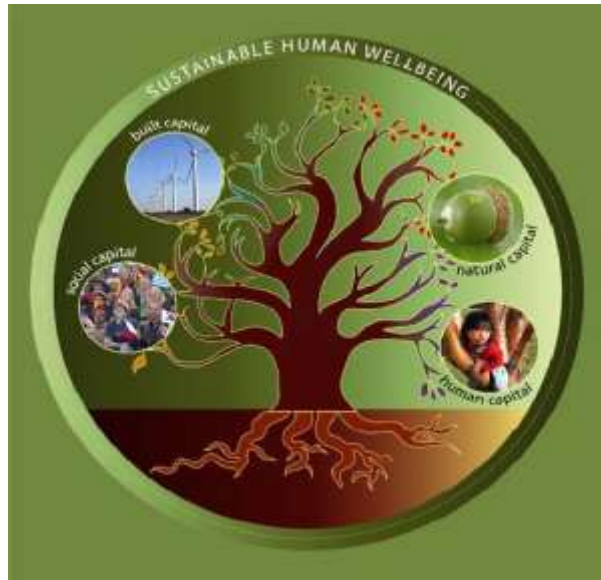


Urban Ecosystem Services and the Green Cities Concept



TSU Tbilisi, Georgia

09.09.2019

Seasonal School „Landscape Sciences“

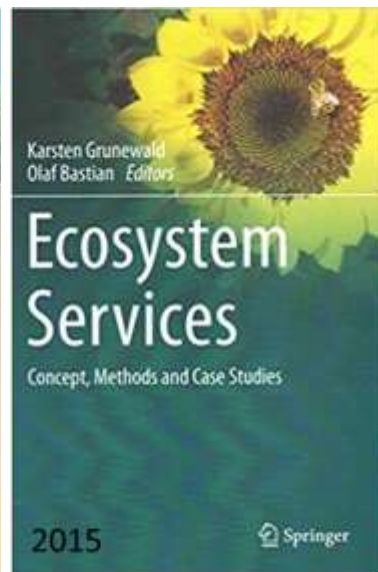
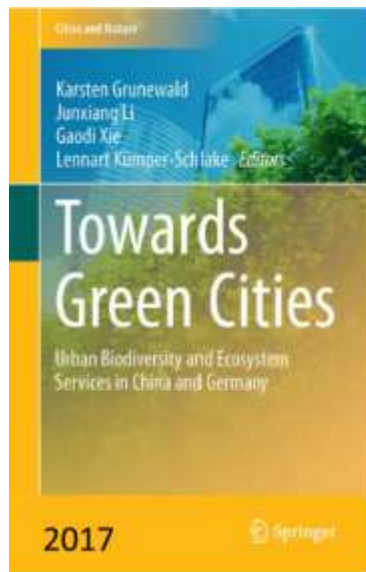
IOER - Leibniz Institute of Ecological Urban and Regional Development, Dresden (Germany)

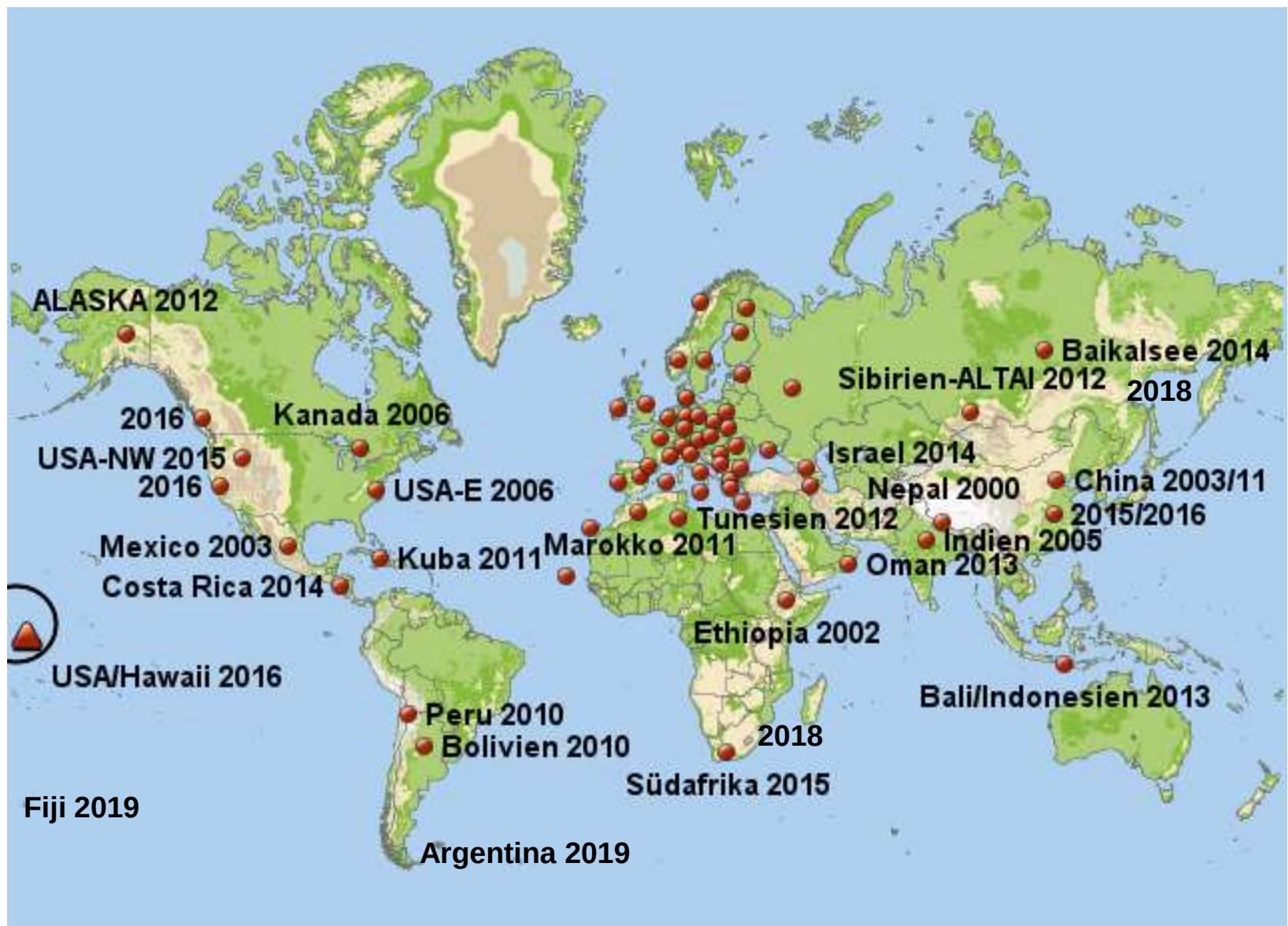
- Non-university spatial development research institute, interdisciplinary approach
- Member of the Leibniz Association
- Founded in 1992
- Ca. 120 employees
- Budget: ca. 8 Mio. Euro, including ca. 2 Mio. Euros of third-party funding (2014)
- Close cooperation with the TU Dresden
- Cooperation with partners in over 20 European countries



Research Area

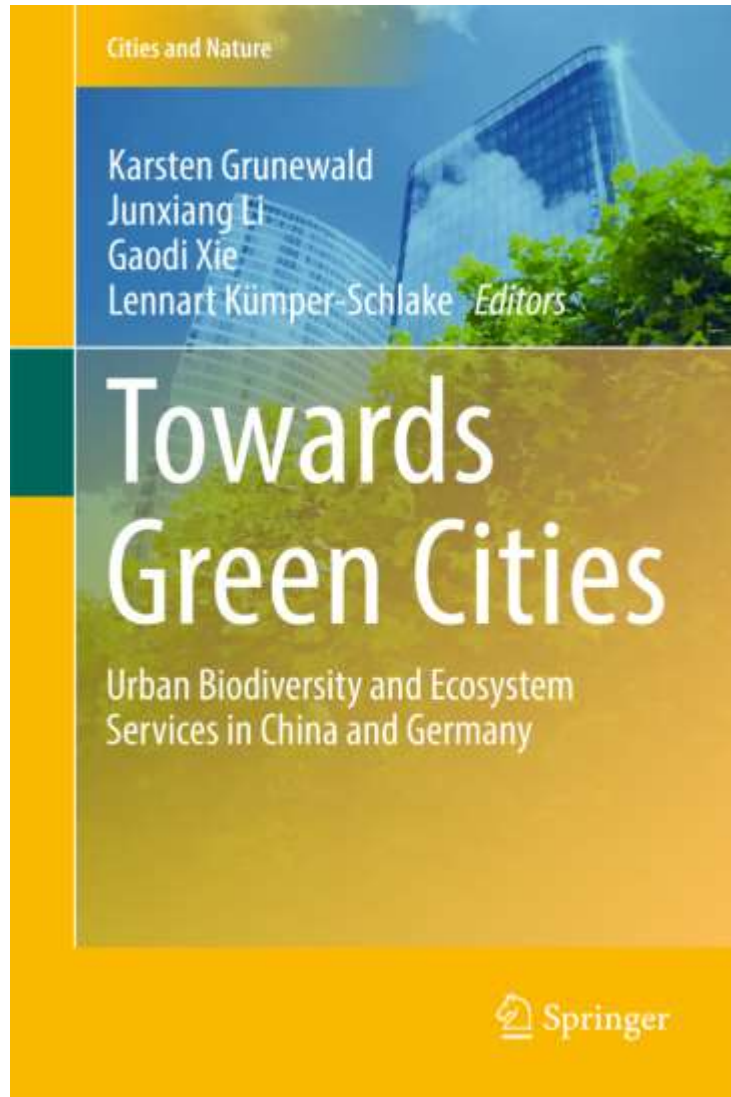
- Landscape Change and Management
- Assessment of Ecosystems and their Services





