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Item Type	Article
Authors	Eisenman, Theodore S.;Laskey, Allison B.
Citation	Eisenman, T.S., Laskey, A.B. Reflecting on urban greening at an historic inflection point with Theodore Eisenman. Nat Cities (2025). https://doi.org/10.1038/s44284-025-00216-y
DOI	10.1038/s44284-025-00216-y
Download date	2026-06-06 13:12:58
Link to Item	https://hdl.handle.net/20.500.14394/56356

Q&A

https://doi.org/10.1038/s44284-025-00216-y

Reflecting on urban greening at an historic inflection point with Theodore Eisenman

For a transdisciplinary perspective on urban greening at this particular juncture in history, we spoke with landscape architect and urban planner *Theodore S. Eisenman* about the contemporary upswell of interest in urban tree planting and related greening initiatives.

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Thank you so much for your time today and for having this conversation on urban greening, which has become a hot topic recently as a strategy to make cities more livable and sustainable. Can you outline how this conversation has evolved over the years?

This is a big topic that could take a full article or perhaps a book to adequately cover, but I will do my best to provide a brief overview. For starters, I define urban greening as the introduction, conservation and management of outdoor vegetation in cities. Importantly, this is a social practice enacted by people in particular places with distinct histories, socio-cultural dynamics and environmental characteristics. Urban greening can be understood as the broad tent that includes a range of mostly landscape-based interventions that include but are not limited to urban park planning and design; community gardening; urban tree-planting initiatives and urban forestry; green infrastructure for stormwater management (such as rainwater-harvesting gardens); green roofs and walls; the conversion of vacant lots, elevated rails and freeways to novel types of parks and green space; and policies that promote such interventions, including the green area factor (which requires a ratio of vegetative cover that given sites must adhere to). Almost all horizontal and vertical surfaces in cities are now open game for greening.

In addition to these applied expressions of urban greening practice, there has also been exponential growth in associated scholarship and discourse over the past decade or two. This draws upon a range of terms and conceptual frameworks that have distinct disciplinary and epistemological orientations, such as ecosystem services, green infrastructure, nature contact or nature experience, ecological planning and design, biophilic design, renaturing, urban ecology, and nature-based solutions. We are also witnessing hybrid governance and engagement through a diverse network of actors who include nonprofit organizations, residents, the private sector and public sector groups, across local, state and federal levels. In 2022, the US Inflation Reduction Act included US $1.5 billion for community forestry, which is an unprecedented infusion of federal funding for urban tree planting and management. Worldwide, over 18.5 million trees have been planted through 'The Trees in the Cities Challenge' – more than double the target of this UN initiative launched in 2019. And the International Council for Local Environmental Initiatives (ICLEI) is promoting greening as a strategy for urban sustainability.

In short, a bounty of urban greening practice, advocacy and related scholarship is emerging today, and this contemporary movement may represent the early stages of a novel chapter in the historical arc of our enduring aspiration to integrate the city (and culture) with nature. The closest precedent – especially if viewed as a systemic practice and discourse that has the potential to transform urban landscapes – could be the 19th century in Europe and North America, when some of the first public urban parks and park systems designed for public use were built. This period also witnessed substantial urban tree planting; landscape historians Henry Lawrence, Sonya Dümpelmann and Tom Campanella have documented this in great detail. Of note, planting trees across the urban fabric – especially along streets – did not become common practice until the late 19th century. Focusing on the American elm (*Ulmus americana*) in New England, Campanella has described this urban greening movement as a uniquely American democratic project; Lawrence has in turn characterized this seminal period as creating a green city ideal and 'model for the world'[1].

Today, urban greening innovation and practice is occurring worldwide[2], and Singapore is often highlighted as a pioneer. In *Urban Green*, Peter Harnik has documented the rise of innovative types of new parks and green spaces[3]. The Biophilic Cities Network is a great resource for global examples of contemporary urban greening, and The Nature of Cities is an online forum that explores contemporary urbanism through a green (and blue) lens.

Help us to set the scene – why do you think this urban greening movement is happening right now?

