Nature-Based Solutions for More Sustainable Cities

A Framework Approach for Planning and Evaluation

Edoardo Croci
Benedetta Lucchitta

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Preface

Edoardo Croci, Benedetta Lucchitta – Bocconi University, GREEN research center

There is a growing recognition that natural capital constitutes the basis of social well-being and lasting economic development. In fact, the biosphere provides essential functions to allow human life on Planet Earth and to perform ecosystem services which, directly or indirectly, sustain human material and spiritual needs.

The Millennium Ecosystem Assessment (MA, 2005) defines ecosystem services as those "multiple benefits provided by ecosystems to mankind," including food, water, fuels and timber, and provides a classification that attributes ecosystem services to four main functional categories:

- Provisioning: this category includes all those resource supply services that natural and semi-natural ecosystems produce (fresh water, food, fuel, timber, biochemicals, genetic resources, etc.);
- Regulation: in addition to maintaining the health and functioning of ecosystems, regulatory functions include many other services that have direct and indirect benefits for humans (such as climate regulation, erosion control, water cycles regulation, waste decomposition, nutrients recycling), usually not recognized until when they are not lost or degraded;
- Cultural: natural ecosystems provide an essential "enjoyment function" and contribute to the maintenance of human health by providing opportunities for reflection, spiritual enrichment, cognitive development, and recreational and aesthetic experiences;
- Support: these functions include all those services necessary for the production of all the others ecosystem services and contribute to the conservation of biological and genetic diversity and evolutionary processes.

In order to effectively provide ecosystem services, natural capital needs to be conserved and enhanced in correspondence to human demand, to avoid depletion of natural assets because of use of nonrenewable stocks or overconsumption with respect to their reproduction rate in case of renewable stocks. Also, the conservation of natural assets is required to avoid their degradation in order to maintain the quality of ecosystem services provided.

Because of their character of positive externalities generated by nature, it is impossible for markets to adequately express the value of ecosystem services through prices.

> There is thus an inevitable wedge between the market prices of goods and services and their social scarcity values. This has far-reaching implications for our conception of our place in Nature. Low market prices for Nature's goods and services have encouraged us to regard ourselves as being external to Nature.
>
> (Dasgupta, 2021)

In order to fully appreciate the wide range of benefits generated by natural capital, economic valuation has gained a relevant role. Assigning a correct economic value to natural assets is a fundamental step for the management and protection of the ecosystems that produce them and for the definition and implementation of appropriate mechanisms and compensation tools for the externalities generated by the various anthropogenic activities. Climate change, in particular, has increased the vulnerability of natural assets which are exposed to disaster risks.

As most ecosystem services are not traded on markets but are generated and maintained in the absence of economic remuneration, they often depend on public policies to put a remedy to market failures. For this reason, bringing out the "hidden value" of ecosystem services, assessing the full social value generated by them, is a necessary step to justify their conservation through public policies and/or to establish private relationships or regulated mechanisms (e.g., Payment foe Ecosystem Services) based on optimal social choices, so to ensure the conservation and enhancement of the natural capital stock that generates them and which otherwise risks being irremediably compromised.

While the care of natural capital with reference to the global, regional, and national scales has been a relevant topic for scholars and policy makers since several decades, only recently its relevance at the urban scale has been studied, in particular in connection with the concept of nature-based solutions (NBS).

Among the several definitions of NBS the more comprehensive is "actions that conserve, manage or restore nature to support biodiversity to help address societal challenges, empower people and provide job and business opportunities can be powerful tools for combatting biodiversity loss and supporting climate change mitigation and/or adaptation and disaster risk reduction while delivering further benefits to human well-being (e.g. health)." Depending on their context, NbS are also framed as Ecosystem-based Adaptation (EbA), Green Infrastructure (GI), Ecosystem-based Disaster Risk Reduction (EcoDRR), or Natural Water Retention Measures (NWRM) (European Commission, Directorate-General Environment (DG Environment), 2020).

Three main types of NBS can be individuated (Eggermont et al., 2015):

- solutions that involve making better use of existing natural or protected ecosystems;

- solutions based on developing sustainable management protocols and procedures for managed or restored ecosystems;
- solutions that involve creating new ecosystems.

