Ökosystemleistungen mit Daten erkennen und beurteilen: Vorstellung der IMECOGIP QGIS-basierten Toolbox

Harald Zepp, Lars Gruenhagen
Ruhr-Universität Bochum, Geographisches Institut

RUB

ILS

in Cooperation with　BOCHUM　Stadt Gelsenkirchen　Ministerium für Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen　OBERMEYER　energydesign Shanghai
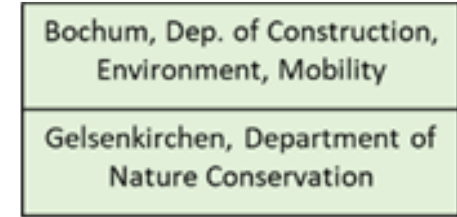
Green Infrastructure provides Ecosystem Services for the well-being of people

Ecosystem services are defined as
''**the benefits people obtain from ecosystems**''
(Costanza et al., 1997, MA, 2005)

Provisioning services

Regulating services

Cultural services

Grüne Infrastruktur und Ökosystemleistungen …
… auf verschiedenen Planungsebenen

EU

„Grüne Infrastruktur (GI) – Aufwertung des europäischen Naturkapitals"
(6.5.2013 (COM(2013) 249 final))

NRW

**Richtlinien
über die Gewährung von Zuwendung zur Schaffung, Erhaltung, Wiederherstellung und Verbesserung von Grüner Infrastruktur
(Grüne-Infrastruktur-Richtlinien – GI RL)**

Runderlass
des Ministeriums für Umwelt, Naturschutz und Verkehr

vom 28. Juni 2023
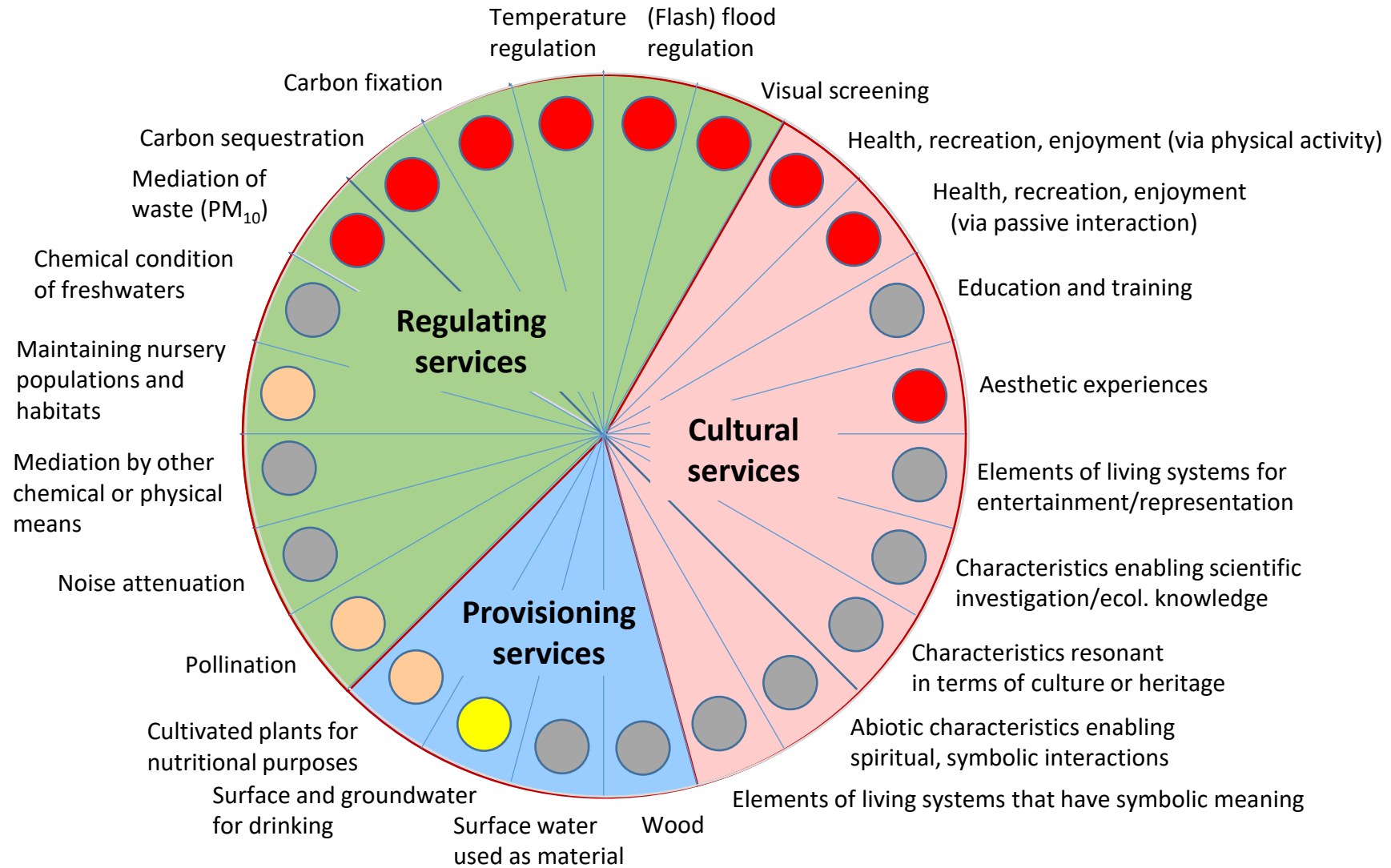Ministerialblatt (MBl. NRW.) Ausgabe 2023 Nr. 28 vom 27.7.2023, Seite 767 bis 798

