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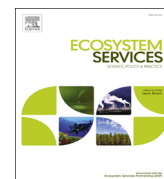
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The uptake of the ecosystem services concept in planning discourses of European and American cities

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ABSTRACT

Ecosystem services (ES) are gaining increasing attention as a promising concept to more actively consider and plan for the varied benefits of the urban environment. Yet, to have an impact on decision-making, the concept must spread from academia to practice. To understand how ES have been taken up in planning discourses we conducted a cross-case comparison of planning documents in Berlin, New York, Salzburg, Seattle and Stockholm. We found: (1) explicit references to the ES concept were primarily in documents from Stockholm and New York, two cities in countries that entered into ES discourses early. (2) Implicit references and thus potential linkages between the ES concept and planning discourses were found frequently among all cities, especially in Seattle. (3) The thematic scope, represented by 21 different ES, is comparably broad among the cases, while cultural services and habitat provision are most frequently emphasized. (4) High-level policies were shown to promote the adoption of the ES concept in planning. We find that the ES concept holds potential to strengthen a holistic consideration of urban nature and its benefits in planning. We also revealed potential for further development of ES approaches with regard to mitigation of environmental impacts and improving urban resilience.

1. Introduction

Emerging from ecological economics in the 1990s, ecosystem services (ES) represent an important and still evolving concept that has the potential to redefine perspectives on human–nature relations towards a more holistic view that highlights our dependence on and responsibility for healthy ecosystems (Norgaard, 2010). An underlying hope of ecology and environmental economics is that the concept of ES can change the way ecosystems are considered in policy and planning and promote policy actions that will reduce environmental degradation and biodiversity loss while enhancing human well-being (e.g., MA, 2005; Schröter et al., in press).

Only recently have ES been discussed as a concept to aid *urban* planning and policy-making (Niemelä et al., 2010; Colding, 2011; Gómez-Baggethun et al., 2013). Particular barriers for integration of the ES concept as a heuristic tool for urban planning and policy-making are to be expected considering the need for (1) a change of planning paradigms and routines towards more systemic and holistic thinking, e.g., by linking ecological, social, and economic considerations (Norgaard, 2010; Scarlett and Boyd, in press); and (2) a shift towards more interdisciplinary thinking and coordination given that different fields in administration are usually in separate departments (Cowling et al., 2008; Primmer and Furman, 2012; Ahern et al., 2014). With the exception of these barriers, urban planning seems well positioned to adopt ES approaches, since consideration of multiple conflicting demands on use of land and natural resources has been a primary goal of the field since its emergence (Wilkinson et al., 2013).

So far, research on ES has primarily considered the relation to planning practice and stakeholder needs (Cowling et al., 2008; Gómez-Baggethun et al., 2013). A very small number of urban ES studies analyzed in a review by Haase et al. (2014) targeted implementation such as considering information needs of city authorities, integrating

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study results in planning processes, or developing assessment tools for planning (e.g., Li et al., 2005; Rall and Haase, 2011; McPhearson et al., 2013a). The perception of the ES concept by planning practitioners has been analyzed for several developed countries (Hauck et al., 2013; Albert et al., 2014; Matzdorf and Meyer, 2014), though few focused on professionals from planning and management of urban green space (Niemelä et al., 2010; Young, 2013). Most methodological approaches to assess the uptake and operationalization of the ES concept in urban planning include interviews with stakeholders and content analyses of plans and policies. These studies consider one to two cases such as Stockholm, Melbourne or Rotterdam (Wilkinson et al., 2013; Frantzeskaki and Tillie, 2014) or execute multiple-case studies within the same planning frame such as coastal cities in Poland (Piwowarczyk et al., 2013). However, a broader comparison for different urban contexts and planning cultures is missing. We undertook an analysis of different policy and planning contexts to better understand the gaps and linkages between the concept of ES and its implementation in urban plans and policies.

This analysis uses a discursive approach where explicit and implicit references to the ES concept are identified. Explicit reference indicate a conscious uptake of the ES concept while implicit references are understood to be based on similar conceptual understandings or underpinnings of urban ecosystems and their benefits without conscious linkages to the ES concept (Hauck et al., 2013; Wilkinson et al., 2013; Matzdorf and Meyer, 2014).

Therefore, this study seeks to answer the following questions based on a discourse analysis of planning documents comparing cities from Northern America as well as Western and Northern Europe:

1. How is the ES concept, in explicit and implicit terms, represented in different urban planning contexts?
2. To what extent are individual ES such as particular regulating or cultural ES represented in the planning documents? Which ES are referred to and how broad is the thematic scope within planning documents?

We suggest that discursive representation and explicit use of ES in different urban contexts indicates a new ecological approach to urban planning.

2. Material and methods

A cross-case comparative analysis of planning documents from five cities, supplemented by local expert knowledge, was conducted to explore the relationship between the ES concept and planning practice. We focus on European and US cities because these two regions represent different periods of time for entering discourses on ES as well as different planning cultures and paradigms. In the United States (US), there has been a surge in ES research in the past decade by federal governmental organizations such as the USDA Forest Service and the US Environmental Protection Agency which have supported awareness, and ES valuation studies have been conducted that are considered in planning and policy-making in some regions (Molnar and Kubiszewski, 2012; Scarlett and Boyd, in press; McPhearson et al., 2014). In Europe, the ES concept has only recently been promoted through European Union (EU) policy, for example in the Biodiversity Strategy to 2020 (EC, 2011) and the Green Infrastructure Strategy (EC, 2013). Attention in EU-member states has risen and scientific knowledge related to ES implementation and policy-making is recently evolving (Hauck et al., 2013; Albert et al., 2014; Matzdorf and Meyer, 2014)

The five case studies analyzed here including Berlin in Germany, New York City and Seattle in the US, Salzburg in Austria, and Stockholm in Sweden, represent different planning contexts,

biogeographic regions and population sizes. They were selected based on the authors' local expertise and their role as case studies in the URBES project (Urban Biodiversity and Ecosystem Services), which helped secure in-depth knowledge of local governance contexts. The city of Seattle is not part of the URBES project but was included as a second case study from the US planning context since the city is well known for its innovative, participatory planning approaches and its efforts in sustainable urban development (Karvonen, 2010; Rouse and Bunster-Ossa, 2013).

During the URBES project and an additional research stay in Seattle the researchers had several points of interactions with stakeholders from the case study cities including interviews, discussion groups, workshops with urban planners and policy makers, and in-situ observations of decision-making processes where the ES concept was explored (for detailed information see Frantzeskaki and Tillie, 2014; McPhearson et al., 2014; Kabisch, 2015). Furthermore, a desk study on the biogeographic and historic context, the current planning system and important drivers of change such as adaptation to climate change or demographic change was conducted for each case study city based on review of literature and planning documents.

2.1. The case study cities and their planning contexts

The case study cities range in population size from 0.15 million in Salzburg to 8.2 million in New York City (Fig. 1). Berlin and New York are amongst the largest cities in their geographical regions. Berlin is a mono-centric and moderately dense city which represents the Germanic planning tradition, with a strong emphasis on formal land use planning based on federal law. However, the city is increasingly using informal strategic planning approaches. Situated along the northeast coast of the US, the New York metropolitan region encompasses an urban core with a high population density of 10,430 people/km² (US Census Bureau, 2010), surrounded by suburban and exurban housing development. To tackle the city's future challenges a landmark strategic plan, PlaNYC, was launched in 2007 with a mission of providing a vision for sustainable development. With its integrated and practical scope, PlaNYC has since gained international attention (Newman and Thornley, 2013).

Seattle and Stockholm represent medium-sized cities in coastal regions, which face immediate pressures from the effects of climate change. Seattle is located in the Puget Sound region in the Pacific Northwest of the US. Low-density development has led to urban sprawl in its urban metropolitan area. The planning system of the city and surrounding region is based on collaborative approaches and characterized by a high number of (informal) visions and strategies with regular plan updates and broad community participation.

The City of Stockholm is the capital of Sweden and is situated on a number of islands between the fresh water lake Mälaren and the brackish Baltic Sea. The city is dense and polycentric with a main central core. It is largely built up along metro lines and with substantial green and blue wedges entering into the city from different directions. Stockholm is a forerunner in Europe for sustainable urban development (Colding, 2013; Metzger, 2013). It also stands out in Europe for early adoption of the ES concept, since the concept was introduced in Swedish policy in the early 2000s and has since grown in importance (Lewan, 2000; Granath et al., 2012).

Salzburg was chosen to represent a small city in our sample. The city's Green Space Declaration, implemented in 1985 as a result of public pressure and increased environmental consciousness, is a crucial instrument aiming at protecting of the city's green space (57% of the whole area; Amt für Stadtplanung und Verkehr, 2009). The declaration is incorporated into the city's development concept of 2007 which is used in accordance with the Salzburg Regional Planning Act as the basis for the city's development.