These kinds of solutions can address several urban challenges, thanks to the multifunctional characteristics of ecosystem services. In fact, ecosystems in healthy condition provide a variety of functions and deliver multiple services contributing to benefit society. Main functions regard: improving the environment, making cities more attractive, and enhancing human well-being, restoring degraded ecosystems, developing climate change adaptation and mitigation, and improving disaster risk management and resilience (EC, 2015).

In fact, functioning ecosystems allow cities to build adaptive capacities and cope with several urban challenges, providing inter alia reduction of local air pollution, microclimatic regulation (heat island phenomenon reduction and temperature increase due to climate change), direct health benefits (such as a lower prevalence of asthma in early childhood), mortality reduction, and general health improvements, flood risk reduction, quality of life improvement: social inclusion, safety, and cultural aspects (Croci & Lucchitta, 2019). Several typologies of NBS can be implemented in cities, at different scales and purposes, such as green roofs and walls, urban parks and gardens, green corridors, river stream restoration, streets greening, urban farming, sustainable urban drainage systems, temporary flooding areas, and urban forests.

The book aims to provide a comprehensive framework for the design, planning, implementation, and evaluation of NBS in urban contexts, in order to systematize a sparse and not homogeneous knowledge, through a multidisciplinary approach, integrating natural sciences, urban planning, environmental economics, naturalistic engineering, and urban landscaping. In fact, cities are facing a broad range of challenges, and have assumed a central role also in International policies, as evidenced by goal 11 of Agenda 2030 and the New Urban Agenda promoted by the United Nations. Both consider the relevance of the presence of nature in urban contexts. Moreover, one of the Urban Agenda objectives is to integrate disaster risk reduction and climate change adaptation and mitigation considerations and measures into resilience-based and climate-effective design of spaces, buildings and construction, services and infrastructure, and NBS.

So, there is growing recognition and awareness that nature can help provide viable solutions to reduce vulnerability and generate value deploying the properties of natural ecosystems and the services they provide. Investing in nature can lead to substantial environmental, social, and economic benefits by reducing pollution, decreasing energy costs, improving health and well-being, and increasing resilience to climate change and natural disasters. In order to make a clear case of performances, impacts, and benefits generated by NBS in cities, a comprehensive framework approach is delivered, from design and planning of NBS to their socioeconomic evaluation.

The book provides:

- a methodological framework to design, plan, implement, maintain, and evaluate NBS in cities;
- a classification of NBS to contribute to face specific challenges in cities (heat waves, flood risk, air pollution, etc.);
- the assessment of policies and instruments to foster the implementation of NBS in cities;
- an analysis of the impacts (social, economic, and environmental) generated by NBS in cities;
- several case studies to highlight the capacity of NBS to cope with cities' challenges.

To achieve these objectives the book is structured in five sections, starting from framing and defining urban NBS, then dealing with their design and planning, passing to evaluating their economic and social impacts, up to assessing governance instruments at different scales. The final chapter provides reference cases and best practices from global cities (Paris, New York, Beijing) and other urban contexts territories (Belo Horizonte, Ruhr, etc.).

The first section is focused on the assessment and description of the multifunctionality of NBS to highlight the benefits generated by them on the quality of the environment, landscape, and socioeconomic dimensions with specific reference to urban contexts. A classification of NBS is defined to identify challenges cities have to cope with (urban heat island effect, flood risk, air pollution, etc.) and to describe the ecosystem services they provide, in order to identify a clear framework of the potential benefits generated by NBS at the urban level highlighting why it is fundamental to reinforce the presence of nature in cities. The nature-based solutions concept has emerged as a strong, recent attempt for "mainstreaming" nature in political, planning, and economic areas. Starting from a description of the role of nature in cities, C. Konijnendijk introduces the NBS concept and its current spread and implementation in an urban context. The contribution of NBS to resilience, health, and well-being, biodiversity is focused on the following chapters. In particular R. Bartlett provides a brief historical review of NBS to address increasing climate extremes in urban areas and emphasizes the importance of connectivity and scale, assessing the direct effects of climate change on potential NBS performance, and the powerful job creation potential of NBS in creating resilience to multiple crises, including the current global recession due to the Covid-19 pandemic. D. Rojas-Rueda shows how urban nature is essential for citizens' health; several studies put in evidence that green spaces can support a healthy lifestyle, improving individual and populational health and reducing the vulnerability of communities to the pandemic. S. Clement explores the ways in which NBS might become an essential part of the solution to biodiversity and ecosystem decline and discusses how NBS can be effectively leveraged to address the biodiversity crisis in urban areas, through

conservation, restoration, and efforts to create thriving places for both people and nature. A. La Notte and G. Zulian provide a framework linking urban ecosystems, NBS, and ecosystem services, thus facilitating sustainability assessment in urban ecosystems, by quantifying the presence of NBS, whose creation/maintenance assure the delivery of ecosystem services.

