

Ecosystem Services – Mapping, Assessment and Perspectives of Application

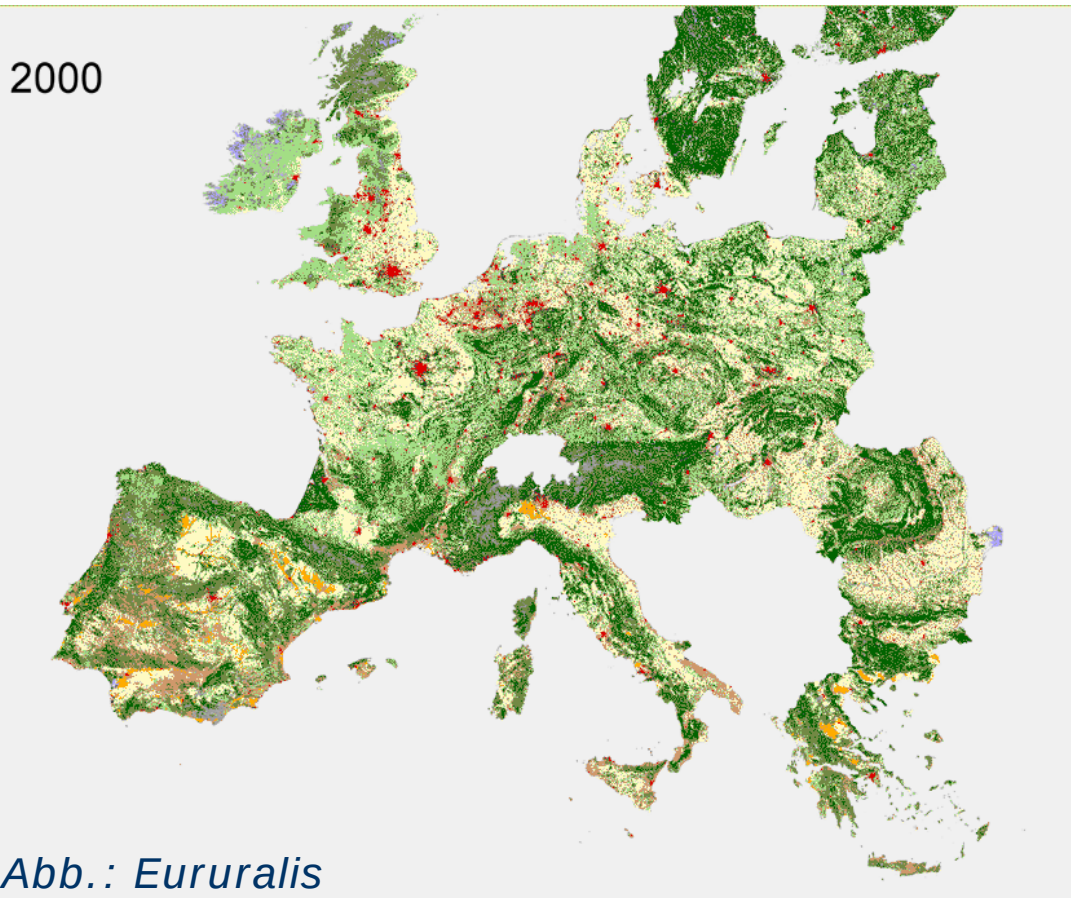
Dr. Ralf-Uwe Syrbe (IOER)

Structure

1. The indicator approach
2. Methodical framework
3. Examples of mapping and assessment
4. Application



The change of lifestyle and the necessity of a „Great Transformation“ (WGBU)



- Forseeable expiring natural ressources
- Economic expansion up to the limits of the planet
- Losses of habitats and species
- Deeper segmentation of society
- Shrinking government authority
- Increased significance of cultural values

Why Ecosystem Services?

Market failure regarding common / public goods

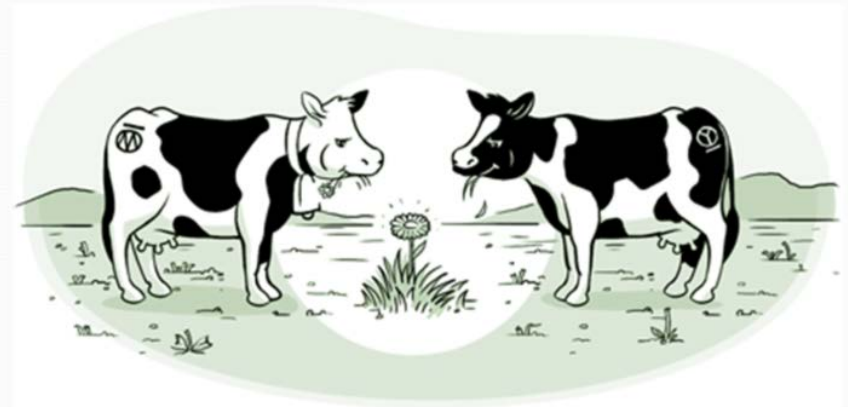
Market rules endanger nature capital!

If you cannot exclude ecosystem users, then...

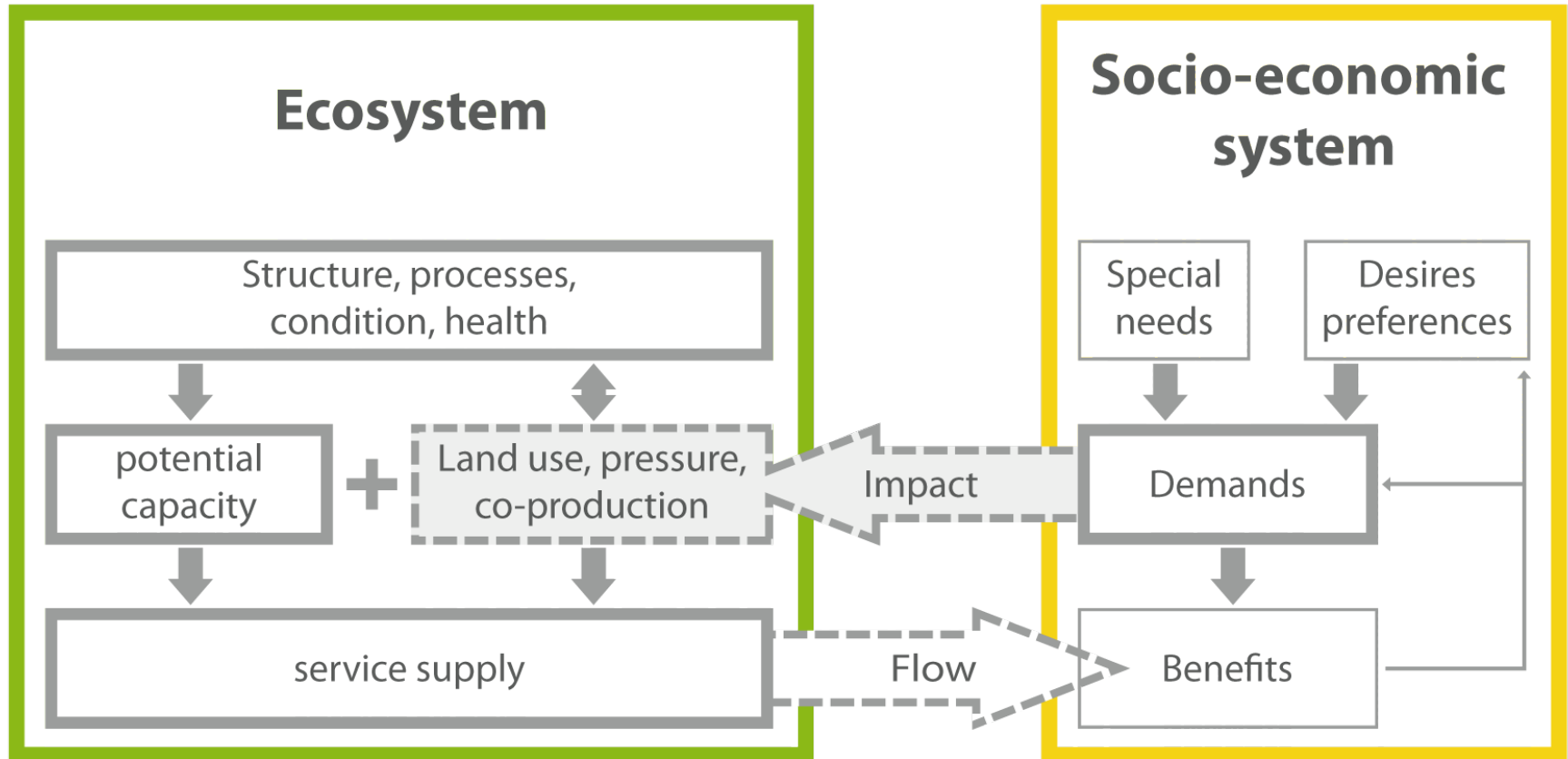
- Free-riders use them without to maintain
- Who use and care will be knocked out of the competition
- Those who remain overuse ...

