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Short communication

COVID-19 pandemic observations as a trigger to reflect on urban forestry in European cities under climate change: Introducing nature-society-based solutions

Dagmar Haase^{a,b,*}^a Humboldt Universität zu Berlin, Rudower Chaussee 16, 12489, Berlin, Germany^b Helmholtz Centre for Environmental Research – UFZ, Department of Computational Landscape Ecology, Permoserstraße 15, 04318, Leipzig, Germany

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ABSTRACT

COVID-19 pandemic observations triggered a reflection by the author on urban forests in European cities under climate change as nature-society-based solutions. This commentary introduces a complementary triad of approaches that are all known but might lead to a novel view of urban nature, including forests, regarding changes in pandemic diseases and/or related to urbanization and climate change: Hybridity, succession, and flexibility: First, allowing for green spaces used by humans and nature but also those that are exclusively for ecosystems to provide space for undisturbed development and thus better control pests and diseases. Second, allow for succession at urban open spaces to let nature experiment on solutions for a drier and hotter climate that urban society can implement in urban forestry. And third, allow planning to set targets in efficiency assessment and monitoring that are matching time periods which natural ecosystems need to adapt to climate change acknowledging nature as a real ‘partner’ in nature-society-based solutions in one-health cities.

1. Reflection

Urban tree canopies—including forests and single trees—are a key element of what we understand as nature in cities and part of what we define as urban green infrastructure *sensu* Pauleit et al. (2019a, b). Urban forests belong to cities, as they exist and are part of the grey-green continuum (Davies and Laforteza, 2017). Trees shape the embedding of an urban fabric; they structure large open spaces in cities, serve orientation purposes in dense urban environments, and provide enjoyment and pleasure. Trees are key components of green infrastructure in cities; many green spaces are placed and developed around trees (Konijnendijk et al., 2006). Trees, as core elements of public parks, gardens, avenues, and cemeteries, provide a multitude of ecosystem services to people and their direct and distant surroundings: they cool the air, produce fresh air (Weber et al., 2014), uptake CO₂ and store carbon (Richter et al., 2020), host thousands of other species and serve as sites of recreation, wellbeing, and enjoyment (Haase et al., 2014; see a typical tree-based park setting in the city of Leipzig in Fig. 1).

Studies on urban forests have provided key insights into the biophysical nature of trees and regarding matter and energy fluxes within tree populations and from trees into their environments (Konijnendijk,

2003). The shadowing and cooling effects of tree-based ecosystems and thus the mitigation of high air temperatures in cities have been indicated using airborne and remote sensing data for individual heatwaves but also for long-term neighbourhood effects (Andersson et al., 2020; Wu et al., 2021). Public health policies in cities also rely on urban forests and trees when searching for strategies to counteract extreme air pollution and noise as well as summer heat and its harmful effects on human health and the respiratory and cardiovascular systems (Kabisch et al., 2017, 2021). Trees are increasingly employed as mediators of mental health problems and elements of natural therapies to balance urban stresses and attenuate light forms of mental disorders (Adli et al., 2017).

Urban planning relies on urban forests and trees when designing plans for more sustainable and climate-adaptive cities (Gill et al., 2007). Trees have been a tool of urban planning and architectural design since early times (Konijnendijk, 1999). Trees are core elements in the appearance of our cities—not exclusively in biomes where trees naturally grow but also far beyond; in other words, trees shape the images of our cities. At the same time, in many cities in Europe, trees share the destiny of being cut down and replaced by buildings or roads in their best age or suffering from limited environmental conditions such as poor soils, human vandalism or pests (Hilbert et al., 2019).

* Corresponding author at: Humboldt Universität zu Berlin, Rudower Chaussee 16, 12489, Berlin, Germany.

E-mail address: dagmar.haase@geo.hu-berlin.de.

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During the 2020/2021 COVID-19 pandemic, urban forests and trees as nature-based solutions in cities received unexpectedly enhanced interest, as people in Europe—used to travel to the mountains or the sea for recreation and holidays—were confined to their homes, and going outside—be it in their neighbourhood or to a nearby park—was the only refuge for many people (da Schio et al., 2020). Trees in parks or forests as well as trees on streets or shaping small pocket parks received much attention that they had not receive in pre-pandemic times. During the lock- and shutdowns but also afterwards, green spaces in general were found to be more important and more attractive for urban citizens across all age groups compared to pre-pandemic times (Barton et al., 2020). During the unstable pandemic phases since spring 2020, the importance of urban forests and urban trees in people's lives in cities has increased (Ugolini et al., 2021). The study by Ugolini et al. stated that missing daily outdoor activities during the sharp lockdown in Italy was a means of "...reinforcing the importance of green spaces for social gathering, sports, and observing nature". Outdoor green classrooms gained a great amount of attention in pandemic times as complementary safe spaces compared to aerosol-prone indoor areas (<https://www.greenschoolyards.org/covid19-media-library>). A cross-European study found that contact with nature 'buffers' the negative effect of shutdown/lockdown conditions on mental health (Pouso et al., 2021). At the same time, shutdowns and lockdowns might have initiated what Nathan and Overman. (2020) called "a big city exodus" as inner-city office spaces have been abandoned to a large extent, and the complete return of all office workers is improbable due to cost-efficiency and flexibility of at-home office work. These studies at least give rise to speculation that urban green spaces, including urban forests, should be considered important nature-based solutions in regard to new, post-pandemic urban master-planning involving the enhancement or reconfiguration of parts of our cities, including city centres but also green spaces.