As you can probably appreciate, 'why' questions are some of the most difficult of all questions, and I cannot offer a definitive answer. But setting the scene, as you say, is important. Having been engaged with this and related topics for some time now – I worked at the US Environmental Protection Agency in the 1990s and I was writing about ecosystem services and urban green infrastructure in the early 2000s – I believe there are two historically significant trends that may help us to understand the contemporary bloom of urban greening. The first of these is urbanization itself, and the second is growing concern over human-caused alteration of the biosphere (in particular, climate change and biodiversity loss). Both of these noteworthy phenomena have gained increasing attention since the early 2000s, and this background context may help to explain – at least in part – the growing interest in urban greening today. In short, I believe that urban greening has increasingly come to be seen as a strategy to address concerns about global environmental decline and the environmental

externalities associated with urbanization. But although these two things are in some ways connected, we need to also understand them as related but separate things — especially as they inform urban greening.

Interesting. Can you expand on this a bit more?

Throughout most of human history, we have been a primarily rural species. European and North American populations became predominantly urban during the Industrial Revolution of the 18th–19th centuries; in 2007 humanity as a whole crossed an important threshold by becoming more urban than rural in our settlement patterns, owing largely to the ongoing urbanization of populations in sub-Saharan Africa and central and southern Asia. Demographers now project that two-thirds of people worldwide will live in cities by 2050, and by the end of this century around 85% of humans are projected to live in urban areas. This recognition has led to the early stage of this millennium being labeled the 'century of the city' and related monikers, and it has understandably gained a lot of attention in both the academic and popular press, prompting cover issues of magazines, special issues in prominent scholarly journals, and new publications. The same can be said of growing concern about environmental decline, the scale of which has been increasingly associated with the Anthropocene proposition by atmospheric chemist Paul Crutzen in 2002: namely, that we have entered a new geological epoch in which the actions of humans can be traced in essentially all of the Earth's biophysical systems. This is especially true of the post-World War II era, which has been depicted as 'the great acceleration' to describe the increasing rate of anthropogenic effects upon the environment[4].

Although urbanization and global environmental decline are in some ways connected, we need to distinguish between correlation and causation, especially as it relates to urban greening. For starters, it is perhaps more accurate to link global environmental decline with human population growth, rising standards of living and fossil-fuel-based industrial civilization over the past two centuries than with urbanization per se, which is most accurately understood as the agglomeration of people in densely built settlements. It should also be noted that urbanization has historically been associated with decreased birth rates. Indeed, the human population is now expected to peak in the 2080s (at about 10.3 billion)[5], when the vast majority of people are also expected to live in cities.

Building on the above, it is also clarifying to distinguish between the ecological and physical footprint of urban areas. In the case at hand, ecological footprint refers to the environmental impacts of and resources required to sustain people living in cities, while physical footprint denotes the land that is actually covered by urban areas. If we consider the flow of material goods, energy, water, food, and associated waste and pollution, the ecological footprint of people living in industrialized cities today is undoubtedly global in scope. Yet, the physical footprint of urban areas is 1–3% (depending on the source) of the Earth's terrestrial surface. By contrast, nearly half (44%) of the global land surface is dedicated to raising crops and livestock for human food consumption. I raise this distinction to highlight that urban greening is by definition an activity that occurs within a relatively modest portion of the Earth's land surface. By extension, there are limits to what urban greening can do to offset anthropogenic environmental effects beyond the physical footprint of cities.

Are there areas that have been overemphasized or are already really well understood in urban greening?

In terms of the rationales that are often used to support urban greening today, there tends to be an emphasis on biotechnical logics — the work that trees can do to offset human activities and so-called externalities, such as sequestering carbon, managing stormwater, removing air pollution and cooling urban heat islands. Also known as regulating ecosystem services, these utilitarian ecosystem functions can be quantifiably measured and translated into monetary value, which helps municipal leaders to advocate for and raise increased funding for greening. There is clearly a place for this. Yet, under closer scrutiny, some of these potential benefits may be limited. Carbon sequestration by urban trees, which typically offset municipal carbon emissions by only 0–3% annually, is one example[6]. Life-cycle analysis has shown that in some places, nursery production, planting, pruning, removal and disposal can generate enough greenhouse gas that planted urban trees are initially net emitters of carbon and it can take some three decades before sequestration outweighs emissions. Furthermore, the capacity of trees to reduce residential energy usage through shading depends upon a range of factors such as climate, heating and cooling systems, and building type[7]. Scholars have also raised concerns about overstating potential benefits that link urban trees, air quality and improved respiratory health. In the aforementioned cases, emphasizing urban greening as a strategy to address these important issues risks diverting attention from the actual source of the problem — reducing fossil fuel emissions.