Berlin, Germany
City area: 892 km^2 (City region*: 30.370 km²)
Inhabitants: 3.4 million (City region: 6 million)
Urban green and blue spaces: 40 %

Salzburg, Austria
City area: 66 km^2 (City region*: 1 227 km²)
Inhabitants: 0.15 million (City region: 0.33 million)
Urban green and blue spaces: 60 %

Seattle, US
City area: 217 km^2 (land) (City region*: 15 210 km²)
Inhabitants: 0.6 million (City region: 3.4 million)
Urban green and blue spaces: 14 % (of land area)

New York City, US
City area: 789 km^2 (land) (City region*: 30 670 km²)
Inhabitants: 8.2 million (City region: 22.1 million)
Urban green and blue spaces: 27 % (of land area)

Stockholm, Sweden
City area: 188 km^2 (land) (City region*: 6 520 km²)
Inhabitants: 0.85 million (City region: 2 million)
Urban green and blue spaces: 40 % (of land area)

km   0   10

* Definition of city-region according to regional planning or census data; New York: "New York-Newark-Bridgeport Combined Statistical Area"; Berlin: "Hauptstadtregion Berlin-Brandenburg"; Seattle: Metropolitan Statistical Area "Seattle-Tacoma-Bellevue, WA Metro Area"; Salzburg: "Stadtregion Salzburg"; Stockholm: "Metropolitan Stockholm", identical to the county region (Storstockholm)

References: Amt für Statistik Berlin-Brandenburg (2013); City of Seattle (2013); Gemeinsame Landesplanungsabteilung Berlin-Brandenburg (2013); NCY Planning (2010); US Census Bureau (2011, 2012, 2014 a,b); Stadt Salzburg (2013); Stadsledningskontoret (2013); Statistik Austria (2013)

Note: Urban green and blue spaces in this figure refer to green spaces such as parks and nature reserves as well forested and agricultural land; shares of private gardens which might contribute a high amount of urban green could not be assessed.

Fig. 1. The five case study cities in comparison (Amt für Statistik Berlin-Brandenburg (2013); City of Seattle (2013); Gemeinsame Landesplanungsabteilung Berlin-Brandenburg (2013); NCY Planning (2010); Stadsledningskontoret (2013); Stadt Salzburg (2013); Statistik Austria (2013); US Census Bureau (2011, 2012, 2014a, 2014b)).

2.2. Document research and selection

For each case study city, planning documents were selected and analyzed for ES related content that represent strategies and principles for spatial organization, land use or built form arrangement, and aim to actively influence the urban structure on a city and city-region level. The selected documents belong to strategic planning since they provide long-term visions, objectives and measures for the further development of the planning area (Albrechts, 2006).

The documents were collected between April and August 2013 through the cities' official websites and after consultation with local planning officers and experts. As urban green (and blue) spaces are the spatial elements capable of providing ES each document was assessed as *high*, *medium* or *low* with regard to its relevance for the future development of urban green space (*high*: urban green space is among the main topics; *medium*: one of several less important topics or only a particular type such as forest or community gardens is considered; *low*: addressed only indirectly, e.g. by sectorial land use decisions). Planning documents from three thematic clusters – regardless of the legal status in its particular planning context – were assessed as most relevant for the future quantity or quality of green and blue space:

1. comprehensive planning as constituting the general direction of spatial development,
2. green space, landscape, and/or biodiversity planning as sectorial planning directly addressing green space,
3. environmental planning as sectorial planning focusing on a single environmental issue or gray infrastructure planning with significant indirect influences on green space (e.g., water management, climate change adaptation, traffic planning).

Depending on the number of existing relevant plans up to seven documents for each city were selected. All plans were put into force between 1996 and 2012 and are still in action.

2.3. Document analysis with regard to the discursive representation of the ES concept and perspectives on human–nature relations

Planning and policy documents can be considered as agreed upon planning paradigms and principles. They capture and represent the discourses of each city's urban planning practice at a certain point in time (Faludi, 2000). Research suggests that shifts of policy discourses can signal changes in policy paradigms (Gunder and Hillier, 2009; Howlett and Cashore, 2009; Roe, 1994).

To answer our first research question, the first step of our document analysis aimed at identifying explicit references to the ES concept and related concepts (e.g., using exact wording; Roe, 1994). Related concepts are, e.g. 'landscape/ecological functions' which are applied, for example, in Germany (Bastian et al., 2012; Haaren and Albert, 2011) and the Netherlands (de Groot, 1992). General references to 'benefits' nature provides for humans were also identified because the notion that humans obtain benefits from nature is central to the ES concept (MA, 2005; Kumar, 2010). Specifically, each document was analyzed with regard to the following questions:

1. Is the term 'landscape function/s' or 'ecological function/s' mentioned?
2. Is the term 'ecosystems services' mentioned?
3. Are 'benefits' humans derive from nature mentioned?

The data were filled in a document analysis inventory (Table A2; presence/absence of terms; description of how the concepts were addressed) and supplemented by quotes from the planning documents.

The second step of the documents analysis aimed to identify perspectives on human–nature relations and to compare those to the perspective represented by the ES concept. The concept of ES implies an anthropocentric framing by highlighting the benefits humans obtain from nature. It aims to raise awareness for the

Table 1
The 21 analyzed ecosystem services.

Ecosystem services (adapted from TEEB, 2011; Niemelä et al., 2010; Piwowarczyk et al., 2013; Gómez-Baggethun et al., 2013)

Provisioning services: material outputs from ecosystems
- food supply
- raw materials supply
- water supply
- medicinal resources

Regulating services: ecosystem processes that serve as regulators of ecological systems
- local climate regulation
- air quality regulation
- carbon sequestration and storage
- noise reduction
- run-off mitigation
- moderation of extreme events
- waste-water treatment
- erosion prevention and maintenance of soil fertility
- pollination
- biological control

Habitat or supporting services: the provision of living spaces and maintenance of plant and animal diversity (serve as the foundation for all other services)
- habitat for species
- maintenance of genetic diversity

Cultural services: non-material benefits obtained from human contact with ecosystems
- recreation and mental and physical health
- tourism
- esthetic appreciation and inspiration
- spiritual experience and sense of place
- education and learning

dependency of human well-being on ES (MA, 2005; Daily et al., 2009).

Furthermore, it was assumed that additional perspectives on human–nature relations will be present in planning practice which, for instance, emphasize nature's intrinsic value (Schröter et al., in press). To explore these perspectives more specifically the inventory included one additional question:

4. In which way are humans and nature, ecosystems, and/or landscape seen as interrelated?

Identified quotes for all four questions were analyzed hermeneutically and grouped by meaning.

2.4. Document analysis with regard to individual ES

To answer the second research question, the second part of the analysis addressed content related to specific ES classes and also the thematic scope in different planning documents. The TEEB classification of ES with some modifications based on literature for urban areas was used to assess the thematic ES coverage. This means that each document was analyzed hermeneutically. Notations were made for any reference to one of 21 ES grouped into provisioning, regulating, habitat/supporting, and cultural services (Table 1), whether or not the service was directly stated. The notations were supplemented with five coding categories to assess the level of detail to which a particular service refers (Tables 2 and A3). To be considered at least as 'acknowledged', all services had to be related to a green space type or ecosystem. For example, if noise reduction is mentioned as a political aim but not related to the potential of vegetation to act as a buffer to noise, it was not counted as a service (code P), while objectives to protect agricultural areas were seen as related to the service "food supply". The coding categories A, I, and E represent different levels of elaboration.

In the content analysis for all steps, the findings were collected for each city in Excel spreadsheets following a coding protocol (Appendix, Tables A2 and A3). All results across cases were reviewed for plausibility and consistent use of the coding categories by the lead researcher to guarantee consistent coding.

3. Results

In total 33 documents were analyzed, 14 from the US and 19 from Europe (Table 3, Appendix Table A1).

3.1. Discursive representation of the ES concept

To answer the first research question we examined explicit references to the ES concept and related concepts such as benefits provided by nature. Fig. 2 shows that most US documents refer to benefits people obtain from nature. Three documents from New York also mention ES compared to none from Seattle. However, three documents from Seattle (SEA_3, 4 and 7) refer to ES assessment tools using the term benefits instead of services or define 'ecosystem benefits' with the same meaning as ES. In the US plans, landscape or ecological functions are mentioned almost as often as benefits.

In the European cases, there is no mention of the terms ES, landscape/ecological functions or benefits in three documents from each city. These documents frequently belong to comprehensive planning such as the State Development Plan Berlin-Brandenburg (BER_2) or Salzburg's Regional Program (SZG_1). Benefits are mentioned in comparably few documents. While the concept of landscape or ecological functions is mentioned in each European city, only four documents from Stockholm, two from Berlin, and none from Salzburg refer to the concept of ES.

Overall, it is striking that the term 'benefits' is explicitly mentioned in most of the US planning documents while in documents from other countries benefits are referred to implicitly – without actually calling them benefits. This use of terms may be caused by language differences. For example, in German the term 'Leistungen' can be used for 'services' as well as 'benefits', which makes it partly impossible to differentiate which is meant. Additionally, in different documents from, for example, Salzburg specific functions such as soil functions are referred to while not explicitly mentioning the term landscape or ecological functions

Regarding expressions of human–nature relations, different perspectives were identified that range from a notion of benefits people obtain from nature to concerns about negative impacts on nature or risks through natural disasters. Table 4 provides examples of perspectives frequently found in the documents.

Perspectives that overlap with the concept of ES such as a description of benefits humans obtain from nature or the dependence of humans on urban nature can be found in several documents (benefit and dependence perspectives). Especially documents from Seattle emphasize the interdependence between humans and nature (interdependence perspective), which can be seen as a continuation of the dependence perspective. An impact perspective refers to the fact that humans may cause environmental problems such as damaging riparian areas or causing

Table 2
The coding categories to assess the level of detail an ecosystem services (ES) is addressed.