Ökosystemleistungen:

„1.1 … Im Fokus steht dabei die Stärkung heimischer Biodiversität sowie von
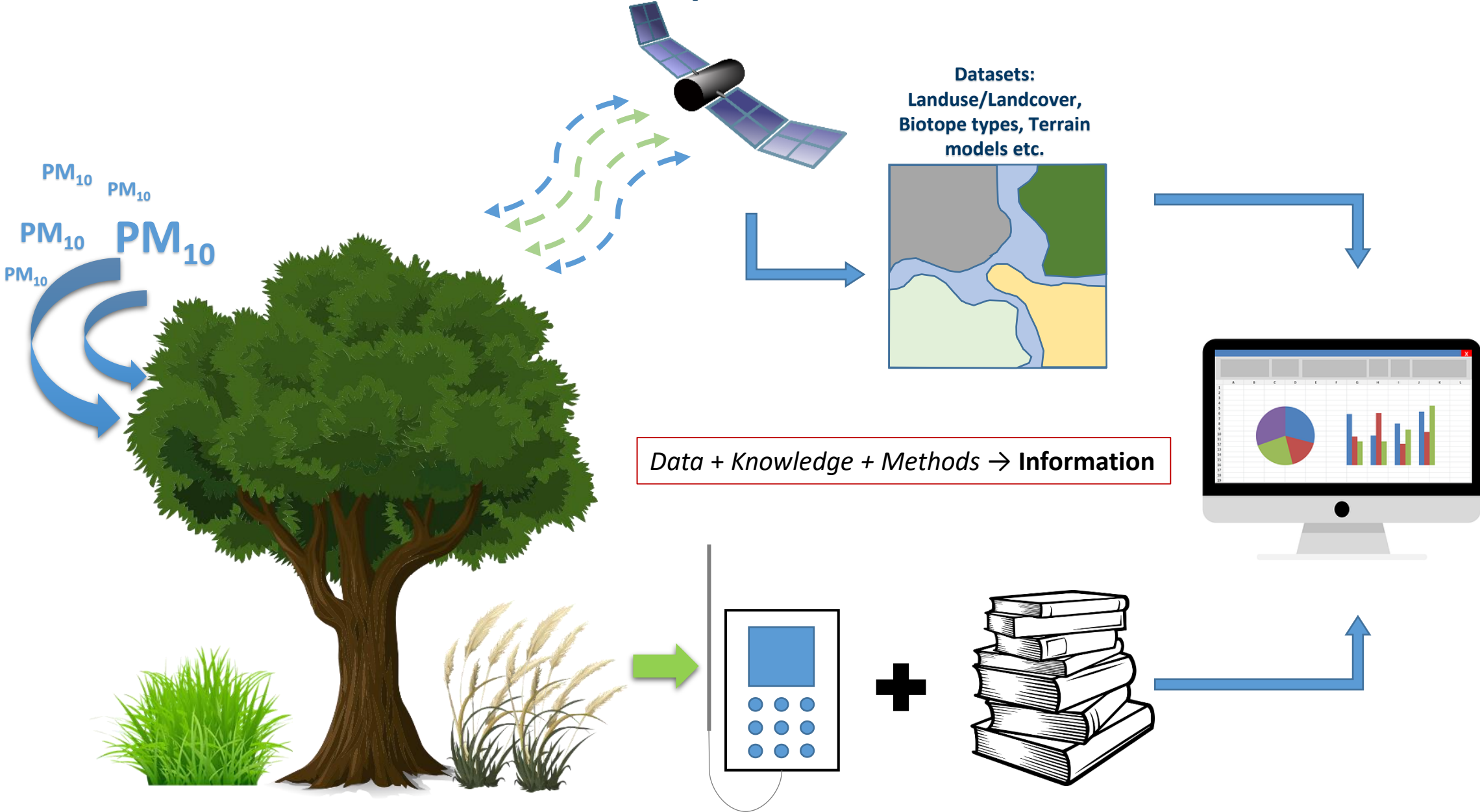**Ökosystemen und ihren Leistungen** durch naturbasierte Lösungen."