Notions and principles for NBS design and planning are described in the second section, taking into account the wide range of NBS to face cities' challenges such as urban regeneration and biodiversity. The integration potential of the NBS in cities' planning is carried out to highlight their capacity to cope with different cities' needs. The adoption of NBS is considered in alternative and complementarity with traditional gray solutions also taking into account the potential use of hybrid solutions. Another fundamental aspect of the definition of NBS relies on the involvement of different stakeholders, so innovative codesign and coparticipation techniques are described. S. Lehmann discusses the opportunities and benefits of applying the concepts of renaturalization and rewilding of cities applying NBS in two areas: new green neighborhoods, and the regeneration and regreening of existing but neglected parts of the city, putting in evidence how essential it is that the design of NBS is fully integrated with other complementary planning interventions and seeks synergies across all sectors. S. Boeri, M.C. Pastore, and L. Shamir discuss the integration of green systems within the complex built environment, providing several examples also driven from their personal experiences. A. Barker, E. Feliù, G. Garcia-Blanco, B. Pedrola, and K. Kwiecinska stress the need for an approach which is both scenarios focused and fully integrated within existing spatial planning frameworks, drawing specific attention to the utility of Strategic Environmental Assessment (SEA) in both embedding environmental evaluation within mainstream spatial planning and providing the basis for the comparative evaluation of alternatives. M. B. Andreucci provides multidisciplinary knowledge on the effectiveness of experimenting with NBS for urban regeneration policy, planning, design, and governance, creating an understanding of what type of NBS development process can bring forward sustainable urban development, the different stakeholders that might be involved, the nature of their involvement, and the relationship between the actors, considering the experiences of Barcelona, Copenhagen, and Marseille. B. Wilk, I. Säumel, and D. Rizzi classify and explore the spectrum of nongovernment actor-led governance arrangements for the cocreation of NBS across different European contexts. Case studies from pilot demonstrators in current European Horizon 2020 projects are used to illustrate collaborative governance arrangements within the operating space of cocreation and delineate respective actor roles.

The evaluation of NBS impacts is relevant to foster their diffusion, as in most cases the natural resources and ecosystem services they provide are not exchanged on markets as they have public or common goods characteristics. The ecosystem services approach allows taking into consideration all the impacts generated by NBS at the urban level to reveal the hidden value of nature that markets are not able to catch. Trade-offs implied by the choice of NBS and potential disservices

produced by them are also considered. In the third section a set of KPIs is also defined to facilitate the impact assessment of NBS. R. Sánchez Francés, S. Gómez Valle, N. García Rueda, B. Lucchitta, and E. Croci provide a comprehensive assessment framework for the evaluation of the contribution of NBS in cities, linking NBS typologies with specific ecosystem services provided and proposing a set of KPIs for the assessment of the impacts generated by NBS in cities. E. Croci and B. Lucchitta identify and analyze the most used methodologies adopted at the urban level for the valuation of ES, linking them to provisioning, regulating, cultural and supporting categories of ecosystem services provided by NBS. S. Pouso and E. Gómez-Baggethun apply integrated valuation of ecosystem services in two Spanish cities, Barcelona and Bilbao, combining different valuation techniques and metrics, both monetary and nonmonetary. S. Borelli, M. Conigliaro, and F. Salbitano show how, if well planned and managed, green spaces can promote social inclusiveness by enhancing the liveability of neighborhoods and promoting the development of social interactions; for this purpose urban green spaces must be designed as places for multiple and diverse social groups.