Politics should counteract, but how?

Garrett Hardin (1968) Tragedy of the Commons



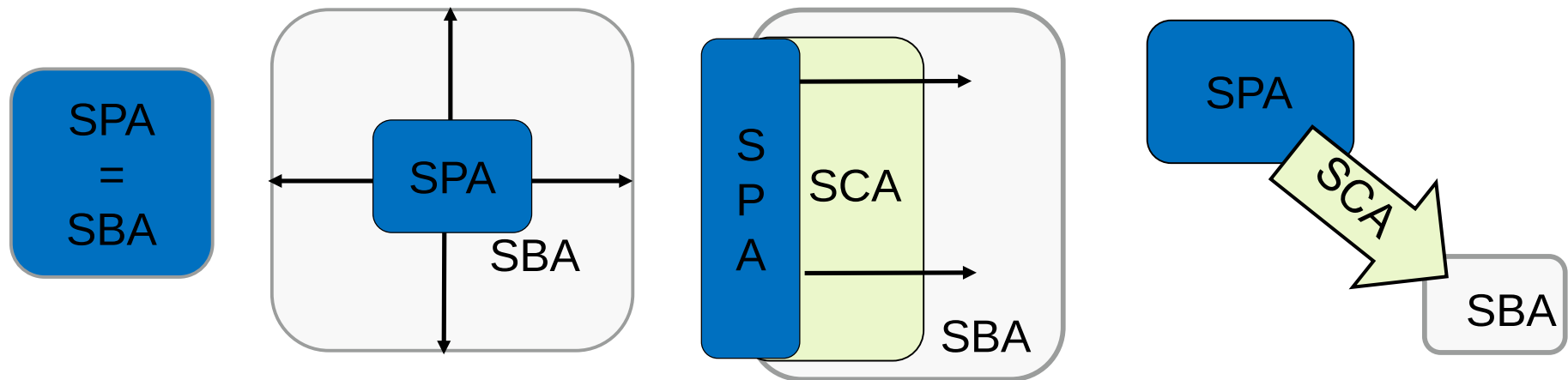
Issues for mapping & monitoring



5.1. What to map?

Spatial aspects of ecosystem services

- Relation between providing and benefit of ecosystem services
 - Service Providing Area SPA
 - Service Connecting Area SCA
 - Service Benefiting Area SBA



Syrbe, R.-U.; Walz, U. 2012. Spatial indicators for the assessment of ecosystem services: Providing, benefiting and connecting areas and landscape metrics In: Ecological Indicators 21 (2012), S.80-88.

Spatial types of ecosystem services' transfer



Ecosystem service assessment



Accounting

- ES inventory
- Matter balances
- Energy turnover
- Area requirements

Query

- Preferences
- Expenses
- Willingness to pay
- Choice model

Market analyses

- Real / hedonic prices
- Risks or damage costs
- Replacement costs
- Stock markets

GIS Tools

- Remote sensing
- Landcover analysis
- Geo- / spatial statistics
- Spatial modelling

GIS-Methodical Tools



ArGIS Extension InVEST

- Carbon sequestration
- Biodiversity
- Pollination
- Timber
- Aesthetic Quality
- Sedimentation
- Hydropower

Natural Capital Project

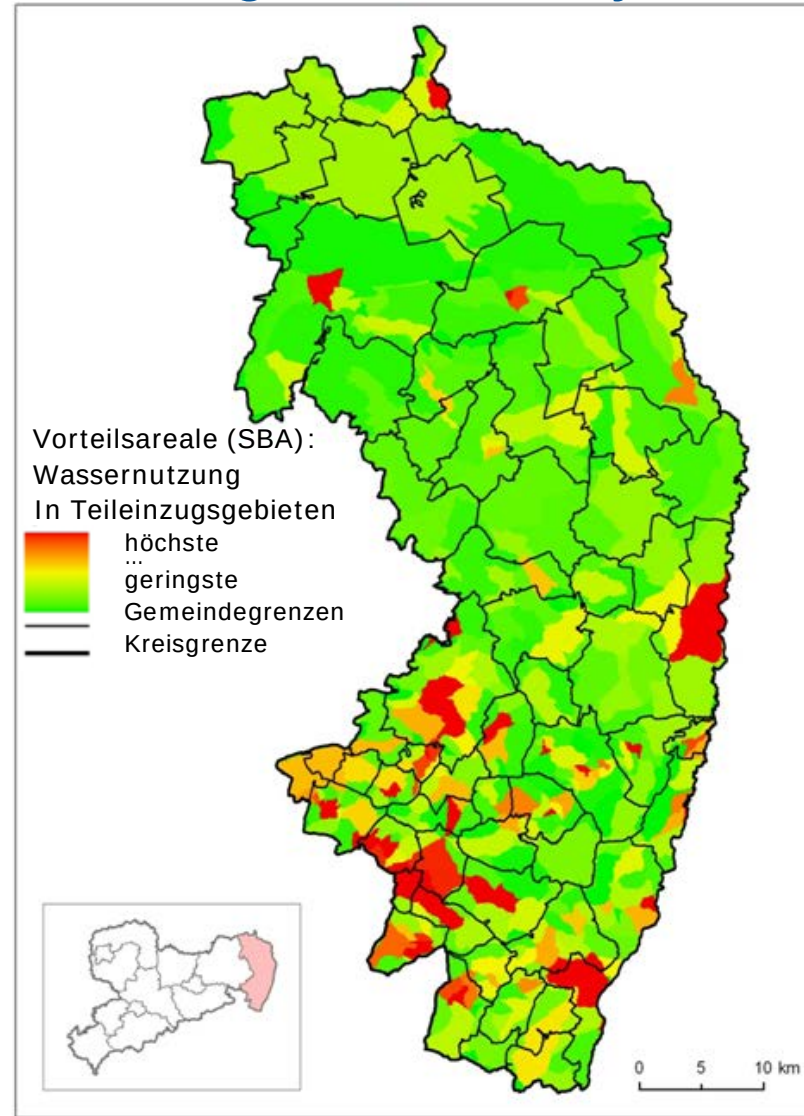
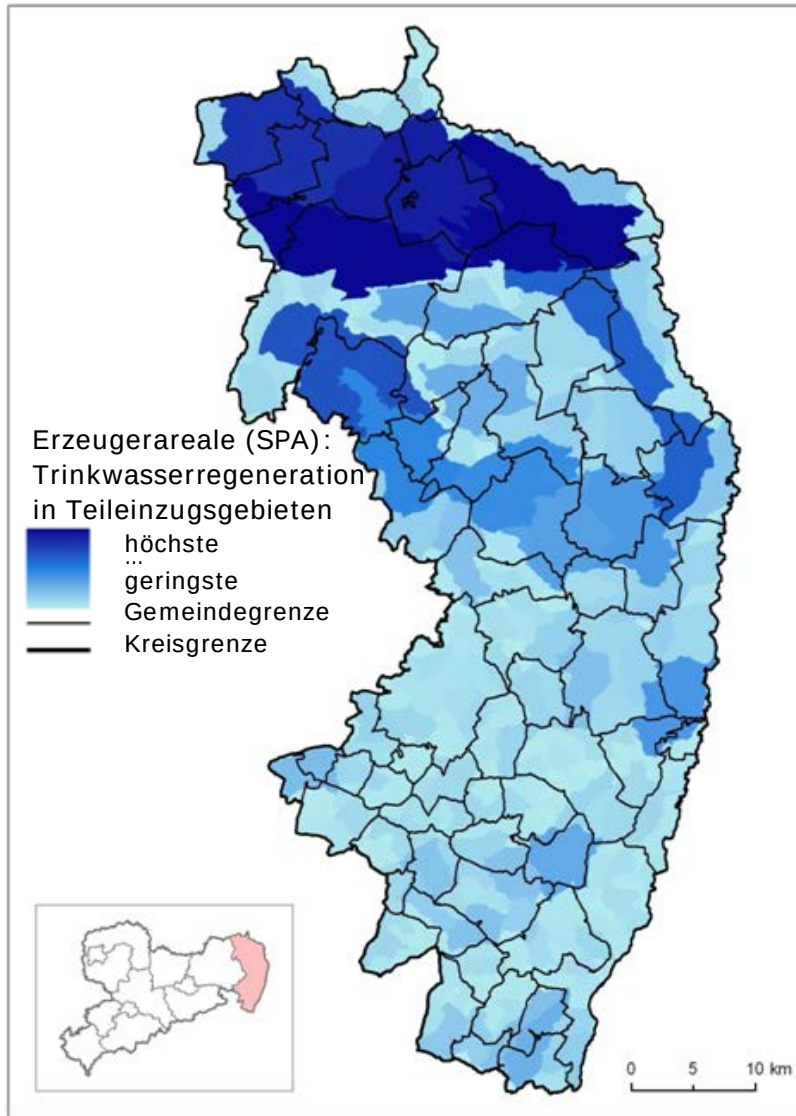


