planting.

Note that this analysis should be considered preliminary, and we urge specific cities to not make decisions solely based on the data in Table 2, but rather to contact the authors of this white paper about how to accurately estimate health benefits with the best possible local data. For example, these estimates do not include health benefits associated with improvement in chronic conditions, such as bronchitis, which will depend significantly on local neighborhood characteristics. This is an important consideration. Results from a related study by Novak,[29] which includes chronic bronchitis, suggest that avoidable healthcare costs could be more than twice as large as those reported here. Similarly, the current study estimates do not include other conditions also impacted by PM such as cerebrovascular diseases, allergies, heat-related illness, diabetes, or health impacts associated with general well-being, not to mention lives saved because of improvements in health. Stated differently, the data in Table 2 only considers one health pathway, the way additional tree planting can benefit health via particulate matter concentration reductions. *Nevertheless, our results make clear that a significant fraction of additional tree planting and maintenance costs would be returned in the form of reduced health costs.*

Solutions

While the four barriers presented in this report (Lack of Knowledge, Public Concerns, Silos, and Lack of Financial Resources) can seem daunting, innovative towns are finding solutions that overcome these barriers. In this section, we present some of the most promising solutions, paying particular attention to those solutions that help break through silos or help provide financial resources to close the investment gap. We first briefly discuss some commonly used solutions, tools that are already in the toolbox of urban forestry but which perhaps deserve more frequent use. Then, we present some transformational new ways to link health care to urban forestry more directly.

Commonly used solutions

Breaking silos by linking urban forestry to other municipal goals:

If urban trees are to be fully valued for their contributions to a range of municipal objectives, several established, existing options might be used to increase funding. Seizing these often necessitates thinking not only across municipal boundaries, but also across jurisdictional boundaries. As the U.S. Forest Service's Vibrant Cities & Urban Forests: A National Call to Action initiative puts it, "By integrating public works, environmental protection, parks and recreation, energy and other relevant municipal input, these coalitions often serve as liaisons among or coordinators of efforts to ensure that greening policies (e.g., regulations, incentives, stewardship) are being effectively and efficiently implemented across the board".[43] We would suggest the inclusion of a public health official as well. Below are a few examples of existing planning processes that could include improved urban forest management as a solution to a cross-sectoral issue.

Sustainability Plans- Comprehensive and sustainability plans, while not universally used by cities, are an increasingly common tool cities are using to guide creation of more sustainable, livable cities. The frame of analysis for such plans is larger than one narrow issue (urban forestry), thus providing a good place to make linkages between the actions of different departments. Comprehensive plans are intended to guide a city's growth and development, balancing the full suite of concerns, including public health. By linking trees to the public health goals for a city at this highest level, such plans can alleviate some of the "downstream" siloing as cities work to implement their plans. Similarly, while sustainability plans often focus on things like transportation, energy efficiency, and waste management, they are a good place to further strengthen the connections between greener cities and public health. When executed well, along with other comprehensive development plans, sustainability plans can be a powerful way to make sure all the agencies in a city are pulling toward a coherent vision.

Heat Action Plans- Extreme heat is a serious public health threat, and the urban heat island effect may exacerbate heat impacts. In July of 1995, Chicago experienced a heat wave where 473 deaths were attributed to excessive heat (Kaiser et al., 2007). Extreme heat, in the form of heat waves, causes heat stroke deaths, excess deaths from other natural causes, and hospitalizations for heat-related illness and chronic conditions that are exacerbated by heat. As heat waves are projected to increase

in length, frequency and intensity over the coming decades, cities are increasingly developing Heat Action Plans to guide them in implementing a range of responses to the health impacts of Urban Heat Islands (UHIs). These include both responses to specific heat events (e.g., how to ensure vulnerable citizens are monitored and, if needed, moved to cooling centers) and preparations cities can take to decrease risk, such as installing cool roofs and increasing tree canopy.

Fine-scale variation in ROI from tree planting

WASHINGTON, D.C.
Land Cover
- Barren Land
- Cultivated Crops
- Deciduous Forest
- Developed
- Wetlands
- Evergreen Forest
- Grassland/Herbaceous
- Mixed Forest
- Open Water
- Pasture/Hay
- Shrub/Scrub