Gemeinden und Gemeindeverbände aus Nordrhein-Westfalen

State of the toolbox version (β-version)

General Idea of Development

PM_{10} PM_{10} PM_{10} PM_{10} PM_{10}

Datasets:
Landuse/Landcover,
Biotope types, Terrain
models etc.

*Data + Knowledge + Methods → **Information***

Geodaten

Hausumringe

ALKIS 2018 (open data@GEOBASIS NRW**)**

Landbedeckung:

Biotopkartierung

- Biotoptyp

FKZ: 01LE1805A1
4/2019-9/2024

Landbedeckung:

Biotopkartierung

Code	Biotope type
A	Forests
B	Small woods
C	Moorland, Swamps
D	Heaths, dry grassland
E	Grassland
F	Waters
G	Rock habitats
H	Other anthropogenic habitats
K	Fringe or linear tall forb vegetation
L	Annuals or areal tall forb vegetation
S	Settlement areas
V	Traffic and service routes

Code	Biotope type
A	Forests
AA	Beech forests
AA0	Beech forest
AA1	Beech and oak forest
AA2	Beech forest with indigenous deciduous woods
AA3	Mixed beech forest with alien deciduous woods
AA4	Mixed beech forest with coniferous woods

Geodaten

Bodenkarte:

1 : 50.000 (BK 50)

- **Nutzbare Feldkapazität (nFK)**

- **Grundwasser Stufe**

   (open Data@Geodatendienstes, Geologischer Dienst NRW)
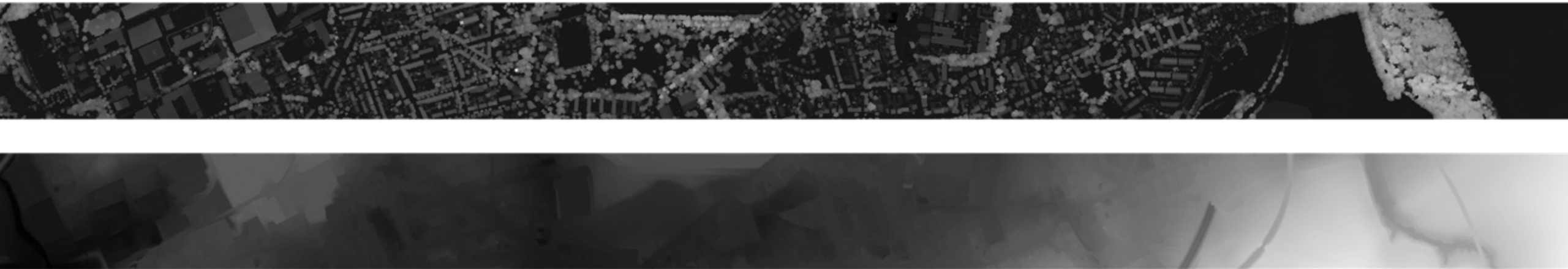
Geodaten

Normalisiertes Digitale Oberflächen Modell (nDOM)

- **50 cm Lidar and Luftbilder Fehler +/- 5 dm in Position und Höhe 2018**
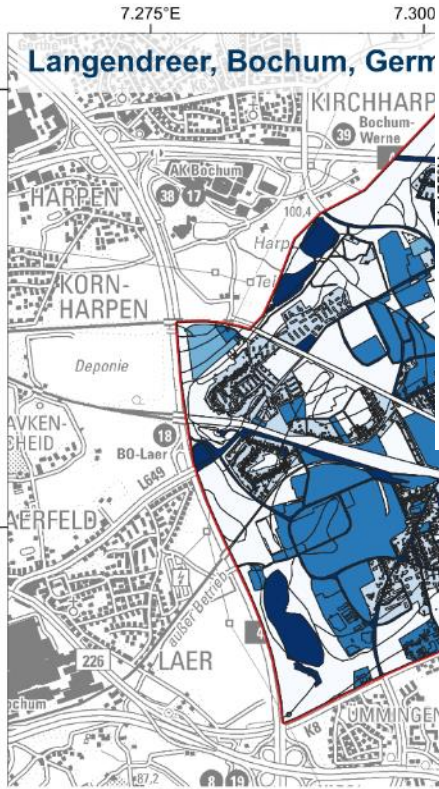
  (open data@GEOBASIS NRW)

Digitales Gelände Modell (DGM)