Model MatterBalance

- Water regeneration
- Erosion
- Water balance



Calculation of Indicators using G.I.S. – by InVest

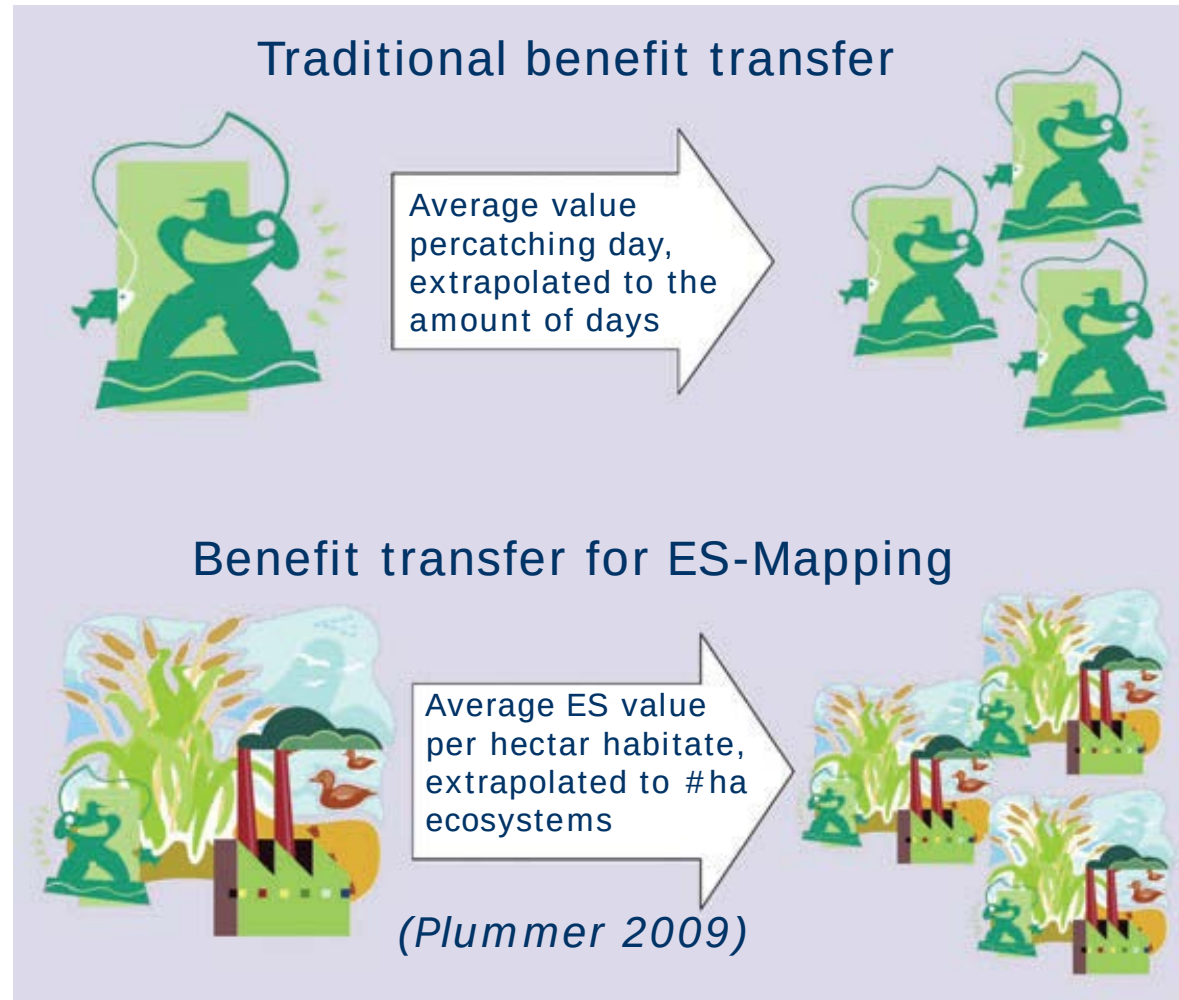


Karte:
M. Holfeld

Benefit Transfer

Mapping method:
Recherche of monetary values for particular environmental goods and transfer these values to other similar goods basing on the count per area

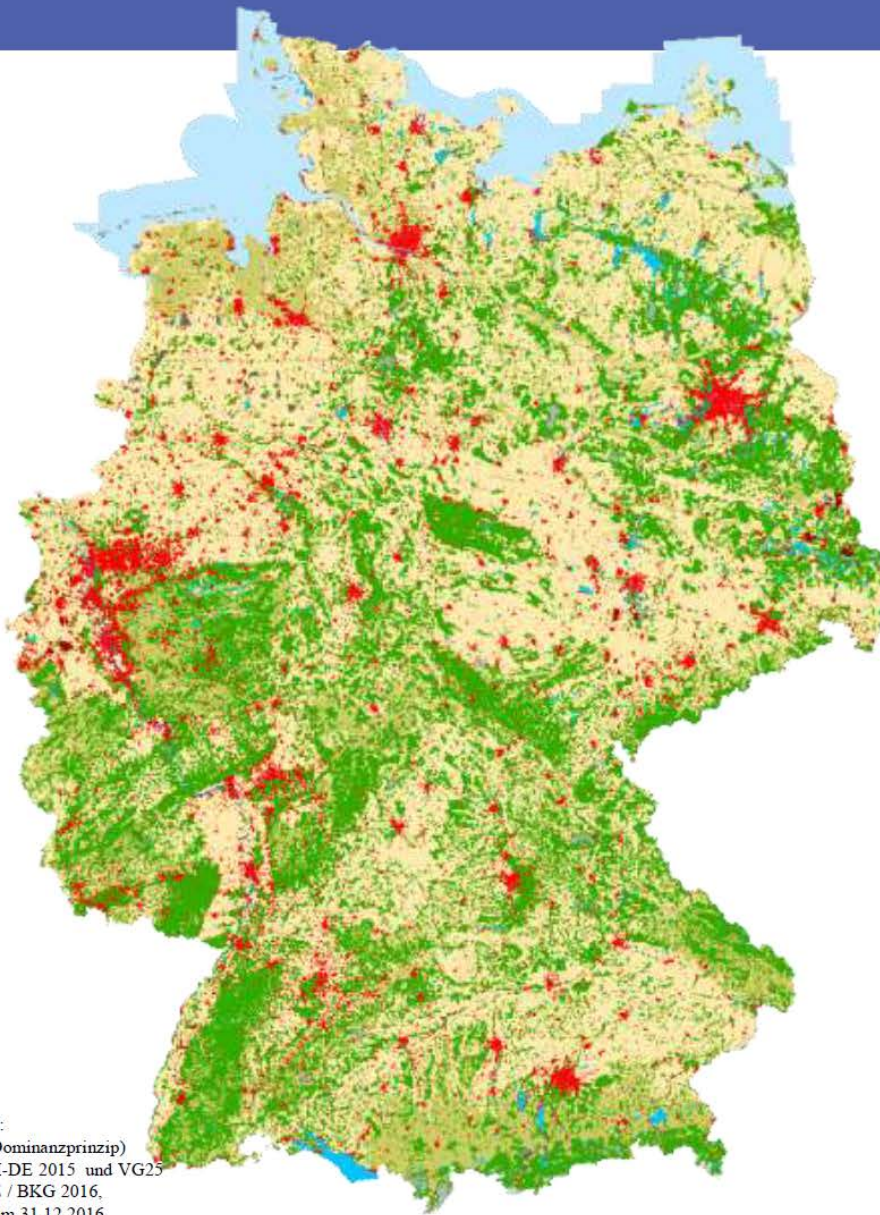
- Use of international data bases (such as TEEB, ESDV, ValueBase^{SWE})