Category	Code	Explanation	Examples
Not mentioned	N	ES is not mentioned at all.	
Problem mentioned but not linked to ES	P	Aspects related to ES (e.g. air pollution, storm water management) are named but they are not related to urban green/ecosystems/natural areas etc. It might be the case that an improvement of the situation is focused on technical solutions or remains open.	"Improving water quality" mentioned as a task for planning. "Habitat loss" mentioned as an issue.
Acknowledged	A	An ES is only mentioned. It links urban green/ecosystems/natural areas to a specific services/function	"Trees sequester carbon." "Soil infiltrates storm water." "Parks provide recreation opportunities."
Indirectly elaborated	I	ES is mentioned in the same way like "A" but loosely related to goals/activities/target. Usually the service/function is used as an argument to introduce the goal/policy etc. But goal/policy is very general – e.g. protection open land/forests	"Trees sequester carbon" and later on "Forests shall be protected".
Elaborated	E	An ES is further elaborated. That means ES is directly linked to goals/targets/objectives. It can also be: mapped or otherwise quantified, or monetary or non-monetary valued (e.g. avoided "gray" infrastructure costs; the most valuable habitats)	"Protection of forests in areas with risks of erosion." "Establish wildlife corridors to improve habitats." Maps with areas that should be greened because of strong heath island effect.

Table 3
List with analyzed documents from the five case study cities. Each document had a code consisting of the IATA airport code (BER=Berlin, NYC=New York City, SZG=Salzburg, SEA=Seattle, STO=Stockholm) and a digit to indicate the plan number.

| Berlin	New York City	Seattle	Stockholm	Salzburg
Comprehensive planning				
BER_1 Landesentwicklungsprogramm der Hauptstadtregion Berlin-Brandenburg/LePro[a] 2007 (State Development Program for the Berlin-Brandenburg Region)	**NYC_1** A Region at Risk: The Third Regional Plan For The New York–New Jersey-Connecticut Metropolitan Area[a] 1996	**SEA_1** Vision 2040[a] 2008	**STO_1** Regional utvecklingsplan för Stockholmsregionen/RUFS[a] 2010 (Regional development plan for the Stockholm region)	**SZG_1** Regionalprogramm Salzburg-Stadt und Umgebungsgemeinden[a] 1999/2007 (Regional Program for the City of Salzburg and Surrounding Communities)
BER_2 Landesentwicklungsplan Berlin-Brandenburg/LEP[a] 2009 (State Development Plan Berlin-Brandenburg)	**NYC_2** PlaNYC 2011	**SEA_2** City of Seattle Comprehensive Plan 2005	**STO_2** Vision 2030: Framtidsguiden 2007 (Vision 2030: A guide to the future) **STO_3** Promenadstaden: Översiktsplan för Stockholm 2010 (The Walkable City – Stockholm City Plan)	**SZG_2** Das räumliche Entwicklungskonzept der Stadt Salzburg/REK 2007 (City of Salzburg's Spatial Development Plan)
Green space/landscape/biodiversity planning				
BER_3 Strategie Stadtlandschaft Berlin 2012 (Berlin's Urban Landscape Strategy)	**NYC_3** New York State Open Space Conservation[a] 2009	**SEA_3** Seattle Parks and Recreation Strategic Action Plan 2008	**STO_4** Stockholms parkprogram 2006 (Stockholm Park Program)	**SZG_3** Gruenes Netz der Landeshauptstadt Salzburg 2007 (Green Network of Salzburg)
BER_4 Landschaftsprogramm/Artenschutzprogramm 1994/2004 (Landscape Program/Species Protection Program)	**NYC_4** Vision 2020: New York City Comprehensive Waterfront Plan 2011	**SEA_4** Open Space 2100: Envisioning Seattle's Green Future 2006	**STO_5** Sociotopkarta för Parker och Andra Friytor I Stockholm Innerstad 2002 (Sociotope Map)	**SZG_4** Studie Salzburger Stadtlandschaften 2009 (Study on Salzburg's Urban Landscapes)
BER_5 Berliner Strategie zur Biologischen Vielfalt 2012 (Berlins Biodiversity Strategy)	**NYC_5** New York City Wetlands Strategy 2012	**SEA_5** Puget Sound Salmon Recovery Plan[a] 2007	**STO_6** Stockholms Biotopkarta 2009 (The Habitat Map)	
Environmental/Gray infrastructure planning				
BER_6 Stadtentwicklungsplan Klima 2011 (Urban Development Plan Climate)	**NCY_6** NYC Green Infrastructure Plan 2011	**SEA_6** City of Seattle 2013 NPDES Storm Water Management Program 2012	**STO_7** The Stockholm Environment Program 2012–2015 2012	**SZG_5** Verkehrsleitbild der Stadt Salzburg 1997 (City of Salzburg's Leitbild/concept for traffic)
BER_7 Wasserversorgungskonzept für Berlin und für das von den BWB versorgte Umland 2008 (Water supply plan for Berlin and surrounding)	**NYC_7** Sustainable Stormwater Management Plan 2008	**SEA_7** City of Seattle Food Action Plan 2012		

[a] Regional level.
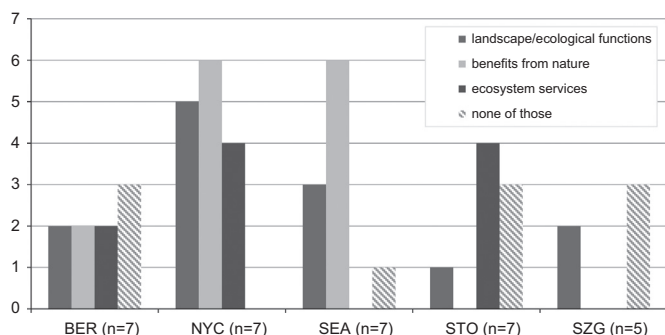
Fig. 2. Number of concepts related to ecosystem services that were explicitly mentioned in the analyzed planning documents from the five case study cities ('*n*' refers to the total number of documents for each case study city).

habitat loss. A general responsibility of humankind to protect ecosystems or biodiversity is also emphasized in several documents, often leaving open if conservation efforts are based on anthropocentric or nature-intrinsic values (conservation perspective). Additionally, some documents, especially from coastal cities, refer to human vulnerability to and risks of extreme nature events (vulnerability/risk perspective).

3.2. Individual ES in planning documents

The ES concept covers a broad range of services humans can benefit from ranging from provisioning, regulating, habitat/supporting to cultural services. We analyzed which types of ES are already considered and, hence, how broad the overall thematic scope is with regard to ES.

Fig. 3 shows that 14 of 21 ES are mentioned in at least half of the documents. With the exception of medicinal resources all provisioning services are mentioned frequently. Amongst the regulating services local climate regulation, run-off mitigation, air quality regulation, erosion prevention/soil fertility, and moderation of extreme events can be found in at least half of the documents. The most rarely mentioned among the regulating services are pollination and biological control. The group of habitat or supporting services consists of two ES. While genetic diversity is rarely addressed, habitat for species is the most often mentioned ES and only absent in one document (STO_2). All five cultural services are mentioned in at least half of the documents, with recreation/mental and physical health as the second most mentioned ES.

Several environmental issues such as local climate regulation or run-off mitigation are mentioned in the analyzed documents

Table 4
Examples of human–nature perspectives expressed in the analyzed documents.