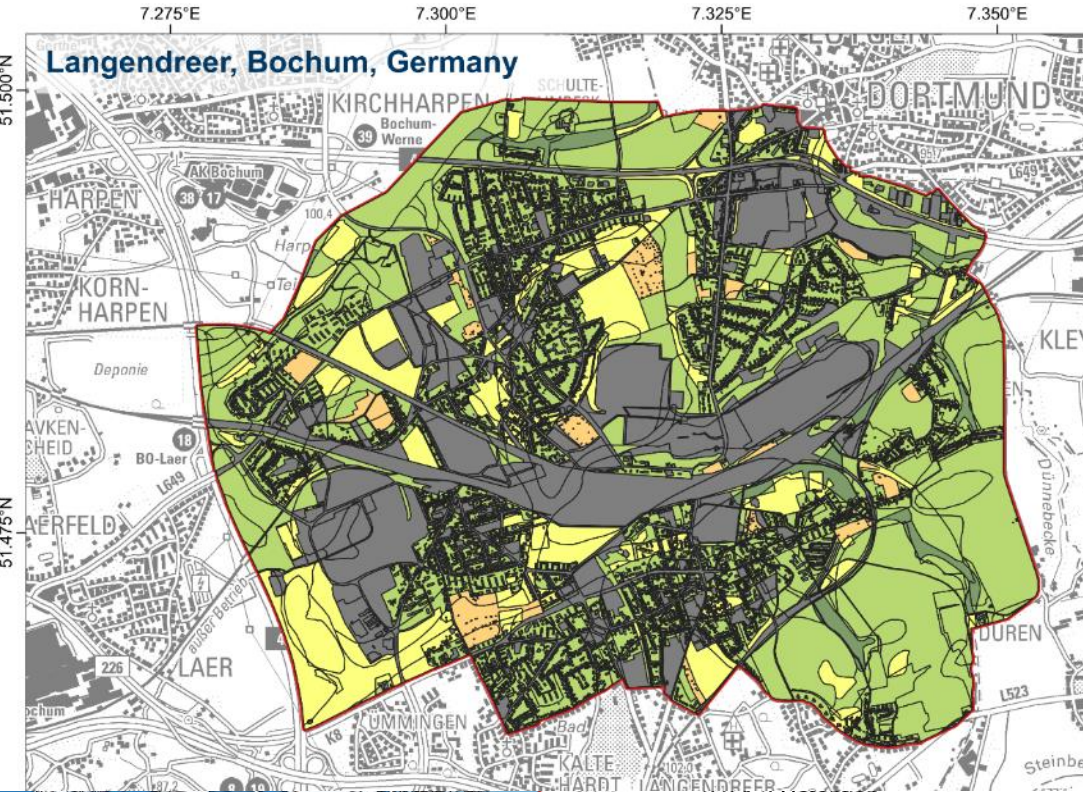- **1 m aus Lidar Fehler+/- 2 dm 2018 (open data@GEOBASIS NRW)**

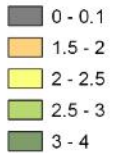**Visibility of landmarks (nice/disturbing)**
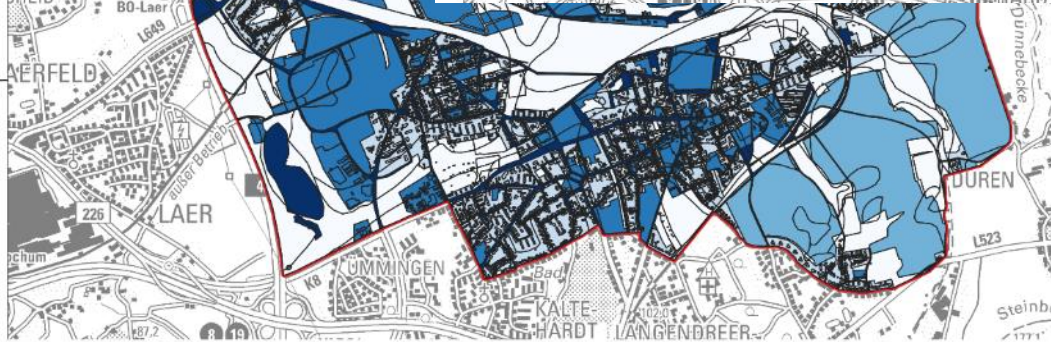
Langendreer, Bochum, Germany

IMECOGIP

Evaporative cooling (kWh/m2)
- 0 - 0.1
- 1.5 - 2
- 2 - 2.5
- 2.5 - 3
- 3 - 4

Langendreer, Bochum, Germ

Langendreer, Bochum, Germany

2.2.1.3 Retention CW
- 0.15 - 0.32
- 0.32 - 0.49
- 0.49 - 0.66
- 0.66 - 0.83
- 0.83 - 1

Biomass (g C m-2):
- 0
- 1 - 1500
- 1500 - 5000
- >10000
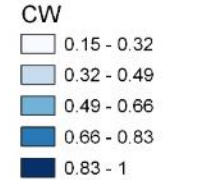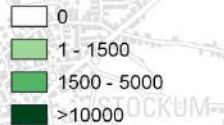
PM10 Filtration along streets

The sample dataset uses only proprietary and open data.

