Chapter 16
Integrating Ecosystem Services, Green Infrastructure and Nature-Based Solutions—New Perspectives in Sustainable Urban Land Management

Combining Knowledge About Urban Nature for Action

Dagmar Haase

Abstract Global urbanisation comprises both urban sprawl and increasing densification of existing cities. Along with the heat waves, floods and droughts associated with climate change, urbanisation challenges our cities, and thus the places where soon 60% of the world's population will live. In addition to human beings and their health, nature and biodiversity are under extreme pressure to function and to survive in these growing urban systems. More and more key biodiversity areas (KBAs) are becoming urbanised, and wetlands are being sealed. However, ecosystems are crucial for a healthy and safe life in cities. So how should we save urban nature as a habitat for humans, flora and fauna? This chapter presents three concepts that provide different perspectives for sustainable urban land management. They represent complementary paths to increased urban sustainability. Nonetheless, implementation is still a long way off, and moreover, unsolved issues still exist, such as the social inclusiveness of the three approaches.

Keywords Ecosystem services · Green infrastructure · Nature-based solutions · Complementary approaches for sustainable land use

16.1 Challenges in Urban Land Management: The Case of European Cities

Urbanisation and urban growth are two overarching phenomena in land use development affecting areas around the planet. Worldwide, more than 55% of the population lives and works in cities, and this trend does not seem to be subsiding (Haase et al.

D. Haase (✉)
Department of Geography, Humboldt Universität Zu Berlin, Unter den Linden 6, 10099 Berlin, Germany
e-mail: dagmar.haase@geo.hu-berlin.de; dagmar.haase@ufz.de

Department of Computational Landscape Ecology, Helmholtz Centre for Environmental Research—UFZ, Permoserstrasse 15, 04318 Leipzig, Germany

T. Weith et al. (eds.), *Sustainable Land Management in a European Context*, Human-Environment Interactions 8, https://doi.org/10.1007/978-3-030-50841-8_16

2018). Europe, a continent that became urbanised relatively early, is stagnating in population growth terms, but cities as such are becoming attractive places to move to (Scheuer et al. 2016; Wolff et al. 2018). Indeed, land take in and around cities is not only not subsiding in Europe—it is accelerating. In addition, when considering the per capita living space increase over the past few decades along with the average decrease in household sizes in Europe (Haase et al. 2013), land has become a scarce resource in cities. Recent construction activities are no longer exclusively concentrated on the urban periphery; on the contrary, densification of inner-city areas and infill development are high on the agenda (Wolff and Haase 2019).

Densification by infill development automatically leads to a decline and a partial complete disappearance of (spots of) nature in city centres (Haase et al. 2018), despite the fact that such areas are often high-value nature areas with a rich biodiversity, due to the wetland and riverine locations of many cities (Kühn et al. 2004). At the same time, we still find peri-urbanisation and land take outside the city cores on formerly arable ground, resulting in a decline in fertile land (Nilsson et al. 2014). Thus, the face of urban growth in European cities is multifaceted and does not include the considerable percentage of cities and towns in Europe that are shrinking (Wolff et al. 2018).

While growing and densifying, cities also face the direct consequences of ongoing climate change, such as long-lasting and early heat waves (as the summers of 2018 and 2019 recently demonstrated) including "tropical night" temperatures exceeding 20 °C. This is clearly a challenge for urban public health, in particular for an ageing urban population in a densely built area (Bosch and Sang 2017). At the same time, high daytime temperatures and continuous irradiance are a challenge for urban tree and shrub vegetation, which already suffers from the lack of rainfall. Therefore, heat has become one of the key challenges for entire urban systems in Europe, including the environment, public health and the economy, especially when considering cities that attract (mass) tourism (such as Vienna, Rome and Berlin).

In addition to heat, an increasing risk of flooding in lowland and coastal cities (Barcelona and Genoa after heavy rainfall, as well as Bosnia, Croatia or Germany after heavy rainfall and stationary depressions in the past decade) appears to be another key challenge for European cities (Scheuer et al. 2017). As cities increasingly accumulate economic value and, of course, human life, the frequency and degree of hazardous flood events need to be incorporated into a more sustainable and flood-proof urban land management (Krysanova et al. 2008). The case of drought and water shortages is similar, which have recently often alternated with floods: most European cities are not well prepared for longer-term water shortage and extreme irradiance.

