

Chapter 5

Towards ‘Green Cities’—Fields of Action and Recommendations

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In order to secure and create urban green space, actions need to be coordinated across different policy areas and between institutions and persons involved in sustainable urban development as well as on different subnational planning levels (regional level, city-wide level, district/site level). The implementation needs to be seen as a joint task by authorities, citizens, enterprises, and other stakeholders. In this final chapter, recommendations are summarized on how to deal with the immense challenges and how to support stakeholders at work. These are based on the results of bilateral field work and the findings from the case studies. A guideline with regard to the integration of biodiversity and ecosystem services into municipal landscape planning, a brief discussion of the role of communication and cooperation between science, policy and practice as well as between countries such as China and Germany, and a set of research needs complete the final chapter.

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5.1 How to Address the Challenges?

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Urban green spaces contribute to sustainable development in manifold ways. Thus, they are essential prerequisites for livable, resident-, and future-oriented cities and municipalities. The concept of ecosystem services can be an integrative tool to help in planning, developing, and managing urban green spaces in compact cities (Artmann et al. 2017). It specifies particular social benefits provided to residents and local associations, thus linking beneficiaries with ecological assets (Fig. 5.1) stated in landscape planning (Sect. 5.2). But how can we integrate urban ecosystems into urban structure and form? Ecological processes need space and time. There is a great need for both ecological and economic development, but space in cities is limited.

For instance, the Shanghai urban green space system (Sect. 4.3.3), like many green areas in both Chinese and German cities, has not been fully evaluated with respect to its benefits for people. Urban green spaces and their management require substantial financial resources (e.g., planning, implementation, and management costs), and effective control is being demanded more and more, also from the political arena. As they will support ecosystem service balances, both, China and Germany, need to develop methods (and their implementation) for assessing the ecosystem services and biodiversity according to which social groups benefit from them and how many people really receive benefits.

Overarching challenges in developing greener cities in China and Germany were pointed out in Sect. 2.1. The recommendations for dealing with these

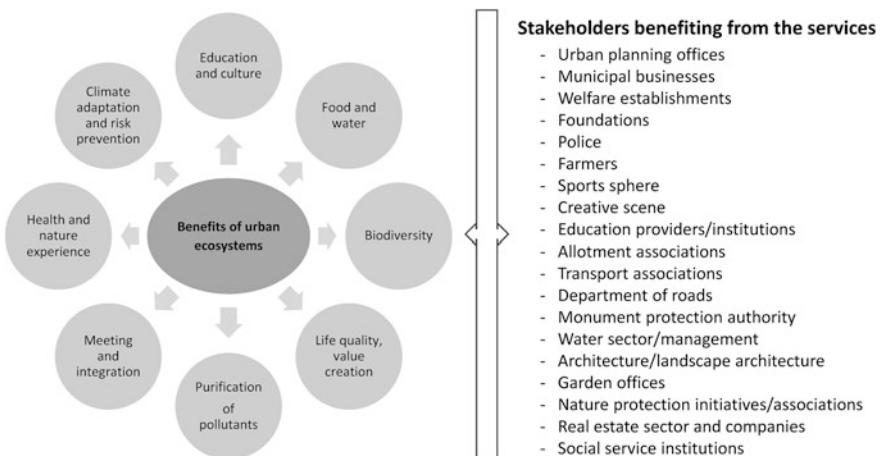


Fig. 5.1 Benefits provided by urban green spaces (*left*) and stakeholders benefiting from the services (*right*). © Karsten Grunewald

challenges are summarized in Box 5.1. Both countries are confronted with urbanization, but are very different in their current status, their dynamics and the forms, control and management of the urbanization processes. During phases of rapid urbanization, individual and societal welfare are boosting resource consumption, especially land and energy consumption. At the same time, both countries consider the urgent need to protect, develop, and enhance urban green spaces in quality and quantity in order to benefit from their ecosystem services as a means to increase human well-being in cities.

Box 5.1 Dealing with the challenges to develop greener cities in China and Germany (see Box 2.2, Chap. 2)

Find ways to

1. Limit urban land consumption and change from quantitative to qualitative urban growth

The limited resources must be efficiently used to achieve the aims of a good quality of life and a healthy environment for an increasing number of urban people. The effective use of all resources consumed in cities, e.g., energy and matter, is an urgent need. Economic and physical urban growth can be organized to be based on existing urban structures and to minimize resource consumption. Green infrastructure, such as green belts, can support the limitation of urban expansion.

2. Find an optimal urban form, integrating various kinds of nature

A compact city with integrated urban green spaces is regarded as a sustainable urban form to reduce urban sprawl and the consumption of resources within the city, connecting it to an urban region.

3. Create healthy urban living conditions

With their location and ecosystem services, urban green spaces are essential parts of healthy urban living conditions. Germany has already reached high urban standards and tries to maintain and improve them. Healthy urban living conditions must be defined by standards, monitored, and implemented. China has much potential to overcome its deficits in this regard.

4. Use urban green spaces and their management for adapting to climate change suitable structure and adjusted maintenance

Urban green spaces can moderate negative thermal and hydrological effects, reduce effects of climate-related disasters, and can contribute to reducing health risks for vulnerable population groups (e.g., children, elderly, disabled people). Urban green spaces must be integrated into the neighborhoods, preferably in places with the highest need (highest negative climate effects, location of most vulnerable people).

5. Ensure that all urban dwellers profit from benefits of urban green spaces

New public urban green spaces should offer ecosystem services in demand to all urban dwellers, be accessibly located, extended, and improved where an urban majority of people can benefit (environmental justice).