**Population
(people/km²)**
- 0
- 0 - 2,500
- 2,500 - 5,000
- 5,000 - 10,000
- 10,000 - 20,000
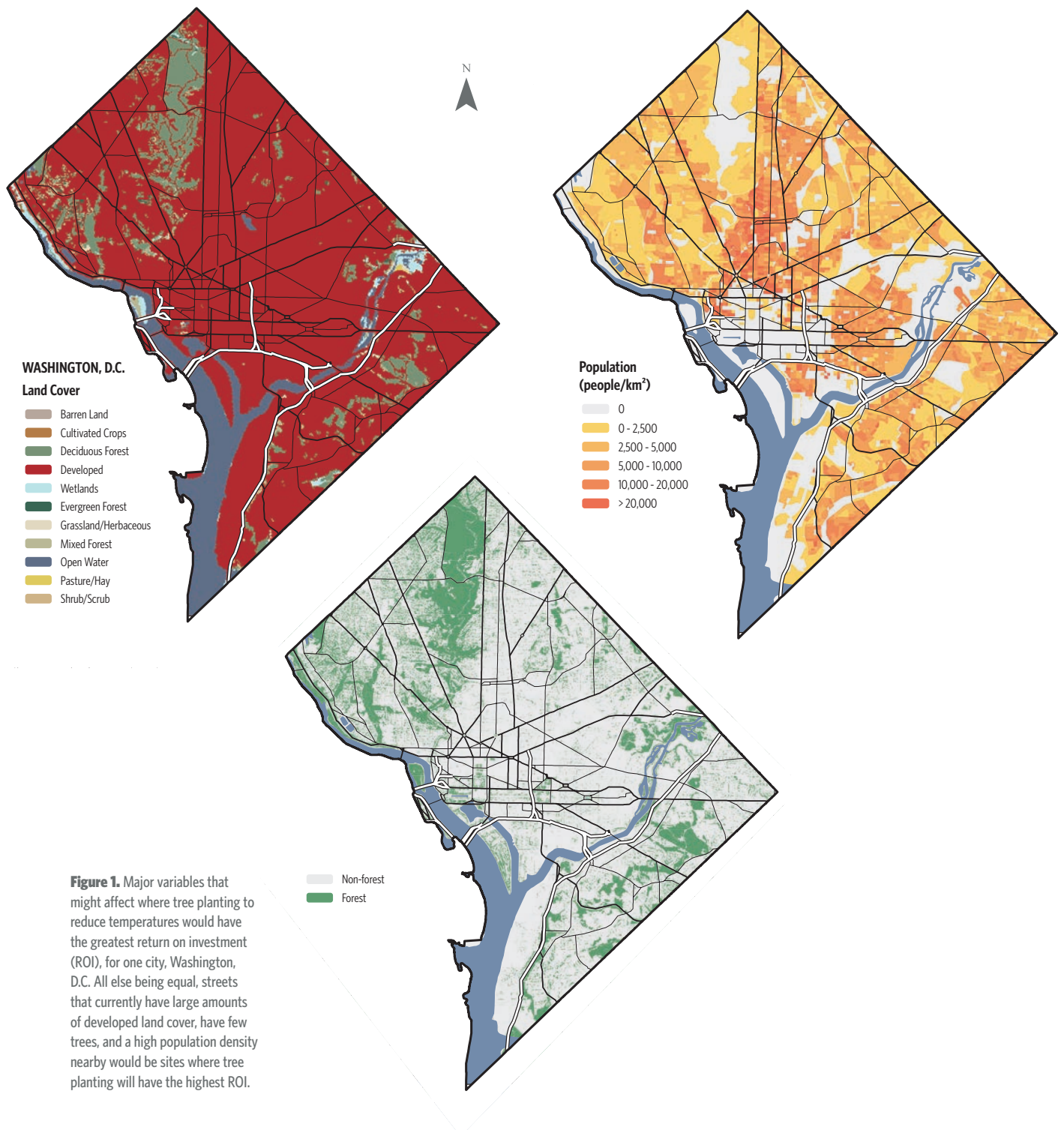- > 20,000

- Non-forest
- Forest

Figure 1. Major variables that might affect where tree planting to reduce temperatures would have the greatest return on investment (ROI), for one city, Washington, D.C. All else being equal, streets that currently have large amounts of developed land cover, have few trees, and a high population density nearby would be sites where tree planting will have the highest ROI.

For instance, in 2006, the New York State Energy Research and Development Authority (NYSERDA) sponsored a New York City Regional Heat Island Initiative to research effects of tree planting, white pavements and roofs, and green roofs on near-surface air temperatures. The most successful overall strategy in maximizing total temperature reductions was the use of high albedo surfaces (such as painting roofs white). However, the study also found that the most effective strategy per unit area is curbside tree planting. The NYSERDA study made the case for the use of both increasing vegetation cover and "cool" surfaces to mitigate NYC's urban heat island.