The IMECOGIP-Toolbox:
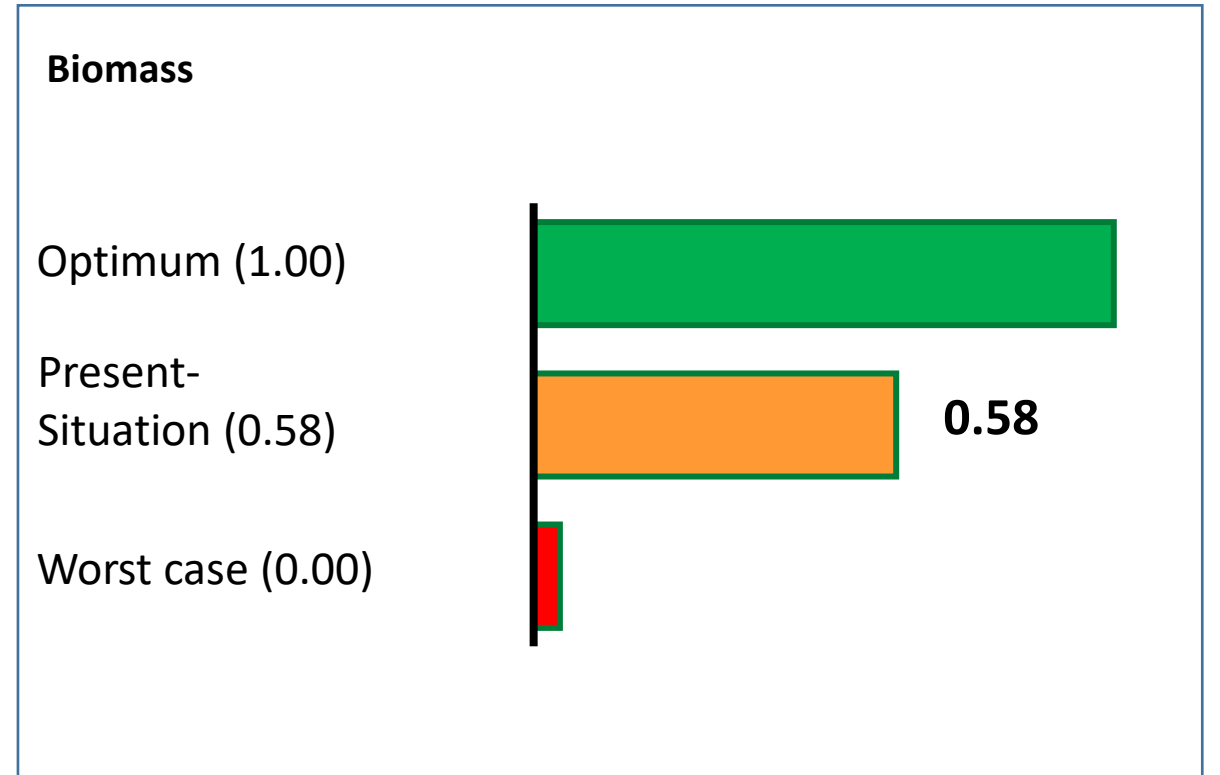# Ecosystem services from neighbourhood to region
Displaying Results

Maps $\longrightarrow$ **Standardization** $\longrightarrow$ **Diagrams**

Biomass

Legend:
- 0
- 1 - 1500
- 1500 - 5000
- >10000

Biomass

Optimum (1.00)

Present-
Situation (0.58)   **0.58**

Worst case (0.00)

Toolbox applications

Ecosystem services performance for each planning variant?