6. Engage people in planning process, decision-making, design, and management of urban green spaces

Education and information sharing about urban green planning on green targets and benefits should be the first step of citizen involvement. Contributions from local people to neighborhood planning should always be welcome and taken seriously by the decision-makers, even when it makes the decision-making process slower or more complicated.

7. Improve the usage and usability of existing scientific and practical knowledge for better decision-making and urban design

The existing scientific and practical knowledge must be made available and accessible for practitioners. It should be integrated into standards that have to be fulfilled in design and decision-making.

8. Reach green city targets with limited public budgets for greener cities

New forms of self-sustaining green spaces and of public–private partnerships in establishing and managing them must be found. All forms of nature should be welcome. This requires education on urban nature benefits and risks. Public–private partnerships should be welcomed in managing urban green spaces and making them as accessible as possible. Citizens' protection and participation can be a valuable contribution to maintenance.

9. Integrate all forms of nature into urban development for people's nature experiences and benefits

Improved nature contact should consider not only the classical urban parks but also many other nature-like relics of pristine nature or rural landscape (agricultural land), horticulturally modified nature, and novel elements of new wild urban nature.

10. Develop eco-districts and build new eco-cities

Green-blue infrastructure is the core of the eco-city concept (Sect. 2.2) and makes up a significant part of the quality of urban life. Eco-cities satisfy demands of dwellers for urban environment, provide numerous ecosystem services such as supporting the adaption to climate change impacts, provide support for biodiversity, and are essential for environmental education and

contact with nature. Eco-districts can be developed proceeding from the existing urban pattern or, mostly in China, newly designed optimal eco-cities can be built.

The governments of China and Germany are committed, as part of their areas of responsibility, to strengthening urban development through integrated and sustainable urban development (Sect. 2.2). In Germany, the 'Green Book' was presented in 2015, which, for the first time and across all departments, summarizes the current knowledge about urban green space (BMUB 2015). This was the beginning of a longer process, with which new, integrated strategies for urban green are developed and implemented. Based on this, a 'White Book' process was launched, which initiated a broad dialogue on recommendations for action toward green cities in Germany. The results were published in May 2017 (BMUB 2017b) and can be a guideline also for other countries such as China.

Overall visions and strategies might help to negotiate and focus on common principles and objectives of urban development among different stakeholders and sectors. Determined strategies and concepts addressing urban biodiversity and urban green spaces might bundle efforts of administrations and civil society to reach objectives and to implement measures appropriately. Implementing urban green spaces is a task of public duty of particularly high importance and should be appreciated accordingly. Therefore, one should use the power of terms like 'green infrastructure' and 'green city' in terms of planning, decision-making, negotiation, etc. Accordingly, *Leitbilder* (guiding visions for urban development) should be reframed, for instance, 'from a car-friendly city to an environmentally friendly city' or 'from urban sprawl to a compact city in a green network'. Further demands to be derived from the current 'Green Book/White Book' process in Germany (BMUB 2015; BUMB 2017b) and the main recommendations of the book in hand are:

- New urban development must be provided with ecological targets and means of monitoring and measuring of results should be guaranteed. Mainstreaming biodiversity and ecosystem services in urban development policies requires the establishment of adequate indicators and the integration of natural capital into national reporting and accounting systems. Based on case study findings, the following measures and targets are recommended: (a) setting threshold values for soil sealing in cities, (b) strict protection of existing high-quality urban green space (establishment of the 'no-net-loss principle' for urban green spaces, and (c) an increase of urban green spaces in both quantity and quality in order to ensure sufficient and equal access to green spaces.
- Green space development plans or 'master plans' for urban green as instruments for overall city planning are relevant, combining individual initiatives and strengthening integrative planning approaches. These must be aligned in the medium-term with a 'zero-hectare strategy' (balance new soil sealing with unsealing, no-net sealing) and 'no-net-loss strategy' (balance of ecosystem

services and biodiversity). Qian et al. (2016) consider the aspects of urbanization and land management systems that are unique to China and conclude that the current top-down directive and mandatory mode of control, which relies on the central government, has very limited effects. We think that a top-down, policy-led approach can be a proper way to ensure the optimum distribution of development and green space at the city level. But the local authorities need their own scope for action (Sects. 2.2 and 4.1).

- Guidelines for construction and development projects should be developed in such a way that a balance between building costs and green space implementation can be achieved. Promote the potential for space-saving construction and the unsealing of un- or underused impervious surfaces. In the case of infill development/re-densification, living quality has to be ensured (so-called ‘double internal development’ strategy in Germany). Guideline values for open space/green in the residential area and at the city scale (Sect. 3.7) should be binding (landscape plan, building legislation).
- Municipalities have to be equipped to develop urban green spaces according to their importance for the population and to maintain them through long-term care and management. Investment programs for nature and the environment in the city are required, as they commonly exist for housing and transport infrastructure. In existing funding programs, e.g., for flood or climate protection, ‘green’ solutions should be increasingly considered.
- As an instrument for the development of multifunctional urban areas, the intervention system (environmental impact assessment or compensation obligations) should be strengthened on the basis of current plans for land use and urban green spaces. Ecological compensation for newly built-up open spaces in the city area is needed (Sect. 4.1). Building greenery should be integrated into intervention and compensation schemes. Corresponding measures should be better controlled, e.g., via publicly accessible cadasters/presentations.
- Urban green space has to be recognized as cultural heritage and a tourism magnet (image of the city). Castles and gardens in Germany, temples, traditional residences, and garden facilities in China are part of the national cultural heritage, especially in urban regions, but they also provide many habitat services as well as regulative and cultural ecosystem services (Sect. 4.2). This is also of importance for the economic development of cities.