The correct valuation of costs and benefits of NBS allows arising innovative business models to catch the social value generated by them. At the same time, innovative policy tools are being adopted to facilitate the development of NBS with diversified functions. The fourth section performs an analysis of business models, financial and economic instruments, and the most suitable policies to foster the adoption of NBS in cities and to involve public and private stakeholders in their implementation and management. A focus is dedicated to the costs related to NBS implementation, maintenance, and management. U. Guarnacci examines the capacity of city networks in putting NBS in the agenda of international negotiations and to foster cocreation and codeployment of NBS to tackle global environmental challenges and promote climate-resilient communities, following a concept of urban diplomacy. A. Ravazzi explores the range of policy instruments available to promote NBS in cities, in particular analyzing the promising features of economic and market-based instruments. D. Uzsoki, L. Casier, and L. Wuennenberg provide an overview of financing solutions (public, private, and blended instruments) for different types of NBS and their applicability to NBS in the urban context, taking into account the different possibilities to capture the value they generate. B. Colaninno, F. Neonato, and F. Tomasinelli provide a step-by-step procedure to assess the ecosystem services provided by green areas in cities, compared to design, building, and maintenance costs, also with reference to specific examples. H. Rosa da Conceição and H. Finlay present some of the opportunities for businesses in implementing NBS, such as the risk and cost reductions, compliance with regulatory requirements, and reputational and financial gains.

Section five is composed of a selection of significant case studies referred to the topics of previous chapters. Best practices from global cities and other local contexts in different countries and regions are analyzed to demonstrate the effective benefits generated by NBS. M. Schwarze-Rodrian presents the evolution

of NBS in the Ruhr region, one of the first examples of regeneration of a former industrial area through nature. N. Buchoud and C. Bernede analyze the role of NBS in the massive public investments in Paris and its region, mainly driven by transportation infrastructures. W. Y. Chen C. Wang and J. Jin present a comprehensive overview of the Beijing Afforestation Scheme, characterized by a shift from outcome-driven to integrated ecological resilience, a change from recreating tree rows to restoring natural boreal forest, and an evolution from top-down to adaptive and inclusive governance. L. Aljabar reviews three cases of community environmental stewardship in New York City, including a distributed community garden movement, restoration of a polluted waterway, and an emerging framework for adaptive coastal protection; these cases emphasize a socioecological view of the city's ecology, showing that we must consider natural resources as *places* which have social and cultural meaning, not merely spaces with ecological functions. L. Norking Rangel, C. Rigolo Lopes, and J. A. Puppim de Oliveira discuss the DRENURBS initiative in Belo Horizonte, a program for urban water drainage using natural ecosystems, so transforming the logic of canalizing water streams into a new NBS with significant positive impacts on biodiversity and social benefits. Finally, D. Rizzi and B. Wilk highlight how cocreation processes have been applied for the implementation of NBS in different organizational systems, governance, and cultural settings around the world, driving cases from Peru, the United States, and Korea, and showing how collaborative governance arrangements for NBS have played out in different contexts.

The book includes the analysis of multiple dimensions of NBS in cities, considering environmental, social, and economic impacts. The innovative methodology based on the ecosystem services approach for the evaluation of NBS allows taking into account the multiple impacts generated by NBS. Moreover, the in-depth analysis of business models and financial instruments for NBS development provides a clear framework to support private and public stakeholders in NBS implementation and management. Case studies give evidence of innovative approaches to improve quality of life, the environment, and economic opportunities through the implementation of NBS in cities.

The book is targeted to a wide audience, including scholars and students in several disciplines on ecosystems and NBS, policy makers, urban planners, architects and engineers involved in the use of nature, and operators in the private sector providing goods and services (including financial ones) in this field.

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Section 1
NBS in the Urban Context

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Chapter 1

What Are Nature-Based Solutions? The Potential of Nature in Cities

Cecil C. Konijnendijk

Abstract

Although people have always been aware of the role and importance of green space, trees, and other nature in cities, wider recognition and policy support is of a much more recent date, for example in the context of current climate and public health challenges. The nature-based solutions concept has emerged as a strong, recent attempt for "mainstreaming" of nature in political, planning, and economic areas. Starting from a description of the role of nature in cities, this chapter introduces the nature-based solutions concept and its current spread and implementation in an urban context. It also raises some questions about the next steps in implementing the concept, perhaps moving away from too much focus on a utilitarian view of nature and ecosystem and toward considering nature as a framework for all planning and decision-making.