Human–nature perspectives	Document code and quote
Perspectives closely related to the concept of ecosystem services	
Benefit perspective: (Urban) nature provides benefits for human well-being/quality of life/(Urban) nature provides economic benefits.	BER_3, p. 3: "This nature in the middle of the city, these green spaces in Berlin are a precious resource for every one of us. It increases the quality of life for a people of Berlin as well as for visitors from all over the world. The multifaceted urban green spaces represent wealth and likewise an economic factor for the metropolis Berlin." [translated from German]
	NYC_2, p. 44: "We are becoming more and more aware of the multiple benefits of urban trees. Today, a growing body of knowledge identifies trees as assets to a city's economic and environmental health. City trees cool summer air temperatures, filter air pollution, conserve energy by providing shade, and reduce stormwater runoff.
	STO_1, p. 106: "Proximity to nature is an important quality in a metropolitan city. Access to varied nature, the shoreline and aquatic environments encourages physical activity, and provides opportunities for relaxation, peace and quiet, play as well as natural and historic environment experiences close to the home. Activity centres, outdoor facilities and events in the natural environment contribute towards more meetings between people. The function of the wedges as natural treatment facilities improves the living environment in the city, for example by purifying water and air, evening out temperature and water flows such as storm water, temperature regulation and air exchange. Proximity to urban green spaces therefore offers considerable added value for the residents, and is important from a public health perspective."
Dependence perspective: Humans are depending on (urban) nature	BER_5, p.6: "Human survival depends on the manifold functions delivered directly or indirectly by biodiversity. It this ecosystem, services that make the earth a inhabitable place for humans." [translated from German]
	NYC_1, p.88: "The time has come to strike a new balance with nature and not just because healthy ecosystems, mighty rivers, and lofty mountains give us clean air and pure water. The region should develop, and redevelop, around its natural systems, instead of at their expense."
	SEA_3, p. 1: "People rely on Seattle's parks, open spaces, and recreation programs for many benefits, ranging from the pursuit of health and fitness to the desire for self-education, finding a connection with nature, or simply seeking a sense of belonging. Taken as a whole, these parks and open spaces create a green infrastructure that provides a refuge from the bustle of urban life, making Seattle a more beautiful and livable city."
Additional perspectives	
Interdependence perspective: Humans and (urban) nature are closely interrelated and depending on each other.	SEA_2, p. vii: "Sustainability is the common-sense notion that the health of our environment, our economy, our bodies, and our community as a whole, are not only closely linked, but dependent on one another."
	SEA_5, p. 9: "As a whole, people take pride in the fact that our region is built on a sustainable economy and healthy natural environment. In short, the region has become a world model for how our ecosystem and economy can both flourish to the benefit of all who share it."
Impact perspective: Humans cause environmental problems through emissions, land use etc.	NYC_3, p. 17: "Riparian areas are often severely damaged during the land development process, leading to unintended negative impacts to our streams and rivers."
	STO_6, p. 7: "The most important influencing factor is the exploitation of natural and park land. The effects described are loss and alteration of plant and wildlife habitats. It in turn leads to loss or degradation of the species populations and ecosystem features – and thus reduced ecosystem services."
Conservation perspective: Humans have the responsibility to preserve (urban) nature	NYC_5, p. 5: "To maintain healthy urban wetlands in the face of sea level rise, the City will evaluate which wetlands are vulnerable and how to improve the resilience of these areas through restoration or protection efforts."
	BER_2, p. 70: "Another important factor for the preservation of biological diversity is the biotope network. A biotope network has also to be suitable for the migration and population exchange of mammals with larger area claims and thus requires the conservation and restoration of corridors and large areas of unfragmented landscape. In particular, the in international comparison very dense road network in Germany has led to a decrease of Undissected Areas (> 100 km²) With Low Traffic Density (UZVR) with at least 100 km² area size, i.e. habitats with sufficient size for wild animals and plants have decreased dramatically." [translated from German]
Vulnerability/risk perspective: Humans need to be protected from extreme nature events	SEA_4, p. 11: "Continue to make the city a safe and healthful place to live. Reduce the risk of natural hazards (slides, flooding, earthquake, soil and water contamination) while reclaiming and treating previously toxic sites."
	STO_3, p.33: "Climate change is expected to cause higher water levels in the Baltic Sea and prolonged, intensive rain will become more common. This may cause flooding of Lake Mälaren and other lakes and watercourses, which could affect low-lying areas and their utilities infrastructure. Groundwater levels are also expected to vary more, which could lead to landslides and damage to buildings.

when examining the ES that were classified as 'P' for 'Problem mentioned but not linked to ES' (Appendix, Fig. A1). This means that it was noted that this particular issue needs to be mitigated or solved but without explicit relation to urban green as one possible contributor to the improvement of the current situation. At least six documents refer to problems with water supply, air quality, noise, wastewater, and lack of biological control (e.g., pests or invasive species) without explicit connection to urban green.

Regarding the depth to which ES are considered in the planning documents, habitats for species as well as recreation/mental and physical health are the most often elaborated (Table 2) which means supplemented by, e.g., particular measures or targets. 'Indirectly elaborated' services, representing a more loose relation between the notion of the service and means for actions, were less commonly found. 'Acknowledged' as a category where the existence of this ES is expressed but with no traceable relation to actions is most often
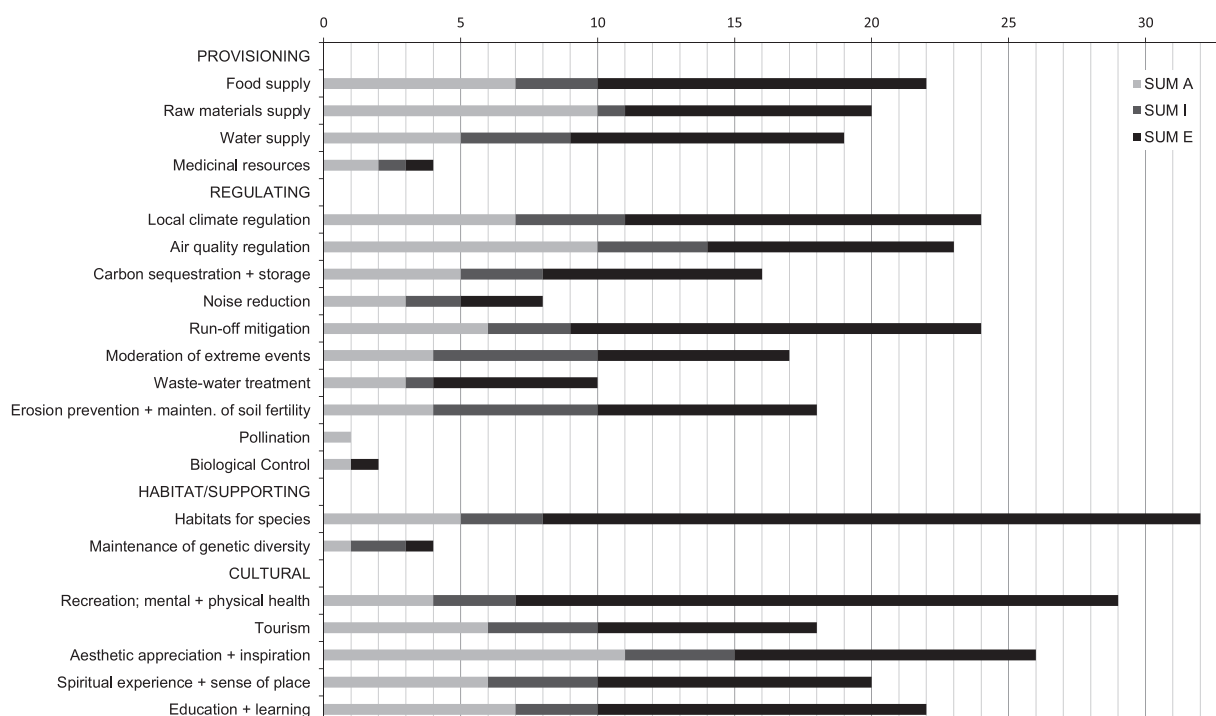
Fig. 3. Total number each ecosystem service is mentioned in the analyzed documents of all five case study cities (total number of documents, $n=33$). The different colors represent the depths a service was discussed (A=acknowledged; I=indirectly elaborated; E=elaborated).
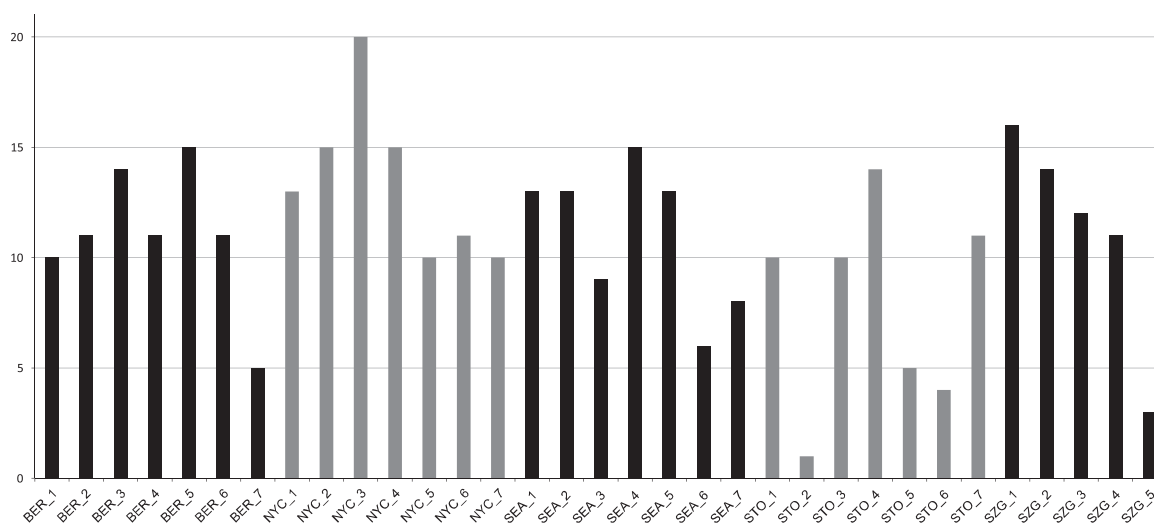
Fig. 4. Total number of ecosystem services ($n=21$) mentioned in the 33 analyzed documents from five case study cities.

used (at least in ten documents) for raw materials supply, air quality regulation, esthetic appreciation and inspiration.

Regarding the overall scope of ES, on average eleven ES were at least mentioned (Fig. 4). In Berlin the informal plans Urban Landscape Strategy (BER_3) and the Biodiversity Strategy (BER_5) are above this value. Also from New York, PlaNYC (NYC_2), the Open Space Conservation Plan for the New York State (NYC_3) and the city's Waterfront Plan (NYC_4) are above the average with NYC_3 as the one document referring to 20 services. The highest number of ES for Seattle can be found in the grass-roots green space plan Open Space 2100 (SEA_4).