In general, China adds much more new urban green space in new districts or even in new cities in a rapidly growing urbanization. In Germany, established cities often do not grow anymore or only do so slowly, or they are even shrinking, which opens new perspectives for greening inside the existing urban patterns. On a larger scale, China formalized its conception of green cities in the Integrated Reform Plan for Promoting Ecological Progress issued in 2015 which promotes respecting, protecting, and benefitting from nature. Protecting the environment, especially in urban areas, is the fundamental policy pursued with high priority. This brings the two countries close together again in their ideas to develop urban areas as

environmental living spaces for the majority of their people, who can eventually benefit from urbanization in balance with nature.

Through top-down policies and strategies the development of good and effective 'Green Cities' concepts will be a focal point in both countries. These concepts can be developed on different scales: (a) for entire cities, and here China is a forerunner worldwide with the concept of 'Eco-Cities', (b) in new and established urban districts, and (c) in the small bits and pieces of green which can be integrated into new and existing urban patterns. Not only more urban green spaces are needed, but also green spaces of better quality to meet the needs of the people. The urban ecosystem approach can be a tool to synergize municipal strategies for both urban green spaces and biodiversity, together with engagement of urban people and for their benefit.

For stakeholders and local decision-makers (Fig. 5.1) the following main challenges (cf. Sect. 2.1; Box 5.1) can be addressed in regard to ongoing urbanization, competition and demand for scarce areas and resources using an integrative, ecosystem-based approach in cities.

(I) Ensure green space quantity (proportion): Integration of all forms of urban vegetation into a coherent green-blue infrastructure network strategy

Recommendation/Action goal	Examples	To be found in book section...
Use modern concepts and binding, negotiated, political strategies; set policies, targets and incentive mechanisms to reduce urban land consumption; set own strategies and concepts for your city/district to address the local challenges, requirements, opportunities; work with standard/target values for urban green spaces in your city	<ul style="list-style-type: none"> – Ecosystem service concept, city biodiversity strategy and action plans – Less than 30 ha aim of the German government for maximum daily land take; 'no-net-loss' strategy of the EU; create incentives to avoid soil sealing – Eco-city/Garden-city concept defined by the Chinese government – Refer to benchmarks (e.g., WHO recommends at least 9 m² green spaces/inh.) 	2.1/2.2 (strategies and concepts) 3.7 (standard/target values)
Ensure the optimum distribution of green space	<ul style="list-style-type: none"> – Compact city in a green network – Protection and low-impact development of urban green spaces, waters and wetlands by allowing natural development 	4.3.6 (<i>Leitbild</i> of the city of Dresden)
Try to establish new green elements on redeveloped sites; link grey and green infrastructure	<ul style="list-style-type: none"> – Creation of new parks, gardens, and grasslands – Roadside greenery – Renaturation of brownfields – Unsealing 	4.3.4 (Munich) 4.3.3 (Shanghai)

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Recommendation/Action goal	Examples	To be found in book section...
	<ul style="list-style-type: none"> – Preservation and protecting/keeping a wide variety of small-scale green spaces (e.g., backyard greening, roof and wall greening, pocket parks in and near residential areas) 	
Promote local self-sufficiency of basic resources to approach regenerative cities; strengthening all forms of urban agriculture; strengthening of roof and wall greening; improve the natural resource regeneration capacity of the city	<ul style="list-style-type: none"> – Protection of agricultural areas – Promotion of community gardens, allotments – Assess supply and demand of ecosystem services related to urban green spaces; promote measures 	3.5 (providing ecosystem services) 4.3.2 (gardening in Berlin)

(II) Enhancement of ecological, social and/or economic qualities of urban green spaces (functionality, design)

Recommendation/Action goal	Examples	To be found in book section...
Promote biodiversity, strengthen the networking function of green infrastructure, emphasize the benefits of protected areas and species	<ul style="list-style-type: none"> – Habitat diversity: opportunities for species diversity, source of nutrition, breeding, and retreat habitats – Integration of natural succession into urban green systems/urban green infrastructure, allowing dynamics – Nature conservation areas – Overall city-wide biodiversity strategies 	3.2, 4.2, 4.3 4.3.8 (Bonn)
Increase the stock of urban trees (adoption of tree protection statutes in all cities), secure and protect trees	<ul style="list-style-type: none"> – Protection of old/outstanding trees – Protection of trees during construction work – Tree planting, afforestation, tree preservation bye-laws 	3.3.3 (trees help improve air quality) 4.3.1 (massive tree planting in Beijing)
Raise awareness of the ecosystem services provided by urban green spaces	<p>Urban green spaces improve:</p> <ul style="list-style-type: none"> – Health of residents, quality of life – Climate–water–air/energy conditions – Recreation opportunities – Reduce stress and anxiety 	4.3.1 3.1, 3.3, 3.4 Box 4.1

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Recommendation/Action goal	Examples	To be found in book section...
Upgrade existing areas; industrial restructuring linked to land renewal	Conversion/transformation of brownfields, former mining areas, etc.	4.3.6 (Xuzhou)
Create spaces for nature experience; avoid interventions in green areas, which serve for sports, play, and movement	Develop urban green spaces according to the demands of different population groups such as children and elderly	4.2, 4.3.8 (Bonn)

(III) Use optimal planning approaches (treated in depth in Sect. 5.2), instruments, governance tools, etc.