Before the pandemic, in 2018 and 2019, and still in 2020, the first core year of the pandemic, Europe had been facing several intense heat summer seasons which started in spring and continued until fall bringing along strong insolation and enormous water deficits (Lin et al., 2021). Focussed on green spaces in pandemic times, for many people in cities the drought-suffering vegetation became extremely obvious. Similar refocussing has been reported for the Global South from Australia after the forest fires of 2019/2020 for example (Ignatieva et al., 2020).

At the beginning of this article, urban forests and city trees were

stated to be hosts of biodiversity. This argument—showing the ambiguity of nature in cities—includes *pro* and *contra* arguments regarding the close spatial connection between humans and forests in cities. On the one hand, trees are key for human wellbeing and interactions with nature in cities (Pauleit et al., 2019a, b). On the other hand, all non-human species in city ecosystems also need undisturbed spaces to survive and create complex food chains (Grimm et al., 2000). The recent COVID-19 pandemic originated in an area where rapid urbanization led to a dramatic reduction in undisturbed natural areas in addition to an overall loss of species within the remnant ecosystems (Wu et al., 2017). Humans and vectors became closer in vicinity, and fewer stepping stones in terms of animal host organisms were available, which could have been the reason for viral diseases close to or within cities. Thus, in addition to ecosystem service delivery, this type of human-nature interaction is today induced by our cities and their peri-urban areas.

In addition, as stated above, climate change—specifically, hotter summers and warmer winters—allows for the increased migration of vector carriers from tropical to non-tropical regions and *vice versa* (Wu et al., 2017). Related jumps from zoonotic hosts to humans and the spread of respective pandemics are more prone in cities where humans and nature are remarkably close and where peri-urban nature has either been exterminated or is in a poor state (Mackenstedt et al., 2015).

1.1. What conclusions can be drawn from this kind of paradoxical setting?

This commentary provides a possible answer to this question by introducing a complementary triad of approaches that are all known but might lead to a novel view of urban nature, including forests, regarding changes in pandemic diseases and/or related to urbanization and climate change: *Hybridity*, *succession*, and *flexibility*.

First, hybridity: To allow for human-nature interactions and for undisturbed spaces, hybrid concepts are required (see White Damian et al., 2016) for human-nature relationships in post-pandemic times with various concerns. Cities need to be converted into spaces where humans and nature are close to each other but are also partly "connected via distance". We need both designed urban green infrastructure where people can experience recreation, enjoyment, and physical activities (see Rall et al., 2017 and Fischer Leonie et al., 2018) and adequate areas of untouched (successional) spaces where plant and animal species can



Fig. 1. Trees as core elements of human recreation in cities. The picture shows active tree rejuvenation through the planting of young trees (Photo by the author).

find undisturbed homes and habitats—at least to allow for vector trapping and maintaining intact ecosystems and thus lowering the disease risk through zoonotic pathogens (Keesing et al., 2009). In other words, we need co-habiting green infrastructure and urban nature in our future cities, but not at the same place, and explicitly including urban forests and trees.

Second, succession: Cities need spaces such as brownfields where urban successive wilderness can emerge and grow in an undisturbed way that is unmanaged by humans and thus explicitly non-designed. Here, urban nature can experiment, develop site-specific diversity (Baldock et al., 2019) and learn to adapt to whatever conditions cities provide and face, namely, poor soils, polluted but nutrient-rich sites, heat waves and phases of extreme drought as well as a certain degree of fragmentation (McDonald et al., 2019). Plants emerge at brownfield sites and continue to grow, and animals use these plants as habitats and form specific niches in and around cities—novel ecosystems (Collier, 2015; Hobbs et al., 2006)—that differ from open land ecosystems but are more resilient to “urban settings”, including variances in and extremes of the biophysical conditions found in cities (Fig. 2 shows an example of spontaneous birch growth in a period of topsoil and subsoil drought). Accepting such specific wilderness spaces (Boivin et al., 2016) means changing our understanding of what we commonly call “nature-based solutions” to “what solution (response) nature would provide” (Ignatieva et al., 2020). In this way, urban wilderness can actively hinder vector jumps to humans as enough non-human hosts are available.

Third, flexibility for active non-action: In terms of urban forest management and town planning, enabling wilderness in cities consequently requires the termination of the regeneration of all brownfield sites as they are excellent spaces for nature to learn and, at the same time, open such brownfield places for urban dwellers who prefer being distant to more designed or structured urban places (Püffel et al., 2018; Draus et al., 2020).