Ecosystem types	CLC-Name		CLC-Code
1) Semi-natural open space	1.1) Natural grassland		321
	1.2) Moors and heathland		322
	1.3) Bare rocks		323
	1.4) Sparsely vegetated areas		333
	1.5) Inland marshes		411
	1.6) Peatbogs		412
2) Forest and woods types	2.1) Broad-leaved forest		311
	2.2) Coniferus forest		312
	2.3) Mixed forest		313
	2.3) Transitional woodland/shrub		324
3) Agrarian types	3.1) Non-irrigated arable land		211
	3.2) Vineyards		221
	3.3) Fruit tree and berry plantations		222
	3.4) Pasture, meadows, other permanent grasslands under agricultural use		231
	3.5) Complex cultivation patterns		242
	3.6) Land principally occupied by agriculture, with significant areas of natural vegetation		243
4) Water bodies	4.1) Water courses		511
	4.2) Water bodies		512
5) Urban and artificial types	5.1) Urban housing	Contious urban fabric	111
		Discontinious urban fabric	112
	5.2) Urban industrial or transport	Industrial and commercial units	121
		Road and rail networks and associated land	122
		Port areas	123
		Airports	124
		Construction sites	133
	5.3) Mining / dumps	Mineral extraction sites	131
		Dump sites	132
	5.4) Urban green space	Green urban area	141
		Sport and leisure facilities	142

Ecosystem extent

Area proportion of sub-ecosystem types 2015



Name (Code)	Share (%)
Grassland and heathland (11)	0,7
Wetland (12)	0,5
Open spaces with no or little vegetation (13)	0,1
Forest (21)	30,1
Grove (22)	1,8
Arable land (31)	35,0
Grassland (32)	17,6
Streams (41)	0,7
Inland water bodies (42)	1,2
Marine waters (43)	6,6
Building and transportation areas (51)	10,6
Mining and dump sites (52)	0,4
Urban vegetated areas (53)	1,2

Datengrundlage:
 1 km²-Raster (Dominanzprinzip)
 Geodaten: LBM-DE 2015 und VG25
 © GeoBasis-DE / BKG 2016,
 Gebietsstand vom 31.12.2016,
 Karte: K. Grunewald, C. Michel, IÖR 2019

Ecosystem services

Classification of ecosystem services (CICES V5.1, Jan. 2018) and prioritization for processing in Germany

- Aim: 21 ESS classes – x Indicators (main-/additional)

State of implementation (Grunewald et al. 2017 (see below))

- designed: 20 ES classes, 50 Indicators
- realised: 4 ES classes with 14 Indicators
description and publication)

→ <http://www.ioer-monitor.de/en/>

 One Ecosystem 2: e14021
doi: 10.3897/oneeco.2.e14021

OPEN ACCESS

Research Article

Germany's Ecosystem Services - State of the Indicator Development for a Nationwide Assessment and Monitoring

Karsten Grunewald[‡], Ralf-Uwe Syrbe[‡], Ulrich Walz[§], Benjamin Richter[‡], Gotthard Meinert[‡], Hendrik Herold[‡], Stefan Marzell[‡]

Example for provisional services: Hay yield

■ Yields from mountain meadows:

Yield

Hay
114,000 dt/a

Effect

Proceeds Ø hay
1.1 Mio €
-
Management
costs
0.9 Mio €
=>
0.2 Mio €

Conditions:

- extensive (careful) management of the meadows
- Consideration of nature conservation requirements
- Additionally possible: Support (subsidies) from the EU to cover the management costs



Foto: Bastian

Wild foods (fish, game, fruit)



■ Game shot / year

a: Municipality Altenberg (SSF 2012)

w: wood share for study area (SMUL 2008/2009)

Class	Amount	Av. weight	Weight	Price rel.	Total
Roe deer	a: 179	10,5	1880 kg	3,81 €/kg	7.161 €
Red deer	a: 82	50,4	4133 kg	3,50 €/kg	14.465 €
Wild boar	w: 87	70,0	6090 kg	3,50 €/kg	21.315 €
Sum					42.941 €



Landesjagdverband Sachsen e. V.

Anerkannte Vereinigung der Jäger des Freistaates Sachsen

Anerkannte Naturschutzvereinigung



Example for regulation services: Erosion control

Universal soil Equation (USLE) Factors:

R Rainfall erosivity: Calculation using summer-precipitation data 1981-2010 (DWD)

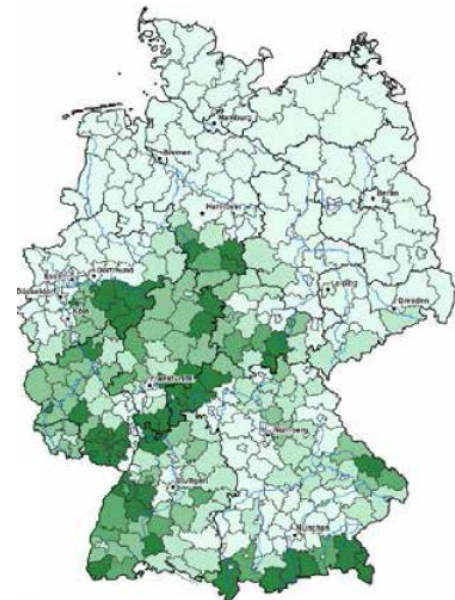
K Soil erosivity: Calculation using BÜK1000Ob

S Slope steepness: Calc. using ATKIS-DHM25

C Land cover: Calculation using LBM-DE 2009 (2012) + DESTATIS Agricult. Data

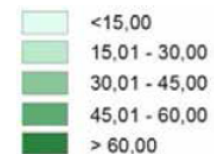
L Solpe lengh (open, poss. calcul. with S)

P planting measures (open, data required)