However, cities in Europe are also places of great vestiges of nature (Haase and Gläser 2009). In addition to the above-mentioned wetlands and riverine land strips, cities harbour old forests, large parks, numerous gardens and green backyards. Recently, urban green ground infrastructure has been complemented by "vertical green" such as green rooftops and living walls (Pauleit et al. 2018). Moreover, we know about the positive effects of urban green and blue spaces in cities when dealing with high air temperatures and irradiance (Weber et al. 2014a). We know the positive effects of green space for public health and the prevention of heart or lung disease, as well as “lifestyle diseases”, such as obesity and diabetes (very frequent in cities with a high poverty rate), and mental disease, such as depression or anxiety disorders (Gruebner and McCay 2019; Gruebner et al. 2017).

Thus, the major research question guiding this chapter of the book will be: How we can make use of urban nature and knowledge about nature to protect human life and, at the same time, protect nature from severe and hazardous conditions and events? Are there forms of urban land management that allow us to effectively and sensibly harness nature for human benefits, leading to more sustainable urban land use?

This chapter provides novel insights by discussing various concepts and the potential to integrate them into cities.

16.2 Three Concepts for One Goal

The next few pages will introduce three different approaches and concepts dealing with urban nature for sustainable cities:

- Urban ecosystem services (demand, flow, supply; Haase et al. 2014),
- Green infrastructure and green infrastructure types (Pauleit et al. 2018) and
- Nature-based solutions (Nesshoever et al. 2017).

All three concepts are interrelated and have a complementary character to a certain degree (Table 16.1 and Fig. 16.1). Urban ecosystem services (ES) focus on the processes and structure of urban nature and the beneficial effects of ecosystem process outcomes for people—in the case of this chapter, urban residents and urban society as a whole (Haase et al. 2014). Urban green infrastructure (UGI) can be understood as a strategic planning approach that takes these functional benefits of ES for “granted”; it thus aims to develop networks of green and blue spaces in urban areas, designed and managed to deliver a wide range of ES and other benefits at all spatial scales (Pauleit et al. 2018; EEA website). Finally, the concept of nature-based solutions (NBS) focuses on problems and challenges of an environmental or a social nature. NBS harnesses the ES functional approach and the design concept of green (blue) infrastructure to adapt both ES and UGI to the distinct and specific needs of cities. NBS, therefore, can be defined as living solutions that are inspired and supported by nature, which are cost-effective, whilst simultaneously providing environmental, social and economic benefits and helping to increase resilience and adaptation to climate change (Kabisch et al. 2017).

Table 16.1 Core properties of the three "green approaches" to sustainable urban land management (own conceptualisation and content compilation)

	Urban ecosystem services	Urban green infrastructure	Nature-based solutions for cities
Basic response or "working" units	Ecosystems (patterns and processes) and elements of them, such as soils, the water cycle and trees in an urban environment	Vegetation and vegetation types, their design and management in a city	Materials, structures and processes that function as, or like, ecosystems
How the approach works, or the idea behind it	Outcomes of ecosystem processes represent flows of material or energy that facilitate human life in cities, e.g. temperature cooling or water purification by soil sediment fixation	Elements of vegetation are planted and/or designed as well as maintained to make use of their ecosystem service flows for human well-being	Elements of nature are either used or constructed (mimicry) to produce ecosystem service flows to address issues related to climate change (solve the temperature problem) or facilitate human life in cities
Role of society	Beneficiaries of flows from ecosystem services at both individual and societal level; reduction of replacement costs	Users of the green infrastructure, whether as recreational users in parks or as urban gardeners (to provide two examples)	Active engagement in the (co-)development and (co-)design of nature (mimicry) and monitoring NBS success
State of implementation	Partly in implementation in cities; still criticism of the concept; ES indicators are in proper use in most urban planning departments across Europe	Widely implemented and refined in European cities; suffers from limited municipal budgets, but is also implemented through NGO and citizen-based activities and programmes	Novel approach, with most implementations in flood management and climate adaptation in bigger cities across Europe, less in food production or environmental education

16.3 Ecosystem Services, or the Benefits Nature Provides to Urban Populations

What are ecosystem services? Urban green and blue spaces deliver a number of ecosystem services (ES) that contribute to maintaining the physical and mental health of urban dwellers, improving their quality of life. Urban ecosystems in cities provide regulatory (air temperature and humidity regulation), cultural (recreation, tourism) and basic provisioning services (food, forage) to people (Haase et al. 2014; Fig. 16.2). Accordingly, healthy ecosystems deliver these services to a proper extent; degraded ones to a much lower extent, if at all (McPhearson et al. 2016).