A   B   C

Legend:
- Street / Traffic area
- Deciduous forest
- Small woods
- Brownfield
- Meadow / Pasture
- Garden / Garden area
- Permanent culture / Fruit culture
- Fields
- Fringe, ruderal and tall herbaceous vegetation
- Green space / Park / Cemetery
- Sports, leisure and recreation facility
- Public buildings or facilities
- Residential and mixed development
- Village settlement area / Farmyard location
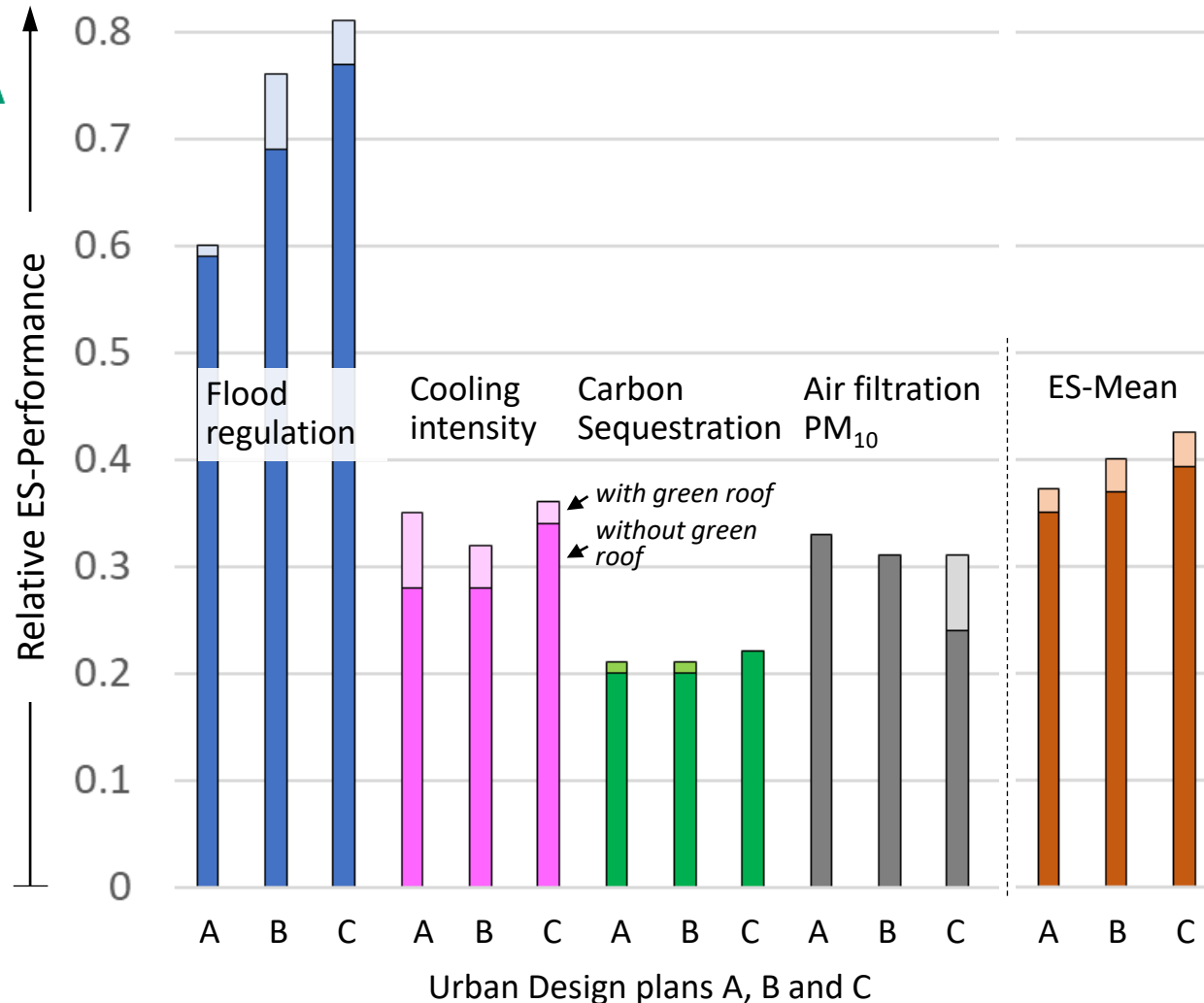- Commercial and industrial area
- Roadside greenery
- Unsealed path

Present land cover

Present vs. plans

Land cover, planned according to the urban design competition

Toolbox applications

**Box 4: Ecosystem services of competing urban design plans**

Against the background of an urban design competition for a new subdivision, we compared three different plans A, B, and C. Which of them promised the best performance of ecosystem services? The bars depict the standardized scores for the four services flood regulation, cooling intensity, carbon sequestration, and air filtration as well as the mean values. Optional green roofs mostly enhance the ecosystem services to a varying degree. Obviously, the differences are not too large, yet, plan C has the highest mean score. It formed the basis for elaborating the binding land-use plan.

Effect of Downscaling on ES: Areal Filtration PM$_{10}$ [kg · ha^{-1} a^{-1}]