Recommendation/Action goal	Examples	To be found in book section...
Set up city profiles, strategic targets (labeling); collect data/information (creation, collection, access); capacity development (knowledge, organizational capacity)	<ul style="list-style-type: none"> – Shanghai will become greener – Wenjiang district in Chengdu as pilot district ('Garden city') – <i>Leibild</i> Dresden (compact city in an ecological network) 	2.3, all case studies in Sect. 4.3
Governance: laws, regulations, policies; institutions (e.g., transparent standards and costs)	<ul style="list-style-type: none"> – Compensation mechanisms, obligatory planning, partnerships, decision-making process, policy integration/coordination – Ecosystem services as guiding principle 	4.1 4.3.1(Beijing)
Use 'planning principle of countervailing influence' (mixed planning or top-down/bottom-up planning)	<ul style="list-style-type: none"> – Existence and input of plans to guide the work of green space planners – Integration of green space planning into other kinds of planning or linkage between them 	4.1
Enhance stakeholder participation and public involvement; education, identification, and communication, iterative process for knowledge production	<ul style="list-style-type: none"> – Include wishes of the people (demand) – Create incentives such as subsidies or competitions to promote greening by residents and investors 	3.4, 4.2, 4.3 4.3.4 (Munich)

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Recommendation/Action goal	Examples	To be found in book section...
Perform economic valuation of ecosystem services; cost–benefit analyses; find innovative financing models, (developing assistance and funding strategies, taxes, loans, lotteries); reduce maintenance and management costs	<ul style="list-style-type: none"> – Economic assessment has the potential to raise public awareness of the value of urban green and provides helpful information for sustainable urban development; – Greening benefits expressed in economic terms complement conventional ecological–environmental emphasis (incentives) – Local fiscal systems should redistribute parts of the urban value generated – Public–private partnerships for urban green/biodiversity 	Chap. 3, in particular Sect. 3.6, 4.1.3 (The findings of various cases studies demonstrate the consequences of land-use changes and loss of urban green spaces for the underlying ecosystem services and provide decision-makers with additional information in the process of urban planning.)
Help to qualify social neighborhood development → environmental justice	Formulate and implement standards for urban areas (access for everyone...)	3.4, 3.7, 4.2

5.2 Guideline on How to Deal with Complex Objectives and Various Scales in the Course of Urban Green Space and Land-Use Planning

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Cities are shaped by complex compositions of different land cover and land-use types, unlike any other kind of landscape. In guiding cities toward sustainability, land-use planning is an important management instrument. Planners can act as mediators for balancing social, economic, and environmental interests arising in the city, in individual parts, or on different land-use types. However, in cities space is limited, and balancing objectives related to environment, economy, and society are challenging. In particular, urban land-use and green space planning need to deal with trade-offs between objectives related to further urban development, such as for residential or commercial purposes (resulting in an increase in soil sealing) on the one hand, and the protection and (re-)development of urban green spaces on the other hand.

Besides dealing with various objectives, urban land-use and green space planning should be organized following the idea of counterflow: Top-down planning, setting overall ambitious objectives and rules beginning from a national, state or regional perspective, needs to be accompanied by bottom-up planning from the site and local level to ensure the inclusion of local needs and knowledge for promoting appropriate and feasible objectives and measures. Higher policies such as the European Green Infrastructure Strategy (EC 2013) can set important signals and promote the implementation of ecosystems services by urban planning at the municipal level (Hansen et al. 2015). However, in Germany the main responsibility for tasks such as managing urban soil sealing is placed at the city scale, where urban planning has the main authority to develop sealing and green space planning strategies and to put them into practice (Artmann 2014). In China, setting central level objectives on urban land use, green space, and soil sealing can be a fitting tool, but policies and mechanisms to motivate the local government to effectively implement such objectives need to be developed.

At present, the green space development and planning system in China forms a top-down complete regulation framework from the national to the local level (Sect. 4.1.1). The plan for National Economic and Social Development (also called 'Five-Year Plan') acts as the top guidance and as a steering wheel, specifying aggregated indicators rather than specific measurements. 'Environmental protection and ecological control program' is a generic term for a series of plans that play an active role in promoting green space development. This category of plans further extends and refines the relevant provisions of green space development and environment protection requirements. The land-use plan is one of the most strict land management means, which can be implemented at the national, provincial, urban, and county levels. As a result, it directly decides the scale, function, and structure of green spaces in spatial aspects. Based on the land-use plan, the urban master and urban green system plan will further determine the layout and form of green spaces at the local level.

Local governments also organize the compilation of some informal plans that closely relate to the development and protection of urban green spaces. These plans are a powerful necessary supplement to the urban master and urban green system plans. Additionally, a series of urban gardening actions have been rapidly carried out in China. This not only helps to protect and develop urban green space and the environment, but also to promote awareness and appreciation of the city, as well as awareness of responsibility and of environmental protection among the citizens.

Within the Chinese context, the following issues still need to be further solved to better implement urban green space development.

- (1) In general, the green space development and planning system in China is complicated and the durations of plans are relatively short. As a result, how to further promote an orientation toward science and enforcement still remains to be solved.
- (2) Because of different goals and orientations of various strategies, trade-offs between ideas and aspects of green space development and green system

planning may exist in plans on the same level. Therefore, a ‘Multiple Planning Integration’ approach is central to planning system reform in China.

- (3) The legal status and enforcement of local non-statutory plans remain to be further enhanced.