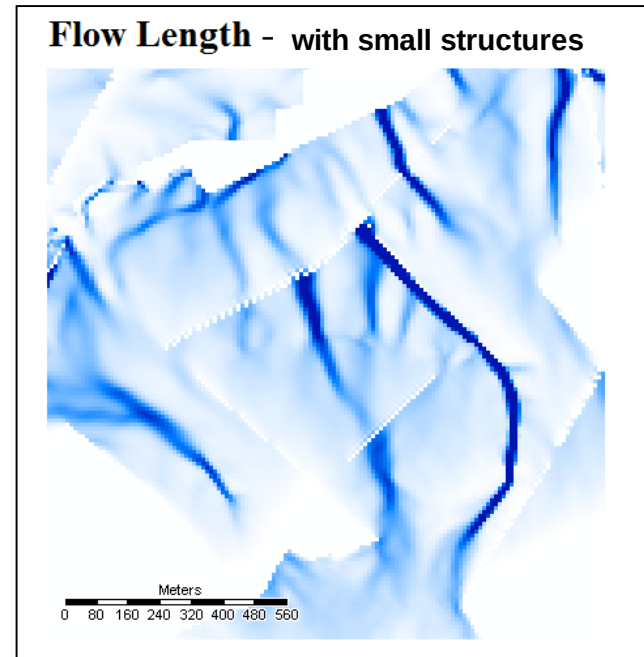
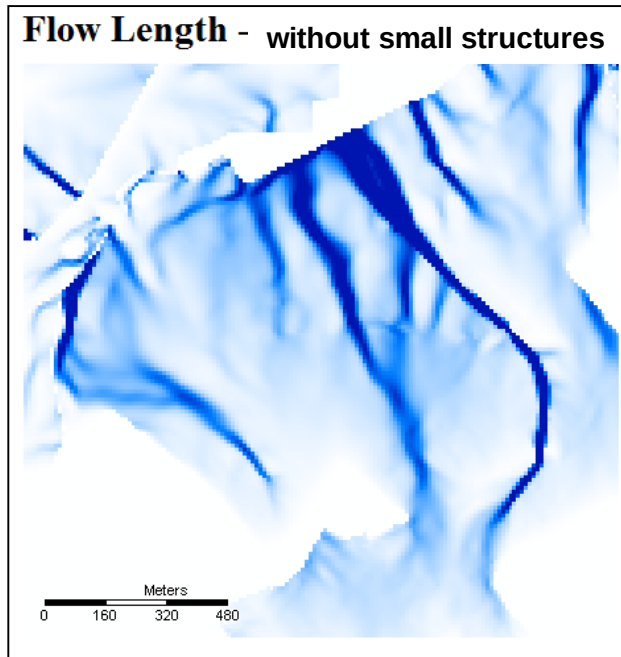


Pilot study

Alternativ vermiedener
Bodenabtrag pro ha und Jahr
im jeweiligen Kreis



Calculation of slope length and LS-Factor using SAGA-GIS



Average slope length in Saxony

Without small structure elements: 156,83 m

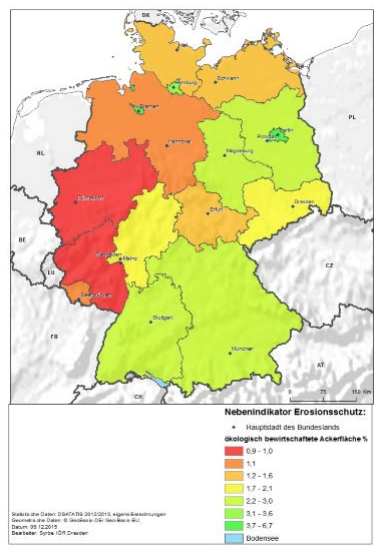
With small structure elements: 149,54 m (-4,6%)

Results

Indicators

- A: Actual water erosion
 - H: *hypothet. soil loss*
 - P: Avoided water erosion
- $$P = H - A$$

- Organic farming (side indicator)

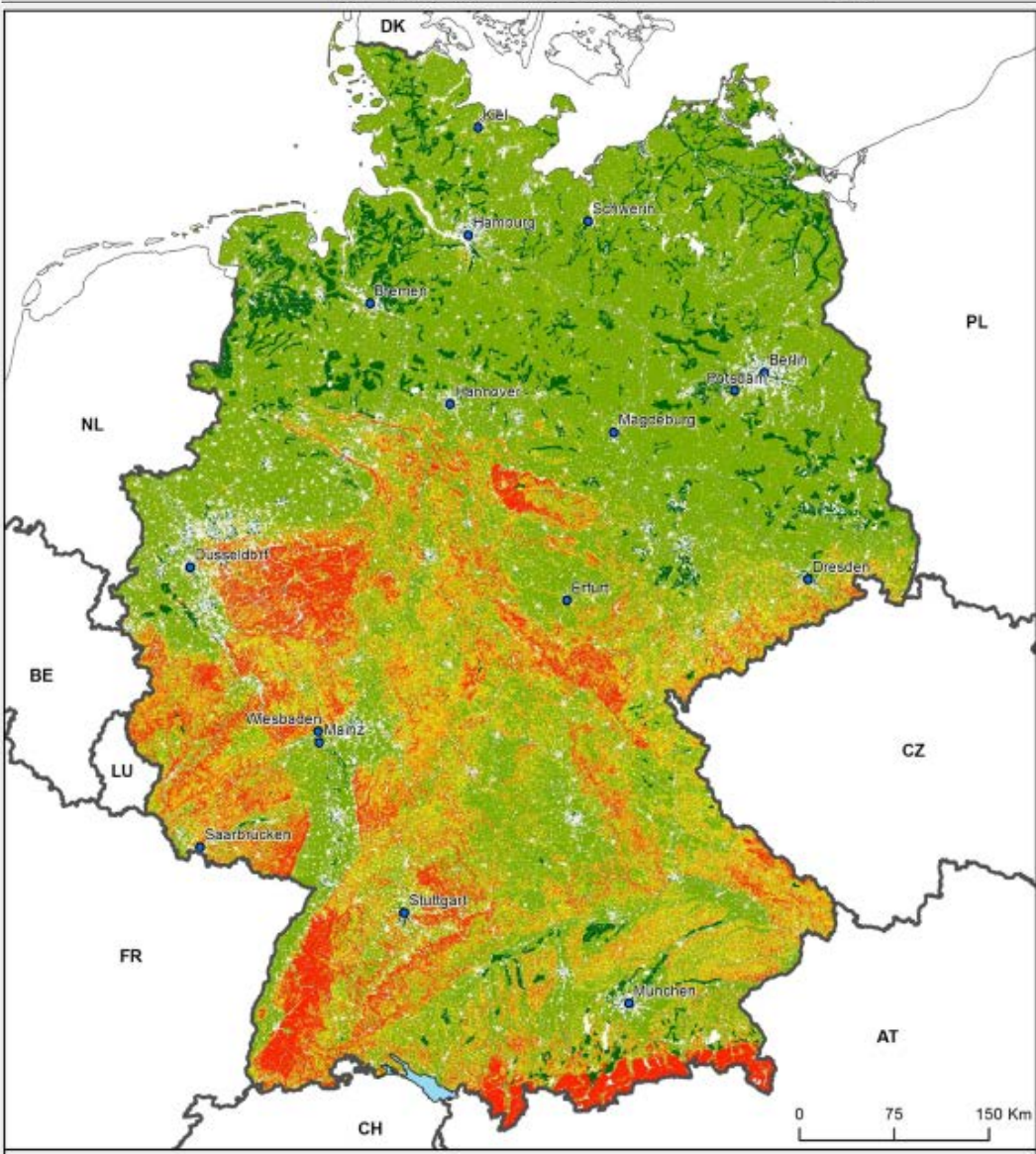
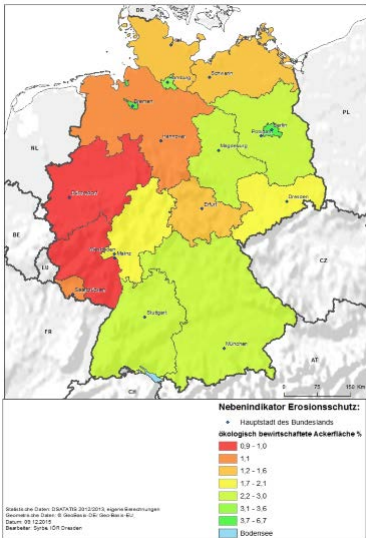