In terms of urban greening practice today, and urban tree planting initiatives (TPIs) in particular, there also tends to be a lot of emphasis on numeric goals, such as thousands or millions of trees planted or achieving a certain percentage of urban tree cover. From a public policy perspective, these kinds of quantitative objectives are understandably attractive, as they help to mobilize political and economic resources for greening. However, this approach can lead to practices that aim to get as many trees in the ground as fast as possible, while not paying attention to critical issues such as meaningful community engagement, place-based landscape planning and design for a range of users and needs, and post-planting stewardship and management to ensure tree survival in both the short and long term.

The emphasis on quantitative planting goals also does not account for more qualitative and practical considerations — in particular, how people actually perceive and experience urban green spaces, and how these landscapes are designed and managed. This is especially noteworthy in light of research spanning roughly four decades — including a seminal 1984 study showing improved post-surgery recovery in rooms with a window view to a stand of deciduous trees[8] — that shows human health and wellbeing benefits from being in visual or physical contact with 'natureful' settings. Importantly, many of these benefits are associated with a range of psychological measures linked to stress reduction and restoration, improved emotional wellbeing and cognitive performance[9,10]. In other words, the way in which people actually perceive and interact with vegetated landscapes — which is a qualitative and experiential kind of logic — is not something that quantitative greening goals and practices necessarily capture. By extension, remote sensing (bird's-eye) methods associated with quantitative greening goals may not capture people's ground-level subjective experience of landscapes.

Urban greening necessarily involves links between disciplines and fields. What kinds of challenges and opportunities come up working across these boundaries?

Urban greening is, indeed, a multidisciplinary field of practice and scholarship. With that in mind, I believe there is a need — and a

real opportunity — for more synthetic scholarship and interdisciplinary collaboration that spans the humanities, natural science and social science. This is exemplified in two 2019 reviews[11,12], which cover links between urban trees or green infrastructure, air quality and asthma, that I codeveloped with researchers from backgrounds that included epidemiology, atmospheric science, horticulture, environmental engineering and urban ecology. We found little multidisciplinary consensus on this topic; importantly, most epidemiological studies at the time of these reviews highlighted detrimental links between urban trees and increased asthma owing to pollen production. Ensuing research has shown mixed results, which reinforces the complexity of this issue.

A noteworthy insight from this work and a cross-disciplinary reading of scientific literature is how different disciplinary orientations can yield disparate perspectives on a similar topic: in the case at hand, the human health and wellbeing benefits of urban vegetation and green space. Part of this problem is due to a cornucopia of competing nomenclature. For example, public health scholars and environmental psychologists generally use terms such as 'nature exposure', 'nature contact', 'nature experience', 'nearby nature' and 'nearby greenspace'[9,10]. Other disciplines (especially those with an environmental science orientation) tend to use terms such as 'green infrastructure', 'ecosystem functions', 'ecosystem services' or 'ecosystem disservices', and 'nature-based solutions'[13]. At the risk of oversimplification, the latter group of terms and associated research tends to foreground interactions between urban flora and environmental processes (for example, carbon emissions, temperature, air quality and stormwater), and then draw associated conclusions about likely human health outcomes; the former group directly measures human health outcomes. Importantly, literature reviews that use the aforementioned terms (and associated keywords) when querying databases tend to yield different bodies of scholarship, different epistemological approaches and different conceptual framings. This creates a challenging situation to make sense of scientific research, especially for municipal leaders and applied fields such as landscape architecture and urban planning. It also reinforces the need for more interdisciplinary teamwork, epistemological pluralism and a greater awareness of how positionality (our lived experience, including disciplinary training) can bias our epistemology (our understanding of the world)[14].

Building on the above, scholars with disciplinary training in political science and social science have had an important role in recent years in elevating the importance of environmental justice considerations in urban greening. Much of this scholarship has focused on concerns related to green gentrification — when environmental interventions (such as new parks, green infrastructure for stormwater management and tree planting) lead to increases in local desirability that result in higher property values and rents, and the displacement of existing residents who are often of low socioeconomic status and have experienced historical marginalization[15]. Equity considerations are, in turn, gaining increasing prominence in urban forestry and associated TPIs. Until quite recently, this body of practice and scholarship tended to focus on distributional justice by seeking to plant trees in areas of low canopy cover and low socioeconomic status. However, research has shown that a lack of community engagement in TPIs can backfire, especially in marginalized neighborhoods, with residents resisting new plantings owing to mistrust in government agencies, real and perceived risks associated with large trees, and municipal disinvestment in tree care, as well as the aforementioned concern about gentrification[16].