Although the concept of ES was introduced quite early in Sweden, the lowest discursive representation of different ES types can be found in Stockholm's documents. Only the Stockholm Park Program (STO_4) is above the average. Around five ES can be found in the Sociotope Map (STO_5) and the Habitat Map (STO_6). Both documents refer to social, cultural (STO_5) and ecological (STO_6) values of

urban green spaces but address only few ES explicitly. From Salzburg, the regional and the city's comprehensive plans (SZG_1 and 2) are above average.

For all cities, functional plans often have low numbers of ES references such as Berlin's Water Supply Plan (BER_7), Seattle's Stormwater Management Plan (SEA_6) or Salzburg's Concept for Traffic (SZG_5). In the group of comprehensive plans the Vision 2030 (STO_2), a very short strategic document of eleven pages, refers to only one ES.

4. Discussion

4.1. Implementation according to explicit ES references

While we found only few references to individual ES types in Stockholm, most explicit references to ES as a concept can still be found in documents from Stockholm and New York, both from

countries that started ES discourses early. Furthermore, two of the recently adopted plans and policy documents from Berlin also note the ES concept (BER_3 and _5, the Urban Landscape Strategy and the Biodiversity Strategy, both published 2012). The example of Berlin indicates that planning organizations are able to adopt new terminology from (international) scientific discourses relatively quickly.

However, the example of Seattle reveals that a lack of explicit references does not mean the ES concept is not adopted. While the term of ES is avoided in favor of ecosystem 'values' or 'benefits', several planning documents from Seattle refer to economic valuation of natural assets or mention ecosystem benefits. Economic ES valuations are considered as an additional tool to inform planning and policy-making and communicate the value of natural assets. In the Seattle and surroundings, ES valuations have been conducted for the Puget Sound (Batker et al., 2008) and the City's urban forest (Ciecko et al., 2012).

These findings indicate two possible ways for mainstreaming ES: (a) ES as a supporting concept for plan and policy-making which is, for example, used to explain the importance of biodiversity protection (e.g., BER_5) or to structure plans and policies conceptually (Matzdorf and Meyer, 2014) and/or (b) as an additional tool that supplements existing planning and policy instruments without necessarily changing them (Ruckelshaus et al., in press). Even if a straightforward implementation in planning and policy cannot taken for granted, the ES concept has high potential as a framework for guiding policy development (Matzdorf and Meyer, 2014; Schewenius et al., 2014).

4.2. Implementation according to human–nature relations

The anthropocentric perspective is partly criticized in ES literature as excluding valuable intrinsic nature values and in this way disregarding the value of nature independently from its actual usability for human purposes (Schröter et al., in press). Our results reveal that an anthropocentric framing is already embedded in urban planning of the case study cities but also the perspective that humans depend on urban nature is present in the analyzed documents. It is, for example, described that biodiversity and ecosystems are shown to provide a foundation for human well-being and therefore require protection, regardless of the immediate use values. Especially, the discourses embedded in the documents from Seattle but also in more recent documents from the European context such as Berlin Landscape Strategy reveal broad similarities with the ES concept in terms of human–nature framing.

Additional perspectives such as the impact perspective (Table 4) should be given greater consideration in ES discourses and the methodological development of ES assessments. ES mitigate human impacts on nature by, e.g., regulating air quality, reducing noise, mitigating run-off or treating waste-water. Thus, these mitigation effects could be highlighted in ES approaches to illustrate consequences of further environmental degradation or potential benefits through improvements in ES delivery (Artmann, 2014; Schwarz et al., 2011).

The perspective that humans are vulnerable to or endangered by extreme natural events is expressed in some of the documents. The anticipated impacts of climate change as well as actual natural disasters such as Hurricane Sandy will likely raise attention for the vulnerabilities, not only but especially, in coastal cities. For example, the 2013 update of PlaNYC "A Stronger, More Resilient New York" (The City of New York, 2013) focuses not only on recovering from the impacts of Sandy but also on increasing the resilience of infrastructure and buildings. Urban planning for resilience should operationalize the ES concepts for increasing the delivery of services such as storm water retention, prevention of erosion and landslides that contribute to the mitigation or avoidance of extreme events (Ahern, 2011; McPhearson et al., 2014; Schewenius et al., 2014).

4.3. Implementation according to thematic scope

The concept of ES encourages the consideration of a broad spectrum of services humans can benefit from including non-marketed values (e.g., Kumar, 2010). Concerning thematic scope (in our case represented by numbers of ES addressed on average in planning documents) New York represents the broadest perspective, while the other cities are comparable addressing often at least half of the analyzed 21 services. This might relate to the country's longer history of using the similar concept of green infrastructure, combined with local factors in New York such as strong political support, high population density and diversity (Rall et al., in review).

With its focus on cultural ES and biodiversity, Stockholm reveals the narrowest scope on average. In Stockholm there has been strong political support for preserving the green wedges of the city with regard to biodiversity and recreational values, influencing the strong consideration of these ES while downplaying other potential ES. A strong thematic focus on the service "habitat for species" and cultural services was also found for other cities. As habitats for species as well as cultural meanings of parks and other urban green spaces – especially for recreation – are themes long discussed in nature conservation or planning for green and open space their representation in planning concepts is not surprising (e.g., Barthel et al., 2005; Randolph, 2012; Lachmund, 2013).

These findings on the one hand reveal a potential to broaden the thematic scope represented by multiple ES, on the other hand they indicate an already comparably holistic perspective as, overall, none of the four groups of provisioning, regulating, habitat/supporting or cultural services is significantly weakly represented. Accordingly, the concept of ES can be applied to further strengthen the holistic perspective and sustainable use of ecosystems in urban planning by using it as a framework for conceptually structuring plan- and policy-making processes (Schröter et al., in press; Matzdorf and Meyer, 2014).

Concerning individual ES, an analysis of plans from Polish cities, representing a country that entered the discourse on ES recently, revealed that ES which already have a market orientation such as tourism and food production have a stronger focus in planning (Piwowarczyk et al., 2013). These results can only partly be supported by our study. The influence of national policies seems more prominent than market orientation. For example, ES related to stormwater management, which is connected with an important binding policy in the US (The Clean Water Act), are strongly represented in the US documents analyzed, while ES related to air quality are frequently addressed in European and American planning documents, both having policies on air quality that impose binding requirements (US: Clean Air Act; EU: Air Quality Directive).

One recommendation for mainstreaming the ES concept is to integrate environmental issues that are of high relevance in planning or political agendas into ES frameworks to better meet the demands of urban planners and managers (Baró et al., 2014).

4.4. Implementation according to planning systems and plan types

Overlaps of planning approaches with features of the ES concept can be found in planning documents from all cities, for example, in terms of anthropocentric framing, holistic thematic scope or focus on benefits provided by nature. Similar results have been found for some planning systems from developed countries (Wilkinson et al., 2013; Hauck et al., 2013), while for others the gaps between the ES concept and planning practice appear comparably large (Piwowarczyk et al., 2013). An influence of high-level policies for mainstreaming of the ES discourse can be noted for the US and Europe, in Europe especially through the implementation of policies and strategies that promote

the ES concept such as the EU Biodiversity Strategy to 2020 (European Commission 2011).

Differences in the uptake of the ES concept between the case studies can be seen in relation to the time period when planning documents where developed and when national ES discourses evolved, more so than in relation to the particular planning system. For some of our case studies such as Stockholm it can be assumed that, on one hand, implementation of ES elements such as the holistic scope may only be a matter of time as planning experts from the City of Stockholm expressed high interest in the ES concept during their participation in the URBES project. The same appears for Salzburg, as a case study from Austria – a country, which quite recently conducted first the ES studies for including agricultural areas or rivers in course of the implementation of the European Biodiversity Strategy (Getzner et al., 2011; Götzl et al., 2011). Urban planning experts expressed interest in in-depth assessments of ES, e.g., for a more detailed functional structuring of the urban landscape within the study on Salzburg's Urban Landscapes (SZG_4) (Brunauer, 2014).

On the other hand, planners from Salzburg expressed concern that such assessments are often not able to capture the reality and complexity of urban nature (Brunauer, 2014). Planners and other stakeholders from Berlin valued the potentials of the ES concept cautiously especially in terms of monetization of ES, while there seems to be a comparably wide openness for economic ES valuations in New York and Seattle (Rall et al., in review; McPhearson et al., 2013b). Planners from Stockholm commented that the emerging ES concept confronts the planners with new challenges of widening the scope of benefits from urban nature and of translating ES as a scientific and policy concept into concrete planning activities. Therefore, we argue that for the implementation of the ES approach into practice further efforts by science are necessary to provide valid and user-friendly assessment methods and to inform urban planning about them (Daily et al., 2009; Fisher et al., 2009).

In terms of plan types, the analyzed documents were distinguished into three groups – (1) comprehensive planning; (2) green space/landscape/biodiversity planning; (3) environmental/gray infrastructure planning. Plans from group 1 or 2 cover a broader range of ES. This is not surprising as plans from the third group often deal with a comparably narrow issue such as transport, food or fresh water supply. Nevertheless, Berlin's Urban Development Plan Climate (BER_6) or the New York's Stormwater Management Plan (NYC_7), refer to a relative high number of ES. Likewise, some plans from group 2 partly have a specific thematic scope such as Stockholm's Sociotope and the Habitat Map (STO_ 5 and _6), and only refer to a low number of ES. It can be concluded, that all kinds of plans or policies can integrate several ES (Hauck et al., 2013). We see potential to put more emphasis on this holistic approaches provided by the ES concept. However, we suggest that different planning instruments of a city need to be coordinated and not all kinds of plans of a city necessarily need to cover all services in-depth.

