

Cities and Nature

Karsten Grunewald
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Towards Green Cities

Urban Biodiversity and Ecosystem
Services in China and Germany

 Springer

Cities and Nature

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Foreword

Today's urbanization processes cause losses of open land at the margins of urban agglomeration and compaction processes in city centers. These developments lead to the transformation and often a destruction of ecosystems, and result in the loss of flora and fauna from previously biodiverse habitats. At the same time, humans' well-being in cities is progressively being challenged by increasing environmental pollution and the risks of negative climate-induced impacts.

Under these circumstances, urban green spaces can offer part of the solution. They can contribute to improve air quality, reduce heat in summer, buffer negative effects of heavy precipitation events, and serve as sites for recreation. But urban green spaces can also provide habitats for numerous species. In fact, cities can act as biodiversity hotspots. Thus, they allow for nature experience and environmental education right at our doorsteps, and thereby increase the acceptance for conservation efforts elsewhere. Eventually, nature-based solutions may solve challenges urban planners and local governments are confronted with.

The need for conservation and restoration of urban ecosystems, such as urban forests and wetlands, urban parks or temporary brownfields is increasingly being acknowledged by international initiatives and captured in related targets. This refers, for example, to the 2030 Agenda for Sustainable Development (SDGs) or the United Nations Habitat III Conference on Housing and Sustainable Development. In the Strategic Plan for Biodiversity 2011–2020 of the Convention on Biological Diversity (CBD), a number of targets are related to the manifold facets of urban biodiversity conservation and ecosystem restoration. Besides, as reflected in Chapter 2 in this book, national strategies and initiatives like the Chinese New-Type Urbanization Plan or the Urban Green process in Germany are developing. They highlight the relevance of nature-based solutions to address urban challenges relevant to growing cities in China, Germany, Europe, and beyond.

Since nature-based solutions represent a rather novel approach to sustainable urban development, this book aims to capture the significance and values of urban biodiversity and ecosystem services and to describe and convey them also to an

audience who is not familiar with the benefits and potential of urban green (Chap. 3).

The implementation of different approaches seems to be hampered by a lack of knowledge and information. Chapter 4, therefore, explores options and barriers for a successful integration of various approaches into planning processes and instruments for enhancing green spaces under land scarcity. Illustrative examples from different Chinese and German cities demonstrate how to strategically plan, finance, and successfully increase urban green space.

Recommendations extracted from this book's case studies and an analysis of further challenges for the development of green cities reveal great potential for further cooperation between China and Germany in order to mutually foster innovations for nature-based solutions (Chap. 5).

Innovations are needed in this rather new field of applied sustainability research. For a long time, urban development policy and sciences have neglected the potential of urban green spaces, and nature conservation policy and sciences also only considered the topic at the margins. This has changed in recent years. Accordingly, we are glad to be in the position to generate new impulses for urban planning, design, and development.

First ideas for a green cities study emerged in 2015 at the 8th Sino-German Workshop on Biodiversity and Nature Conservation, jointly organized by the Chinese Research Academy of Environmental Sciences (CRAES) and the German Federal Agency for Nature Conservation (BfN). First results were presented at the 5th Sino-German Environmental Forum held in 2016 in Nanjing, organized by the Chinese Ministry for Environmental Protection (MEP) and the German Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB). We appreciate contributions from different scientific disciplines and feedback from agencies of various ministries and nonacademic organizations to several drafts. The joint generation of knowledge as well as inter- and transdisciplinary modes of work are crucial for fostering innovation and providing tangible recommendations for urban planners, decision-makers, and stakeholders on how to increase and enhance urban green spaces in quantity and quality.

We hope that this book may serve as an impulse from the view point of nature conservation to various stakeholders, including the Sino-German Partnerships on Urbanization and the Environment. We thank the authors, especially from IOER, ECNU, CUMT, University Salzburg, and IGSNRR/CAS, for their contributions and the Springer publishing house for including this book in their new Series "Cities and Nature".

Beijing, China
Bonn, Germany

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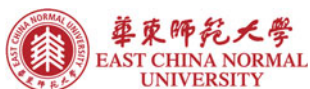
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This book is an outcome of the project “Towards Green Cities: The Values of Urban Biodiversity and Ecosystem Services in China and Germany”. The project has been initiated and commissioned by the German Federal Agency for Nature Conservation (BfN) and is implemented by a research consortium comprising the East China Normal University (ECNU), the University of Salzburg, the China University of Mining and Technology (CUMT) and has been led by the Leibniz Institute of Ecological Urban and Regional Development (IOER). The project has been supported by the Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences (IGSNRR, CAS) and the Chinese Research Academy of Environmental Sciences (CRAES). This study contributes to the Sino-German Urbanization Partnership.