Mountaineering and Nature in a City, Singapore





Sino-German Project „Green Cities Study“

- ✓ Key terms
- ✓ Challenges, strategies, concepts
- ✓ Assessment of urban ecosystem services
- ✓ Implementation of urban green spaces in city development
- ✓ Fields of action, recommendations

Book (Engl.+Chin.), 37 authors

The BIDE LIN-Project



The value of ecosystem services, biodiversity and blue-green infrastructures in cities, exemplified by Dresden, Liberec and Děčín



Europäische Union. Europäischer
Fonds für regionale Entwicklung.
Evropská unie. Evropský fond pro
regionální rozvoj.





Aims:

- Evaluation of ecosystem services in project cities
- Demonstration of values and services to the public and practitioners
- Provision of supporting arguments for the preservation and protection of urban nature in decision-making processes



Urban Landscapes in Transition: Market versus Planning in the City of Tbilisi, Georgia



Joseph Salukvadze, Tbilisi State University

Presentation prepared for the 18th International
symposium „Landscape diversity and biodiversity“



Smolenice, 25 April 2019

Urban Ecosystem Services - Outline

- 1 Challenges (Urbanization and nature)
- 2 Concepts (SDG's; BD; ESS; NbS...)
- 3 Terms (More than buzzwords?)
- 4 Assessment (Indicator based; „Greenest city?)
- 5 Implementation („double inner development“)

Background

- Increasing **threats** on nature (biodiversity)
- Manifold and growing **demands** on limited resources
- Fostering **sustainable land use**

→ **Concept of ecosystem services (ES)**

= *Contributions of nature (ecosystems) to human well-being*



Background (driver): Ongoing urbanization

Region	Urbanization rate [%]			Percentage point increase [%]	
	2000	2010	2050	2000-2010	2010-2050
Europe	70.8	72.7	82.2	1.9	9.5
Asia	35.5	42.5	62.9	7.0	20.4
China	35.9	49.2	77.3	13.3	28.1
India	27.7	30.9	51.7	3.3	20.8
Africa	35.6	39.2	57.7	3.6	18.5
North America	79.1	82.0	88.6	2.9	6.6
Latin America	75.5	78.8	86.6	3.4	7.8

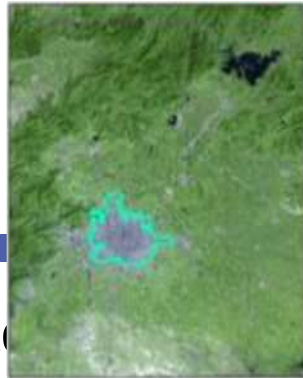
Source: Asian Development Bank (peak values in red)

- The world is “urbanizing”
- North America has the highest urbanization rate
- Asia has the highest speed in urban development (top speed: China)

- Urban sprawl / (re-) densification of cities
- Environmental problems
- High pressure on biodiversity



Beijing
© K. Grunewald



- The consequences of urbanization include:
 - land disturbance and conversion to impervious surfaces;
 - increased temperatures, water run-off and production of carbon dioxide (Whitford et al. 2001, Bryant 2006);
 - removal of native vegetation and introduction of exotic species;
 - changes in species composition and species extinction (McKinney 2006);
 - changed water and nutrient cycles (Bierwagen 2007);
 - degradation, fragmentation and isolation of natural habitats.
- Uniqueness and importance of urban biodiversity derives from its special features :
 - the exclusive physical and ecological conditions of cities;
 - the mixed and small-scale habitat mosaic;
 - the combination of native and introduced species that create a recombinant habitat with its own dynamic, ecology and value;
 - the presence of habitat types and biological communities that are significantly different from other occurring elsewhere. (Mueller 2007, 2010)

2 Concepts / Strategies

The **‘Green city concept’** follows the vision and ideals of sustainable urban development

Analysis and assessment of urban biotopes and ecosystem services = evidence based research approach

Development of **strategies and planning tools** for mainstreaming and implementation of nature based solutions in cities





Global initiatives, strategies, e.g. TEEB, NEA, MAES



Habitat III, SDG's
→ New Urban Agenda



GREEN *economy*



CBD CoP10 Nagoya, Japan (18.-29.10.2010): Strategic Plan 2011-2020

Aichi targets:

VISION

By 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people.

MISSION

Take effective and urgent action to halt the loss of biodiversity in order to ensure that **by 2020** ecosystems are resilient and continue to provide essential services.

IPBES - Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (assessment 2019)

EU Biodiversity Strategy 2020

First **European assessment** of the provision of ecosystem services (Maes et al. 2011)

Working Group on Mapping and Assessment on Ecosystems and their Services (MAES)

Coherent **analytical framework**

Typology of ecosystems in Europe based on **CICES-classification** (Common International Classification of Ecosystem Services) (Haines-Young & Potschin 2012; Maes et al. 2013, 2014)

Strategies: Green Infrastructure



Ecosystem services and green infrastructure
can help to guide landscape planning towards
compact and green cities
by reflecting the
socio-ecological complexity of cities.

In Germany:

Sustainability, biodiversity strategies / White book of urban green



2001, 2017



2007



2015



2017

Masterplan City Nature (2019), among other

- Improving data bases for urban nature
- Strengthening municipal landscape planning
- Legal strengthening of green infrastructure in urban development support

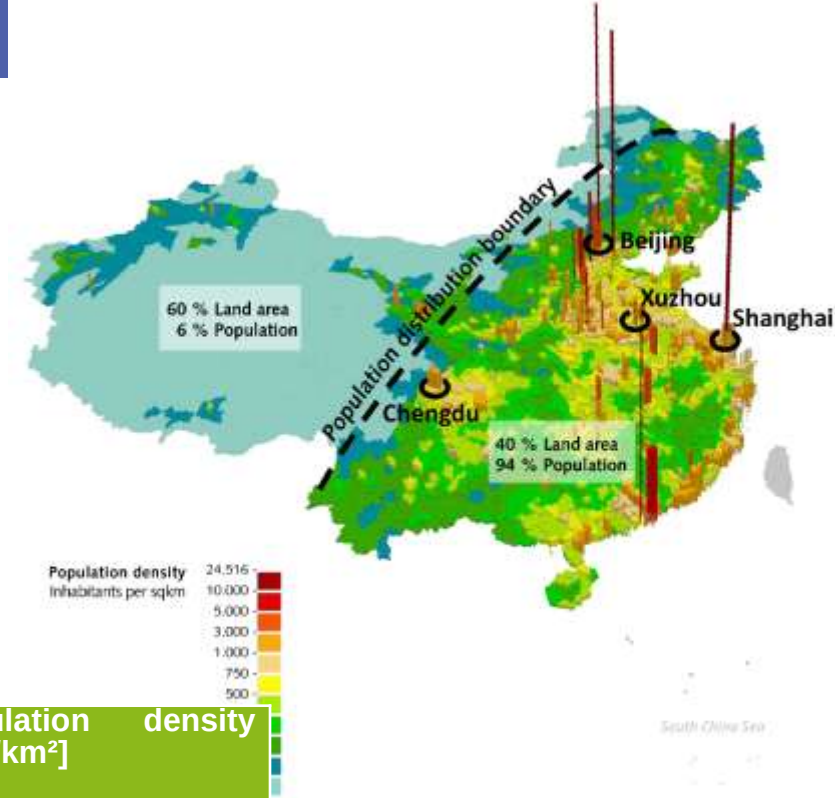
3 Key terms

Cities can be understood as permanent human settlements characterized by three dimensions and their interlinkages (Kuper & Kuper 1996):

- City as economic and societal unit represents economic and social processes.
- City as political unit represents an administratively defined area.
- City as physical structure defined by buildings, green spaces, infrastructure.