4.5. Implications for future research

Comparative case studies can help to better understand governance arrangements that foster or hinder the implementation of new planning approaches in different geographic, political and social contexts. An analysis of policy and strategic planning documents can be applied to explore agreed upon policy paradigms for a particular period (Faludi, 2000; Wilkinson et al., 2013). Since planning documents are relatively easy to access, analysis of their content can lead to comparable data. For a quite recently developed concept such as ES, the results derived from a document analysis can be influenced by the time period in which the surveyed document were developed as the principles, ideas and concepts fixed in documents can differ from current planning practice. As document analyses are restricted to information presented in this format (Honrado et al., 2013;

Piwowarczyk et al., 2013), in our study the knowledge of the researchers based on several forms of interactions with urban planners and a desk study delivered context and expertise for discussion and validation of the findings from the document analysis. Additional interviews and questionnaires would strengthen the assessment of the current state of ES awareness and understanding as well as the perceived opportunities and limitations. Our study focusing on comparative analysis provides a foundation for such in-depth exploration of stakeholder perspectives (Kabisch, 2015; others in preparation).

Explicit references are an obvious but nonetheless relevant indicator for the entry of the ES concept in policy discourses. Implicit ES references or less tangible similarities with the ES concept may be caused by overlaps between ES and other concepts such as landscape functions (Albert et al., 2014) and cannot be considered as evidence for conscious uptake of the ES concept, as we found, for example, in Berlin's Landscape program from 1996 (BER_4), even if they indicate a similar understanding of nature's benefits (Wilkinson et al., 2013).

Conversely, the uptake of terminology may just pay lip service to ES and is not a sufficient indicator on its own for the application of the concept (Primmer and Furman, 2012). Additionally, this study shows that a lack of explicit references to a concept does not mean that is not embedded (e.g., for Salzburg specific landscape functions are discussed without naming the concept). Furthermore, the findings from Seattle reveal that linguistic preferences (ecosystem benefits or values instead of services) can impede such analyses. Analyzing both explicit and implicit references allows more comprehensive insight and should be pursued in future research. For cases from non-English speaking countries, linguistic characteristics must be taken into careful consideration when applying ES terminology (Niemelä et al., 2010).

While we consider the thematic scope used in urban planning, other studies focus on the integration of conceptual or structural ES elements into plans and policies, e.g. based on a model for "ideal" ES-driven policy with indicators, e.g., for ecosystem capacity or cross-sector cooperation (Matzdorf and Meyer, 2014) or for operational features such as mapping or valuation (Hauck et al., 2013; Primmer and Furman, 2012). To provide a holistic picture, a policy analysis should cover awareness based on terminology as well as understanding represented by conceptual and/or operational features.

Our results suggest that urban planning is strongly influenced by policies, e.g. through legal frameworks or incentive programs. Some plans such as Berlin's Biodiversity Strategy (BER_5), New York's PlaNYC (NYC_2) or Seattle's Open Space 2100 plan (SEA_4), which have a broad thematic scope and discursive ES references, were developed by or in cooperation with local universities. Therefore, we need to better understand the role of research agencies and universities in fostering knowledge exchange between research and practice and perhaps especially for the implementation of concepts such as ES (Kopperoinen et al., 2014).

5. Conclusion

Considering the different dimensions of discursive representation and uptake of ES in urban planning, our case studies provide a multifaceted picture of gaps and linkages between the ES concept and its implementation into planning. Evidence for uptake of the concept of ES could be determined for more than half of the case study cities. Three already use ES terminology and a fourth refers to conceptual ES elements such as economic valuation of ecosystem benefits. Concerning overlaps between the ES concept and planning approaches, in all cities an anthropocentric framing of human–nature relations was detected. We also identified clear expressions of the dependence of human well-being on urban

ecosystems in planning discourses. However, the concept of ES could be applied to strengthen the holistic perspective on urban nature to represent additional benefits from the environment.

Overall, we conclude that promotion of the ES concept on high policy levels will contribute to the mainstreaming of ES in a relatively short time span if the planning organization of the cities have the capacity to react to new concepts. However, skepticism of some practitioners has to be considered, and research needs to provide proof of the validity and added value of ES approaches.

It is still an open question whether integration of ES features such as the terminology, thematic scope or a holistic perspective on human–nature relations can be considered sufficient for mainstreaming ES, or even whether the aim for mainstreaming ES should go further to implement ES methods for measuring and valuing urban ecosystems. Our results indicate that both forms of implementation take place in urban planning. A holistic perspective fostered by ES without applying ES assessment, mapping, or valuation methods could still have positive effects on urban ecosystems and human well-being. In both cases, adoption of normative foundations of the ES concept in policies and planning is crucial if the ES concept aims to reconnect humans with urban nature and the sustainable use of natural resources. We find that the ES concept is, perhaps finally, beginning to become more main-stream in urban planning in the US and Europe and because of this, increases the potential of urban planning to utilize green infrastructure to address needs for climate change resilience and meet goals for urban sustainability.

Appendix A

See Fig. A1 and Tables A1–A3.

Ecosystem Services — BERLIN / NEW YORK CITY

Ecosystem Services		BER_1	BER_2	BER_3	BER_4	BER_5	BER_6	BER_7	NYC_1	NYC_2	NYC_3	NYC_4	NYC_5	NYC_6	NYC_7
PROVISIONING	Food supply	E	E	E	A	E		A	E	E	E	A	A	E	
	Raw materials supply	E	E	A	A	A	A	A		E	E	E	A		
	Water supply	A	P	E	E	E	I	E	E	E	E	A		P	A
	Medicinal resources							P							
REGULATING	Local climate regulation		A	E	E	E	E	P	E	I	E	A		E	E
	Air quality regulation	P	A	E	E	E	E		E	I	I	A	A	E	E
	Carbon sequestration + storage	P	E	E		E	E		P	I	E		A	A	A
	Noise reduction	P	P		P		A							E	
	Run-off mitigation			A	E		E	P	I	E	E	E	E	E	E
	Moderation of extreme events	E	E	A			A		I	I	E	E	I	P	I
	Waste-water treatment				P		P	A	E	E	E	E	P	E	P
	Erosion prevention + mainten. of soil fertility	I	E		E	E	A			I	I	I	P		E
	Pollination														
	Biological Control					A		P			P				
HABITAT/	Habitats for species	I	E	A	E	E	E	E	E	E	E	E	E	A	E
SUPPORTING	Maintenance of genetic diversity				I	A					I				
CULTURAL	Recreation; mental + physical health	E	E	E	E	E	A		E	E	E	E	E	I	E
	Tourism	I	E	E		E			I	E	E	E			
	Aesthetic appreciation + inspiration	A	E	E	E	A			E	I	E	E	A	I	A
	Spiritual experience + sense of place	I		A		I			I		E	E			
	Education + learning			E		E			I	E	E	E	E	A	E

Ecosystem Services — SEATTLE / STOCKHOLM

Ecosystem Services		SEA_1	SEA_2	SEA_3	SEA_4	SEA_5	SEA_6	SEA_7	STO_1	STO_2	STO_3	STO_4	STO_5	STO_6	STO_7
PROVISIONING	Food supply	E	I		E	I		E	A			A			I
	Raw materials supply	I			E	A			E		A				A
	Water supply	I	P	A	I	P		P	E			P	I		
	Medicinal resources				A							I			
REGULATING	Local climate regulation		E		I	E		A	A		E	A		A	I
	Air quality regulation	A	E	A	P		A	P	A	P	P	A			P
	Carbon sequestration + storage	I	E	E	I			A	P		P	A		E	P
	Noise reduction	P	E	P	P	P			P		P				P
	Run-off mitigation	A	E	E	E	I	E	I	A		E	A		P	E
	Moderation of extreme events	I	A		P	E	P		P		I			P	
	Waste-water treatment	P			E	P			P		P	A			I
	Erosion prevention + mainten. of soil fertility	I	E		A	E	E	P	P						
	Pollination														
	Biological Control	P	E	P		P	P	P							
HABITAT/	Habitats for species	E	E	E	E	E	E	A	E		E	E	A	E	E
SUPPORTING	Maintenance of genetic diversity					E									
CULTURAL	Recreation; mental + physical health	I	E	E	E	A	P	A	E	A	E	E	I		E
	Tourism	A			I	A			E		I	A			
	Aesthetic appreciation + inspiration	I	E	E	I	A	A		I		A	E	I		
	Spiritual experience + sense of place	E		A	E	E		A			A	E	I		A
	Education + learning		E	E	E	A	E	I			I	A	A	A	

Ecosystem Services — SALZBURG

Ecosystem Services		SZG_1	SZG_2	SZG_3	SZG_4	SZG_5
PROVISIONING	Food supply	E	P		A	
	Raw materials supply	E	A		E	
	Water supply	E	E	A		
	Medicinal resources		E			
REGULATING	Local climate regulation	E	E	I	A	
	Air quality regulation	E	I	I	A	P
	Carbon sequestration + storage					
	Noise reduction	E	I	I	P	P
	Run-off mitigation	A	E	A		
	Moderation of extreme events	E	E	A		
	Waste-water treatment	A	P			P
	Erosion prevention + mainten. of soil fertility	A	E		A	I
	Pollination					
	Biological Control					
HABITAT/	Habitats for species	E	E	I	A	I
SUPPORTING	Maintenance of genetic diversity					
CULTURAL	Recreation; mental + physical health	E	E	E	E	
	Tourism	E	A	A	I	
	Aesthetic appreciation + inspiration	A	E	A	E	
	Spiritual experience + sense of place	E	E	A	E	I
	Education + learning	A		A	E	

Legend:
- (blank) not mentioned
- P — problem mentioned but not linked to ES
- A — acknowledged
- I — indirectly elaborated
- E — elaborated

Fig. A1. ES related content in the analyzed 33 planning documents of all five case study cities.