We would kindly like to thank all the authors for providing English text of contributions and Dr. Felix Pahl, Berlin for the language polishing. We thank especially Sabine Witschas, Dipl.-Ing. Cartography at IOER for improving the figures of the book, Burkhard Schweppe-Kraft and Beyhan Ekinci at BfN for reviewing subchapters, and Natalja Leutert at IOER for checking the references. The organization and the cooperative effort, with Springer as editor, were carried out in a notably pleasant atmosphere.



Leibniz Institute of
Ecological Urban and
Regional Development



Sino-German
Urbanisation
Partnership

Key Issues

- *‘Towards green cities’ means ecologically sound development*, a crucial issue in general and within the international competition of cities for sustainable urban development. But many challenges remain when it comes to implementation. Is urban green space development consistent with a compact city which is argued to be a sustainable urban form for reducing urban sprawl and the consumption of land resources within the city and its fringes? Is it possible to reconcile modern urban living, a growing infrastructure, attractive work, and recreational opportunities with preservation of biodiversity and a balanced supply of green spaces? (Chaps. 1 and 5).
- *‘Green’ urban development figures prominently on the political agenda in China and Germany*. We review recent challenges and concepts of urban development at the global, national, and municipal level, assuming that the integration of urban biodiversity and urban ecosystems into urban planning strategies is essential for human well-being in general. However, we understand that all planning activities, also concerning the implementation of urban green infrastructure should be particularly tailored to the specific characteristics of a city. Additionally, we present in which context current approaches of the two countries can be compared (Chap. 2).
- *‘Green matters’*—we not only celebrate our appreciation for nature, we demonstrate the *multiple benefits as well as nonmonetary and monetary values of urban green space* for health and well-being, environmental justice and recreation as well as for the regulation of climate, water, and air in cities. Valuation of ecosystem services can highlight the cost-effectiveness and profitability of investments in nature-based solutions. Additional economic arguments enable a new promising perspective and contribute to better consideration of environmental aspects in decision making. How ‘green’ are our cities and how much ‘green space’ is enough? The establishment of target values is difficult. In addition to the proportion and volume of green space, spatial arrangement, accessibility, and other, especially qualitative aspects play a key role (Chap. 3).

- The evidence- and indicator-based assessment of urban biodiversity enables the *integration of ecosystem service values into policy and planning*. We show common features and differences between the Chinese and German planning and financing system for urban green space as well as options, forms, and perceptions for the green and blue infrastructure elements for different purposes. What can we learn from each other regarding green city development? In which areas both countries can be forerunners? (Chap. 4).
- *Case study examples from China and Germany* with facts, lessons, successful projects, new trends of green spaces, and biodiversity being integrated into the city development show the contribution of nature-based solutions to air quality improvement, water regulation, soil protection, or climate change adaptation and mitigation and often provide cost-effective alternatives to technological options (Chaps. 3 and 4).
- Forward-looking *city planning strategies should safeguard urban green space in quantity and quality* to provide biodiversity and ecosystem services for the well-being of the population even in growing cities. For the overall understanding it is important to accept the coexistence of green and gray infrastructure; for the planning side, this requires integrated approaches, regulations and tools, action plans, and funding available; and to address implementation challenges, participation of local initiatives, overall communication and cooperation are prerequisites. Addressing urbanization processes with nature-based solutions is a key challenge of the twenty-first century in China, Germany, and elsewhere. This will require bringing all allies on board (Chap. 5).

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Chapter 1

Introduction to an Urban Ecosystem Approach

**Karsten Grunewald, Junxiang Li, Gaodi Xie
and Lennart Kümper-Schlake**

In the context of ongoing urbanization processes and sustainable urban development, the aim is to capture, describe, and convey to various target groups the current significance, the values, and the potentials of urban biodiversity and ecosystem services. To seek sustainable pathways, the current developments and different approaches are to be studied globally, whereas this book focuses on current processes and practices in China and Germany in more detail. The strategic goal is a long-term appreciation of the potentials and increased consideration of urban green spaces as nature-based solutions in city planning and development. What are predominant processes and most pressing issues? What can we learn from each other regarding ‘green city development’? What are central terms in this field and how are they defined in this book?