Results

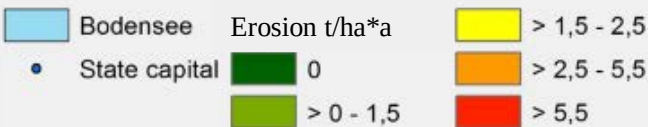
Indicators

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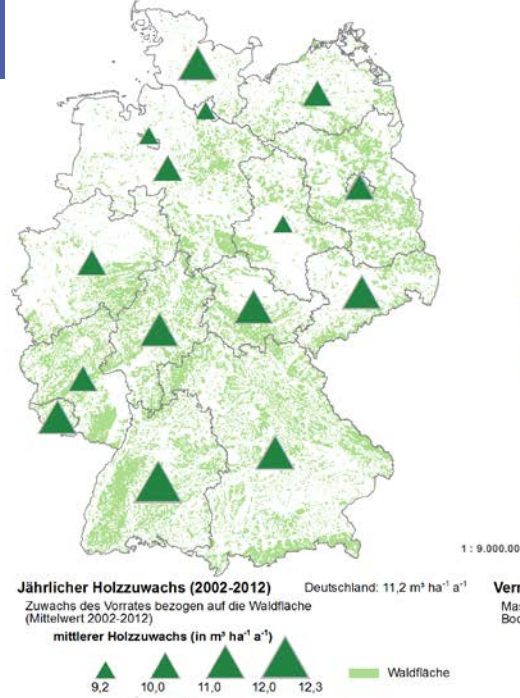
- Organic farming (side indicator)



Prevented soil loss



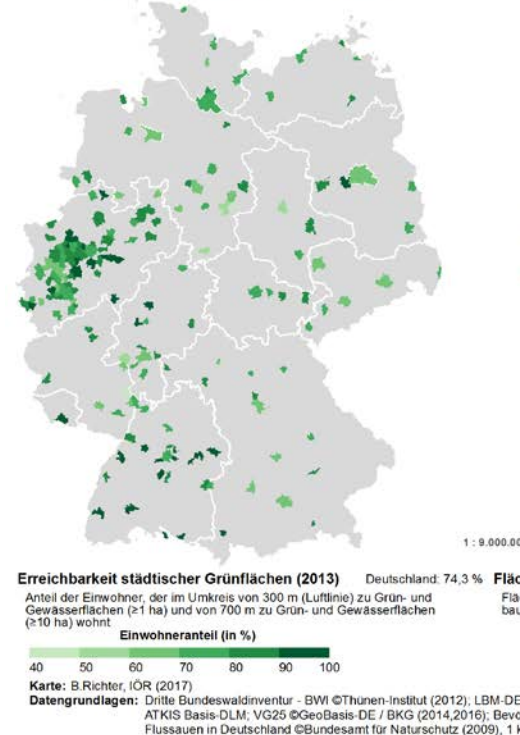
Annual wood accrual
 $11,2 \text{ m}^3 \text{ ha}^{-1} \text{ a}^{-1}$
 (mean 2002-2012)



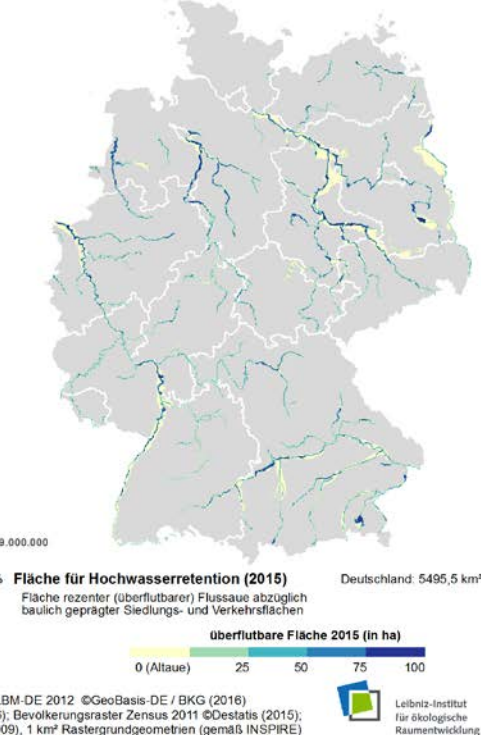
Avoided water erosion
 $14,8 \text{ t ha}^{-1} \text{ a}^{-1}$ (2012)



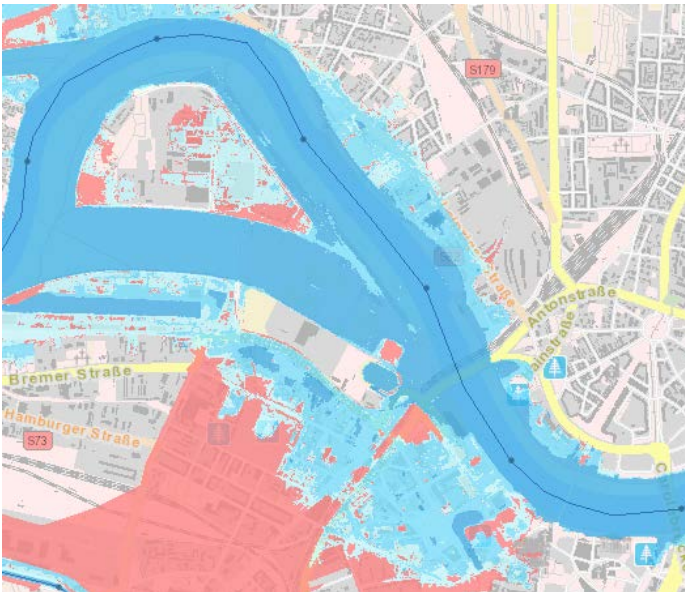
Access to urban green space:
 74,3 % of inh. (2013),
 Calculated for all cities
 ≥ 50.000 inh.



Area for flood retention
 547.550 ha (2015)
 (share of built-up
 areas in recent flood-
 plains increased 2010
 – 2015 with 726 ha !)



Flood mitigation: Preservation of retention area in floodplains



Dresden Flood risk area (HQ100)

Source: Saxon LfULG

Flood mitigation: Preservation of retention area in floodplains

Calculation

recent floodplain – build up area therein

$$\blacksquare \text{ Indicator} = \frac{\text{recent floodplain – build up area therein}}{\text{morphological floodplain}} \times 100$$

Data basis: ATKIS Basis-DLM(BKG), Floodplain state report (BfN)



floodplain with flood protection wall

Ecosystem services (national scale)

Flood mitigation: Pres. of retention area in floodplains

Municipalities

(Raster 1km)

Deutschland: 35,7

>66 - 100

Local assessment result: flood protection

Regulating effects of forests:

- Interception
- Enhanced transpiration
- Higher macropores soil storage (because of root penetration)
- 1 km² forest avoid in cases of 100-year flood c. 0.44 m³/s peak runoff



Replacement costs calculation:

- Costs of the flood retention basin Glashütte (1 Mio m³): 2.5 Mio €
- 39 km² natural forest save costs of c. **1.25 Mio €**

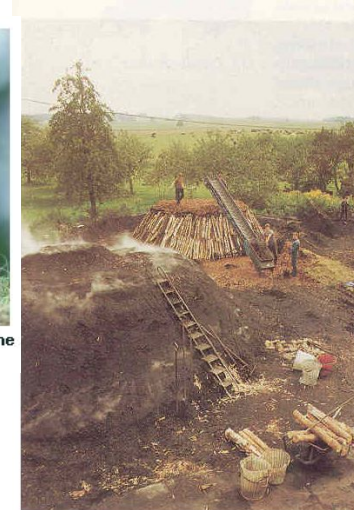




Landscape recreation value



Quelle: http://www.lbv.de/modules/alt/magazine/img/birkhuhn_1.jpg



Holzkohlerei Quelle: "Heimat und Welt, Band 1 Deutschland, Thüringen" westermann, 1996