Clean Water Act- In 2011, EPA issued a memo recognizing that population growth, aging infrastructure, economic and social challenges, and increasingly complex water quality issues were stressing municipal implementation of Clean Water Act programs. In this memo, the EPA committed to developing an integrated planning process that, in addition to traditional grey infrastructure, supports using more sustainable and comprehensive green infrastructure solutions (like increased urban tree canopy) to improve water quality and support other environmental and quality of life attributes that enhance local communities. By connecting green infrastructure to Clean Water Act compliance, a number of financing streams become available.

One such mechanism that would allow tree plantings to be financed at low interest rates, just like grey infrastructure, is the U.S. EPA's Clean Water State Revolving Fund (CWSRF). CWSRF is a loan assistance program that sustains itself and provides financing for the capital costs of water quality improvement projects such as wastewater treatment, stormwater management, nonpoint source pollution control, and watershed and estuary management. Unlike the situation for the Clean Air Act, the concept of green infrastructure for regulatory clean water compliance is very well established, and multiple recent efforts encourage more green infrastructure in CWSRF funding. This is another case where an existing public health concern (stormwater and waste water management) could be aided by increased investment in trees if a more comprehensive view were taken.

Common finance mechanisms for urban forestry

Some municipalities are already funding urban forestry through a variety of mechanisms. Based on this success to date, such as the recent trends across the U.S. in voter-approved ballot measures and the strengthening of local tree policies, there is potential for these mechanisms to be used more widely.

Broadly, municipal mechanisms for funding and advancing urban forestry fall into three categories: 1) Public revenue; 2) Municipal codes and policies; and 3) Partnerships. Voter-approved ballot measures provide an opportunity for a municipality to design a measure that includes urban forestry investment and to allow voters to approve establishment of a new revenue source by authorizing a new tax, bond measure, or other means of raising revenue. Municipal codes and policies include both regulatory and incentive-based tools such as zoning ordinances, stormwater utility fees, and density bonuses or other incentives for private developers. Lastly, many communities, particularly those not experiencing rapid growth and urban development, are leveraging public-private and intergovernmental partnerships to realize urban forestry goals. These techniques can be used separately or in combination to generate local resources and leverage investments for urban forestry.

Public Revenue- Generally, three types of revenue sources are utilized by local governments to pay for investments in parks and land conservation, such as urban forestry or tree planting: Discretionary annual spending, creation of dedicated funding streams, and debt financing. The funding options utilized by a community will depend on a variety of factors such as taxing capacity, budgetary resources, voter preferences, and political will.

Significant, dedicated funding generally comes from broad-based taxes and/or the issuance of bonded indebtedness, which often require the approval of voters. In many cases, local ballot measures that include funding for parks and open space – including funding for urban forestry and tree planting – provide a tangible means to implement a local government's vision. With their own funding, local governments are better positioned to secure scarce funding from state or federal governments or private philanthropic partners, as well as establish long-term conservation and forestry priorities.

According to The Trust for Public Land's LandVote Database, between 1988 and the present, voters have approved 1,968 of 2,608 ballot measures (75% approval rate) in 43 states, generating $75 billion in funds for land conservation, parks and related purposes. Nationwide, a range of public financing options has been utilized by local jurisdictions to fund parks and open space. The predominant funding sources (Figure 2) have been general obligation bonds (41% of total measures), the property tax (41%), and local sales tax (8%).

Less frequently used mechanisms include special assessment districts, real estate transfer taxes, impact fees, and income taxes. The ability of local governments to establish dedicated funding sources depends upon state enabling authority. Several local ballot measures have specifically identified tree planting, forestry or reforestation as purposes that were eligible as part of a comprehensive funding program for parks and open space. Among the most prominent measures were Baltimore, MD Question D (2016) – $45m bond measure; San Francisco, CA Measure A (2008) – $185m bond measure (2008), and Los Angeles County, CA Proposition B (1990) – $817m bond measure. We also identified smaller measures in Flint, MI (2016), Durango, CO (2015) and Joliet, IL (2014).