Table A1
List of all analyzed planning and policy documents.

BER_1: State Development Program for the Berlin-Brandenburg Region/Landesentwicklungsprogramm der Hauptstadtregion Berlin-Brandenburg/LePro. 2007. Available from: http://gl.berlin-brandenburg.de (accessed 3 November 2013) [in German]
BER_2: State Development Plan Berlin-Brandenburg/Landesentwicklungsplan Berlin-Brandenburg. 2009. Available from: http://gl.berlin-brandenburg.de (accessed 3 November 2013) [in German]
BER_3: Urban Landscape Strategy Berlin/Strategie Stadtlandschaft Berlin. 2012. Available from: www.stadtentwicklung.berlin.de (accessed 6 November 2013) [in German]
BER_4: Landscape and Species Protection Program/Landschaftsprogramm/Artenschutzprogramm. 1994/2004. Available from: www.stadtentwicklung.berlin.de (accessed 3 November 2013) [in German]
BER_5: Berlin's Biodiversity Strategy/Berliner Strategie zur Biologischen Vielfalt. 2012. Available from: www.stadtentwicklung.berlin.de (accessed 6 November 2013) [in German]
BER_6: Urban Development Plan Climate/Stadtentwicklungsplan Klima. 2011. Available from: www.stadtentwicklung.berlin.de (accessed 6 November 2013) [in German]
BER_7: Water supply plan for Berlin and surrounding/Wasserversorgungskonzept für Berlin und für das von den BWB versorgte Umland. 2008. Available from: www.stadtentwicklung.berlin.de (accessed 6 November 2013) [in German]

NYC_1: A Region at Risk: The Third Regional Plan For The New York-New Jersey-Connecticut Metropolitan Area. 1996. [printed version]
NYC_2: PlaNYC. A greener, greater New York. Update April 2011. Available from: www.nyc.gov (accessed 5 November 2013)
NYC_3: New York State Open Space Conservation. 2009. Available from: www.dec.ny.gov (accessed 12 March 2014)
NYC_4: Vision 2020: New York City Comprehensive Waterfront Plan. 2011. Available from: www.nyc.gov (accessed 5 November 2013)
NYC_5: New York City Wetlands Strategy. 2012. Available from: www.nyc.gov (accessed 5 November 2013)
NCY_6: NYC Green Infrastructure Plan. 2011. Available from: www.nyc.gov (accessed 5 November 2013)
NYC_7: Sustainable Stormwater Management Plan. 2008. Available from: www.nyc.gov (accessed 5 November 2013)

SEA_1: Vision 2040. 2008. Available from: www.psrc.org (accessed 12 March 2014)
SEA_2: City of Seattle Comprehensive Plan: Toward a Sustainable Seattle 2004–2024. 2005. Available from: www.seattle.gov/dpd (accessed 3 November 2013)
SEA_3: Parks and Recreation Strategic Action Plan. 2008. Available from: www.seattle.gov/parks/ (accessed 3 November 2013)
SEA_4: Open Space 2100: Envisioning Seattle's Green Future. 2006. Available from: www.open2100.org/ (accessed 3 November 2013)
SEA_5: Puget Sound Salmon Recovery Plan. 2007. Available from: www.psp.wa.gov (accessed 3 November 2013)
SEA_6: Storm Water Management Program. 2012. – Available from: www.seattle.gov/util/ (accessed 3 November 2013)
SEA_7: City of Seattle Food Action Plan 2012 – Available from: www.seattle.gov/environment/food (accessed 3 November 2013)

STO_1: Regional development plan for the Stockholm region/Regional utvecklingsplan för Stockholms-regionen/ RUFS. 2010. Available from: www.tmr.sll.se/rufs2010/; www.tmr.sll.se/english/RUFS-2010/ (accessed 12 March 2014) [in Swedish and English]
STO_2: Vision 2030: A guide to the future/Vision 2030: Framtidsguiden. 2007. Available from: www.stockholm.se/OmStockholm/Vision-2030/; http://international.stockholm.se/Future-Stockholm/ (accessed 12 March 2014) [in Swedish and English]
STO_3: The Walkable City – Stockholm City Plan/Promenadstaden: Översiktsplan för Stockholm. 2010. www.stockholm.se/oversiktsplan; http://international.stockholm.se/Future-Stockholm/Stockholm-City-Plan/; (accessed 12 March 2014) [in Swedish and English]
STO_4: Stockholm Park Program/Stockholms parkprogram. 2006. Available from: www.stockholm.se (accessed 12 March 2014) [in Swedish]
STO_5: Sociotope Map/Sociotopkarta för Parker och Andra Friytor I Stockholm Innerstad. 2002. Available from: www.stockholm.se (accessed 12 March 2014) [in Swedish]
STO_6: The Habitat Map/Stockholms Biotopkarta. 2009. Available from: www.stockholm.se (accessed 12 March 2014) [in Swedish]
STO_7: The Stockholm Environment Program 2012–2015. 2012. Available from: http://international.stockholm.se/ (accessed 12 March 2014)

SZG_1: Regional Program for the City of Salzburg and Surrounding Communities/Regionalprogramm Salzburg-Stadt und Umgebungsgemeinden.1999/2007. Available from: http://www.rvs.salzburg.at/regionalprogramm.htm (accessed 12 March 2014) [in German]
SZG_2: City of Salzburg's Spatial Development Plan/Das räumliche Entwicklungskonzept der Stadt Salzburg/REK. 2007. Available at: www.stadt-salzburg.at (accessed 12 March 2014) [in German]
SZG_3: Green Network of Salzburg/Gruenes Netz der Landeshauptstadt Salzburg. 2007. Available at: www.stadt-salzburg.at (accessed 12 March 2014) [in German]
SZG_4: Study on Salzburg's Urban Landscapes/Studie Salzburger Stadtlandschaften. 2009. Available at: www.stadt-salzburg.at (accessed 12 March 2014) [in German]
SZG_5: City of Salzburg's Leitbild/concept for traffic/Verkehrsleitbild der Stadt Salzburg. 1997. Available at: www.stadt-salzburg.at (accessed 12 March 2014) [in German]

Table A2
Coding protocol for the analysis in regard of the discursive representation of the ES concept with shortened example.

	Example: SEA_1 Vision 2040		Doc_1 Findings	Quotes/examples
	Findings	Quotes/Examples		
1. Is the term 'ecosystems services' mentioned?	no			
Coding: yes=1; no=0	0			
2. Is the term 'landscape' or 'ecological function/s' mentioned?	Yes, ecosystem/ecological functions are mentioned several times	e.g., p. 35: Stewardship means managing those resources in a manner that is […] protective of key ecological functions.; p 36: Critical areas, such as wetlands, floodplains, aquifer recharge areas, wildlife conservation areas, and certain geologic areas perform key functions that enhance both the natural and built environments, and also protect us from floods and other hazards.		
Coding: yes=1; no=0	1			
3.Are 'benefits' humans derive from nature mentioned?	Benefits are often mentioned in relation to reducing impact (benefits FOR the environment); benefits through nature are more rarely addressed	p. 34: VISION 2040 stresses the importance of the natural environment in providing ecological and esthetic benefits, and protecting our water and air.		
Coding: yes=1; no=0	1			
4.In which way are humans and nature, ecosystems,	They are seen as strongly connected; the notion that human health and well-being as well as economic prosperity depend on natural resources and healthy/	the document has an "environmental framework" which explains the interrelation supported with illustrations of "natural ecosystem conditions", "humans impacts" and		

Table A2 (*continued*)

	Example: SEA_1 Vision 2040		Doc_1	Quotes/
	Findings	**Quotes/Examples**	**Findings**	**examples**
and/or landscape seen as interrelated?	functioning ecosystems is underlying the argumentation of the whole document. Reducing environmental impacts as human responsibility is the underlying argument of most goals and policies	"Ways to Improve Ecosystem Conditions"— p. vi: The phrase conveys that the people of the region, our economic prosperity, and our relationship to the planet are tied together in a mutually supportive and interdependent way. Social and environmental goals cannot be achieved without economic prosperity — and achieving prosperity is highly related to social well-being and environmental quality. […]		
Assessment				
Perspectives on human–nature relations	dependence perspective: humans and nature are interdependent — protection/impact perspective: reduction of pollution and avoidance of environmental degradation as well as protection and restoration are major objectives – benefit perspective: the regions prosperity depends on natural resources and healthy/functioning ecosystems			

Table A3

Coding protocol for the analysis in regard of ES related content with shortened example (ES description based on TEEB, 2011; Niemelä et al., 2010; Piwowarczyk et al., 2013; Gómez-Baggethun et al., 2013; assessment: N=Not mentioned; P=Problem mentioned but not linked to ES; A=Acknowledged; I=Indirect; E=Elaborated).