Within the German context, a number of instruments are available to deal with issues of ‘urban biodiversity’, ‘urban ecosystem services’, and ‘green space development’ (Sect. 4.1.2). To be successful:

- (1) mainstreaming of these issues into spatial planning instruments is needed;
- (2) individual issues need to be addressed at the appropriate scale;
- (3) all planning levels, from regional through city-wide and district to site level, need to be considered;
- (4) formal instruments cannot be replaced but must be supplemented by informal instruments.

In Germany, landscape planning is an important tool to shape urban land use and land cover and to set visions toward sustainable urban development (BfN 2008). Landscape planning includes at least a two-stage landscape planning process: the regional landscape plan is based on the landscape structure plan, and the local regional plan is reflected by the landscape plan. The landscape plan identifies nature conservation objectives and interlinked management guidelines on the local scale. Green infrastructure planning and ecosystem services can support landscape planning in structuring the complex task of sustainably managing urban ecosystems and their environment on different scales. The concepts of green infrastructure and ecosystem services can support for instance landscape planning in approaching compact and green cities as a crucial challenge arising in urban land-use planning (Sect. 4.3.6). Green infrastructure and ecosystem services can support German landscape planning in the future and provide opportunities for retaining challenges of compact and provide opportunities for retaining challenges of compact cities. The concepts of green infrastructure and ecosystem services support landscape planning in reflecting cities as socio-ecological systems (e.g., different demands by urban residents on the urban ecosystem such as recreation or contact with nature) and considering spatial heterogeneity and properties of urban ecosystems and landscapes (e.g., different types of urban green spaces such as urban parks or allotment gardens). The guideline for compact and green cities reflects three major modules in German landscape planning: (I) analysis and evaluation of landscapes; (II) planning targets and measures; and (III) the impact assessment of planning targets and measures. In each module, the vision of a compact and green city is considered by reflecting green structures and governance processes as part of green infrastructure planning. The multi-functionality of green infrastructure is reflected by the supply of various ecosystem services (Table 5.1). A multi-scale green space

Table 5.1 Considering green infrastructure and ecosystem services in landscape planning (LP) to build compact green cities, on the example of Germany (Artmann et al. 2017)

	(I) State of nature and landscape	(II) Planning targets and measures	(III) Planning impacts
<i>(1) Guidelines for considering green structures within landscape planning for compact green cities</i>			
(1.1) Multi-object approach	LP classifies different types of urban green space, e.g., urban parks, forests, and private gardens (see Table 5.2)	LP formulates planning targets and measures for different types of urban green space, e.g., targets for provision of private and public areas (see Table 5.2)	LP evaluates the impacts of planning targets and measures on different urban green space types, e.g., impacts on urban parks (see Table 5.2)
(1.2) Integration	Within LP the status of integration of urban green space in developed areas is analyzed, e.g., the provision of roadside trees in urban centers (see Table 5.2)	LP formulates planning targets and measures to integrate urban green spaces into developed areas, e.g., increase in <i>per capita</i> green spaces in the urban center (see Table 5.2)	LP evaluates the impacts of planning targets and measures to integrate urban green spaces into developed areas, e.g., risk of noisy recreational activities in parks (see Table 5.2)
(1.3) Connectivity	LP considers the connectivity of urban green spaces, e.g., the process of connecting green spaces between the city center and the urban fringe	LP formulates planning targets and measures to connect urban green spaces functionally and physically, e.g., connecting recreational spaces through roadside trees	LP analyzes the impacts of planning targets and measures for green infrastructure connectivity, e.g., impact of green networks on biodiversity
(1.4) Multi-functionality	The status of green spaces providing ecosystem functions, e.g., supply of fresh air in the city center, is analyzed within LP	LP formulates planning targets and measures for ecosystem functions provided by urban green spaces, e.g., increased cooling capacity in highly sealed districts	LP evaluates the impacts of green infrastructural measures on ecosystem functions, e.g., effect of open private green spaces on reducing heat stress

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Table 5.1 (continued)

	(I) State of nature and landscape	(II) Planning targets and measures	(III) Planning impacts
<i>(2) Guidelines for considering green governance processes within landscape planning for compact green cities</i>			
(2.1) Multi-scale approach	LP considers multi-scale regulations for compact green cities, e.g., the need to reduce land take according to national targets	LP formulates planning targets and measures in alignment with multi-scale regulations for compact and green cities, e.g., implementation of green networks under national nature conservation laws	LP evaluates impacts of planning measures by reviewing multi-scale targets for compact and green cities, e.g., national targets to foster the compact city
(2.2) Strategic approach	LP analyzes the state of green infrastructure in relation to urban sprawl	LP formulates planning targets and measures for reducing urban sprawl through green infrastructure	LP evaluates measures to reduce urban sprawl through green infrastructure
(2.3) Social inclusion	LP considers different actor groups for the evaluation of nature and landscape, e.g., impact of climate change on vulnerable population groups	LP formulates planning targets and measures for various actor groups to realize compact and green cities, e.g., by motivating residents to create green buildings	LP evaluates the impacts of planning targets and measures on various actors, e.g., impact of limiting urban sprawl on farmers
(2.4) Transdisciplinarity	LP uses expertise from various disciplines to analyze the status of the compact and green city, e.g., research on noise pollution	LP formulates planning targets and measures for compact and green cities using expertise from various disciplines, e.g., scientific models of climate regulation	LP evaluates the impacts and conflicts of planning measures using expertise of different disciplines for compact and green cities, e.g., scientific findings on the impact of green roofing on climate regulation

planning and integration of the green into the gray infrastructure is also considered in the guideline by applying the multi-object approach of green infrastructure planning (Table 5.2).