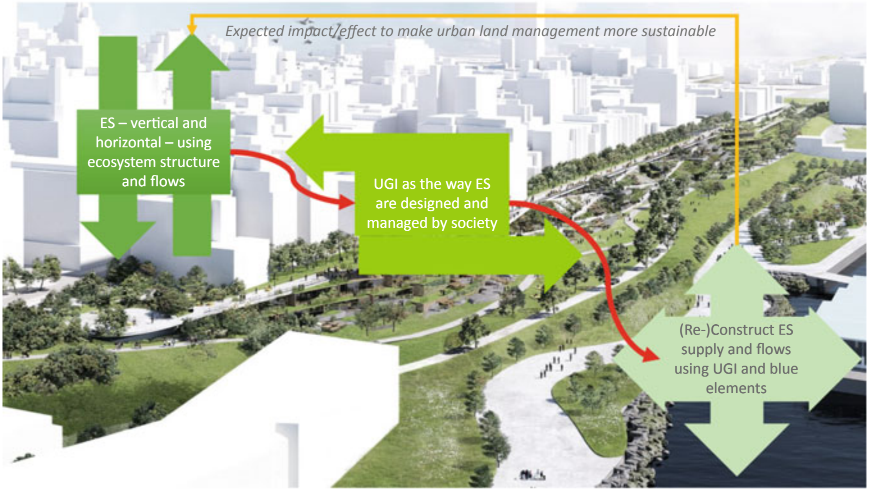

Fig. 16.1 Main links, partial overlaps and the differences between the three concepts (own sketch)

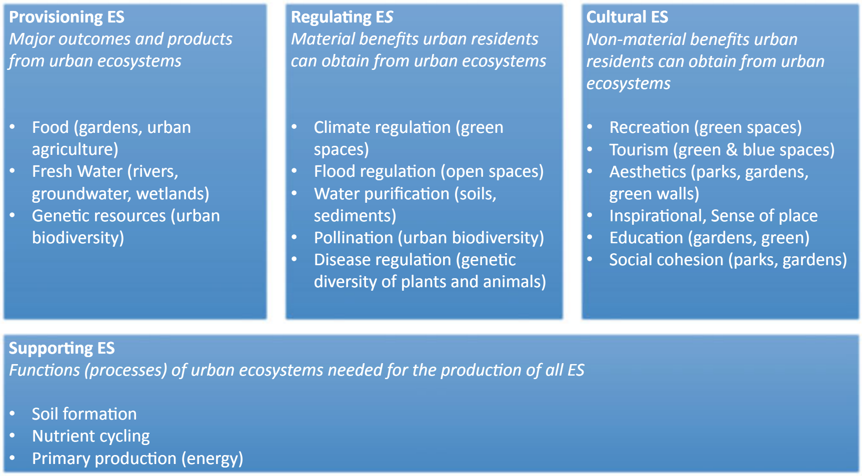

Fig. 16.2 Urban ES classifications with examples for typical urban infrastructures providing the respective services (own compilation)

The increasing frequency of heat waves have confronted Europe's urban residents with very high day and "tropical night" (>20 °C) temperatures (Weber et al. 2014a); moreover, they are exposed to particulate matter and traffic noise (Weber et al. 2014b). These environmental pressures can impair human health and result in higher illness, morbidity and mortality rates, as well as impaired mental health (Adli 2017). Europe's growing elderly population is particularly vulnerable to these problems (Gruebner et al. 2017). Illnesses caused by heat and pollution dramatically limit the quality of life in cities and incur major costs to urban society, especially for healthcare, as well as reducing labour capacity.

Regulatory ES provided by intact ecosystems definitely and effectively help to minimise these environmental pressures (TEEB Germany 2017): During spring and summer heat waves, such as Europe has experienced in 2018 and 2019, there is a significant increase in illness, morbidity and mortality rates (Gabriel and Endlicher 2011). For example, estimates of up to 5% of deaths in the city of Berlin are linked to heat (Gabriel and Endlicher 2011). Urban vegetation such as trees as well as various grasslands and meadows can significantly reduce peak summer temperatures (Weber et al. 2014a). Records show that a green space measuring 50 to 100 m wide is up to 3 °C cooler on hot, wind-still days than the surrounding developed area (Pauleit et al. 2018). Moreover, green spaces have a cooling impact on their direct urban surroundings (Andersson et al. 2019). In addition to heat relief, urban green spaces play a major role in air pollution control (Pauleit et al. 2018). Trees filter particulates by between 5 and 15%, depending on height, density and configuration (Weber et al. 2014a). In residential neighbourhoods, nature is especially beneficial to human health, as green spaces invite residents to spend time outdoors and to participate in active recreation such as sports, games, or even passive nature enjoyment and relaxation (Rall et al. 2017). A number of studies have provided very good and clear evidence that being outdoors supports reductions of aggression and anxiety, and, vice versa, raises concentration and performance levels across all age groups (Bosch and Sang 2017).