Ecosystem Service	Description	Example: SEA_22 Vision 2040				Doc_1			
		Findings	Quotes/Examples	Assessment	Review	Findings	Quotes/ Examples	Assessment	Review
Provisioning									
1. Food supply	*Agriculture, food, crops, grain/dairy/vegetables produced, vegetable/fruit garden, allotment, fish, fishery, game, mushrooms, berries, fruit, honey*	The importance of environment/ natural areas for food production is mentioned several times; fishing is also mentioned several times regional goal: rural lands/ resource lands shall be preserved to provide this services in the future; health related policy: agriculture and fishery shall be supported to enhance the regional food system	P. 6: The area's natural environment […] creates economic opportunities through traditional industries such as fishing […]; p. 10: There is a growing understanding of the role the environment plays in […] food production […] —— p. 15: Natural Resource Lands: agricultural lands that have long-term significance for the commercial production of food or other agricultural products (see also p. 27 – no urban growth in these areas) […]	E					
2. Raw materials supply	*Timber, energy (from biomass)*	"Resource lands" and "forest lands" as important for the provision of raw materials are mentioned several times; regional goal: "natural resource lands" shall be preserved (indirect link to the provisioning function mentioned earlier); renewable energy is mentioned, too	P. 6: The area's natural environment […] creates economic opportunities through traditional industries such as fishing, timber harvest […] —— 15: Natural Resource Lands: forest lands that have long-term significance for the commercial production of timber, and mineral lands that have long-term significance for the extraction of minerals. (see also p. 27 – no urban growth in these areas) […]	I					
3. Water supply	*Fresh water, drinking water, water supply, groundwater, water infiltration, water suspension, water storage*	Water quality/pollution is mentioned several times; it is stated, that ecosystems and clean water are interrelated; Service goals and policies to promote better management of water resources	p. viii: "improving water quality" as regional task mentioned; p. 10 There is a growing understanding of the role the environment plays in […] water quality […]" – p. 8: Water is and will remain a challenge for the region. What was once a seemingly abundant resource has become polluted, diverted, and, in some instances, a health risk. There have been changes to water quality, the quantity of water flowing through natural ecosystems, and even to water temperature. […]	I					
4. Medicinal resources	*Biotechnological and pharmaceutical use of plants etc.*	Not mentioned		N					
Regulating									
5. Local climate regulation	*Local climate regulation, microclimate regulation, mitigating heat island effect, evapotranspi-ration, cooling, shading, reflecting solar radiation, wind blocking*	Only in relation to climate change (rain, draughts, snow cover)		N					
6. Air quality regulation	*Air quality, air pollution purification, absorption of pollutants, cleaning the air*	Air pollution is mentioned as an environmental problem several times; reducing gas emissions and air pollutants as regional task mentioned; loss of vegetation/ sealing are mentioned as	p. 39: Air quality is primarily a public health concern, but it also affects plant and animal life, as well as visibility. […] today – and into the future – the region's most problematic pollutants are and will continue to be fine particles and toxic emissions, along with	A					

		problems –potentials of forests so filter air are mentioned; goals are only related to reduction of emission	ground-level ozone. Greenhouse gases are also major air pollutants. […]	
7. Carbon sequestra-tion and storage	*Gas cycles, carbon sequestration and storage, biomass/soils as carbon sinks*	"Addressing potential climate change impacts" as regional task mentioned (p. viii); goals and policies are mainly related to reduction of harmful elements, but one policy suggest tree planting to reduce carbon; importance of forest lands for carbon dioxide is mentioned——goal: protection of natural resource land (forests)	p. 39: CLIMATE CHANGE GOAL AND POLICIES: Goal: The region will reduce its overall production of harmful elements that contribute to climate change. —————Policy MPP-En-24: Take positive actions to reduce carbons, such as increasing the number of trees in urban portions of the region. […]	E
8. Noise reduction	*Noise reduction, noise cushioning*	Noise is mentioned as environmental problem that needs to be mitigated	p. 35: Environmental Stewardship: policy MPP-En-7: Mitigate noise caused by traffic, industries, and other sources, also p. 48	P
9. Run-off mitigation	*Stormwater regulation/ retention, rain water infiltration/ absorption, rain water drainage, balancing storm water peaks, reducing stormwater runoff*	Stormwater management is discussed as important issue. Green streets and vegetation in general are mentioned as one solution.	p. 60: Innovative techniques: Low-impact development relies on more environmentally sensitive approaches to how land is developed and used, especially in managing stormwater runoff. […] Reducing stormwater drainage infrastructure – pipes, ponds, and other structures – can actually lower infrastructure costs. […]	A
10. Moderation of extreme events	*Flood prevention, buffering from damage through storms/ floods/ waves*	Flooding is mentioned several times (also see fresh water); surface sealing/vegetation loss are mentioned as problematic; climate change as driver; forests and so called "critical areas" are mentioned as important areas for precipitation to limit flood—— policies: protection of natural resource land (forests) (but not directly related to the ES) and of critical areas such as wetlands and floodplains	p. 8: Climate change will probably create severe pressure for the already stressed Puget Sound salmon population by affecting its physical environment, including the availability of food. The Clean Air Agency's research suggests that as the region's average temperatures continue to rise, warmer summer weather, accompanied by reduced runoff in spring, could increase drought, water shortages, and the risk of forest fires, affecting air pollution and human health. A hotter climate could also lead to more noxious pest infections and damage to the food chain […]	E
11. Waste-water treatment	*Waste water treatment, filtering waste water, sewage*	Impact on water quality; policies for reducing waste water/ improving sewers –but not related to ES	p. 80: Policy: MPP-PS-6: Obtain urban services from cities or appropriate regional service providers, and encourage special service districts, including sewer, water, and fire districts, to consolidate or dissolve as a result. […]	P
12. Erosion prevention and mainte-nance of soil fertility	*Erosion prevention, humus production, maintaining nutrient content*	Forests are mentioned as areas to control erosion——goal: protection of natural resource land (forests) (but not directly related to the ES)	p. 55: Forest Lands. Forests […] absorb precipitation, which limits flooding and controls erosion.	I
13. Pollination	*Pollination, bees, seed dispersal*	Not mentioned		N
14. Biological control	*Biological control, pest control, disease control*	Pest are mentioned as a problem (see ES 9); insect damage is also mentioned in relation to forests (p. 55)		P

Habitat or supporting

15. Habitats for species	*Habitats, maintenance of habitats, maintenance of*	Habitat protection/development as regional task is mentioned	p. viii: conserving habitat; p. 6: The area's natural environment provides habitat; also p.	E

Table A3 (*continued*)

Ecosystem Service	Description	Example: SEA_22 Vision 2040				Doc_1			
		Findings	Quotes/Examples	Assessment	Review	Findings	Quotes/ Examples	Assessment	Review
	biodiversity, refugee for species	several times; Salmon as target species for habitat protection is mentioned several times—————————ecosystem/ habitat protection as a regional goal: wildlife corridors and preservation/restoration of native vegetation are mentioned; counties shall develop habitat assessments	34; p. 36 theme "Earth and Habitat": The central Puget Sound region hosts a wide diversity of native wildlife and habitats. The loss and degradation of terrestrial habitat threatens the region's biodiversity. Fragmentation of habitat, especially in forests, is also a major threat to biodiversity and species sustainability. […]						
16. Mainte-nance of genetic diversity	*Genetic diversity*	Not mentioned		N					
Cultural services									
17. Recreation and mental and physical health	*Outdoor recreation, mental and physical health, tranquilizing effects, sports, walking, gardening, fishing, hunting, sunbathing, boating*	The value of the landscape for recreation is mentioned several times; environmental health and human health are seen as related; ecosystem/environmental protection as a policy to ensure human health – but no specific suggestion related to health; parks are one policy goal	p. 5: The central Puget Sound region's surroundings create stunning backdrops for our cities and towns, contribute to our economic prosperity and quality of life, and lend themselves to many recreational activities, including hiking, fishing, boating, and wildlife watching. […]	I					
18. Tourism	*Tourism, sights*	The value of natural areas for tourism is mentioned	P. 6: The area's natural environment […] creates economic opportunities through traditional industries such as […] recreation, and tourism	A					
19. Esthetic apprecia-tion and inspiration	*Esthetic appreciation, inspiration for culture, art and design*	The beauty of the landscape and its value for the quality of life are mentioned several times; goal and policies for "Regional design" relates to this aspect	p. 1: The region's physical geography is one of its greatest assets. Its mountain ranges, waterways, lush forests, and greenery offer a stunningly beautiful natural environment; p. 10: There is a growing understanding of the role the environment plays in […] visual and esthetic features. […]	I					
20. Spiritual experience and sense of place	*Identity, spiritual experiences, sense of place*	The regions identity is mentioned as important; two policies of "Regional design" address sense of place (preservation of archeological sites, historic and cultural landscapes, and areas of special character)	p. 10: There is a growing understanding of the role the environment plays in […] sense of place" —— p. 75: Policy regional design: Puget Sound Regional Council 58 MPP-DP-33: Identify, protect and enhance those elements and characteristics that give the central Puget Sound region its identity, especially the natural visual resources and positive urban form elements. […]	E					
21. Education and learning	*Learning, education, environmental education, social learning, perception of nature, nature experience*	Not mentioned		N					
Comments									

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