Urbanization and Cities in China

... there are three levels of cities:
municipalities, prefecture-level cities,
and county-level cities;
... state-owned urban land



Distribution of
population density in
China (© G. Xie)

	Million inhabitants in 2010		Area [km ²]		Population density [inh./km ²]	
	Admin. area	Urban area	Admin. area	Urban area	Admin. area	Urban area
Chongqing	28,846	15,693	82,402	26,025	350	603
Shanghai	23,019	22,315	6,340	5,155	3,630	4,329
Beijing	19,612	18,827	16,408	12,187	1,195	1,545
Chengdu	14,048	7,416	12,121	2,064	1,159	3,593
Tianjin	12,938	11,091	11,946	7,418	1,083	1,495
Xuzhou	8,577	1,967	11,258	1,180	762	1,667

Source: National Bureau of Statistics of China

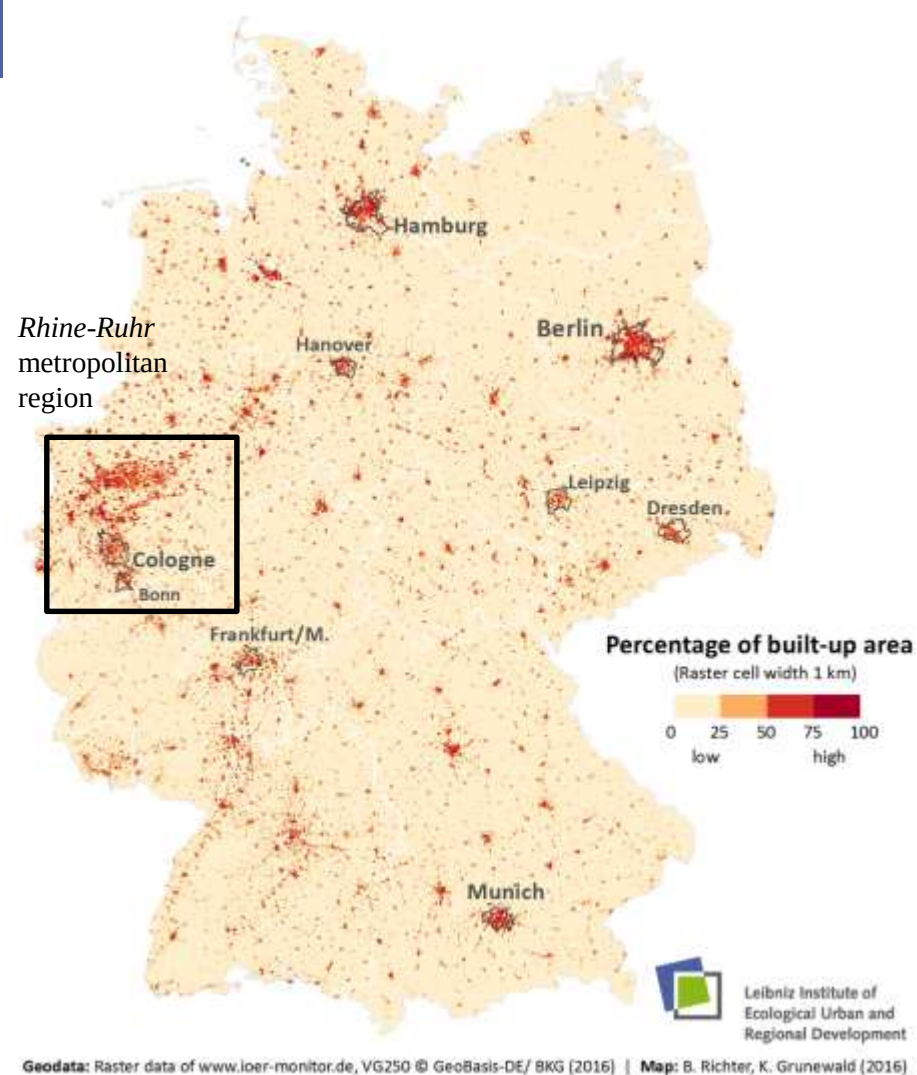
Urbanization and Cities in Germany

... is highly urbanized

... 75% of population live in cities,
two-third of them in small- and
medium-sized cities

Characteristics of the five biggest German cities
and selected case study cities (StaBA 2014)

	Population (rank)	Area [km ²]	Population density [inh./km ²]
Berlin	3,470,000 (1)	891.7	3,890
Hamburg	1,763,000 (2)	755.3	2,330
Munich	1,430,000 (3)	310.7	4,600
Cologne	1,047,000 (4)	405.0	1,210
Frankfurt/Main	718,000 (5)	248.3	2,580
Leipzig	544,000 (11)	297.4	2,430
Dresden	536,000 (12)	328.3	1,630
Hanover	524,000 (13)	204.2	2,570
Bonn	314,000 (19)	141.1	2,230



Distribution of big cities in Germany

The **‘Green city concept’** follows the vision and ideals of sustainable urban development, focusing on environmental issues to some extent.

In the context of political objectives of the EU **‘Green infrastructure’ (+blue)** is defined as “a strategically planned network of high quality natural and semi-natural areas with other environmental features” (EC 2013; EEA 2014).

‘Urban green spaces’ addressing the entity of biotic and nature elements in urban areas.

‘Urban ecosystems’ are mainly represented by different types of urban green spaces in the city (parks, forests, cemeteries...), they provide services for dwellers.

‘Biodiversity’ particularly supports the ‘functioning of ecosystems’.

Four basic forms of nature found in cities (Kowarik 2005):

- 1) Nature 1: Remnants of primary “original” natural landscapes (woods, wetlands, rocky areas, etc.)
- 2) Nature 2: Agricultural cultural landscape arose through tradition of modern agriculture and forestry (fields, meadows, meadows with mixed fruit trees, heathland, dry grassland etc., forests)
- 3) Nature 3: Horticulturally designed symbolic nature (parks, gardens, street trees, flower tubs etc.)
- 4) Nature 4: Specific urban-industrial nature (scraggy wall vegetation, vegetation on sidewalks, spontaneous vegetation on gaps between buildings and on abandoned areas etc.)

4 ES Assessment

At the interface ecosystem services–land use an integrative management is necessary, which aims at the balance between the conservation, the sustainable use and the fair allocation of benefits from the utilization of the land.

The Ecosystem Services Partnership

launched in 2008 by the Gund Institute for Ecological Economics (University of Vermont, USA); now being coordinated by the Environmental Systems Analysis Group (Wageningen University, the Netherlands)

- consists of institutional and individual members
- 10th world conference 21-25 Oct. 2019 Hanover

Aims

- enhance communication, coordination and cooperation, and to build a strong network of individuals and organizations

www.es-partnership.org

Assessment of UES in Germany – national level

Natural Capital Germany – TEEB DE (2012-2017)



ES in the city
(Kowarik et al.)

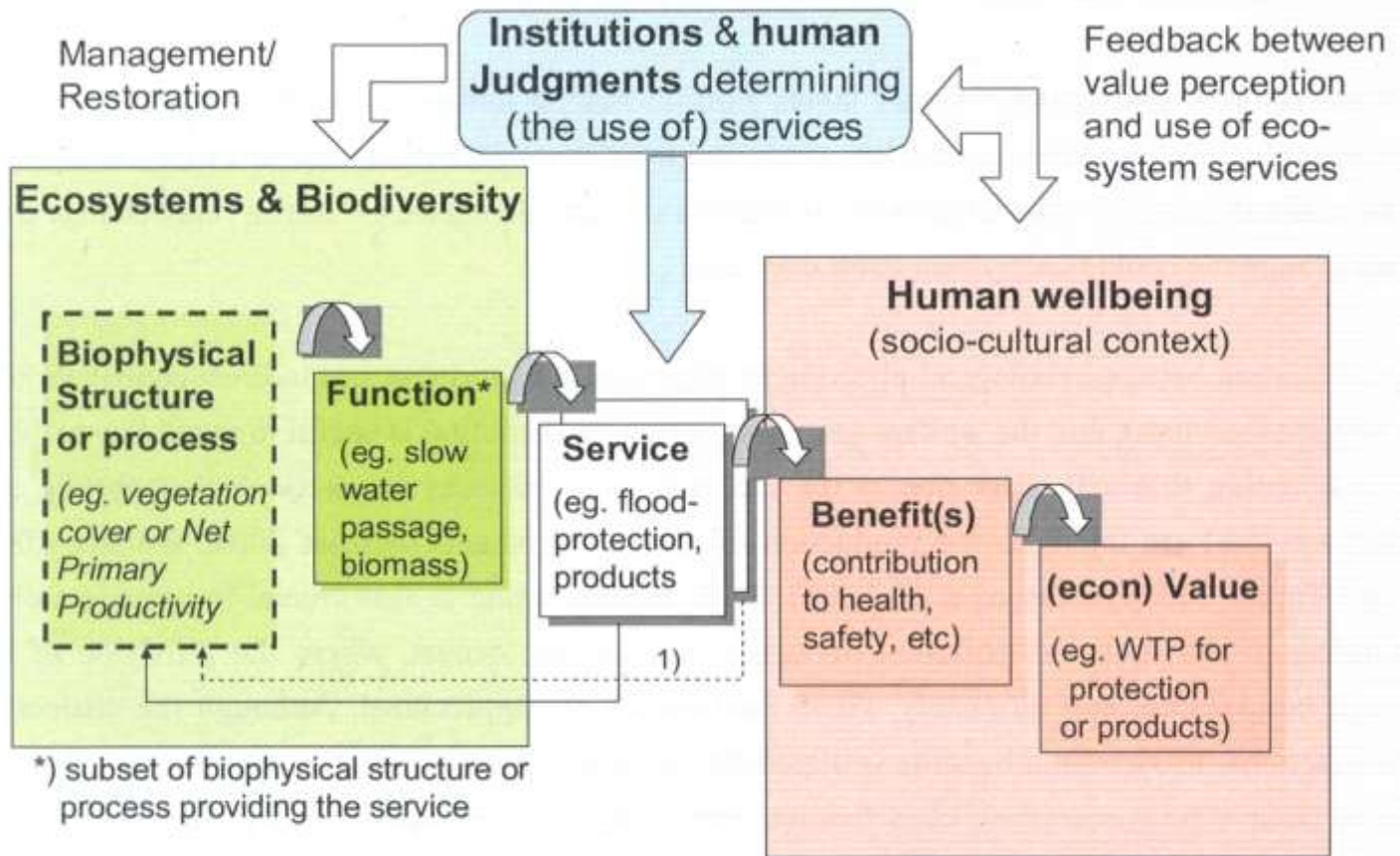
Aims:

- ❖ Raising awareness of the social and economic importance of ES
- ❖ Facilitate knowledge exchange between science & policy
- ❖ Support sustainable urban development

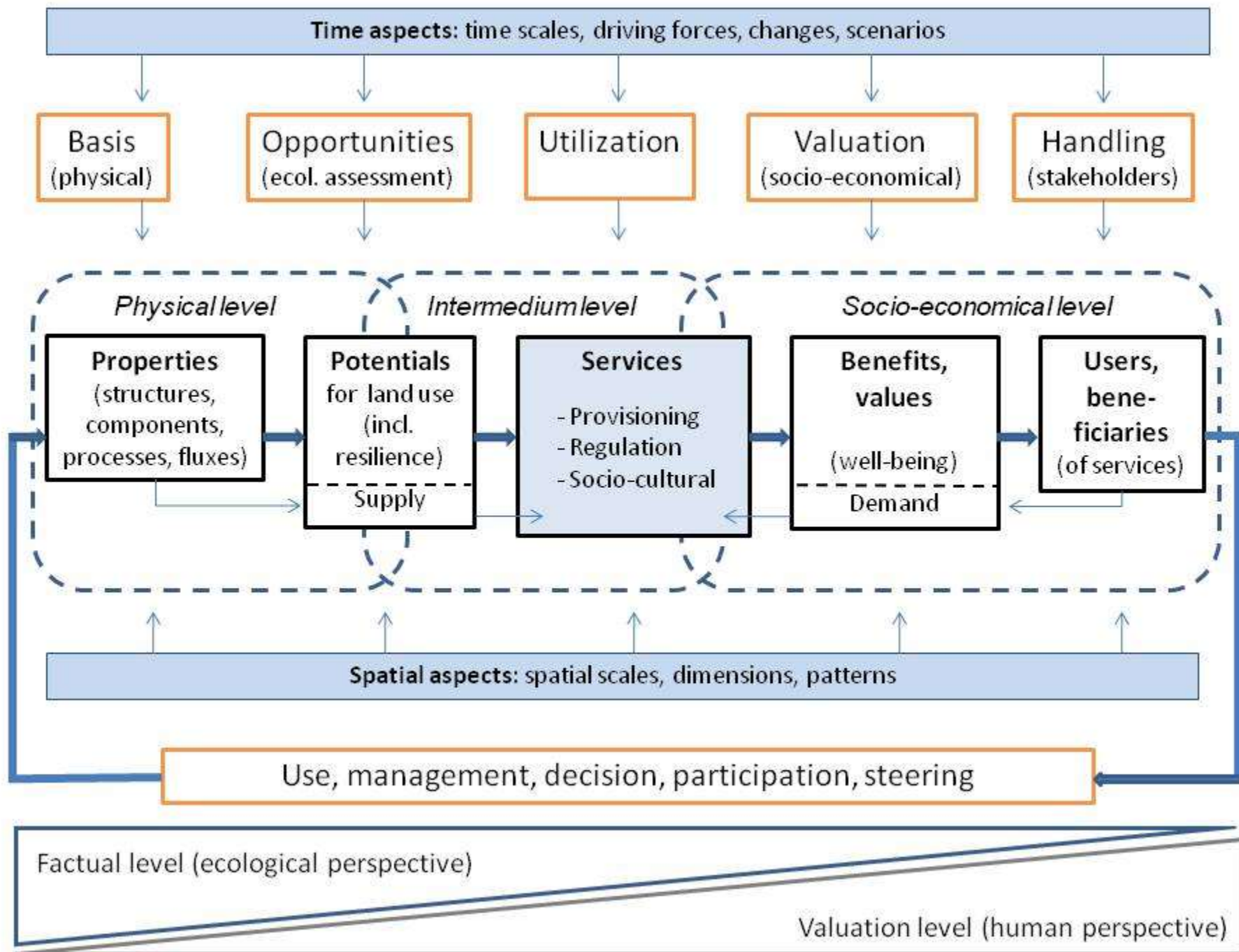
(No national ES assessment, no comprehensive economic valuation study)

ES frameworks

ES cascade → TEEB (2009)



Adapted from Haines-Young & Potschin, 2009 and Maltby (ed.), 2009



Classification of ES

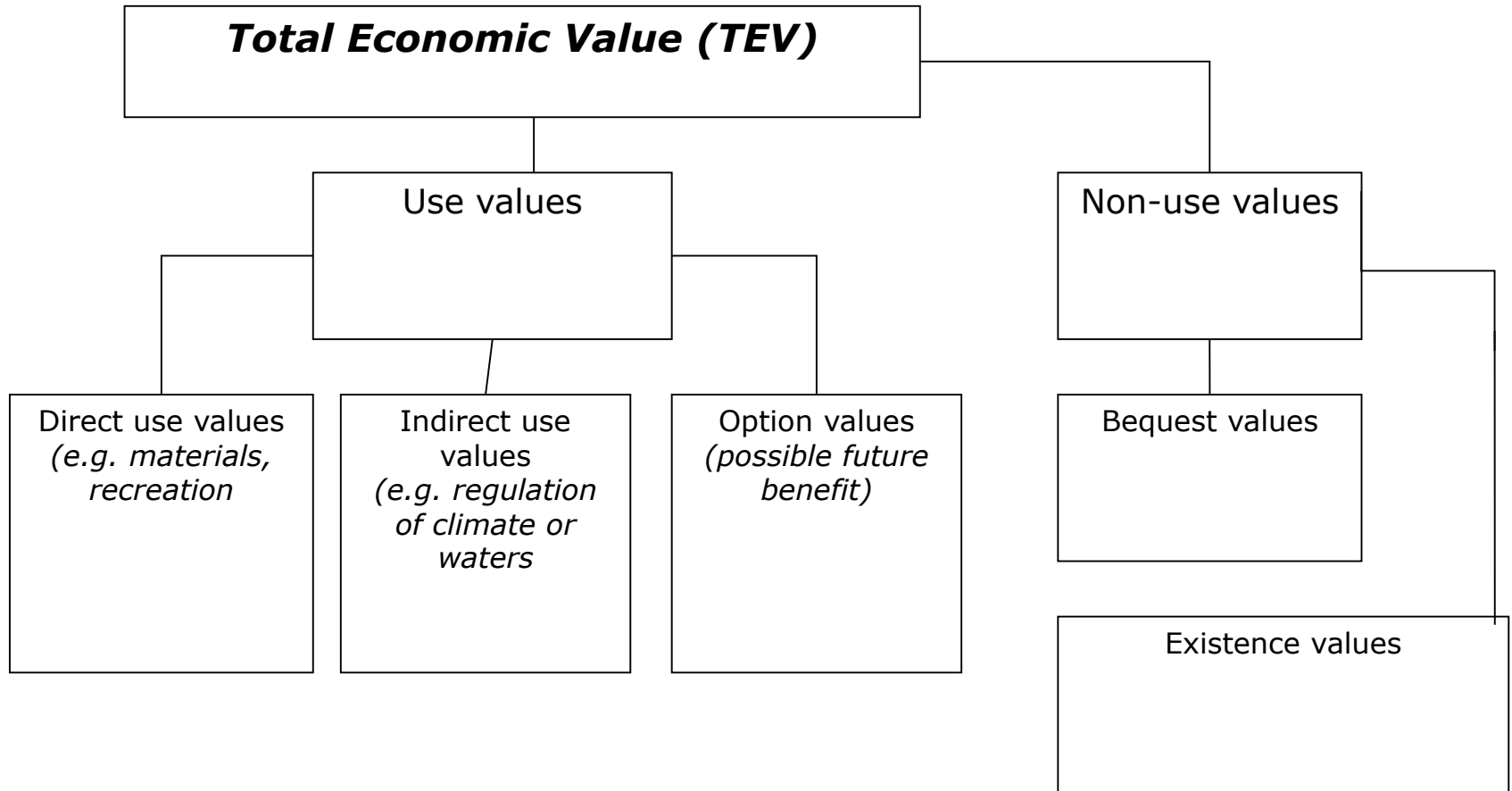
Advantage of the breakdown into

- Provisioning ES,
- Regulation ES, and
- Socio-cultural ES

→ link to the concept of **sustainability** with its established ecological, economic and social development categories



ES assessment



Why ES Assessments?