Diversity: calculation of count and variety of elements and structures

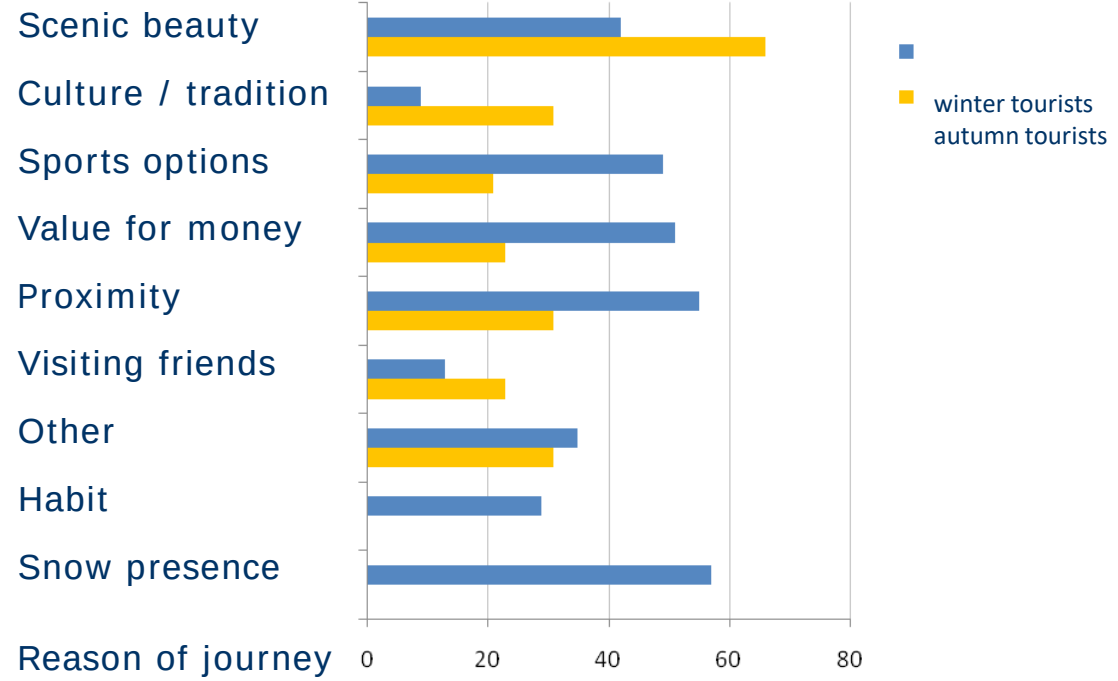
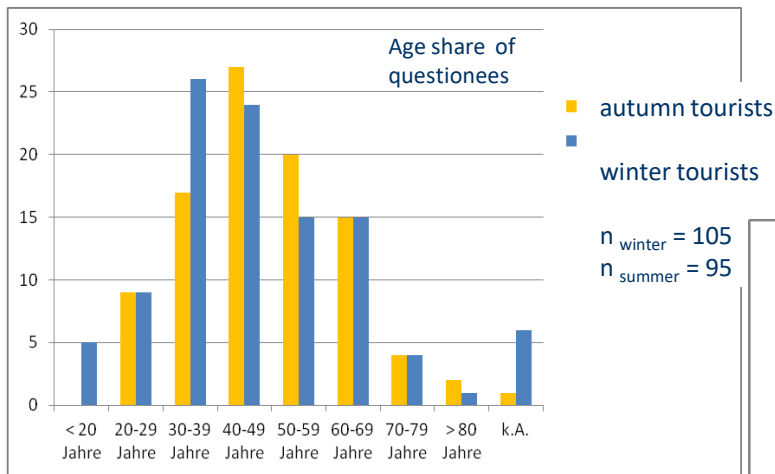
Peculiarity: expert knowledge about uniqueness and historical continuity of landscape

Beauty: appreciation of the „educated average observer“ (no expert!)



Survey among tourists and tourist experts at the mountain ridge

Empirical study: 200 tourists,
20 tourist experts
(autumn and winter 2010/11)



Comparison travel costs and willingness-to-pay

→ Extrapolation of the sample
to the total of tourists

Results:

- Travel costs (real expenses):
≈ 42 € per guest/day (tot. 142.000)
= **5,5 Mio. € / a**, of it 5 Mio. local
- Willingness-to-pay (hypothetical):
≈ 4,50 per guest/visit
= **800.000 €** per year

possible
impairments

devastation of bogs

increasing wind power
plants

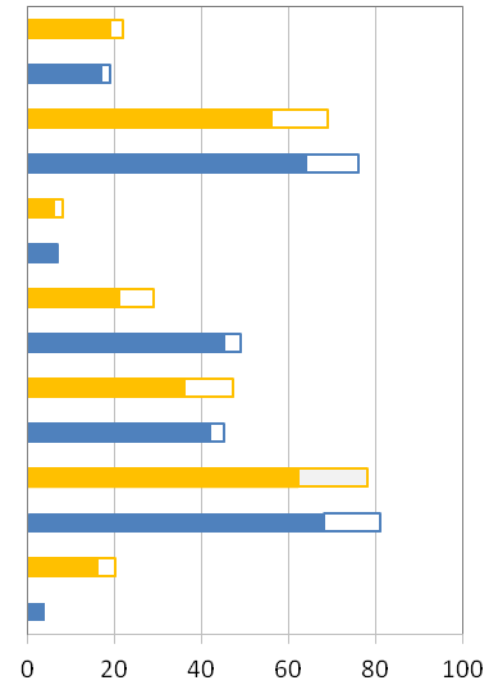
afforestation at the
mountain ridge

termination of landsc.
maintenance

extinction of species

deforestation

other



Choice experiment: the value of landscape maintenance

Grassland



Creek



Clearance cearn



Choice 1

Reiseziel 1

Kosten für Anreise
(einfach)

35 Euro

Blühende Wiese
ohne Weidetiere,
nicht verwachsen



Steinrücke,
unbewachsen



Natürlicher
Bachlauf



KARTA 20

Reiseziel 2

Kosten für Anreise
(einfach)

20 Euro

Wiese ohne Weidetiere,
nicht blühend,
verwachsen



Steinrücke,
überwachsen



Natürlicher
Bachlauf



Karte 20/2

Choice 2

Reiseziel 1

Kosten für Anreise
(einfach)

50 Euro

Blühende Wiese
ohne Weidetiere,
nicht verwachsen



Steinrücke,
überwachsen



Natürlicher
Bachlauf



KARTA 21

Reiseziel 2

Kosten für Anreise
(einfach)