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1.1 Background and Objectives

Lennart Kümper-Schlake, Boping Chen and Karsten Grunewald

Urbanization is a major syndrome of global change, and at the same time a key driver of global environmental change. Besides demographic, economic, and societal shifts, urbanization processes have major implications for ecosystems in cities, their hinterlands, and remote areas (MEA 2005; UNDP 2012). For decades, professionals in environmental sciences and nature conservation policies have focused on the protection and management of large-scale ecosystems and decision-makers managing urbanization processes have neglected the relevance of urban green spaces (Elmqvist et al. 2013). However, due to increased environmental problems and risks linked to converted ecosystems, in recent years this has been changing. Not only environmental scientists, urban designers and planners but also decision-makers for policies and businesses started considering the relevance and potentials of urban ecosystems for both integrated nature conservation and supporting public well-being (Wu 2014). This volume therefore presents recent developments to further support mainstreaming and implementation efforts, as well as protection and restoration activities of urban ecosystems with a specific focus on China and Germany.

Urbanization Processes and Changing Urban Ecosystems

Since 2008, more than half of the world's population has been living in cities, and by 2050 two-thirds of humankind is expected to live in agglomerations, which amounts to 6.3 billion urban dwellers, and it is expected that more than 60% of the urban area that these people will live in is yet to be built (UN 2014a, b). To date, the urban share of the population in many developed countries, such as Germany, is around 75%, but Asia, and in particular China, has the highest rate of change (Table 1.1). China's urbanization level has increased from 35.9% in 2000 to 49.2% in 2010 (UN 2014a, b), and it is expected to exceed three quarters of the overall population in 2050. After some years of less dynamic migration, German major cities are witnessing growth and re-densification processes again (Sect. 2.3). Globally, these migration processes combined with changing household and

Table 1.1 Global urbanization—status and prediction (Source UN 2014a, b)

Region/Country	Proportion urban (%)			Average annual rate of change (%)
	1990	2014	2050	
Asia	32	48	64	1.5
China	26	54	76	2.4
Europe	68	69	78	0.1
Germany	73	75	83	0.3
Northern America	75	81	87	0.2
Latin America	71	80	86	0.3
Africa	31	40	56	1.1

consumption patterns lead to increased land take for settlement and transport in the urban fringes and to concentration and compaction processes in the city centers—including in China and Germany (WBGU 2016).

While cities only occupy about 2% of the earth's surface, the activities and needs of the urban population are responsible for 60–80% of the global energy consumption, 75% of carbon emissions, 60% of residential water consumption and the use of three quarters of timber (Grimm et al. 2008; SDG 2015). The urban ecosystems and the natural and near-natural surroundings of the population centers are being subjected to sometimes massive pressure through changed land-use and emissions into air, water and soil, leading to impairment of the ecosystem functions and corresponding services. These developments lead to risks for the functioning of—especially mega cities'—economies and societies (Kraas 2008). These risks are relevant for the local level, but also for a global level, with a view to the safe operating space for human development and well-being (WBGU 2016).

Seto and Reenberg (2013) explore five major trends in the urbanization process that are likely to have implications for biodiversity and ecosystem services, but at the same time might offer opportunities for implementing ecologically valuable green spaces in cities (Box 1.1). Many of these global observations also hold true for China and Germany and will be further explored in this book.

Box 1.1 Urbanization trends and impacts (cf. Seto and Reenberg 2013):

- (1) The physical extents of urban areas are expanding faster than urban populations. This trend is based on the assumption that more land needs to be built up and urban populations will continue to increase. At some point, this is no longer true, since urban areas are also shrinking and are in need of restructuring and urban renewal (WBGU 2016).
- (2) Urban areas modify their local and regional climate through the urban heat island effect and by altering precipitation patterns.
- (3) Expansion of built-up areas will draw heavily on natural resources, in particular water (such as break of river connections), timber and energy. The land-use change at urban fringes often consumes agricultural land, with knock-on effects on habitats, biodiversity, and ecosystem services elsewhere.
- (4) Urban land expansion is occurring fast in areas adjacent to biodiversity hotspots and faster in low-elevation, biodiversity-rich coastal zones than in other areas.
- (5) Most future urban expansion will occur in areas of limited economic development and institutional capacity, which will constrain abilities to invest in the protection of biodiversity and the conservation and restoration of ecosystems.

Urban Biodiversity and Ecosystem Services

As cities continue to sprawl and change in size and shape, science and policy are recognizing the need to also protect, restore, and design urban ecosystems. This understanding is mainly based on the potentials urban green infrastructure can offer for increasing the cities' resilience towards climate change impacts, for well-being and quality of life as well as for the conservation and management of urban nature/biodiversity.