Sources of Financing for Conservation Projects Listed in the LandVote Database
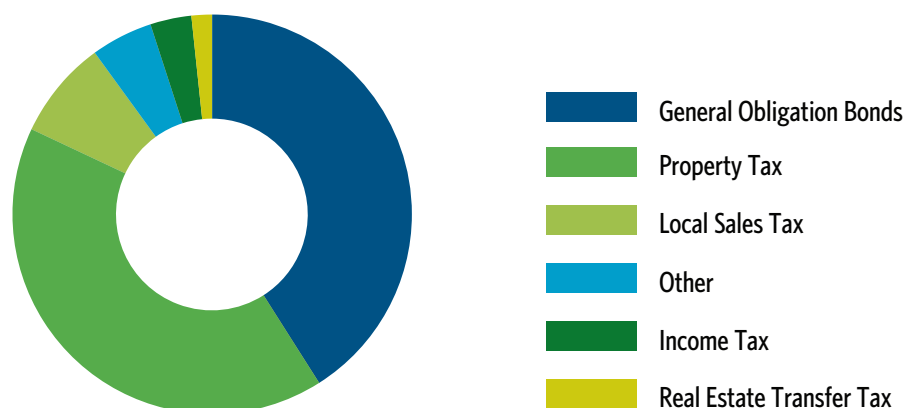

Figure 2. Sources of financing for conservation projects listed in the LandVote database. Source: Trust for Public Land?

Municipal codes and policies- Aside from establishing and expending revenue for urban forestry, many municipalities currently protect and expand urban tree canopy through traditional means of managing land development. These policy mechanisms are important since they can affect urban canopy on privately-owned land, far beyond a municipality's direct reach.

Zoning and building codes are local ordinances which designate the appropriate use, density and form of new development, regulate alterations to existing development, and typically establish a minimum amount of on-site open space or maximum building lot coverage ratio. These aspects of ordinances can help create the planting space required for tree planting. For instance, Washington, DC, has developed a Green Area Ratio requirement, in which new developments are scored based on the types of green landscape and design features they use and the area which they cover, and new developments must exceed a minimum score to be approved.[44] Similarly, Seattle, WA has developed their Green Factor rating system, where in certain parts of Seattle, projects have to exceed a certain minimum Green Factor score, based on different green practices.[45] Some municipalities also have a tree code, or section within the city code that is dedicated to the preservation, maintenance and planting of trees. The City of Portland, OR, for instance, updated its tree code in 2010 to streamline the process for tree planting on development sites and to improve the maintenance of existing trees on private property.[46]

Development sites are also opportunities for urban forestry beyond the minimum code requirements. If deemed a priority by the municipality and stakeholders and successfully negotiated through the development plan review process, cities can generate additional funding for tree planting or achieve even greater tree planting at the time of construction. Often referred to as 'developer contributions,' these resources for community forestry are typically deployed at or close to the development site.

Municipalities can raise new funds for tree planting across their land base through the initiation of a stormwater utility fee. With this utility, property owners pay an annual fee to the city, typically based on the volume of unmanaged stormwater that their property produces. The cumulative funds are used by the city to install infrastructure and establish programs that will help manage the city's stormwater and improve overall water quality, including planting new trees and other green infrastructure. Some municipalities have leveraged the stormwater fee program to incentivize tree planting on private properties. Under the Treebate Program, the City of Portland, OR will reduce a property owner's stormwater fee for each new tree planted.

Partnerships- For cities or neighborhoods that aren't growing or even have shrinking populations and economies, private development and management of trees alone will not expand the tree canopy. In these cases, partnerships are key to advancing urban forestry. With interagency, intergovernmental alignment on forestry goals and a strong base of local organizations, resources can be matched and pooled to establish significant urban greening programs that utilize a city's existing assets. In Baltimore, MD, the city, along with federal agencies (including the EPA, HUD, USFS, and DOT) and community-based partners (including Parks & People, Center for Chesapeake Communities, and Baltimore Green Space), is

targeting tree planting in the city's 14,000 vacant lots. This coordination among governmental agencies and local organizations is expanding the urban tree canopy in Baltimore MD, while providing the health, aesthetic and quality of life benefits for those neighborhoods most in distress.