The guideline developed was tested on the example of the landscape plan for Dresden, which follows the *Leitbild* ‘Dresden—the compact city in an ecological network’ (Sect. 4.3.6). The results revealed that multi-scale urban green space planning and urban green space integration into the gray infrastructure were underrepresented in the landscape plan (Artmann et al. 2017). However, the land-use plan might be a more suitable planning instrument than the landscape plan to incorporate requirements on the greening of buildings at the site scale. Thus, the consideration of different possibilities of green space implementation needs to be addressed at the appropriate scale. However, so far in Germany not all potentials are used to implement the greening of roofs or walls, even though the greening of buildings can supply a range of ecosystem services, such as microclimate regulation, reduction of stormwater runoff, and support of biodiversity or food supply. Thus, further efforts in legislation, financial incentives, research, and education are necessary to foster the implementation of green buildings (Table 5.3). In general, urban planning should make use of a mix of instruments and strategies to foster green cities by reflecting various actors and spatial scales.

Table 5.2 Multi-object and multi-scale planning of green infrastructure in landscape planning (Artmann et al. 2017; based on Landscape Institute cited by EEA 2011; Davies et al. 2015)

<p>LP considers integration of green infrastructure into the built environment:</p> <ul style="list-style-type: none"> – Roadside trees and hedges – Green buildings (e.g., green roofs and facades) – Green space in built-up areas – Greenery in residential spaces – Greening of social infrastructure (e.g., schools) – Greening of commercial/industrial spaces – Greenery along transport infrastructure – Greening of water management systems – De-sealing/dismantling of built infrastructure 	<p>LP considers urban green infrastructure at site scale:</p> <ul style="list-style-type: none"> – Pocket parks – Private gardens – Cemeteries – Ponds and streams – Small woodlands in developed areas – Playgrounds – Sports grounds – Greened city squares – Allotments – Vacant land
<p>LP considers urban green infrastructure at city and district scale:</p> <ul style="list-style-type: none"> – City/district parks – Forest parks – Lakes – Rivers and floodplains – Major recreational spaces – Brownfields – (Former) mineral extraction areas – Agricultural land – Viticulture 	<p>LP considers urban green infrastructure at regional and national scale:</p> <ul style="list-style-type: none"> – Regional parks – Road and railway networks – Regional greenbelts – National parks – Open countryside – Long distance trails – Road and railway network

Table 5.3 Activities to promote green buildings in Germany (based on Fachverband Raumbegrünung und Hydrokultur 2016 with own adaptations)

<p>Legislation and planning:</p> <ul style="list-style-type: none"> – Green roofs and facades as a basic and obligatory requirement stipulated in legal regulations such as in urban development plans – Consideration of green buildings in the legal offset regulation – Initiation and promotion of urban green building strategies including an analysis of potential spaces where to green buildings and simulations for climate improvement 	<p>Financial incentives:</p> <ul style="list-style-type: none"> – Direct monetary promotion of roof and facade greening provided by grants from the federal government and the states. Establishment of financial support programs – Provide grants for residents and investors to green their buildings additionally to legal requirements (Sect. 4.3.4) – Provide incentives through indirect promotion, such as rainwater charges and implementation of the split waste water fee in all major cities (Sect. 4.1.3)
<p>Research:</p> <ul style="list-style-type: none"> – Initiation and support of research projects. Establishment of a central research database – Transdisciplinary cooperation between research, architects, engineers, and planners (see also Artmann 2016) – Research is needed for: measuring evaporation performances, climate improvement, pollutant and fine dust binding, noise absorption, water retention during heavy rain, biodiversity, cost-benefit analysis, quality management, thermal insulation, and CO₂ binding 	<p>Education:</p> <ul style="list-style-type: none"> – Workshops especially for cities, politicians and architects – Mandatory seminars on roof and facade greening for architects and city planners – Knowledge transfer through conferences, e.g., World Green Infrastructure Congress (WGIC) – Central website as a knowledge platform and data pool: http://www.gebaeudegruen.info/

5.3 Potentials for Cooperation and Outlook

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Increasing urban populations and pressure for urban development will continue to challenge the provision and the quality of green spaces and green infrastructure now and in the future. On the one hand, the prospects for green space may depend on the ability to achieve convincing preservation. On the other hand, decisions about urban green development are made by society and urban dwellers. In this context, systematic thinking and a holistic approach are necessary (as provided by the ecosystem service concept, Grunewald and Bastian 2015).

Natural capital and ecosystem conditions/services will become more and more critical with population growth and increasing demand for natural resources and space. Additionally, we can expect further obstacles and challenges, including

ongoing climate change, aging population, changing transport systems (e.g., electric cars), increasing energy consumption, and a further digitized world. International standards and strategies for the reduction of land consumption and the development of goals, indicators, and monitoring concepts are necessary.

The promotion of sustainable urbanization in previous years has led to many positive experiences. It is believed that sharing and learning best practices between different countries can make significant contributions to the global mission of sustainable urbanization (Shen et al. 2013). In order to share experiences of green city development, there is a need for properly evaluating the performance of the implemented approaches and identifying best practices.