Enabling wilderness in cities as suggested above requires a change, or, better, an amplification, in prevailing town planning and governance systems as well as in the thinking patterns of city planners. Planning must actively include “non-action” as a tool equivalent to co-designing, co-development and co-creation (Jagt et al., 2018). Flexible non-action planning—as it is termed herein—converts open spaces into a mosaic of classical landscapes and planned town areas, urban green infrastructure

design, and wilderness, enabling through non-action the representation of a kind of “nature-society-based solution” (NSBS) to urban challenges such as vector-driven pandemics and climate change.

1.2. How does the novel idea of “nature-society-based solutions” apply to urban forests and trees, the starting point of this commentary?

Some important conclusions can be drawn from this analysis: In cities, we need both parks and woodlands as types of urban forests. We need boundary biotopes and areas in the form of longitudinal patches or vegetation stripes between forests and woodlands to allow nature and society to co-create. We need educational work to spread knowledge and arguments regarding what both types of urban tree assemblages mean and what they are good for. In relation to the latter, we need to study tree growth in brownfields to understand the potential development of nature under current and changing conditions and what time periods need to be taken into consideration for adaptive change. The latter could help revise landscape planning in cities in a revolutionary way if undisturbed nature were actively allowed in cities complementary to designed nature. To do so, we need landscape planners, urban foresters and urban real estate managers who understand urban forests and trees as 3-D systems (Baldock et al., 2019) equivalent to building architecture. Enabling non-action explicitly includes the variable of “time” as a fundamental part of any NSBS confronting short-term, utility-driven land change proposals with a lens of sustainability.

To better understand the effects of such combined active design and non-action “planning” of nature in cities, we need to invest in better mechanistic and interpretational monitoring to obtain knowledge on the effectiveness of both approaches. Trait-based ecology (Andersson et al., 2021) can be applied for the nature/wilderness component, and assemblage thinking (Ghoddousi and Page, 2020) as well as actor-network theory (Müller and Schurr, 2016) can be applied for the planning part, as these approaches are seen as promising for unravelling the causes and consequences of biodiversity filtering on ecosystem processes and the urban societal response. Assemblage theory is promising for the mechanistic and interpretation component on behalf of society “... because of its capability to include the role of the material [...] and by showing how [human] agency emerges out of complex relations” (Ghoddousi and Page, 2020; p. 1).



Fig. 2. Spontaneous birch tree succession at a large former railway brownfield in the city of Leipzig, Germany, in a period of continuous topsoil and subsoil drought (<http://www.vanderhoffmann.de/>).

Compiling ecological traits that reveal the health of urban forests and trees in either designed or wilderness spaces could be based on the more frequent and effective use of remote sensing data time series to create spatially nested and temporally replicable samples (Wellmann et al., 2020). This sampling scheme would permit continuous and thus change-relevant habitats and robust mapping and monitoring systems (Pinho et al., 2021). Using the traits approach—where traits are understood as core attributes that are closely related to plant shape, colonization, survival, growth, and mortality—helps scientists as well as planners to understand and assess species' specific responses to unexplored niches (Pinho et al., 2021) and climate variabilities (Egerer et al., 2021) across planted and spontaneously growing plant and tree species to identify and quantify phenotypic plasticity and adaptations to the above-described urban forest types, densities, and degrees of disturbance, including the movement of probable vectors as a key component of active pest control and vector dispersal (Wu et al., 2017; Andersson et al., 2019).

For the societal part of NSBSs, flexibility in spatial arrangements, regulations and decision-making is seen as a core property for creating and maintaining urban forests and tree-based green spaces in cities to serve as a solution for complex urban challenges, such as the next pandemic or heat wave. Design and aesthetics play a key role in this goal, but the suitability and efficiency of green spaces to serve physical and mental wellbeing have also been proven by urban stress studies (Hunter et al., 2019; Adli et al., 2017). In addition to designing green spaces, the easily accessible direct surroundings of trees in cities—small spaces, pedestrian zones or open spaces—should be considered for place-making and social cohesion for people in late pandemic times and preserved, where possible, in post-pandemic times (see results by Holtan et al., 2014). Social media, following Ilieva and McPhearson (2018), can and will accompany this kind of autonomous place-making and monitor the emergence of a novel urban space-related agency—as argued above—that results from complex human-nature interactions involving trees.

For urban planning, there are three core implications that can be derived from this argumentation: (1) Planners need to consider longer time periods for the implementation of nature-based solutions to let them develop including failure. (2) Planning must include nature determinism in green infrastructure design which means allowing nature to adapt to higher temperature and less rainfall and this way learn from nature what could be urban green solutions under changed climate, and finally, (3) Planners should create space for both humans and nature in cities but also provide spaces exclusively for nature to let it adapt, success and develop less disturbed by humans.

Finally, wild, undisturbed urban forests and tree ecosystems belong to this newly defined nature-society-based solution (NSBS), as they allow distancing to be maintained where needed but also allow for diversity at both ends, nature and society, and enable interactions where possible. In this way, forests and tree-based NSBSs can entirely address what is meant by the slogan highly placed on current global political agendas: One health [for cities].

Declaration of Competing Interest

The author declares that she has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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