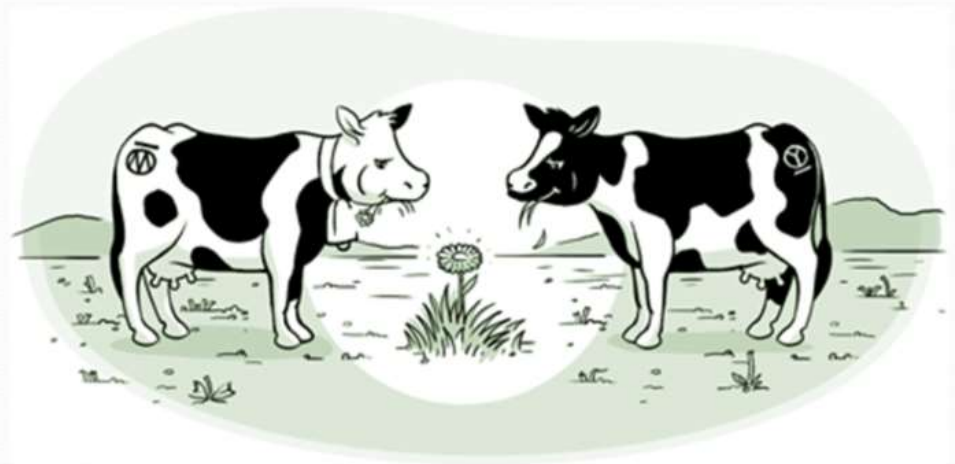
Market and policy failure in dealing with public goods

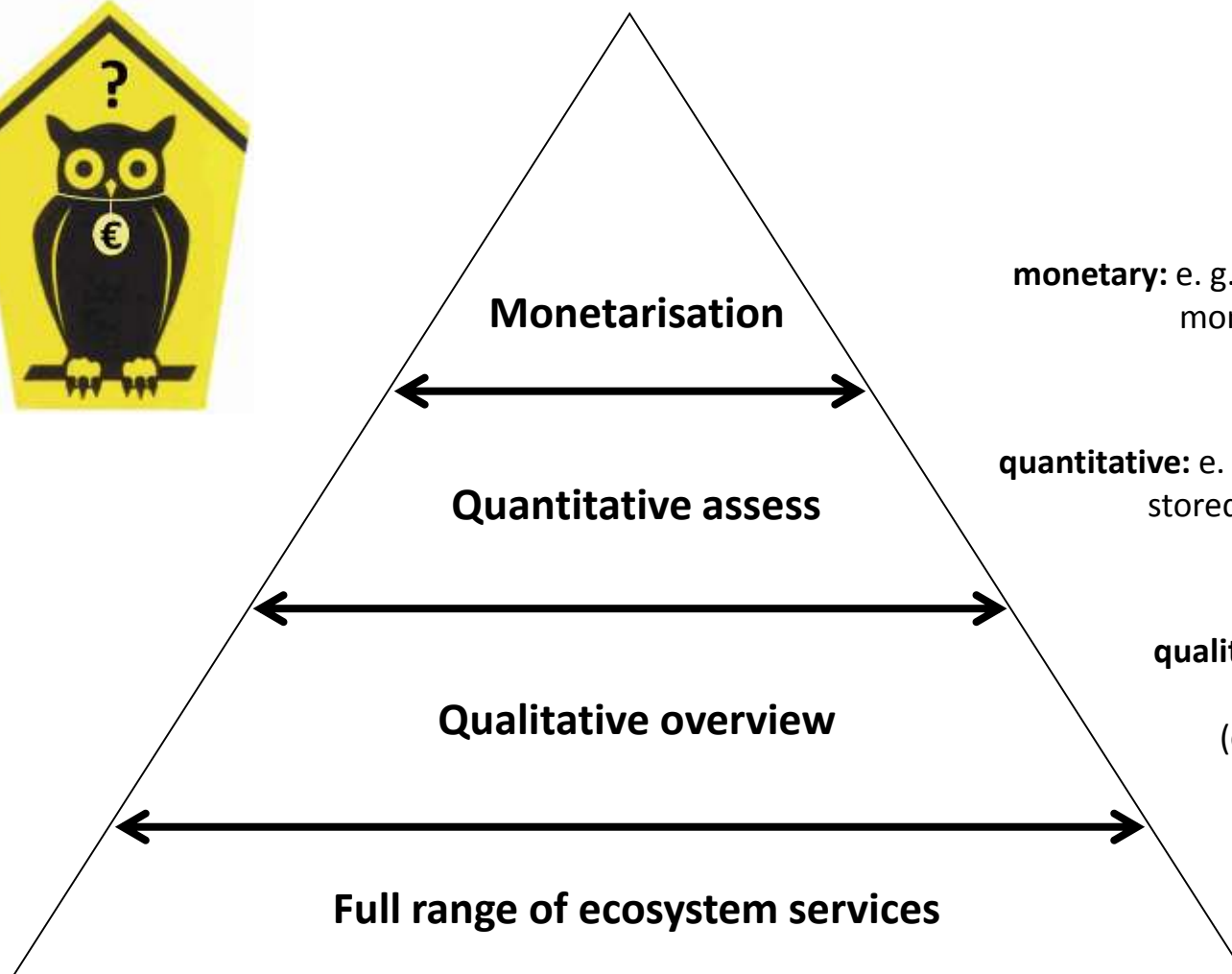
Market rules promote the overuse

The policy would have to counter-control, but how?



Garrett Hardin (1968) Tragedy of the Commons





monetary: e. g. avoided costs of water treatment, money terms of carbon sequestration, value of collected medicinal plants

quantitative: e. g. volume of treated water (in m³), stored carbon (in t), amount of collected medicinal plants (in kg)

qualitative: number/amount of services based on ecosystems, benefits (e. g. health, income, well-being) as well as existing knowledge gaps

Basic approaches to ES evaluation (ten Brink 2008)

ES-Assessment: 4 steps (MAES)

- (1) Identifying ecosystems
- (2) Assessing the conditions of ecosystems
- (3) Mapping and assessing ecosystem services
- (4) Integrative assessment

Example: ES „C-sequestration“

Regulating ES

ES	Methodics (if possible for monetary valuation)	Required data	Re
Carbon sequestration (vegetation / soils)	<u>Benefit transfer and calculations</u> -Using Biotope-Table with values for C-sequestration in soil and vegetation (combination soil and vegetation volume) -possible <u>focus</u>: street trees; basic / rough calculations by means of tree cadaster data -external model / software? → I-Tree Eco	Tree cadaster Biotope mapping data / Vegetation cover (e.g. based on CLC, like LBM DE or KVES) Green volume (Stadt Dresden) or Tree Cover density data (EU) Soil maps	Soi (x) (x) (x) Stre (x) (x) (x)

Example: ES „C-sequestration“ in Dresden

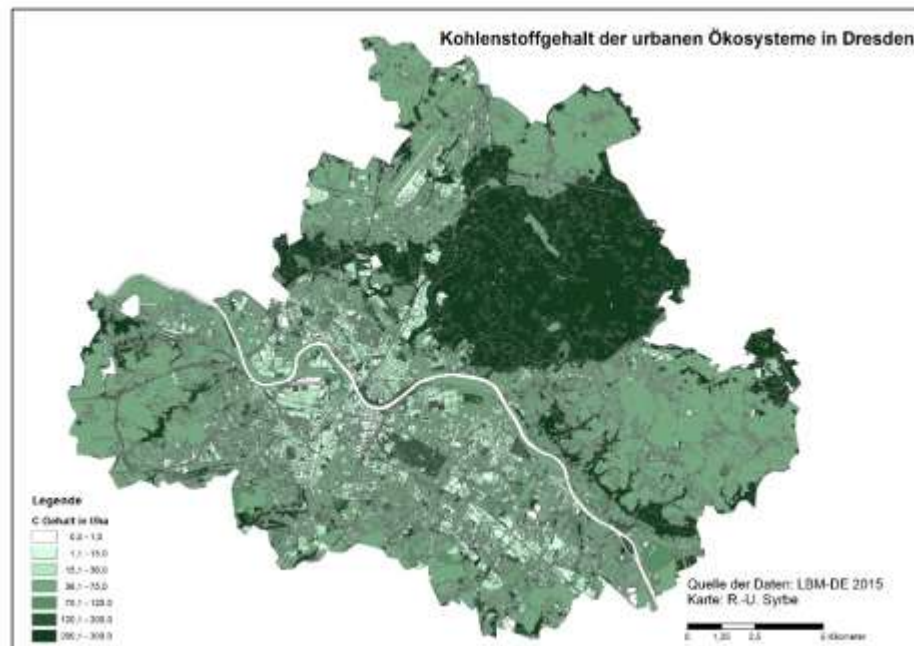
■ C-Sequestration (etc.): Street trees

■ CO₂-Reduktion und O₂-Produktion

	C-Vorrat	CO ₂ -Reduktion	O ₂ -Produktion	Jährliche C-Sequestrierung	Jährliche CO ₂ -Reduktion	Jährliche O ₂ -Produktion
Minimal [kg]	0,02	0,06	0,05	0,06	0,22	0,16
Maximal [kg]	9.306	34.122	24.816	285	1.045	760
Gesamt [t]	12.463	45.697	33.234	662	2.429	1.767