In terms of urban society and the social life in cities, which are also core concerns of urban land management, healthy ecosystems contribute to strengthening social cohesion by providing “aesthetic places for communication” (Kremer et al. 2016). When freely accessible, urban parks, gardens, rivers and lakes serve as refuges for urban residents to go to for multiple leisure and social activities with family and friends (Voigt et al. 2014). Allotments and community gardens facilitate encounters, joint activities and intercultural exchange (Pauleit et al. 2018). Growing local food in the city—be it in different types of gardens, on balconies or in abandoned cemeteries—increases urban self-sufficiency (Rodríguez-Rodríguez et al. 2015), and, at the same time, raises awareness about regional and healthy food (counteracting problems such as obesity among children and adults). Thus, recreational ecosystem services contribute to urban public health in multiple ways. However, these ES only arise if all groups of residents see these aforementioned green spaces as available, accessible, and attractive (Biernacka and Kronenberg 2018). With respect to the last of these, one key component of this attractiveness of green spaces is biodiversity—and is something that park users recognise (Fischer et al. 2018). This is a clear signal for more and better (more consistent) nature conservation in cities for ensuring the delivery of necessary ES.

Many of the aforementioned ES that nature delivers in cities are to a large extent neglected or simply ignored by urban planners and decision-makers dealing with land use and urban landscape/surface design (Kain et al. 2016; Kaczorowska et al. 2016; TEEB Germany 2017). Thus, the ES concept that is proposed here is a tool focusing

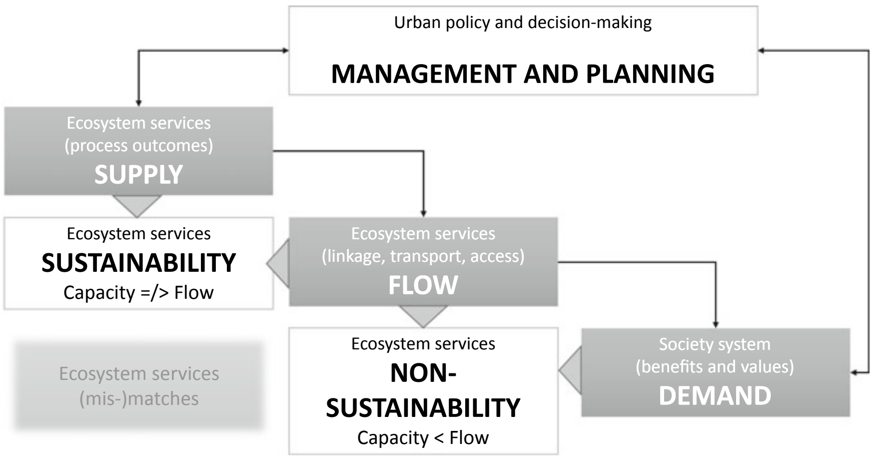

Fig. 16.3 Adapted cascade of urban ES supply, flow, and demand, and its incorporation into land management [building on earlier diagrams by Baró et al. (2017), Potschin and Haines-Young (2011), Villamagna et al. (2013) and Geijzendorffer et al. (2015)]

on the functional outcomes of nature's processes in urban areas; it can be used as both a planning and a monitoring tool in urban decision-making for fairer, more sustainable land use in our growing cities to balance density, social-environmental segregation and species loss (Fig. 16.3; McDonald et al. 2019).

16.4 Designing nature's Benefits into Green Urban Infrastructure in Cities

A second approach that appears promising for more sustainable urban land use through management and design is the urban green infrastructure (UGI) approach (Pauleit et al. 2018). The idea behind UGI is based on the principle that protecting and enhancing nature and natural processes are consciously integrated into urban spatial planning. UGI, in this sense, can be framed as a strategically planned network of (semi-)natural areas together with other natural features designed and managed to deliver a wide range of ES in the urban context (EEA 2019).