Keywords: Green infrastructure; nature-based thinking; nature-based solutions; urban greening; urban green space; urban nature

1.1 Introduction

With most of us humans living in urban areas these days, and urbanization increasing, there has been growing focus on ways of making our cities and towns more liveable, resilient, healthy, and vibrant. Sustainable Development Goal 11, for example, specifically addresses these aspects, and among others, calls for providing access to safe green spaces to all citizens. Across the world municipal authorities and other stakeholders have made efforts to improve our cities through urban greening. Many cities can look back at greening histories extending over several centuries (e.g., Konijnendijk, 2018). With increasing urbanization as well as a series of grand challenges faced by human society today,

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such as climate change, public health and welfare challenges, biodiversity loss, and recently also the COVID-19 pandemic, there is a new sense of urgency and a call for intensifying greening efforts and ways of planning and developing cities in closer connection to nature. The concept of nature-based solutions (NBS), as introduced in this chapter and also the primary focus of this book, is one of the recent and most promising approaches to developing greener and better cities.

With most of the world's population experiencing at least partial lockdowns and restrictions to their movements during 2020, the local park, woodland, and even street tree plantation provided much appreciated respite and relief (e.g., Honey-Rosés et al., 2020). Studies and analysis of, e.g., smartphone and Google maps data showed clear spikes in the use of local green spaces. In countries where access to public parks was limited, residents urged authorities to grant a reopening. This reappreciation of urban nature has also been connected to a wider debate on reenvisioning public space in cities, in the light of crises, environmental equity, and the like (Honey-Rosés et al., 2020).

As mentioned, the world's cities have seen a long history of greening, but it is fairly recent that the crucial role of green spaces in developing resilient, vibrant, and healthy cities has become supported by strong scientific evidence. Obviously, the current public health and climate crises have intensified the call for more and better urban green structures. Urban green space is no longer seen as "icing on the cake," but rather as critical infrastructure and a basic public service. In line with this, a series of concepts and approaches have emerged during the past years (e.g., Pauleit, Zölch, Randrup, & Konijnendijk van den Bosch, 2017; Randrup, Buijs, Konijnendijk, & Wild, 2020) with an underlying aim to "mainstream" urban nature and make it part and parcel to urban planning and decision-making. These concepts have included, among others, green infrastructure, urban ecosystem services, ecosystem-based adaptation, and more recently also NBS (Pauleit et al., 2019).

This chapter starts with a brief introduction of the importance of urban nature, followed by an initial presentation of the NBS concept and some of its characteristics. The final section of the chapter places the NBS concept in a wider frame, calling for a nature-based thinking approach to the development, planning, and management of the places where we live, work, and play.

1.2 Nature and Cities

As long as there have been cities, there have been urban gardens and other urban nature. Although humans have been aware of the importance of urban nature for our health and well-being for quite some time, as we sometimes intuitively kept nature close, only rather recently has high-quality research addressed (and measured) a more comprehensive range of benefits. The emergence of the concept of ecosystem services has accelerated development. Urban nature, in the shape of, for example, parks, woodland, street tree plantation, private gardens, cemeteries, wetlands, balcony plants, and the wildlife that comes with these, provides essential ecosystem services. First of all, from a supporting services perspective, urban nature fulfills important roles in terms of nutrient and water cycling (and purification), soil formation, and the like. These processes all underpin the other

services that are more directly fulfilling human needs. Provisional services, such as providing food, water, fuel, and construction materials, have been in focus for many centuries, as urban dwellers were often heavily dependent on local trees and woods (e.g., Konijnendijk, 2018). Cities were initially built with the timber from local woodlands, and we've used fuelwood and other natural products for heating our urban homes. More recently, community gardening, urban agriculture, and food forestry are once again placing these benefits in focus. During recent decades, the regulatory services provided by urban nature, e.g., in terms of adapting cities to climate change through, e.g., cooling and stormwater regulation, have been widely studied. Finally, cultural ecosystem services are widely recognized, as urban green spaces and other nature provide essential settings for recreation and tourism, while they also inspire us, educate us, and make us more creative (Konijnendijk, 2018).

Relations between people and nature, however, run much deeper than the rather utilitarian perspective represented by the ecosystem service concept ("nature's gift to people"). In a fascinating article, Townsend and Barton (2018) analyze the complex relationship between humans and trees over time, primarily from what they call an evolutionary psychology perspective. As they argue, empirical studies have provided strong evidence of the relationship between trees and other aspects of the landscape and human emotions. We humans have coevolved with trees, and this still impacts our strong social as well as individual connections to trees. Trees often evoke strong (and mostly positive) reactions in people, and we are often willing to stand up for them if they come under threat.