Legend:
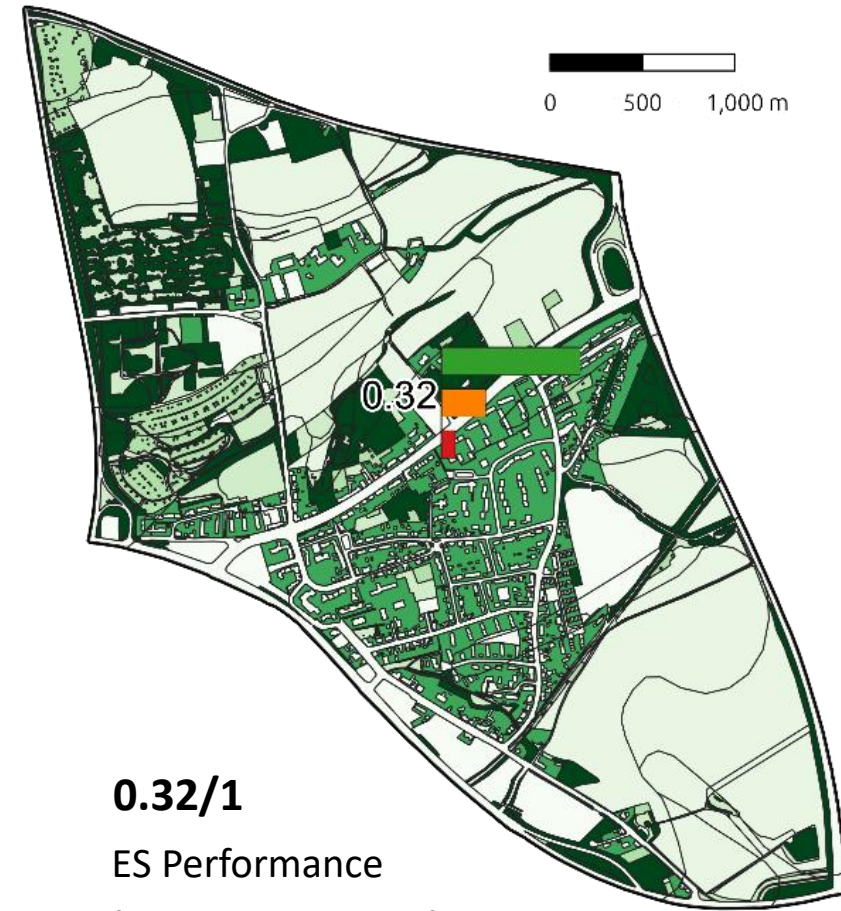- < 1
- < 45
- < 65
- < 85
- < 110
- < 135
- < 155
- < 175
- < 200
- < 220

0 500 1,000 m
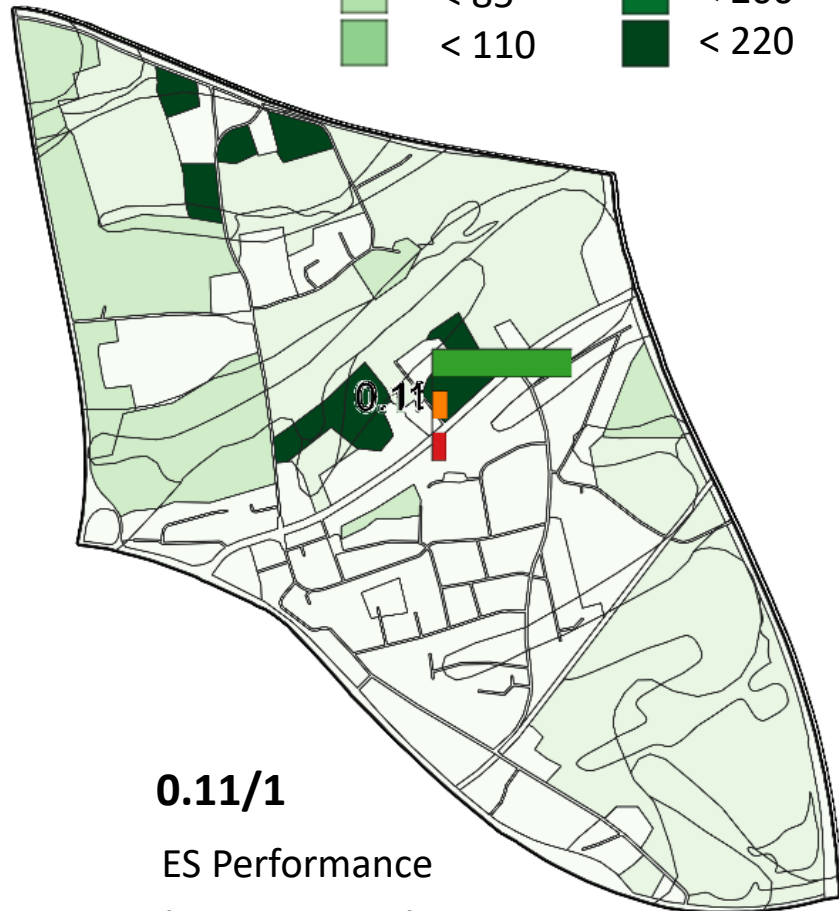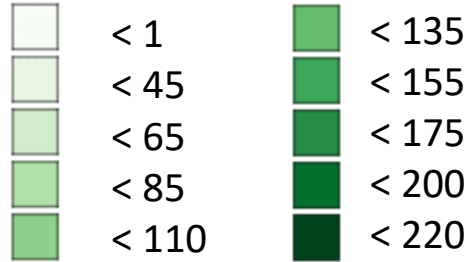
0.11/1