In contrast to common human-made, means-constructed, urban infrastructure approaches that often serve a single purpose, UGI's "living system" character entails multifunctionality; the elements or types of UGI can offer multiple benefits and flows of benefits—urban ecosystem services—provided that ecosystems are in a healthy state (Pauleit et al. 2018; Andersson et al. 2019): A single park supports not only climate change adaptation and mitigation, but also active and passive recreation, including educational benefits, and increases species biodiversity (Andersson et al. 2015; Rall et al. 2017). The multifunctional performance of such single infrastructure

Fig. 16.4 Types of UGI allocated by a multifunctional element of UGI—the urban tree. UGI can provide multiple benefits if it is healthy; if not, no flows of ES can be expected (tree by https://gunnisontree.com/tell-tree-dead-just-needs-water/)

units supports a more sustainable yet still resource-efficient urban land development process in European cities, where both space and resources are limited (Andersson et al. 2019).

UGI comprises a wide range of environmental features that operate at different scales—from the neighbourhood to the region—and in the best case these features form part of an interconnected ecological of new green infrastructure and other sustainability investments in cities have to accrue to positive outcomes for low-income and underprivileged residents as well, respecting their ideas and recreational needs equal to that of the wealthier part of urban society, which dominates discourse (Haase et al., 2017) (Fig. 16.4).

16.5 ES and UGI as Nature-Based Solutions to Urban Land Management Challenges?

A third approach has also started to emerge, making use of urban nature for more sustainable land management in cities and urban regions: nature-based solutions (NBS). According to the IUCN, NBS are defined as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (Cohen-Shacham et al. 2016). NBS are intended to support attaining society's development goals and safeguarding human well-being in ways that (a) reflect the cultural and societal values of a multi-origin urban society, and (b) enhance the resilience of urban ecosystems, and their capacity to provide the aforementioned ES (Kabisch et al. 2016a, b). NBS are designed nature—similar to UGI—that are implemented to address the urban challenges listed in the introduction of this chapter: food security, climate change, water shortage, human health, and disaster risk (Nesshoever et al. 2017).

NBS are based on both the ES and UGI concepts, but are novel in that they are conceptualised and implemented (Table 16.2): NBS always address a specific urban challenge, such as shown in Fig. 16.5, using the single planted tree as an example. NBS can be implemented as individual measures, or in an integrated manner combined with additional "grey" (i.e. technological, engineering or digital) solutions to urban challenges. Compared to city-wide ES flows and UGI networks,

Table 16.2 Classification of NBS in cities (modified from Cohen-Shacham et al. 2016)

Category of NBS Approaches	Examples from urban land management
Restoration NBS approaches	• Ecological restoration of wetlands, riparian forests and brownfields (including natural succession of grasslands) • Ecological engineering (co-creation of new parks at brownfield sites) • Forest landscape restoration (reforestation of former forest sites and afforestation of urban brownfields)
Adaptation NBS approaches	• Ecosystem-based adaptation (using functional adaptation and mutation properties of ecosystems, such as adapted species or populations) • Ecosystem-based mitigation • Climate adaptation ecosystem services (using the transpiration and evaporation functions of vegetation and soils) • Ecosystem-based disaster risk reduction (retention properties of open soil and natural wetlands)
Infrastructure NBS approaches	• Blue infrastructure (design of water-depending sites such as ponds or constructed wetlands) • Green infrastructure (design of parks, gardens, green roofs and walls)
Management NBS approaches	• Integrated coastal zone management (stormwater zones and coastal dune protection) • Integrated water resources management (constructed wetlands, bioswales, rain gardens at rooftop level, river revitalisation, floodplain de-sealing)
Conservation NBS approaches	• Locally based nature and biodiversity conservation approaches, including management of protected areas (urban national parks and biosphere reserves, nature playgrounds, beekeeping in cities, old tree maintenance)

Fig. 16.5 How an urban NBS works and how it can be related to the concepts of urban ES and UGI (own sketch)

NBS are often determined by site-specific natural and social-cultural contexts. NBS recognise and address existing trade-offs between the production of a few immediate health or economic benefits or risk reduction, and future (time-dependent) options for the production of the full range of ES flows and UGI network habitat and population-related effects, again as shown in Fig. 16.5, using the single planted tree as a multifunctional and long-living example (Nesshoever et al. 2017).