Contrary to common perceptions, cities are biodiversity hotspots due to their diverse structure and micro-climates (Kowarik 2005). In general, all forms of urban biodiversity can be an object of nature conservation and management. This may vary from natural remnants and traditional cultural landscapes to designed parks and gardens and urban-industrial nature (Sect. 3.2). While natural and traditional cultural landscapes are legally protected in Germany and China, and through ecological red-lining also in China, newly developed and designed parks offer great potentials to better integrate recreational functions and habitat conservation, especially given that structural diversity is likely to increase the attractiveness for recreational use (Sects. 4.2 and 4.3). Urban-industrial nature has been shown to be highly diverse, but the public's recognition towards it remains ambivalent (BMUB 2015). Regardless of their uniqueness, these urban spaces remain under great pressure from building activities in the process of re-densification (Schröder et al. 2016).

Besides the focus on urban biodiversity, the international scientific community started to apply the human-centered approach of ecosystem services on a broad scale over a decade ago (MEA 2005). It aims at highlighting the multiple benefits humans obtain from intact ecosystems, at the same time also highlighting the value and cost-effectiveness compared to conventional technical solutions. With the support of international and national initiatives like TEEB (The Economics of Ecosystems and Biodiversity; TEEB 2010; TEEB DE 2016), the policy arena is now starting to make use of first results and supports further research in related fields.

One major field that urban ecosystem services can be linked to is climate change adaptation. Ecosystem-based approaches are being used ever more frequently to increase the resilience of the urban fabric. Urban flood plains or lowered parks can serve as recreational areas, where urban dwellers spend their leisure time, but at the same time, these green spaces can help to buffer flood events or storm waters, leave space for air circulation and reduce urban heat island effects (Sect. 3.3). The underlying intention to promote nature-based solutions is based on the insight that old-fashioned planning, including soil sealing and ecosystem destruction, has increased the cities' vulnerability to risks. Illustrative case studies from Chinese and German cities demonstrate these facts (Chaps. 3 and 4).

Well-being and quality of life are increasingly being acknowledged in political and scientific discussions on urban green infrastructure. Human well-being increasingly is becoming a primary focus of urban sustainability projects (Bai et al. 2014), and urban

green spaces play a major role in terms of their recreational function and an increase in the quality of life. Urban parks, for example, are highly welcomed by urban dwellers and are being used to spend their leisure time (BMUB 2015). Besides personal health benefits in terms of well-being, reduction of stress and decrease of high blood pressure, urban green is also a factor in improving the attractiveness of cities that compete for specialists and young talent (Sects. 3.1 and 4.2).

As cities are social-ecological systems with the highest density of human population that interact with various ecosystem types, ranging from natural remnants to novel urban ecosystems in relatively small areas, they are crucial for environmental education, for knowledge transfer on ecological processes and compartments. Thus, urban ecosystems increase the acceptance for nature conservation not only in cities but also elsewhere (Schröder et al. 2016).

International Cooperation: Partnerships on Sustainable Urbanization

When it comes to exchange of scientific and applied knowledge on urban ecology and the implementation of urban green spaces, international collaboration is beneficial for increasing the speed and quality of decisions and municipal measures being taken. Best practices and reporting of difficulties during the implementation process offer valuable insights for adjusting and improving one's own initiatives, plans and programs. Based on these premises, the China–ASEAN partnership for ecologically friendly development (and jointly pursued green development) and the EU-China Urbanization Partnership have been initiated. In addition to these partnerships, China's Ministry of Housing and Urban-Rural Development (MoHURD) and Germany's Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) have signed the Sino-German Urbanization Partnership to deepen bilateral exchange also in the fields of urban ecosystem protection, rehabilitation and restoration (Sect. 5.3). The German Federal Agency for Nature Conservation (BfN) supports this endeavor together with partnering institutions in Germany, China and beyond.

These partnerships contribute to the needs of European and Asian experts, policymakers and city planners to translate political goals of sustainable urban development into practical actions (Sects. 5.1 and 5.2). The potential for international and inter- as well as transdisciplinary cooperation in creating 'eco-friendly cities' is immense. Also, China's leading international advisory body on questions of sustainable development, CCICED (China Council for International Cooperation on Environment and Development), has addressed questions on ecosystems and their management (Chen et al. 2014) as well as good city models under the concept of ecological civilization (CCICED 2014) in the past—but did not yet consider urban development and ecosystem management together.

Aim and Structure of the Book

This book aims at highlighting relevance, values, and potentials of urban biodiversity and ecosystem services for different target groups (policy-makers, urban planners, academics, public and private decision-makers, etc.) against the backdrop