Of course there is also a "shadow side" to urban nature, as it can bring with it disease (e.g., malaria, Dengue fever, Lyme disease), dangers from fallen branches or trunks, nuisances from roaming urban wildlife, and other negative aspects that are sometimes called "ecosystem disservices." There is a "forest of fear" in many of us, partly linked to earlier stages of our evolution (Konijnendijk, 2018). We still have a tendency to control and design nature, and to make sure that it follows our frames as much as possible. Ultimately, of course, full control over nature will not be possible – and humans are very much part of nature themselves.

In spite of the growing body of evidence on the crucial role and benefits of urban nature, as well as increasing attention of some of the potential drawbacks and risks involved with urban greening, green space does seldom feature prominently in key policy documents. Rather than being integrated in, e.g., climate adaptation, public health, transportation, education, and other key policies, policy attention for urban green is often rather sectoral, without strong standing. Some of the initiatives that strive for greater integration of urban green space in urban development policies include the Biophilic Cities approach (Beatley, 2011), which build on E.O. Wilson's theory of biophilia referring to an innate and genetically determined affinity of human beings with the natural world. Rather than trying to control and sometimes even remove nature, biophilic cities embrace nature and make it an integral part of their fabric and development.

Biophilic and other decision-makers have an increasing body of knowledge and practice to build on. We have mapped the structure of our urban ecosystems and identified and assessed the many ecosystem services these provide. A lot of work

has been done, for example, on understanding regulatory ecosystem services such as cooling, air pollution reduction, climate change mitigation through carbon sequestration, and stormwater regulation. There is also a rapidly growing evidence base on the importance of urban nature for our health and well-being. Living in green environments has been found to have positive impacts on various health indicators. The precise mechanisms – i.e., what type of green space or green element provides which benefits, and why? – are still more elusive, but research is trying to find ways of informing planners, designers, and managers of urban spaces.

1.3 The Emergence of Nature-Based Solutions in Cities

As mentioned, the NBS concept emerged as part of a string of concepts and approaches that aimed to promote the importance of nature for sustainable and resilient human societies. This "mainstreaming" of nature of something that is "nice" to something that is "necessary" (or event essential) has also aimed to bridge between different disciplines and professions, trying to move away from the sectoral "silo" thinking that has made it difficult to fully realize the sustainability and resilience potential of cities. The concept of ecosystem services was already mentioned, as was that of biophilic cities. Other important concepts include, e.g., green infrastructure planning, green urbanism, and ecosystem-based adaptation (Pauleit et al., 2017). NBS is one of the more recent additions to the list, and it starts from the premise that humankind is facing a series of major challenges and crises that urgently need solutions.

The definition and scope of the NBS concept are still under debate. Some policy actors have promoted a broad approach to NBS, including all solutions to societal challenges that are supported or inspired by nature. The European Commission, which has represented a strong voice in promoting the NBS concept in both policy and research, initially defined it as comprising

> …solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions.
>
> (EC, 2015)

Organizations such as the International Union for Conservation of Nature (IUCN) have strongly argued against a too broad approach, calling for exclusion of solutions that are just "inspired by" nature (as, for example, through biomimicry in architecture and engineering). IUCN sees NBS as only pertaining to 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 (IUCN, 2016). Thus it is not only about humans deriving benefits from ecosystems, it is also about us giving back to nature, e.g., by restoring ecosystems and protecting biodiversity.

As cities are today's primary human habitat, with more than half of the world's population already being urban, and also are disproportionally impacted by challenges such as climate change and public health threats, a lot of the NBS work to date has had an urban focus, although not exclusively so. A rapidly growing body of publications, policies and guidelines, seminars and conferences, and case studies is now available (see, for example, Frantzeskaki, Borgström, Gorissen, Egermann, & Ehnert, 2017; Frantzeskaki, 2019; Pauleit et al., 2017). NBS has rather rapidly become recognized as an important delivery tool for sustainable development policies by governments at different levels and scales.