New finance streams linking nature and health

One potentially promising new funding source for urban forestry is to link funding for trees and parks to health goals and objectives. If trees have significant benefits to physical and mental health, if they are part of the environmental determinants of health, then why not consider a link between health funding and urban forestry? As shown above, just the benefits of trees to particulate matter reduction could result in health benefits that offset roughly 13% the costs of tree planting and maintenance, and this is just one of several pathways by which nature can improve health.
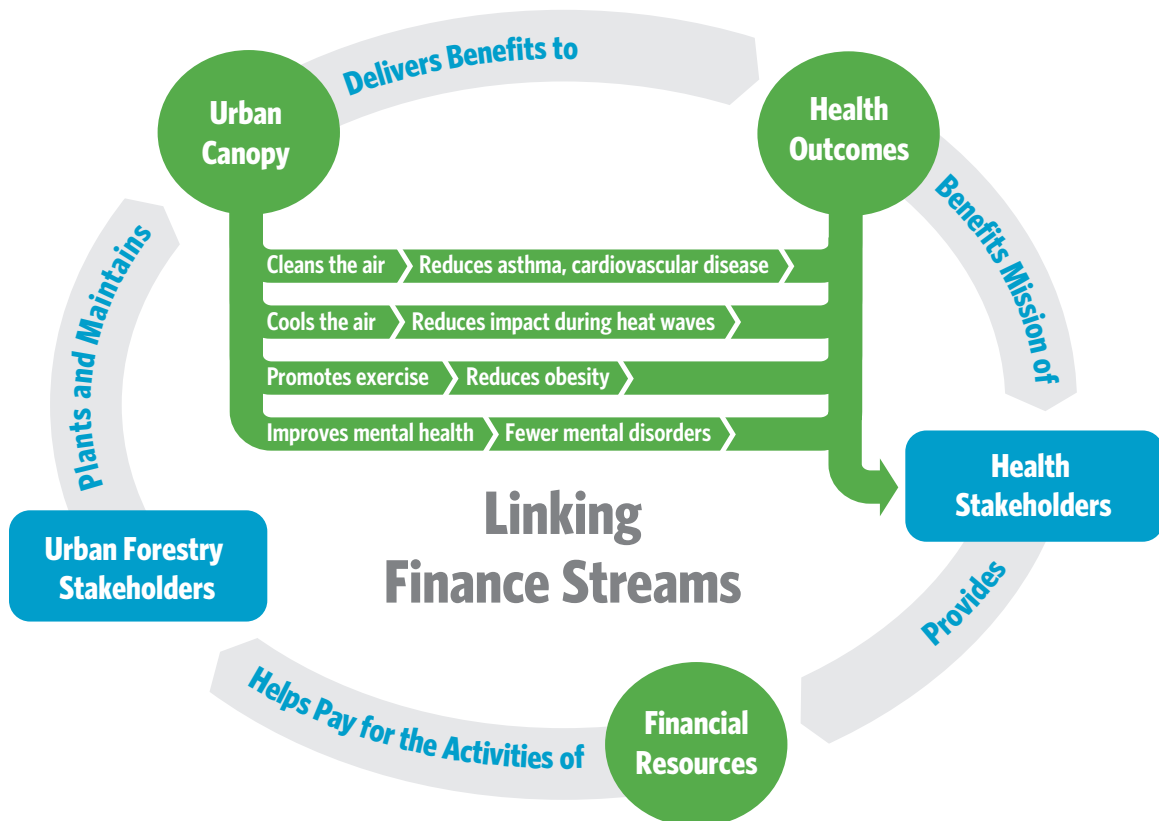

Figure 3. Conceptual model of the linkage between urban forestry funding and health funding.

The concept of linking finance streams for nature and health seems simple (Figure 3). Those whose mission it is to plant and maintain trees and other urban vegetation spend money and resources to make urban areas greener, which delivers significant benefits for mental health. This helps those in the health sector better achieve their mission of improving people's well-being and health. To complete the circle, therefore, the health sector could supply some financial resources that help partially pay for the activities of those in the urban forestry sector.

While this sounds conceptually simple, the hard question is how to practically do it. The potential funding model varies, first of all, depending on who in the health sector pays, the private or the public sector. Regardless of who pays, there is also the question of how strictly tied to ecosystem service delivery are the payments. There is a continuum of funding models in this regard. At one extreme, urban forestry projects can just be loosely motivated by potential health gains, without any clear quantitative link between ecosystem service provision and payment. On the other extreme, urban forestry projects could deliver ecosystem service benefits, with health sector payments directly compensating for health services rendered by the urban greening.

Private-sector models

In many communities, increasing attention is being paid to the possibility of corporate or philanthropic grants paying for part of the municipal urban forestry activities. Philanthropy for the public good has always had a role in funding urban forestry in some communities, such as New York, NY where a portion of the Plant a Million Trees program was financed by philanthropic donations. However, relatively little support for urban forestry and parks has come from health-related foundations, with some notable exceptions, such as the work of the Robert Wood Johnson Foundation.

Increasing the contribution of health-sector philanthropic funding to urban forestry is appealing simply because of the large size of this sector. Around 8% of U.S. philanthropic donations went to health in 2015 ($29.8 billion per year), while the entire environment and animal welfare sector (which includes topics far beyond urban forestry) received only 3% of giving ($10.7 billion per year).[47] For context, consider the $7.74 per person per year investment gap in urban forestry we estimated above. It is inappropriate and unrealistic to expect this entire gap to be paid for by health-sector funds, but let's assume that 12.5% of this investment gap ($1.01 per person per year) could be paid for by the health sector, a ratio that is consistent with the level of health benefits from air pollution reduction demonstrated by this report. Note that this 12.5% is only the air pollution reduction, and there are other potentially significant pathways by which trees can improve health. Nevertheless, it is instructive to consider a hypothetical investment by the health sector solely premised on the air pollution reduction benefit. There were 249 million people in urban areas in the United States in 2010,[48] so the health sector investment under this hypothetical scenario is $154 million per year, which would only represent 0.8% of the annual U.S. philanthropic donations to the health sector.