A recent review study reports, on the one hand, that, despite a lack of consensus about a single "final" definition of NBS, there is a shared understanding among European stakeholders that the NBS concept encompasses human and ecological benefits beyond the core objective of ecosystem conservation, restoration or enhancement. On the other hand, the study also reveals that resources are often limited in city municipalities, and each city has different needs. This makes it critical to prioritise the challenges NBS is to address during the urban land use planning process (Ershad Sarabi et al. 2019).

16.6 Conclusions for Sustainable Urban Land Management in the Future

The absolute strength of the three concepts and approaches introduced here lies in their combination and complementarity of functionality, design, management and straightforward implementation, as well as problem-based orientation to make urban land management more sustainable. Supply and demand as well as flows of nature are central in all three concepts. The complementary concepts link different disciplines and disciplinary strengths, bringing them all together towards a new approach in sustainable urban land management.

A clear weakness of all three approaches is that they neither include nor address one of the most crucial urban social and democracy-related questions of today: justice and fairness questions at the local—i.e. city—level are almost neglected. At the global level, telecouplings have not even been touched (Haase 2019), and thus urbanisation at the global level is difficult to tackle with any of the three concepts, although papers have already been published on global principles and upscaling from single cities and urban areas.

Acknowledgements Dagmar Haase's research was supported by Project ENABLE, funded via the 2015–2016 BiodivERsA COFUND call for research proposals. National funders of the project were the Swedish Research Council for Environment, Agricultural Sciences, and Spatial Planning, the Swedish Environmental Protection Agency, the German Aeronautics and Space Research Centre, the National Science Centre (Poland), the Research Council of Norway and the Spanish Ministry of Economy and Competitiveness.

References

Adli, M. (2017). *Stress and the City: Warum Städte uns krank machen.* Und warum sie trotzdem gut für uns sind. C: Bertelsmann Verlag.

Andersson, E., McPherson, T., Kremer, P., Frantzeskaki, N., Gomez-Baggethun, E., Haase, D., et al. (2015). Scale and context dependence of ecosystem service providing units. *Ecosystem Services, 12,* 157–164.

Andersson, E., Langemeyer, J., Borgström, S., McPhearson, T., Haase, D., Kronenberg, J., et al. (2019). Enabling green and blue infrastructure to improve contributions to human well-being and equity in urban systems. *BioScience*, in press. https://doi.org/10.1093/biosci/biz058.

Baró, F., Gómez-Baggethun, E., & Haase, D. (2017). Ecosystem service bundles from a supply-demand approach: Implications for landscape planning and management in an urban region. *Ecosystem Services, 24,* 147–159. https://doi.org/10.1016/j.ecoser.2017.02.021

Biernacka, M., & Kronenberg, J. (2018). Classification of institutional barriers affecting the availability, accessibility and attractiveness of urban green spaces. *Urban Forestry and Urban Greening, 36,* 22–33. https://doi.org/10.1016/j.ufug.2018.09.007

Bosch, M., & Sang, A. O. (2017). Urban natural environments as nature-based solutions for improved public health—A systematic review of reviews. *Environmental Research, 158,* 373–384.

Cohen-Shacham, E., Walters, G., Janzen, C., & Maginnis, S. (Eds.). (2016). *Nature-based solutions to address global societal challenges*. Gland, Switzerland: IUCN. https://doi.org/10.2305/IUCN.CH.2016.13.en.

EEA website. (2019). https://www.eea.europa.eu/themes/sustainability-transitions/urban-environment/urban-green-infrastructure/what-is-green-infrastructure.

Ershad Sarabi, S., Han, Q., Romme, L. A. G., de Vries, B., & Wendling, L. (2019). Key enablers of and barriers to the uptake and implementation of nature-based solutions in urban settings: A review. *Resources, 8*, 121. https://doi.org/10.3390/resources8030121.

Fischer, L. K., Brinkmeyer, D., Honold, J., van der Jagt, A., Botzat, A., Lafortezza, R., et al. (2018). Recreational ecosystem services in European cities: Sociocultural and geographic context matters for park use. *Ecosystem Services*. https://doi.org/10.1016/j.ecoser.2018.01.015

Gabriel, K., & Endlicher, W. (2011). Urban and rural mortality rates during heat waves in Berlin and Brandenburg. *Germany. Environmental Pollution, 159*(8–9), 2044–2050. https://doi.org/10.1016/j.envpol.2011.01.016

Geijzendorffer, I. R., Martín-López, B., & Roche, P. K. (2015). Improving the identification of mismatches in ecosystem services assessments. *Ecological Indicators, 52,* 320–331.