In addition to the existing EU-China Urbanization Partnership, the Sino-German Urbanization Partnership has been initiated in May 2013 by the German Chancellor Angela Merkel and the Chinese Premier Li Keqiang. The German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and the Chinese Ministry of Housing and Urban-Rural Development (MoHURD) are jointly responsible for implementing activities based on this partnership (BMUB 2016a). The aim is to develop a climate-friendly, integrated and sustainable urban development policy through political dialogue, city-city exchange of experience, and training with a practical emphasis. A Joint Declaration of Intent between BMUB and MoHURD was signed in November 2015 and 4.8 Mio. € until 2020 were allotted to the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) to implement the Sino-German Urbanisation Partnership in the framework of the International Climate Initiative of BMUB (Müller 2015).

The Sino-German Mayors' Program was launched in 1982 and continues to operate with one summit annually. The insights and experience gained from the cross-city dialogue events and the Mayors' Summit are being fed into the policy dialogue between Germany and China. On this basis, policy recommendations for decision-makers at the national, provincial, municipal, and local levels are being developed. The Sino-German Environment Forum, which takes place every three years and is organized by BMUB and the Chinese Ministry of Environmental Protection (MEP) together with the industry. It covers topics such as air pollution control, water management, resource and energy efficiency, the carbon market, biodiversity, green procurement, sustainable business, sustainable consumption, and environmental labeling (BMUB 2016a).

One focus of the Sino-German cooperation is in the field of biodiversity and ecosystem services, *inter alia* because this ensures connectivity to international processes in nature conservation policy such as MEA, CBD, TEEB, and IPBES. In China, air, water, and soil are also attracting the attention of its environmental policy. Starting from partially critical states of ecosystems, fundamental strategies will be developed and implemented in the near future in the area of conservation and restoration of ecosystems and their services as well as biodiversity, especially in urban and peri-urban areas. The authors of this book are especially involved in this process, and intensive exchange (e.g., joint workshops and real green-city-lab

field studies in Berlin, Dresden, Chengdu, Shanghai, Beijing, Nanjing, Xuzhou, Xianju in 2015/2016) has been incorporated into this study.

In European cities, urban green space development has been a hot topic for more than 100 years. Green networks with parks and urban forests have been taken into account in the expansion of cities. For example, in Dresden, after a flood disaster in the middle of the nineteenth century, the town authorities recognized the value of the floodplain meadows along the Elbe River for the general public and kept them free from construction by law. However, over the past decades low-density suburban development in the periphery of Europe's cities has become the norm, and in many European countries the expansion of urban areas has exceeded the population growth by more than three times. On the one hand, traditional environmental health problems from unsafe drinking water, inadequate sanitation, poor housing, or air pollution are mostly solved or reduced. On the other hand, the sprawling nature of the cities in the Western urban world is critically important because of major impacts that are evident in increased energy, land, and soil consumption, which threaten natural, urban, and rural environments. The rising greenhouse gas emissions, which cause climate change and raise air and noise pollution levels, often exceed the agreed human safety limits (e.g., Uhel 2008).

Germany already started with research on urban ecology and with implementing the results in practice in the late 1960s (Sukopp and Wittig 1998); Twenty years later, China initiated its basic research in this field. 'Green city development and urban biodiversity and ecosystem services' became a subject in Chinese urban ecological research less than 10 years ago. Despite the heated international discussion on ecosystem services and their enhancement, so far administrative institutions responsible for the planning of German cities have been hesitant to take up the issue (e.g., Haase in Grunewald and Bastian 2015).

Current subjects of Chinese studies are spatiotemporal patterns and driving processes of urbanization, urban growth modeling, urban heat islands (many studies, Sect. 3.3.1), environmental impacts of urbanization, urban ecosystem services, sustainable cities/eco-cities, and urban sustainability assessment. The interaction of research and practice has only recently been developing in the field of urban ecological research and development. Besides universities and institutes, such as the Chinese Academy of Science, schools also play an important role in Chinese research on the subject.

Germany can learn how the implementation of greening ideas can be executed in well-managed large-scale top-down steered projects and German enterprises; landscape planners and architects can participate in this process. China can learn about technologies and facets of urban greening and include this knowledge and experience in its own developing projects. The political level expects results which (still) do not exist and perhaps need more time or different stimulations. To bridge this gap, policy declares 'positive results' which lack profound research (e.g., awarding of eco-cities by the Ministry of Civil Affairs on merely statistical criteria). This on the one hand frustrates the very motivated scientists in this field, and on the other hand indicates a need for more research on how to deliver effective results.

Potential starting points for a collaboration at the interface between science and politics in both China and Germany are as follows:

- In China, politics is a top-down subject broadly accepted as such in society. Only with political support can specific subjects be included in research to legitimate them. A subject in research must be recognized by political institutions before intensive research occurs.
- Urban ecological research has been recognized as something worth supporting from the highest political level in China. This allows getting political (and financial) support for such research. But the political level also affects the fields the research should focus on, since political programs are set from time to time and may indicate their acceptances of results. Research subjects and targets sometimes become political slogans (e.g., 'national park city', 'eco-city', 'eco-cultural development', etc.).
- The political level demands practically applicable results but has not explored clear ways to process them. That is why the cooperation between research and practice is still lacking.

Further topics of collaboration between China and Germany:

Both countries are addressing the challenge to approach compact cities by limiting urban sprawl. However, to provide a city of high living quality the compact city concept should integrate the aspects of the protection, qualification, and (re-)integration of urban green spaces. This concept is accepted by both sides, China and Germany, and it is addressed by their governmental and scientific institutions. The Sino-German collaboration in terms of knowledge and good practice exchange can support the process of making cities greener by recognizing the multiple benefits of urban green spaces that are often neglected in contemporary urban planning.