It is perhaps easiest and most tractable for many cities to use the already established philanthropic model to loosely link urban forestry to health outcomes. Corporations or foundations can make donations to urban forestry activities, whether one-time capital costs for new planting or ongoing donations to cover maintenance. These donations can be premised upon the health benefits, but there needn't be a strict link between the quantity of health benefits provided by trees and the amount of funding provided.

Imagine if a major health insurer headquartered in a community gave a large donation for urban forestry activities in a town, analogous to Kaiser Permanente's recent funding of park access projects (See box below). These urban forestry

activities could be explicitly targeted to the right locations to provide maximal health benefits. The health insurance company will have a pool of employees living in the community near their headquarters that will be healthier because of the investment, potentially reducing absenteeism and improving performance. If they have many insurance enrollees from that community, they will also be improving their health, perhaps reducing their insurance claims and saving themselves some money. Moreover, there will be an immediate reputational benefit for the insurer, as their philanthropic activities become more widely known and respected in the community.

It will be important, even for a project done on this philanthropic model, to have some sort of monitoring to make sure the urban forestry activities are achieving their goals. These can be simple impact metrics, such as counting and mapping the additional trees planted and the demographics of the households nearby. Ideally, there would also be some scientific monitoring of the impact on health, perhaps by measuring air pollution or temperature reductions, or surveying residents about their health before and after the intervention. The design and set-up of such monitoring projects are often beyond the scope of many municipal urban forestry departments, but could be done in collaboration with local universities or NGOs that may find these subjects worthy of study.

However, for large financial investments by the health sector in urban forestry, it may be necessary to create a more direct connection between ecosystem services rendered and payments. The principle here is that, to the extent tree planting reduces costs for private sector actors, they should be willing to financially support municipal tree planting activities. For instance, if tree planting would result in a reduction in health insurance claims in a community, insurers might rationally want to help fund urban forestry activities in the town. This is called "monetizing" the economic benefits that trees provide, helping ensure that the economic impact of the health benefits trees provide has a monetary value in decision making.

To our knowledge, there are no current examples of communities that have taken the idea of nature for health this far. Some close analogies from other sectors are worth examining, though. For instance, some electric utilities provide incentives to encourage tree planting near houses, particularly on the south and west side (in the Northern Hemisphere). This reduces solar insulation in the summer, and thus helps keep the houses cool. This, in turn, reduces electricity use for air conditioning. Perhaps the most famous example in the U.S. is in Sacramento, CA, where the Sacramento Municipal Utility District provides free shade trees to their customers to encourage their use, with the understanding that the customers will maintain the trees once planted.

Imagine if your health insurance bill were slightly reduced if you had more than a certain threshold of greenness in your yard. There is good scientific reason to think this affects your health, and hence in principle could affect your health insurance rate. For instance, the Harvard Nurses Study found a 12% reduction in all-cause mortality for those who had a high level of greenness within 250m.[49] However, many urban dwellers may not have a yard, or may rent, so they may have little ability to affect the greenness near their house. The public-policy challenge is that many individuals don't have much control of the overall greenness near their house. Much of the land in cities that contains trees is on the public right of way, or on other people's private property. It is hard, therefore, for an incentive to individuals to do much to fully correct what is a community health problem, a neighborhood's lack of greenness.

Other analogies do involve links between health-sector funding and community-level decision-making. For instance, the Federal Emergency Management Agency's National Flood Insurance Program (NFIP) in part sets its rates based upon the Community Rating System (CRS), which rates how vulnerable communities are to floods and what mitigation steps they have taken. The Nature Conservancy and other environmental groups have explored the idea that protecting or restoring natural habitats that reduce flood risk improve the CRS score of a community, lowering their flood insurance rates. This gives a financial value to projects that the community might undertake to protect or restore natural habitat.