Projektarbeit L. Maul, 2018

■ C-Sequestration: Vegetation and soils

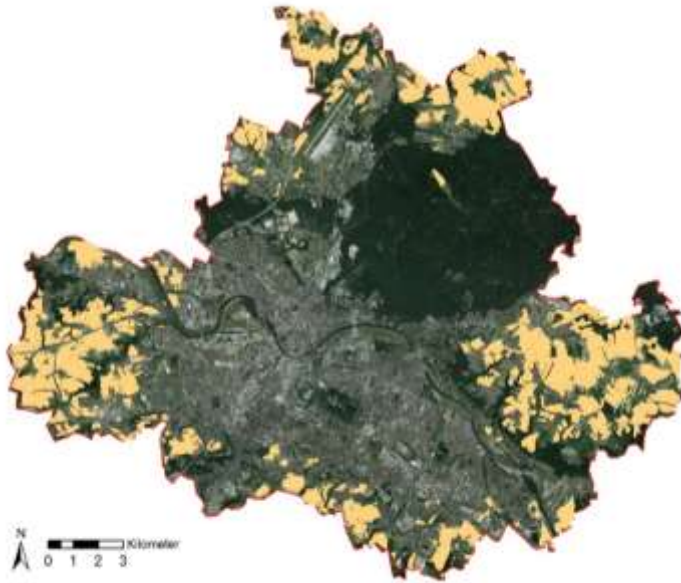


Calculated ecosystem services of the **Dresden city forest**

Ecosystem service	Value (€/ha x a)	%
Timber production	179	2.8
Game	13	0.2
Water protection (nitrate elimination)	127	2.0
Water retention	176	2.8
Erosion control	617	9.7
Carbon sequestration	47	0.7
Oxygen production	539	8.4
Noise protection	71	1.1
Dust filtration	250	3.9
Settlement value	393	6.1
Recreational potential	2163	33.8
Biodiversity / species and habitat protection	1817	28.4
	6393	100

Arable land

Räumliche Verteilung der Ackerflächen in Dresden



**Yield potential:
30 320 t grain/year**

**~ supply of 70% of
Dresden's population
for 1 year**

Stadtgebietsfläche

1. Flächenerhebung nach Art der tatsächlichen Nutzung

	2014 ¹⁾	2015	2016	2017
	in ha			
Siedlung	10 417	10 432	10 454	10 501
Wohnbaufläche	5 419	5 389	5 382	5 382
Industrie- und Gewerbefläche insgesamt	2 006	2 027	2 038	2 061
davon				
Handel	785	799	808	810
Industrie u. Gewerbe	1 039	1 048	1 051	1 071
Versorgungsanlage	75	76	76	75
Entsorgung	106	104	104	104
Halde	71	74	74	74
Tagebau, Grube, Steinbruch	135	135	135	135
Fläche gemischter Nutzung	50	51	52	53
Fläche Besonderer funktionaler Prägung	901	908	928	934
Sport-, Freizeit- und Erholungsfläche	1 664	1 676	1 672	1 689
darunter Grünanlage	809	810	789	793
Friedhof	172	172	172	172
Verkehr	3 364	3 374	3 377	3 381
Straßenverkehr	2 406	2 363	2 367	2 374
Weg	249	300	302	302
Platz	101	108	106	106
Bahnverkehr		---		88
Flugverkehr				10
Vegetation	10 311	10 311	10 311	10 311
Landwirtschaft	10 703	10 693	10 665	10 605
Wald	7 175	7 170	7 170	7 169

-10 ha -28 ha -60 ha

2014 to 2017: - 100 hectares

Fließgewässer	517	505	505	505
Hafenbecken	12	12	12	12
Stehendes Gewässer	150	164	166	166
Bodenfläche insgesamt	32 831	32 848	32 848	32 848
darunter Siedlungs- und Verkehrsfläche ¹⁾²⁾	13 647	13 670	13 696	13 746

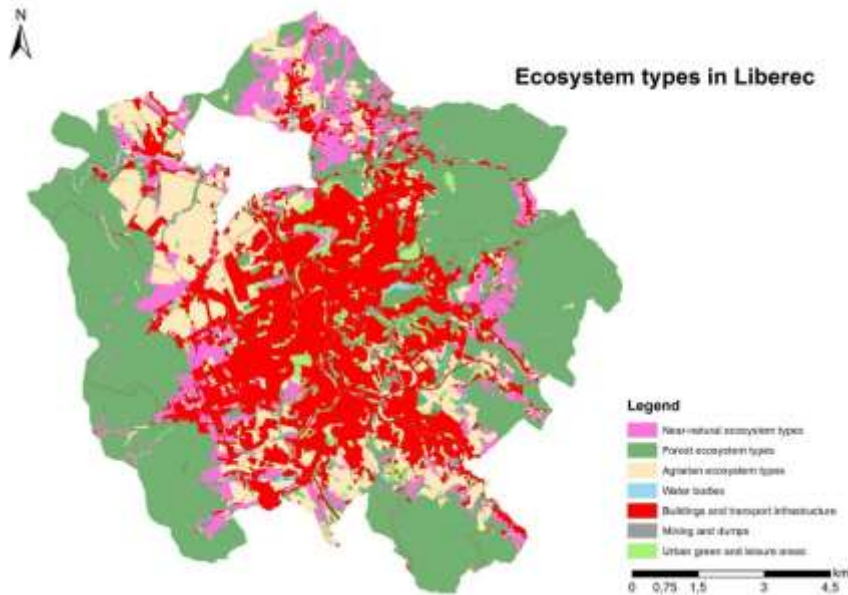
Anmerkung: ¹⁾ Im Jahr 2014 erfolgte die Umstellung der Datenbasis von ALB-Daten auf ALKIS-Daten ab 2015.

Das Jahr 2014 wurde auf die neue Struktur umgerechnet, jedoch ist ein Vergleich mit 2015 nur eingeschränkt möglich. Das betrifft auch die Siedlungs- und Verkehrsfläche. Die Gesamtfläche Dresdens hat sich durch die Umstellung erhöht.

²⁾ Siedlung + Verkehr - Tagebau, Grube, Steinbruch

Quellen: Amt für Geodaten und Kataster, Staatsbetrieb Geobasisinformation und Vermessung Sachsen

Economic value of habitats in Liberec



Using **Biotope Valuation Method** (SEJÁK et al. 2003):

- combination of expert and cost method
- value of habitat services only

The capital **value of habitats** of Liberec
→ **2,381,695,505 €**

Annual total value of habitats of Liberec
→ **119,084,775 €/a**

Access to urban greenspace

ES: Recreation in cities

Class: Utilization of landscapes

- Main indicator:

Greenspace available

Greenspace of high quality
(by size 0.5 / 10 ha)

IÖR, 2003

+

+

Access allowed for all people

Greenspace achievable
(by distance 300 / 700 m)

Rößler, 2007

Rößler, 2007



Ecosystem Service Capacity "after work recreation"



Green areas (>1 ha)

Ecosystem Service Demand



Population density

Ecosystem Service Flow



Access to urban green for "after work recreation"

Access to urban green?