NBS can take many shapes and forms, from an individual tree or a citywide tree canopy cover providing shade and cooling to green roofs and green walls with aesthetic and energy saving functions. They can also relate to community gardens and urban farms for food production, bioswales for stormwater management, and tree shelterbelts against wind or dust. The ThinkNature project developed a comprehensive overview of different ways of categorizing NBS (Somarakis et al., 2019). These can relate, for example, to different levels of intervention and engineering. Solutions can sometimes be provided with no or minimal intervention in ecosystems, as, e.g., natural forest areas providing cooling islands and biodiversity conservation and mangrove forests helping with flood control. In urban areas, it will be more common to have managed ecosystems where sustainability and multifunctionality are in focus, such as managed urban woodland. Finally, NBS can also be delivered by the design and management of entirely new ecosystems, such as green roof systems. Other ways of classifying NBS look at the challenges specific solutions aim to address (e.g., climate change, public health challenges) or at the ecosystem services that are being provided (e.g., provisioning, regulating, cultural). NBS can be implemented at different scales, from the individual urban tree to the full urban tree canopy of a city, and from an individual green roof to a metropolitan green infrastructure.

Over time, often unsuccessful efforts have been made by "green" professionals to have decision-makers, planners, engineers, economists, and others pay attention to urban nature. The history of cities and other settlements shows frequent fights over the protection of remaining green space and natural areas, with housing, infrastructure, and other development interests often winning (e.g., Konijnendijk, 2018). Even sustainability policies can be detrimental, for example when urban densification leads to the loss and fragmentation of green space (see Haaland & Konijnendijk van den Bosch, 2015). But the emergence of the NBS concept has helped raise the profile of nature in cities as well as in rural areas, especially also in the light of the current climate crisis.

While not denying this important role of the NBS concept in mainstreaming urban nature and opening the door to, e.g., urban planning, engineering, and economics, there is also a need for critical reflection. The debate between different organizations about whether to include solutions that are merely "inspired by nature" is an illustration of the tensions inherent to the concept. Do we include, e.g., biomimicry in architecture and engineering, and hard-engineered stormwater storage structures with just a hint of green? Or large-scale, single tree plantations? What about green walls that require large amounts of resources and energy and

are not at all sustainable? The dominance of keywords such as "solutions" and "services" in NBS discourse and practices has a strong performative effect on our thinking. The prevailing discourse of nature's gift or contribution to people is highly utilitarian and does not give a lot of space to nature in its own right.

1.4 Advancing Urban Nature through NBS – And Moving toward Nature-Based Thinking

The implementation of the NBS approach is still in its infancy, although rapid progress is being made. As debated above, one of the advantages of NBS has been that it "speaks a language" that is understood across policy domains, scientific disciplines, and government scales, and that it has a solution-based focus. It can be an important vehicle for further integration of nature into our cities, all the way to people's doorsteps, and from the park and street to the walls and roofs of our buildings. As part of "green(blue) infrastructure", it enters the same area as other types of important or even critical infrastructure in our cities, such as energy, transport, waste, and drainage systems. This could embody a true paradigm shift in how we view urban nature and its role.

On the other hand, the NBS concept also comes with challenges of its own, e.g., in terms of how much NBS should be, and how the rather abstract concept can be connected to local communities and place making/keeping. Other chapters in this book will discuss some of these issues, while also showcasing some of the advances made, for example, in terms of successful case studies and demonstrations.

As the NBS concept is still being shaped and critiqued, perhaps these developments provide fertile ground for a broader approach to Nature-based Thinking (NbT) under which nature becomes a truly integral part of cities and the way in which we shape our societies (Randrup et al., 2020). Similar to, e.g., the Biophilic Cities concept, NbT acknowledges the interconnectedness of humans, nature, and technology, which is a useful starting point to be inspired by natural processes in all aspects of urban development to create more holistic approaches to sustainable cities. By balancing anthropocentric and ecocentric values, as well as the relational values of nature, in combination with acknowledging the importance of the social and governance dimensions in a more balanced socioecological perspective, more healthy and long-term sustainable urban nature solutions may be developed. As a result, more room is given to nature and natural processes, rather than often "overdesigning" and "overplanning" our human habitats. This would help build in redundancy and enhance resilience – much needed in the challenging times we face. NBT – with NBS as only one specific component – would be transformative in how we shape and manage our cities. It would also be inclusive, primarily in acknowledging the value of nature beyond solutions and services (recognizing nature's intrinsic value; "nature for nature's sake"), while at the same time being inclusive of culturally diverse and community-centered ways of thinking about and relating to nature (Randrup et al., 2020).

According to Randrup et al. (2020), such an NBT approach would include three dimensions. By revisiting the ecological dimension more room can be created for