Gruebner, O., & McCay, L. (2019). Urban design. In S. Galea, C. Ettman, & D. Vlahov, D. (Eds.), *Urban health.* Oxford University Academic Press, forthcoming.

Gruebner, O., Rapp, M. A., Adli, M., Kluge, U., Galea, S., & Heinz, A. (2017). Cities and mental health. *Deutsches Ärzteblatt International, 114,* 121–127. https://doi.org/10.3238/arztebl.2017.0121

Haase, D. (2019). Urban telecouplings. In C. Friis & J.Ø. Nielsen (Eds.), *Telecoupling*. Palgrave Studies in Natural Resource Management. https://doi.org/10.1007/978-3-030-11105-2_14.

Haase, D., & Gläser, J. (2009). Determinants of floodplain forest development illustrated by the example of the floodplain forest in the District of Leipzig. *Forest Ecology and Management, 258,* 887–894. https://doi.org/10.1016/j.foreco.2009.03.025

Haase, D., Kabisch, N., & Haase, A. (2013). Endless urban growth? On the mismatch of population, household and urban land area growth and its effects on the urban debate. *PLoS ONE, 8*(6), e66531. https://doi.org/10.1371/journal.pone.006653

Haase, D., Larondelle, N., Andersson, E., Artmann, M., Borgström, S., Breuste, J., et al. (2014). A quantitative review of urban ecosystem services assessment: Concepts, models and implementation. *Ambio, 43*(4), 413–433.

Haase, D., Kabisch, S., Haase, A., Larondelle, N., Schwarz, N., Wolff, M., et al. (2017). Greening cities—To be socially inclusive? About the paradox of society and ecology in cities. *Habitat International*. https://doi.org/10.1016/j.habitatint.2017.04.005.

Haase, D., Guneralp, B., Bai, X., Elmqvist, T., Dahiya, B., Fragkias, M., & Gurney, K. (2018). Different pathways of global urbanization. In T. Elmqvist, X. Bai, N. Frantzeskaki, C. Griffith, D. Maddox, T. McPhearson, et al. (Eds.), *The urban planet: Patterns and pathways to the cities we want*. Cambridge: Cambridge University Press.

Kabisch, N., Bonn, A., Korn, H., & Stadler, J. (Eds.). (2017). *Nature-based solutions to climate change in urban areas-linkages of science, society and policy*. Berlin: Springer.

Kabisch, N., Frantzeskaki, N., Pauleit, S., Naumann, S., Davis, M., Artmann, M., et al. (2016a). Nature-based solutions to climate change mitigation and adaptation in urban areas—perspectives on indicators, knowledge gaps, barriers and opportunities for action. *Ecology and Society, 21*(2), 39. https://doi.org/10.5751/ES-08373-210239.

Kabisch, N.; Strohbach, M.; Haase, D., & Kronenberg, J. (2016b). Green space availability in European cities. *Ecological Indicators, 70*, 586–596. https://doi.org/10.1016/j.ecolind.2016.02.029

Kaczorowska, A., Kain, J.-H., Kronenberg, J., & Haase, D. (2016). Ecosystem services in urban land use planning: Integration challenges in complex urban settings—Case of Stockholm. *Ecosystem Services, 22,* 204–212.

Kain, J. H., Larondelle, N., Haase, D., Rodríguez Rodríguez, D., & Kaczorowska, A. (2016). Land use scenarios exploring local consequences for supply of urban ecosystem services in Stockholm year 2050. *Ecological Indicators, 70,* 615–629. https://doi.org/10.1016/j.ecolind.2016.02.062

Kremer, P., Hamstead, Z., Haase, D., McPhearson, T., Frantzeskaki, N., Andersson, E., et al. (2016). Key insights for the future of urban ecosystem services research. *Ecology and Society, 21* (2), 29 [online]. https://www.ecologyandsociety.org/vol21/iss2/art29/.

Krysanova, V., Buiteveld, H., Haase, D., Hattermann, F. F., Van Niekerk, K.; Roest, K., et al. (2008). Practices and lessons learned in coping with climatic hazards at the river-basin scale: Floods and droughts. *Ecology and Society, 13*(2), 32. https://www.ecologyandsociety.org/vol13/iss2/art32/.

Kühn, I., Brandl, R., & Klotz, S. (2004). The flora of German cities is naturally species rich. *Evolutionary Ecology Research, 458*(6), 749–764.