The concepts of green infrastructure and ecosystem services provide guidelines on how to interlink the 'urban gray' with the 'urban green'. Case studies in Germany and China can exhibit how both approaches are implemented in planning practice for compact and green cities. A main focus for future research on cities as socio-ecological systems can be the aspect of social inclusion as a major pillar of green infrastructure planning. How can urban residents be motivated to green their city, where do benefits arise through bottom-up approaches, and how can the government, local authorities and others support such activities? In this regard, research needs to focus more on the demand side of ecosystem services to reflect cities as socio-ecological systems. Thus, to be able to respond to current challenges connected with urbanization, such as climate change, biodiversity loss, limitation of resources, and population growth, there is a need to integrate humans, their habits, and attitudes into basic and applied research more deeply (McPhearson et al. 2016). In China, but also in Germany, public awareness of the benefits of urban ecosystems needs to be improved so as to develop better public perception of nature and facilitate the overall ecological conservation process.

Research needs in the field ‘Green city development and urban biodiversity and ecosystem services’:

Making the monetary and non-monetary value of urban green spaces visible through accounting of ecosystem services could be a chance to consider external costs connected with the degradation of ecosystems. A better understanding of cross-scale dependencies between different ecosystem services is needed to get a clearer picture of urban ecosystem service flows as well as options and challenges for their safeguarding depending on scales of responsibilities and policy actions. A further question is how to manage urban growth processes such that negative socioeconomic, human, and environmental impacts of urbanization are minimized or avoided, and that socially integrative cities can develop in an environmentally friendly and financially viable way in order to provide favorable living conditions for the population.

Status of research in China with focus on urban green space issues:

- There is a lack of comprehensive Chinese studies of biodiversity and ecosystem processes in cities. The majority of researchers working on urban ecological subjects are geographers and environmental scientists who are skilled in remote sensing, GIS, and related technical areas, but lack training in fundamentals of ecology (Wu 2014).
- The Chinese Ecosystem Research Network (CERN; <http://www.cern.ac.cn/>) was established in 1988 by the Chinese Academy of Sciences. It contains 42 sites; only one revolves around urban ecology (in Beijing).
- There is a lack of tested conceptual frameworks systematically developed for urban ecological research in Chinese cities. Many studies are dealing with one or few aspects of urban ecological systems without considering the entire urban ecosystem.
- Considering the efficient top-down approach in China, assessment tools to evaluate urban green can be good policy tools. However, there is a need for further research on systematic, qualitative, and process-oriented assessment tools in order to ensure quality development of green cities rather than short-term political achievements.
- Most use-inspired or problem-oriented studies lack either ecological science or design practicality. The dual phenomenon of ‘developing cities without planning’ and ‘planning cities without ecology’ reflects the poor communication and collaboration between the two camps (Wu 2014).
- A novel, deep, and innovative/smart understanding of urban ecosystems is necessary, including landscape sciences, land system sciences, urban ecology and architecture, the relationship of urbanization to climate change and human health, the relationship between urban ecosystem services and human well-being, balancing environmental health, human welfare, and social equity in urban areas, and the relationship of biodiversity and quality of life in cities.
- A transdisciplinary science of urban regions is required to meet the national needs (Wu 2014).

- There is a tremendous lack of cooperation between different sciences and schools and different institutions which compete for research funding.
- Chinese urban researchers (ecologists, geographers, etc.), planners, and designers need to increase their collaboration.
- There is lack of unification of multiple regulations. In China, cities have separate plans, such as a plan for animal and plant diversity protection, a plan for urban biological diversity (urban resource and urban property), urban green space regulation, etc. They are also under the remit of different ministries which further complicates a unified approach.

A selection of recent research topics with focus on urban green space aspects in Germany (BMUB 2016b, 2017a), which topics can also help address some common urban challenges faced by both China and Germany (such as urban sprawl, soil sealing):

- Simulation projects to test new solutions for the green infrastructure and to develop concrete action strategies and instruments;
- Further development and testing of measures and instruments to reduce the amount of new soil sealing—compact city development, inner development, land recycling;
- Assessment/planning of climate protection and climate adaptation in the settlement sector in connection with ecosystem services/biodiversity;
- Assessment/planning of ecological impact of integrated inner-city development concepts on the infrastructures of urban expansion areas;
- Integration of ecosystems and ecosystem services into the environmental economic accounting—theoretical framework conditions and methodological principles;
- Planning-oriented steering/management of the development of urban settlements in urban/suburban regions, with particular emphasis on nature-adapted land-use and space-saving spatial planning;
- Investigation of consumer behavior and relevant consumer goods with regard to their impact on biodiversity and ecosystems worldwide with the derivation of recommendations for action and instruments for sustainable consumption as a contribution to the achievement of the Sustainable Development Goals;
- Investigations to gain knowledge for improving the implementation process.

We want to conclude with an outlook statement by Uhel (2008): “Reliable scientific arguments exist for shaping urban sustainability around the spine of environment quality and ecosystem services rather than simply based on meeting energy and transport demands. To this effect, we are more and more often confronted with long-term problems for which the outcomes are highly uncertain. Making sense in a complex world requires that we separate straightforward problems that can be solved through exchange of best practices, complicated ones where good practice helps, complex problems where practices are emerging and problems borne out of chaotic systems where novel practices are needed. If we want to seriously address the sustainability of our consumption and production we need to

recognize uncertainties about the future, go beyond the short timescales of current policies and change our current preoccupation with working on many separate issues. We need to develop policies that reflect the complexity of the systems we are dealing with, so that we can address the needs of today's disenfranchised as well as those of future generations."

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