This reinforces the need to foreground procedural justice (how greening initiatives are planned and implemented) and recognitional justice (how different cultures, experiences and worldviews are incorporated) when pursuing urban greening programs such as TPIs. More specifically, this means conducting deep community engagement across all phases of a TPI, especially in the upfront preplanting stage when goals and associated landscape plans and designs are formulated. Importantly, some studies have shown that residents may prefer small-statured flowering and fruit-bearing trees over large shade trees. This may conflict with goals to maximize canopy cover, which — as noted earlier — tends to be the dominant approach in urban TPIs and urban forest management plans. Yet, fruit-bearing and flowering trees can support food sustenance and psychosocial benefits, especially in communities who suffer from disproportionate physical and mental health challenges.

These real-world considerations are timely and important. Can you expand on this a bit more?

Sure. Another important consideration as municipal leaders pursue urban greening is stewardship and survival of newly planted trees. Drawing on scholarship covered in the work of my frequent collaborator, Lara Roman — who has particular expertise on urban tree survival and mortality — about 30% of typical urban tree plantings die within the first 5 years and roughly half tend to survive 13 to 18 years[7]. In some instances (with an extreme lack of appropriate tree planting and care techniques), mortality can reach 25% within the first few months of planting. This reflects what has been described as 'greenwasting': an environmental initiative that is presented to the public as meaningful but fails to deliver on stated goals and promises. It also represents a 'sunk cost' — an expenditure that cannot be recovered, which is no minor consideration given that the average cost of planting a new urban tree in the US can range from $500 to $3,500, with street trees generally at the upper end of the spectrum owing to expenses associated with site preparation in constrained conditions.

To put this in perspective using a thought experiment of fairly conservative estimates: if 5,000 trees are planted as part of an urban TPI at $500 per tree, and roughly half die within 15 years, this amounts to a $2.5-million planting project with $1.25 million in sunk costs. Additionally, the sight of dead trees can function as a kind of blight with potentially negative effects on a local community's self-image and wellbeing. Low tree survival also risks decreasing public support for related initiatives in the future, all of which raises some reasonable questions: would we accept this level of failure for hard ('gray') infrastructure? Is the intent of TPIs to achieve ambitious planting goals, or is it to cultivate thriving and long-surviving trees with and for communities?

With this in mind — and building on the point I made earlier about the need for greater community engagement — my colleagues and I in a recent paper[17] have proposed roughly even allocation of resources across all three phases of an urban TPI: one-third for preplanting community engagement and planning; one-third for site preparation, tree purchasing and planting; and one-third for postplanting maintenance (especially watering), monitoring and sustained engagement (Fig. 1). This is a departure from business as usual, as TPIs in the USA have tended to allocate roughly 70% of funds for tree purchasing and installation, and about 10% for maintenance[18].

In addition to the above, it is important to approach urban greening as involving place-specific practices that respond to the local context of a given city, neighborhood and site. This is especially important as greening — and TPIs

in particular – become increasingly globalized with norms related to percentage of urban tree cover, tree species selection, and tree management practices. Cities around the world have substantial differences in urban form (which informs 'plantable' space), distinct cultural traditions related to tree species selection and management, and a range of governance norms. In the USA, for example, volunteerism and resident engagement figures prominently in urban forestry practice and associated scholarship, but this might not be as common in other countries. Likewise, heavy pruning of street trees – which requires considerable investment in equipment and staff, and reflects a particular aesthetic landscape norm – is common in European cities and less so in North America.

There are also site-specific and regional considerations. Private yards represent substantial plantable space but require different landscape designs and approaches from those suited to public spaces. Not all types of desirable urban green space (such as vegetable gardens, open lawns for public gathering and playing, and scenic views) align with extensive tree cover. And although urban trees offer considerable potential for cooling and improved thermal comfort (which are critical issues in an urbanizing and warming world), regional context is an important consideration. This includes risks and tradeoffs: in cities that are prone to hurricanes or ice storms, it is critical to select species that can withstand strong winds and to plant large species away from utilities. In arid and semi-arid climates, TPIs must contend with trade-offs related to local water conservation and wildfire, while also considering nonvegetative cooling strategies such as shade structures, increasing the albedo of paved surfaces and roofs, and passive cooling architecture. Broadly speaking, thermal comfort goals may be best achieved by strategically planting in places frequented by people, such as street corridors, transit stops, schoolyards, public plazas and neighborhood parks[6].