35 Euro

Wiese ohne Weidetiere,
nicht blühend,
verwachsen



Steinrücke,
überwachsen



Künstlicher
Bachlauf

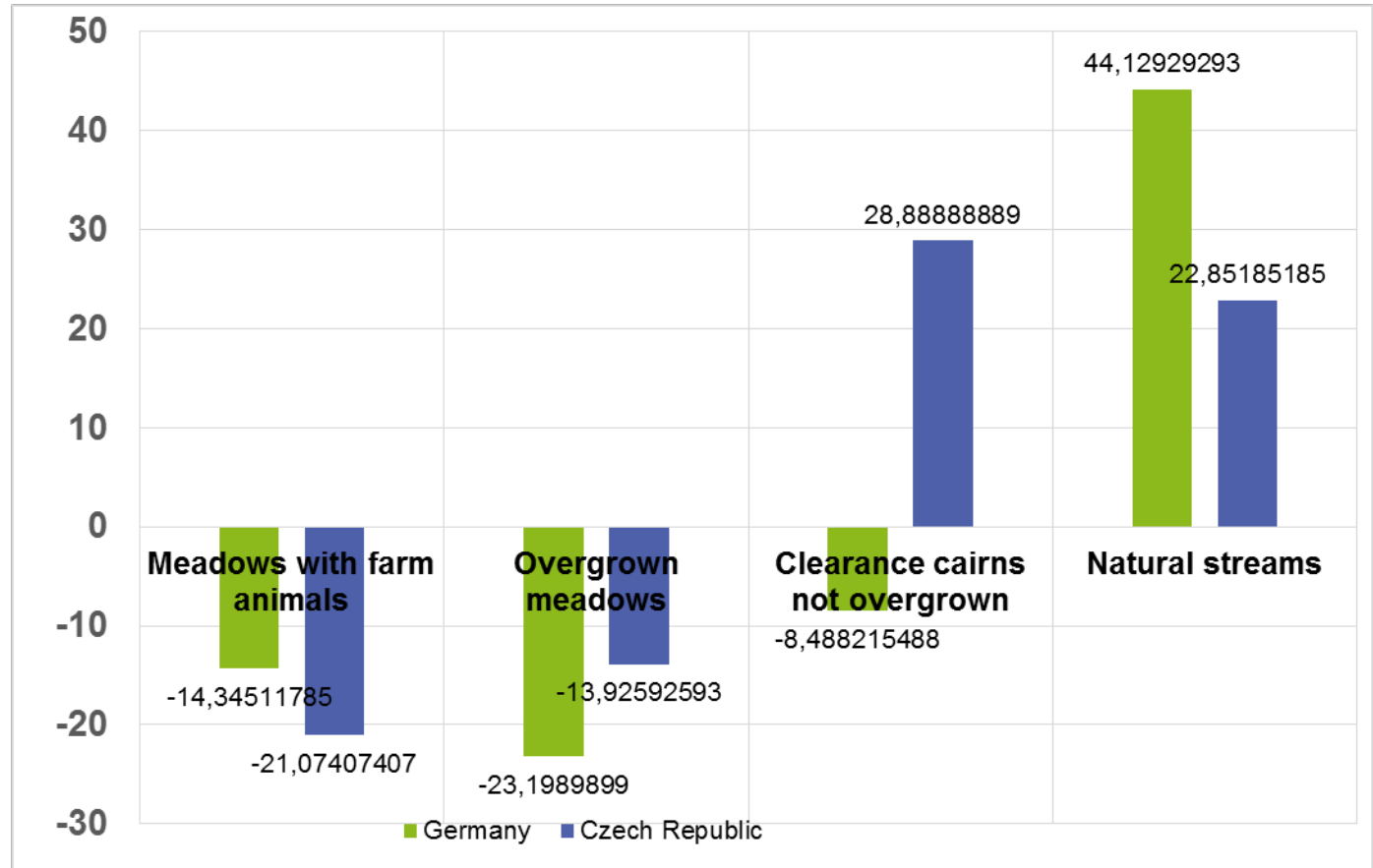


Karte 21/2

Result of the choice experiment in the Ore Mountains



Appreciation by tourists (in €/person)



The nature as a source of inspiration for music, painting and regional identity – not measurable!



Walzertempo **Dar Vugelbärbaam** *Volkslied*

B F C F⁷ F C F

Kan schin - nern Baam gippt's wie dan Vu - gel-bär - baam, Vu - gel-bär - baam, dan

7 B F B F C F⁷ F

Vu - gel-bär - baam. As wärd a su lecht nett ann schin - nern Baam gahm,

13 C F B Eb B

schin - nern Baam gahm, ei ja. Ei ja, ei ja, ann Vu - gel-bär -

20 F 1. B 2. B

baam, ann Vu - gel-bär - baam ann Vu - gel-bär - baam, ei baam, ei ja.



2. Beim Kantr sen Haus stieht a Vugelbärbaam,
Vugelbärbaam, ä Vugelbärbaam.
Dort sitzt unserm Katern sei Weibesn drnahm,
Weibsen drnahm, ei ja. Ei ja, ei ja ...

3. Na losst se nähr sitzn, se schleft ja drbei,
schleft ja drbei, se schleft ja drbai,
un hat ses verschlafn, da huln mer sche rei,
huln mer sche rei, ei ja. Ei ja, ei ja ...



Do Ecosystem Services exist in the underground?



Synthesis of implemented main indicators

Indicator	Spatial approach*						Timesheet	First Trend DE**	Assessment of service provision
	IN	DE	BL	KR	GE	RA			
Annual wood accrual	x	x	x				2002-2012 (2022)	3	
Area for flood retention	x	x	x	x	x	x	2010-2015 (2020)	2-3	
Avoided water erosion		x	x	x	x	x	2009-2012 (2015)	2	
Accessibility of green spaces		x	x		x	x	2008-2013-2015 (2018)	2-3	

* IN international, DE Germany, BL Federal state, KR county, GE municipality, RA Raster

** Trends: 1 decreasing, 2 slightly decreasing, 3 stable, 4 slightly increasing, 5 strong increasing

Public relations



GPS/App guided hiking tour

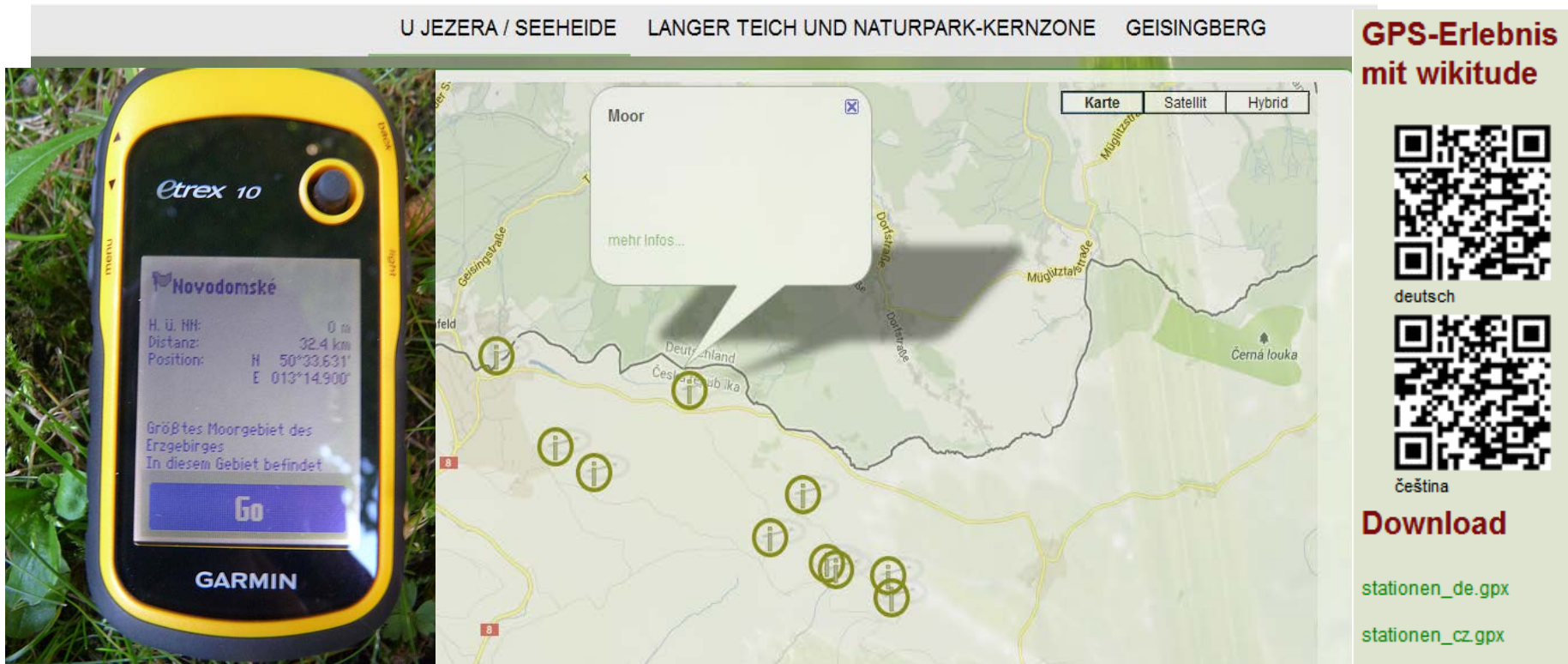
Illustrated booklet
„Add Value East Ore Mountains“



Mehrwert Natur Osterzgebirge

Ökosystemdienstleistungen
erkennen, bewerten und
kommunizieren

Science pathways and GPS game: Environmental education offers via Internet and App



Author: Nils Kochan – „Software im grünen Bereich“

Thank you for your attention!

Book recommendation:

<https://ab.pensoft.net/article/12837>