Yes

No

High

Low

Population density

Dresden

[Artmann et al. 2017]

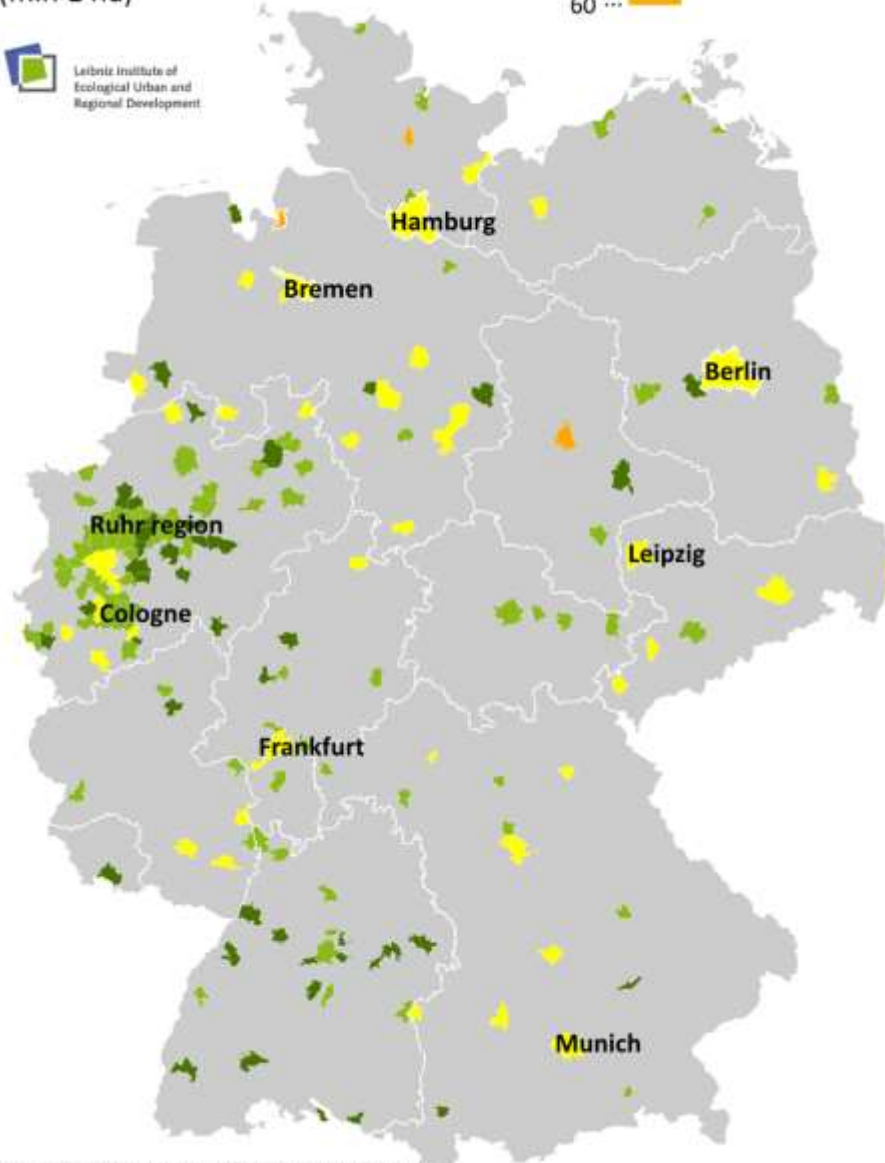


Leibniz-Institut
für ökologische
Raumentwicklung

Percentage of inhabitants
within walking distance (max. 300 m)
to nearby green spaces and water areas
(min 1 ha)



Leibniz Institute of
Ecological Urban and
Regional Development



74.3 % of the inhabitants (all cities $\geq 50,000$ inhabitants, $n=182$) can reach green spaces in the residential environment.

Acceptance / implementation
of the indicator
(Biodiv.strategy)

Grunewald et al. 2016

Assessment of UES in Germany – city / neighborhood level

Dresden example



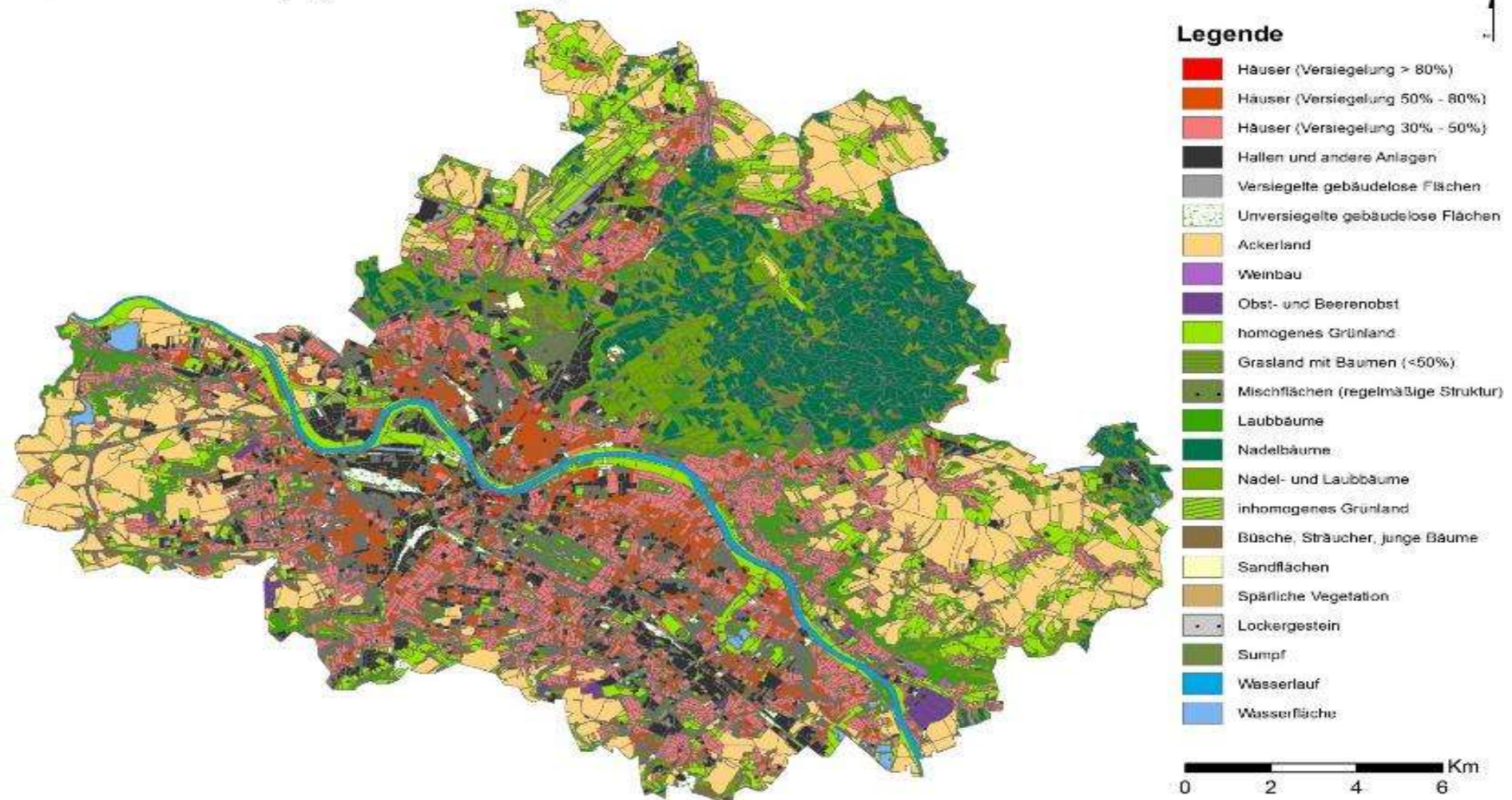
- demonstration of values and services of urban nature
- city level + habitate types

■ ES assessment



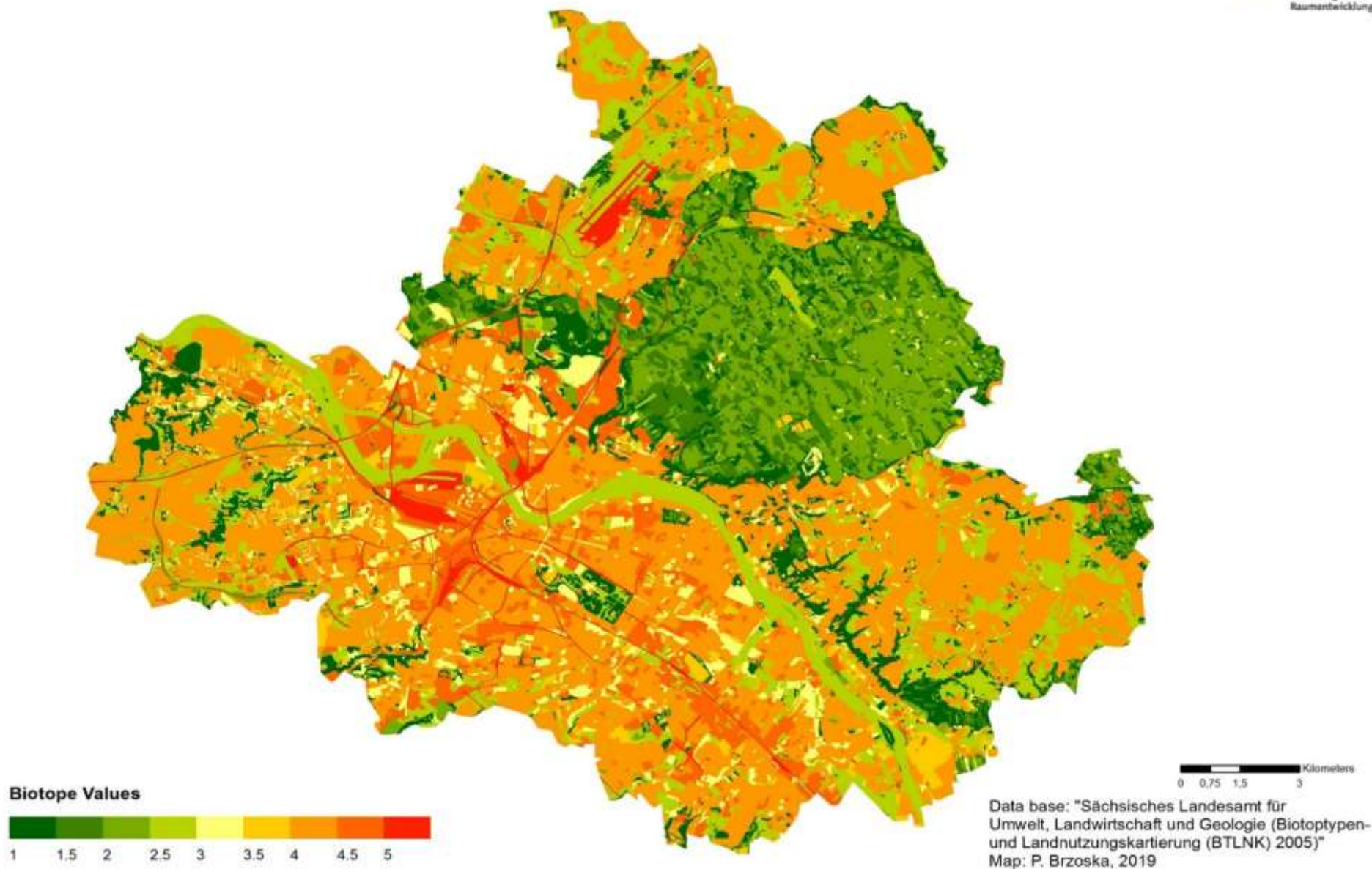
- development of measures for heat-resistant quarters
- neighbourhood level