There is no clear analogy of the NFIP system for health insurance, which is run by many private companies, each of which have different systems for setting rates, and which generally set rates at the individual not community level. But imagine if there were community-level programs that cities could opt into, and that major insurance companies would agree to slight reductions in insurance rates for policyholders located in those communities who are participating in the programs. One such program could be having a sufficient urban forestry program to provide health benefits for residents. For cities to be incentivized to participate in the program, some portion of the economic benefits that health insurers are receiving from having policyholders in greener communities would have to be returned to the city to finance tree planting and maintenance. For instance, major insurers could provide financial incentives to towns that participate, partially offsetting their raised costs.

Insurance Sector Tests Urban Greening Impact

One prerequisite for health insurers or others being willing to contribute to urban forestry is the ability to quantify the health benefits of urban trees in precise, economic terms. An exciting new research collaboration between Kaiser Permanente and academic researchers at the University of Illinois and the University of Nevada aims to provide this information.

The study will examine the more than 4 million members of Kaiser Permanente's Northern California region, quantifying the proximity and amount of tree canopy around their homes and communities. This information will then be statistically related to individuals' health utilization and cost data. Studies like this one will allow insurers and health care organizations to quantify the health benefits that current trees are providing, and how greater investment in tree canopy might be a cost-effective way to achieve some health outcomes.[50]

Kaiser Permanante also recently announced that they will donate $2 million to support 11 community organizations that run programs that connect people to parks. Specifically, Kaiser grants will support programs that encourage at-risk youth, seniors, people of color and residents from low-income communities to visit parks and enjoy outdoor physical activity. The majority of programs receiving funding are in the San Francisco Bay area, where a large number of Kaiser's members are located.[51] www.conservationfinancenetwork.org/2017/05/22/urban-forests-prune-health-care-costs

Public-sector models

Just as there are models where the private sector interested in health outcomes is the funder for urban forestry, there are also potential models where public sector entities interested in health outcomes put forth the money for urban forestry. In some ways, the potential for the public sector, broadly construed, to pay for urban forestry is greater than for the private sector, since the public sector accounts for such a large share of total health care spending. The Federal government pays for 29% of health care spending, while state and local governments pay for another 17% of U.S. health care spending. However, only a small fraction of health care spending is for public health-related activities that might reasonably be used for urban forestry. The clear majority of Federal government spending on health is through Medicare and Medicaid, for instance, which are generally focused on treating diseases in individuals, not insuring community health. This section of the document talks about health care spending by the public sector in the broad sense, understanding that public health agencies per se may have the strongest natural links to urban forestry but also may have very tight budgets that limit their ability to finance much urban forestry.

There are various public sector models, but the key is to have some simple, transparent mechanism to share funds from one entity that is interested in health (or in reducing health care spending) to another entity that can plant and maintain trees and parks. Clearly defining how the urban forestry activity will help fulfill the mission of the health-focused entity (the value proposition) is key. Then, after the money is transferred and the urban greening has occurred, there must be some adequate level of monitoring to ensure that health benefits are being delivered. As with private sector models, there are different degrees of academic rigor demanded in monitoring, depending on how the value proposition is formulated. The value proposition can just be a loose conceptual link (e.g., "tree planting is part of creating a green, healthy, walkable community, so we should fund some trees") to a strict scheme for payment for ecosystem services (e.g., "we will transfer $X to plant trees that deliver Y health benefits to my city").

Photo: © iStock/kazoka30

Photo F: Green space can support long, healthy lives.

One potentially simple way for health agencies to contribute money for urban forestry is to include a line item in the budget of the health agency, which most likely takes its money from the general fund of a city. General funds are the largest proportion of most city budgets, and there is generally flexibility in how they are spent. While in principle, a public health department line item could transfer funds to urban forestry, in reality, most municipal public health departments are quite small, so the magnitude of the transfer may be limited. Even a small transfer can be helpful, however, if done with an understanding that the health department can collaborate in setting urban forestry priorities that also provide health co-benefits.

Another possible source of public-sector health funding for urban forestry could be one of the federal or state grants for public health. One complexity, though, is that many grants are only available to deal with specific issues. For instance, grants programs are often for specific diseases or other special purpose categories. Urban forestry activities will only be accessible for some specific categories of projects, and would require some willingness from grant makers to fund a nontraditional public health project. However, in principle, if urban forestry supplies tangible health benefits, these should be appropriate for grant support.