ES Performance

(EU Urban Atlas)
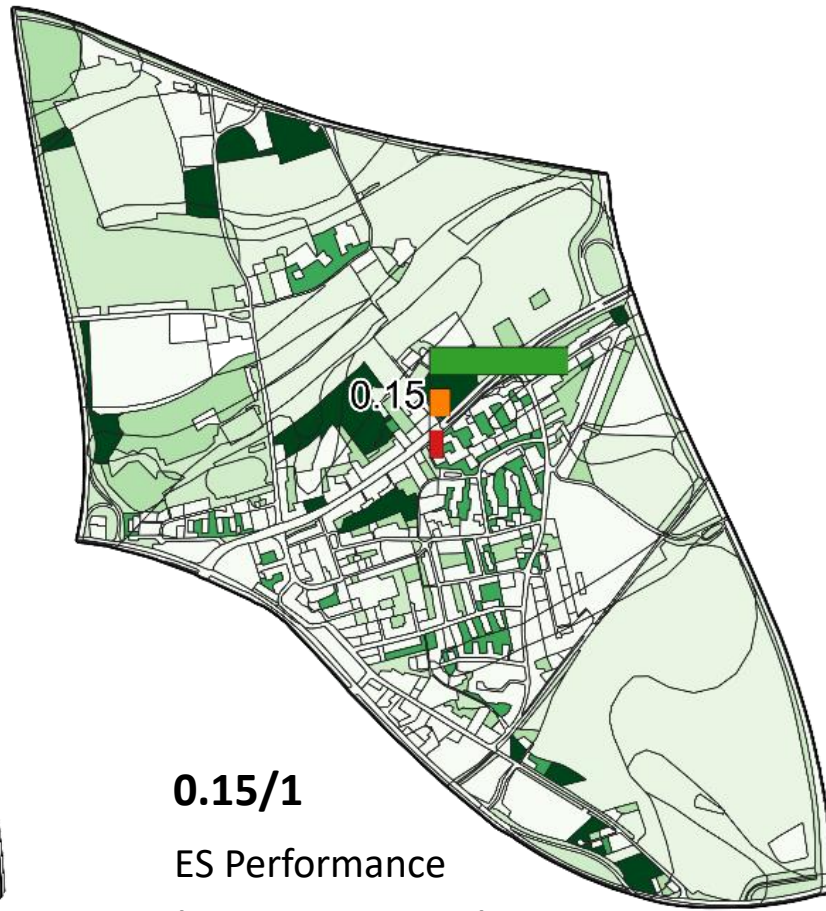
0.15/1

ES Performance

(RVR Land Use Map)

0.32/1

ES Performance

(Urban Biotope Map)

Air filtration PM$_{10}$ 108 kg · ha^{-1} · a^{-1}

0.27

Output
StaBiKa_schulhof
FAYB
☐   < 1
☐   45 - 65,99
■   > 200
☐   FAYBB

150 kg · ha^{-1} · a^{-1}

0.37

Output
StaBiKa_schulhof
FAOIY2
☐   < 1
☐   1 - 44,99
☐   45 - 65,99
■   135 - 155,99
■   > 200
☐   FABY2

Box 3: **The schoolyard exercise**. A municipality asked us, to have the toolbox evaluate the effect of the schoolyard renewal. Comparing the two maps, the existing schoolyard (left) and the planned (right), we see that new elements of GI (dark green) shall be inputted and the layout will change. Consequently, air filtration will increase to 150 kg per year. By using the toolbox, the optimization this ecosystem service as well as others become measurable.

How to use the Toolbox?

Herausforderungen in der Anwendung in Deutschland:

- **Integration der ES-Bewertung in den verwaltungsinternen Datenfluss (DWG/DXF/PDF zu SHP-Dateiformat)**

- **Unspezifische Angaben zu Elementen der Grünen Infrastruktur**

- **Unterschiedliche QGIS-Versionen**

Why you should consider using the IMECOGIP Toolbox

Solutions	• Rapid analysis of current state, detecting deficits and spatial inequities in ES provision • Rapid evaluating of planning scenarios
Innovations	• Biophysical indicators for many ES (accuracy depends on scale) • New Methods • Nested approach (scalable from region to building block)
Methods	• Open source GIS-technology
Transferability	• Proven in several use cases in China, Germany, Czech Republic, Latin America • Existing datasets can easily be adapted

LG

Thank you for your attention

IMECOGIP - Implementation of the Ecosystem Services concept into the Green Infrastructure Planning for resilient urban development

Harald Zepp[1], Malte Bührs[1], Lars Gruenhagen[1], Christin Busch[2],
Luis Inostroza[1,3], Nannan Dong[4]

[1] Ruhr-University Bochum, Institute of Geography
[2] Research Institute for Regional and Urban Development, Dortmund
[3] Mendel-University, Brno
[4] Tongji University, Shanghai, College of Architecture and Urban Planning

For more information:

Ruhr-University Bochum
Institute of Geography
Building IA, Room 6/117

+49 234 32 – 23313

imecogip@rub.de