Land cover map (LBM DE 2012) - Dresden



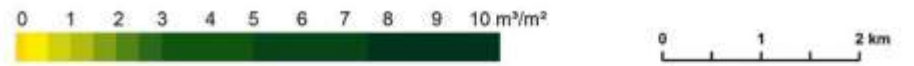
Mapping of ecosystems, species

Valuation of biotope types in Dresden (according to Bastian & Schreiber 1999)



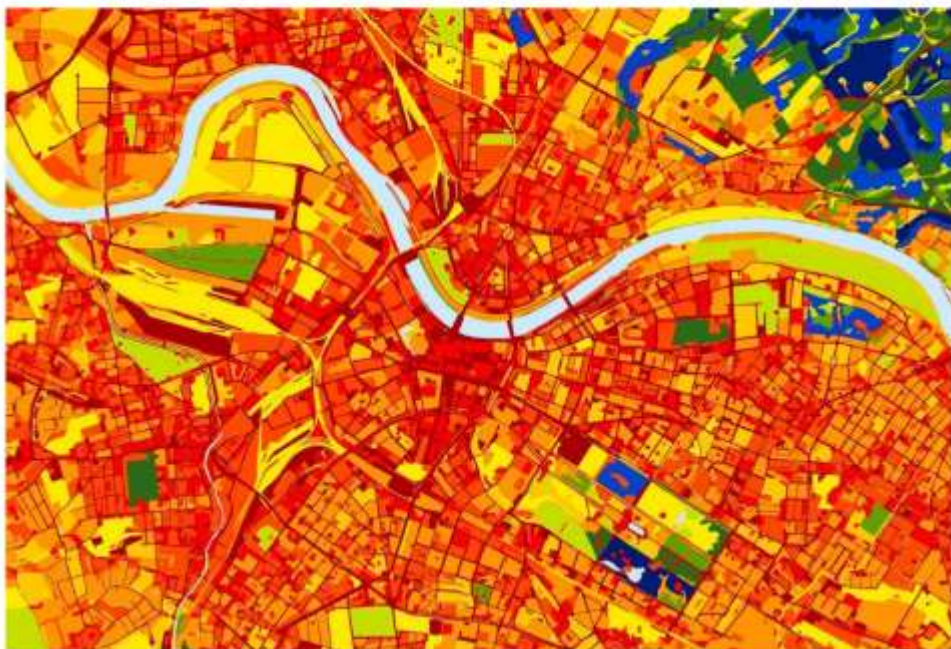
ES climate regulation

Temperature reduction by green structures in city centre of Dresden (Germany)



Distribution of green volume [m^3/m^2]

Basis for both maps: urban vegetation structure types, IÖR
basing on the biotope mapping for Dresden Municipality 1999



Maximum cooling effects [Δt_{max} in K] of different urban
vegetation structure types in 1,5 m height, related to a dry
sealed surface at a radiation-high summer day
Modelling of cooling effects: HIRVAC-2D, TU Dresden

Ecosystem services of street trees in Dresden

▪ CO₂-reduction und O₂-production

	C-Vorrat	CO ₂ - Reduktion	O ₂ - Produktion	Jährliche C- Sequestrierung	Jährliche CO ₂ - Reduktion	Jährliche O ₂ - Produktion
Minimal [kg]	0,02	0,06	0,05	0,06	0,22	0,16
Maximal [kg]	9.306	34.122	24.816	285	1.045	760
Gesamt [t]	12.463	45.697	33.234	662	2.429	1.767

Questionnaires: how do the people of Dresden evaluate urban nature (demand)?



5 Implementation

Dealing with the challenges to develop greener cities

Find ways to

- 1 ... limit urban land consumption and change from quantitative to qualitative urban growth**
- 2 ... find an optimal urban form, integrating various kinds of nature**
- 3 ... create healthy urban living conditions**
- 4 ... use urban green spaces and their management for adapting to climate change (suitable structure and management)**
- 5 ... ensure that all urban dwellers profit from benefits of urban green spaces**
- 6 ... engage people in planning process, decision making, design and management of urban green spaces**
- 7 ... improve the usage and usability of existing scientific and practical knowledge for better decision making and urban design**
- 8 ... reach green city targets with limited public budgets for greener cities**
- 9 ... integrate all forms of nature into urban development for people's nature experiences and benefits**
- 10 ...develop eco-districts and build new eco-cities**

UES for Dresden

- provision / illustration of data, facts, values on urban nature → communication
- combined consideration of monetary/physical characteristics or supply/demand of ES
- opportunity: Integration of the benefits of nature into landscape plans
- lack of legal basis, therefore no comprehensive assessment has been carried out so far → process

Summary: Mainstreaming UES

‘**Urban ecosystems**’ are mainly represented by different types of urban green spaces in the city (natural remnants, agriculture, gardens, parks, forests, cemeteries, urban-industrial spaces), they **provide services** for dwellers. ‘**Urban ecosystem services**’ (UES) are produced and demanded within the city’.

- Less heat
- Clean air
- Less noise
- Stormwater management

Reduction of environmental pressures



Benefits from urban nature

- Better health
- Recreation
- Nature experience
- Social cohesion
- Attractive sites for living

Human wellbeing

How green are our cities? How much “green” is enough?

Indicators and target values for green space in cities (standards), e.g. 9m² green space per capita (WHO)

Target values in Germany:

- were set already 100 years ago and updated by the conference of garden office directors (GALK 1973), for instance, 20 m² of public green space per capita is demanded.
- In Germany, 39 % of the cities currently use benchmarks to measure green space (Kühnau et al. 2016).
- The German land use ordinance (BauNVO 2013) places several limits on the construction density on individual parcels, depending on their classification in the land use plan. For instance, ordinary housing plots should comply with a site occupancy index of 40 % and not exceed a maximum of 60 %, which also applies to the soil sealing degree.

- **‘Green’ urban development (UES)** figures prominently on the political agenda in Germany and many other countries.
- The establishment of **quantitative benchmarks** or **target values** is difficult. In addition to the proportion and volume of green space, spatial arrangement, accessibility and other, especially qualitative aspects play a key role.
- Indicator-based city rankings can be problematic, but they can also be useful if they get us **talking about what’s really important**.



Urban nature/landscape – balance of grey-green infrastructure

ES: Russia, NUS (incl. Georgia)

Karsten Grunewald, Olaf Bastian
und Alexander Drozdov (Hrsg.)

**TEEB-Prozesse und Ökosystem-Assessment
in Deutschland, Russland und weiteren
Staaten des nördlichen Eurasiens**

Karsten Grunewald, Olaf Bastian,
Alexander Drozdov und Vasily Grabovsky (Hrsg.)

**Erfassung und Bewertung von
Ökosystemdienstleistungen (ÖSD)**
– Erfahrungen, insbesondere aus Deutschland
und Russland –

No cities (UES)

But in 2020?

Карстен Груневальд, Олаф Бастиан
и Александр Дроздов
(Составление)

**TEEB процессы и экосистемные оценки
в Германии, России и в некоторых других
странах Северной Евразии**

Карстен Груневальд, Олаф Бастиан,
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(Составление)

Учет и оценка экосистемных услуг (ЭУ)
– Опыт, особенно Германии и России –

Thanks for listening !