Since a larger proportion of public sector funding for health care is for treatment of disease, it makes sense to examine how these treatment entities could help fund prevention instead. For instance, the Affordable Care Act (ACA, sometimes otherwise known as "Obamacare") included the creation of a National Prevention Strategy — to set national goals to identify effective strategies for improving health in the United States. The ACA also created a Prevention Fund to provide communities around the country with more than $16 billion over the next 10 years to invest in effective, proven prevention efforts, like childhood obesity prevention and tobacco cessation. In tandem, the ACA created the Centers for Medicare & Medicaid Services (CMS) Innovation Center, which funds pilot efforts to create Innovation Models, to improve health system performance, increase quality of care, improve patient experience, and decrease health care costs. One of these Innovation Models is the idea of Accountable Communities for Health (ACH), which focuses on community-wide health interventions that reach whole populations.[52] It is worth noting, however, that legislative changes to the ACA and health care may occur in the future, potentially altering or eliminating the ACH program and the structure of the CMS Innovation Centers.

Urban greening and strategic tree planting could be part of these efforts by CMS. Right now, most participants in an ACH pilot are hospitals or public health departments, and to our knowledge there hasn't been activities under the ACH model that explicitly focus on urban trees or parks. However, you could imagine that a public health department might work with a municipal parks and recreation department or an urban forestry department to make investments in a city that would promote health. Similarly, such activities would also fit into the national wellness and prevention strategy, so, in principle, might be funded from part of the Prevention Fund.

Finally, one potential avenue for health funding is government and industry spending required for Clean Air Act compliance. The goals under the Clean Air Act to regulate criteria pollutants are motivated by health, and if trees improve air quality, in principle, urban forestry should be a qualifying compliance activity. Tree planting as a means of Clean Air Act compliance is still a relatively new but promising path to increased finance for trees to help address the public health concerns caused by (for example) excess ozone emissions. In 2004, the U.S. EPA released a guidance document detailing newly approved measures for regulated entities to achieve compliance with increasingly strict regulations of ground-level ozone (O_3). Included in these approved methods are "strategic tree plantings", which can be incorporated into State Implementation Plans (SIPs). A SIP is a collection of the regulations, programs and policies that a state will use to clean up polluted areas. Currently, large scale urban reforestation is allowed as part of what is called either an "Emerging Measure" or "Voluntary Measure" for inclusion in SIPs. This means that as states develop new means for meeting stricter regulations, they are encouraged to include tree planting to compensate for small percentages of their total compliance needs. Funding for the actual interventions that comprise a SIP come from a range of sources, including regulatory penalties for polluters and government clean air programs. The US Forest Service has published a helpful overview of some of the complex details of including tree plantings in Clean Air Act SIP.

The Call to Action

This report tries to explain an apparent paradox. Just as the scientific case for the health benefits of trees and urban nature has become more solid over the last few decades, public investment in urban forestry has actually declined. U.S. cities are becoming on average less green.

Upon analysis, there is no paradox, but rather a situation similar to what is happening for other types of public goods. Just as there is persistent U.S. underinvestment in many types of grey infrastructure, such as roads and bridges, relative to what would be rationally optimal for social benefit, there is also persistent underinvestment in green infrastructure.

Photo: © Devan King/TNC

Photo G: The Brightside Organization, The Nature Conservancy, UPS and Brown-Forman partnered to plant 150 trees along West Broadway from 20th Street to the end at Shawnee Park in Louisville, Kentucky.

We identified four main barriers to action in this report, four reasons that most cities are not adequately investing in urban nature:

• Decision-makers and the public may lack knowledge of the benefits trees provide. We hope reports such as this one can play a role in closing this knowledge gap.

• There are some public concerns about potential problems with trees, but these concerns often can be alleviated by better urban forestry practices, public education and engagement campaigns, or assistance for long-term stewardship on private property.

• Agencies are often siloed, with different agendas and unclear communication between agencies. We discuss in this report how cooperative planning processes are one way to overcome this barrier.

• Finally, there is a persistent lack of funding for urban forestry, caused by constrained urban budgets and cities generally prioritizing urban forestry budgets relatively low compared with other priorities.

This report tried to quantify the investment gap—how much more investment in trees we would need to maintain our current urban canopy and then significantly expand it to seize greater potential health benefits. We estimate that an additional investment of around $8 per person annually would be enough to create this green future in US cities. We emphasize that this is an average figure, and the situation will vary greatly in different cities. Nevertheless, it is enough to show that a green urban future is not an impossible dream, but is quite affordable, if policymakers and others decide to make this investment.

The last section of the report describes some specific solutions to this funding barrier. The solution that will work will vary by city, but what matters is giving value—financial and ethical—to the benefits that trees provide to health. We propose in this report that one way to overcome the funding barrier may be to more closely link the goals and funding of the health sector with the goals and funding of urban forestry agencies. We urge all cities to begin exploring ways to create this vital link between the health sector and urban forestry agencies, using one of the potential models discussed in this report.

Working together, the health sector and the urban forestry sector can achieve a healthier, more verdant world.

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