McDonald, R, Mansur, A. V., Ascensão, F., Colbert, M., Crossman, K., Elmqvist, T., et al. (2019). The growing impacts of cities on biodiversity. Research gaps limit global decision-making. *Nature Sustainability*. https://doi.org/10.1038/s41893-019-0436-6.

McPhearson, T., Pickett, S., Grimm, N., Niemelä, J., Elmqvist, T., Weber, C., et al. (2016). Ecology for an urban planet: Advancing research and practice towards a science of cities. *BioScience*. https://doi.org/10.1093/biosci/biw002.

Nesshoever, C., Assmuth, T., Irvine, K. J., Rusch, G. M., Waylen, K. A., Delbaere, B., et al. (2017). The science, policy and practice of Nature-Based Solutions: An interdisciplinary perspective. *Science Total Environment, 579,* 1215–1227. https://doi.org/10.1016/j.scitotenv.2016.11.106

Nilsson, K., Nielsen, T. S., Aalbers, C., Bell, S., Boitier, B., Chery, J.-P., et al. (2014). Strategies for sustainable urban development and urban-rural linkages, research brief. *European Journal of Spatial Development*.

Pauleit, S., Olafsson, A. S., Rall, E., van der Jagt, A., Ambrose-Oji, B., Andersson, E., et al. (2018). Urban green infrastructure in Europe—Status quo, innovation and perspectives. *Urban Forestry and Urban Greening*. https://doi.org/10.1016/j.ufug.2018.10.006

Potschin, M. B., & Haines-Young, R. H. (2011). Ecosystem services: Exploring a geographical perspective. *Progress in Physical Geography, 35,* 575–594.

Rall, E., Bieling, C., Zytynska, S., & Haase, D. (2017). Exploring city-wide patterns of cultural ecosystem service perceptions and use. *Ecological Indicators, 77,* 80–95. https://doi.org/10.1016/j.ecolind.2017.02.001

Rodríguez-Rodríguez, D., Kain, J. H., Haase, D., Baró, F., Frantzeskaki, N., & Kaczorowska, A. (2015). Urban self-sufficiency through optimised ecosystem service demand. A utopian perspective from European cities. *Futures, 70,* 13–23. https://doi.org/10.1016/j.futures.2015.03.007

Scheuer, S., Haase, D., & Volk, M. (2016). On the nexus of the spatial dynamics of global urbanization and the age of the city. *PLoSONE, 11*(8). https://doi.org/10.1371/journal.pone.0160471.

Scheuer, S., Haase, D., & Volk, M. (2017). Fastest-growing urban areas as hotspots of change: 20th century climate trends and urbanization call for co-management of global change in cities. *PLoS ONE, 12*(12). https://doi.org/10.1371/journal.pone.0189451.

TEEB Germany. (2017). Ecosystem services in the city. Protecting health and enhancing quality of life. https://www.ufz.de/export/data/global/190507_TEEB_De_Broschuere_KF_Bericht3_Stadt_engl_web.pdf. Accessed on July 8, 2019.

Villamagna, A. M., Angermeier, P. L., & Bennett, E. M. (2013). Capacity, pressure, demand, and flow: A conceptual framework for analyzing ecosystem service provision and delivery. *Ecological Complexity, 15,* 114–121.

Voigt, A., Kabisch, N., Wurster, D., Haase, D., & Breuste, J. (2014). Structural diversity as a key factor for the provision of recreational services in urban parks—A new and straightforward method for assessment. *Ambio, 43*(4), 480–491.

Weber, N., Haase, D., & Franck, U. (2014a). Assessing traffic-induced noise and air pollution in urban structures using the concept of landscape metrics. *Landscape and Urban Planning, 125*, 105–116.

Weber, N., Haase, D., & Franck, U. (2014b). Zooming into the urban heat island: How do urban built and green structures influence earth surface temperatures in the city? *Science of the Total Environment, 496*, 289–298.

Wolff, M., & Haase, D. (2019). Mediating sustainability and liveability—Turning points of green space supply in European cities. *Frontiers in Environmental Science, Section Land Use Dynamics*, in press. https://doi.org/10.3389/fenvs.2019.00061.

Wolff, M., Haase, D., & Haase, A. (2018). Less dense or more compact? Discussing a density model of urban development for European urban areas. *PLOS ONE*. Published: February 28, 2018. https://doi.org/10.1371/journal.pone.0192326.