An additional place-based consideration is species composition. Although the diversity of tree species is important for pest and disease resistance and wildlife habitat, trees are also essential elements of urban design that give form and identity to spaces, and in so doing create places that have local meaning and cultural significance. As such, goals related to species diversity are perhaps best achieved at the municipal scale, and not within a single block or street. There is also a growing body of scholarship on selecting trees for low-allergenic pollen (and associated respiratory

Pre-planting

Installation

Post-planting

Fig. 1 | Examples of resource allocation across the three phases of an urban tree-planting initiative. Left image, in Los Angeles, California (photograph courtesy of Carlos Campero); middle image, in Palo Alto, California (photograph courtesy of Jean-Paul Renaud); right image, in Worcester, Massachusetts (photograph courtesy of Lara A. Roman).

complications), although this does not yet seem to be a prominent consideration in practice.

Thanks for sharing these insights. Do you have any concluding thoughts?

In both my teaching and scholarship, I encounter a somewhat misguided understanding of urban trees, flora and green spaces as 'natural' settings that will automatically take care of themselves. This echoes the idea of self-regulating or self-sustaining systems in classical ecology in wildland settings. But in urban landscapes, many – and perhaps most – trees are deeply embedded in human labor and culture. From plant breeding and propagation to nursery care and growing; to species selection and planting location; to site preparation and transplanting; to watering and pruning; and, ultimately, to removal and disposal, urban trees are as much a cultural as a natural artifact. In other words, the ontology of urban trees and flora is different from counterparts in nonurban settings.

This is an important consideration when pursuing adaptation or rewilding of abandoned lands in so-called shrinking or legacy cities – urban areas that have experienced substantial population loss and land vacancy due to economic decline. To avoid further neighborhood decline, it is especially important in these areas that greening interventions incorporate cues to care[19]: landscape design elements and management practices that signal human presence, intentionality, and upkeep, such as edges demarcated by rocks or mowing, signage, and removal of fallen trees or limbs. The cleaning-and-greening program in Philadelphia, Pennsylvania, is a noteworthy precedent. More broadly, thoughtfully designed green spaces that are actively stewarded through investment of local resources are essential elements of sustainable urban landscapes.

Frequent collaborators and I are also concerned about a narrative that frames greening as a panacea and, in so doing, deflects attention from underlying problems such as decarbonizing the industrial economy upon which modern cities are built. Approaching urban greening as a straightforward solution also risks diverting attention from other important urban planning and design strategies. For example, vegetation and associated green infrastructure initiatives can clearly help to manage urban stormwater; but many cities have traditional gray infrastructure systems that are over a century old and in need of upgrading, and future plans to manage projected flooding, sea-level rise and storm surges will require multipronged efforts in which green infrastructure is but one element. Likewise, plans to reduce illness and death during extreme heat events – described as silent killers because they take more lives than all other natural disasters combined – must include both environmental cooling strategies as well as robust emergency response plans to support the most vulnerable people.

This raises a broader concern; namely, that urban greening risks perpetuating a kind of environmental determinism (the idea that environmental interventions alone can solve complex problems). Yet, cities are foremost socioecological systems built by and for humans[20]; this means that people's lived experience of urban landscapes, the processes by which places are planned and designed,

and the disciplines with associated expertise (including human health and wellbeing) must be foregrounded in urban greening research and practice.

Taking a broad historical perspective, the above is especially important when we consider that our transition from a rural to urban species — notwithstanding the emergence of urban settlements following the Agricultural Revolution several thousand years ago — has occurred mostly over the past 200 years. This is merely seven to ten generations, which represents a notable break in the longue durée of human evolution and raises important questions and opportunities to reconsider how we plan and design our principal habitat: the urban landscapes and buildings in which the vast majority of people will soon live, work and play. Urban greening can play a critical part in how we conceive, and build, these places. With that said, it is important to reinforce that urban greening itself is not the goal; rather, it is a means towards the greater goal of creating more livable, equitable and sustainable cities[17].

In closing, I thank A. Borg, L. K. Campbell, T. Lim and L. Roman for providing valuable insights, and the many scholars and practitioners who have informed my thinking on urban greening.

Theodore S. Eisenman was interviewed by Allison B. Laskey

Published online: 30 April 2025

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