A New Methodology to Assess the Ecosystem Service Potential of Urban Streams in Developing Countries

19th American Ecological Engineering Society Meeting

Prof. Dr.-Ing. Jochen Hack

Research Group SEE-URBAN-WATER
INSTITUTE OF APPLIED GEOSCIENCES
Section of Ecological Engineering

Darmstadt, Germany

contact@geo.tu-darmstadt.de
www.tu-darmstadt.de/see-urban-water

SPONSORED BY THE

Federal Ministry
of Education
and Research

Motivation

Characteristics of urban streams in developing countries:

- Deteriorated water quality

- Highly impacted by uncoordinated urbanization processes

- But relatively good hydromorphological quality

Objective

- Apply the Ecosystem Service Concept to urban streams

- Highlight the ecological and social potential

- Inform and guide conservative actions
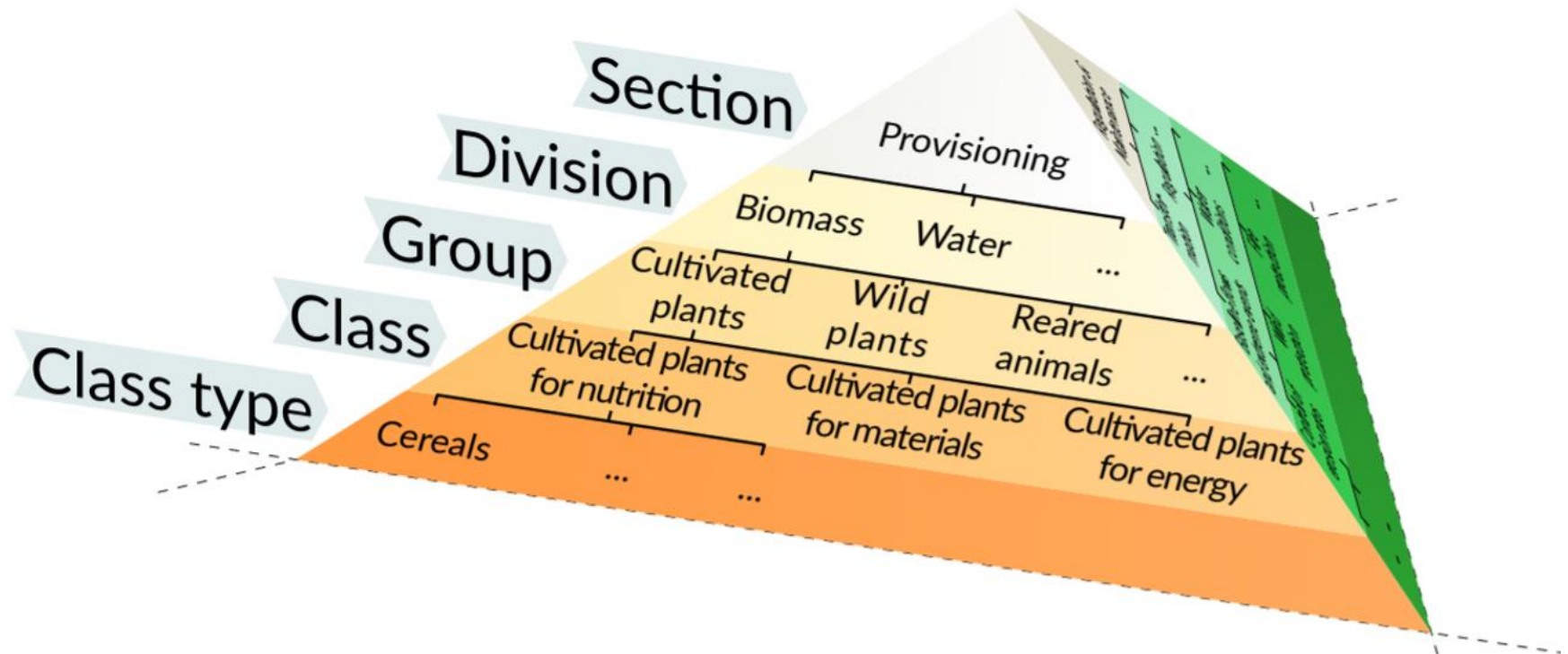
Ecosystem Services - Concept

- Cascade Model (adapted from Potschin and Haines-Young, 2016)
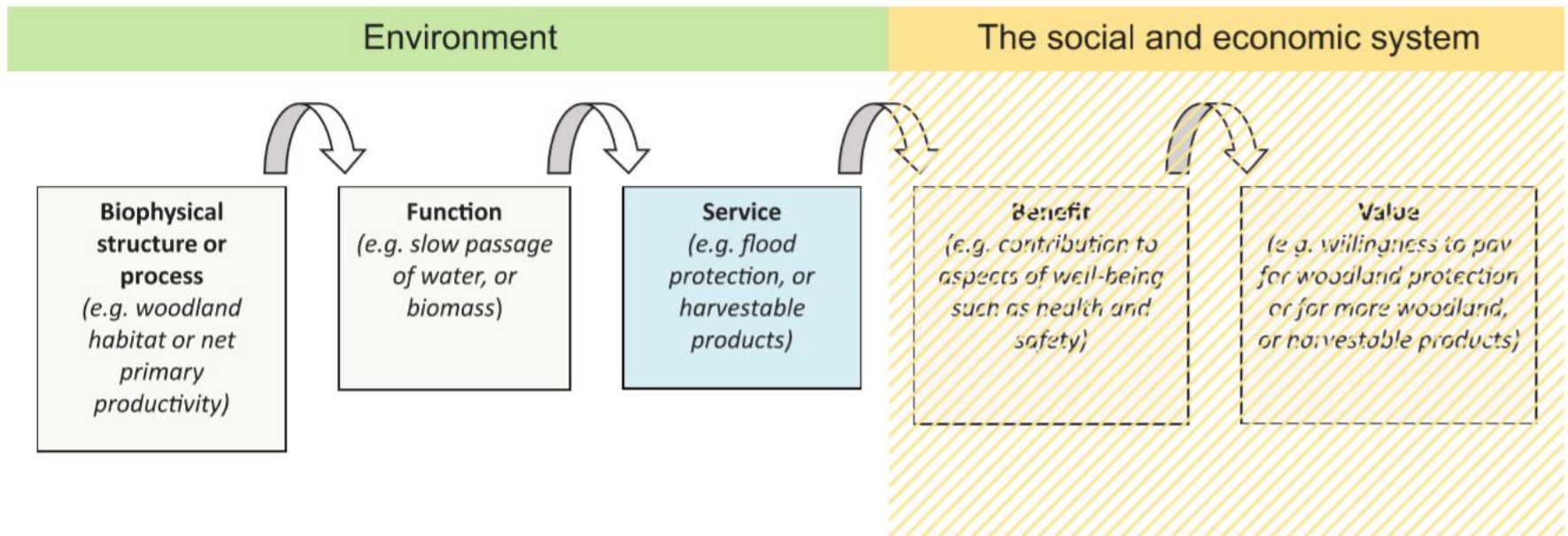
➜ ES as connection between the natural environment and society

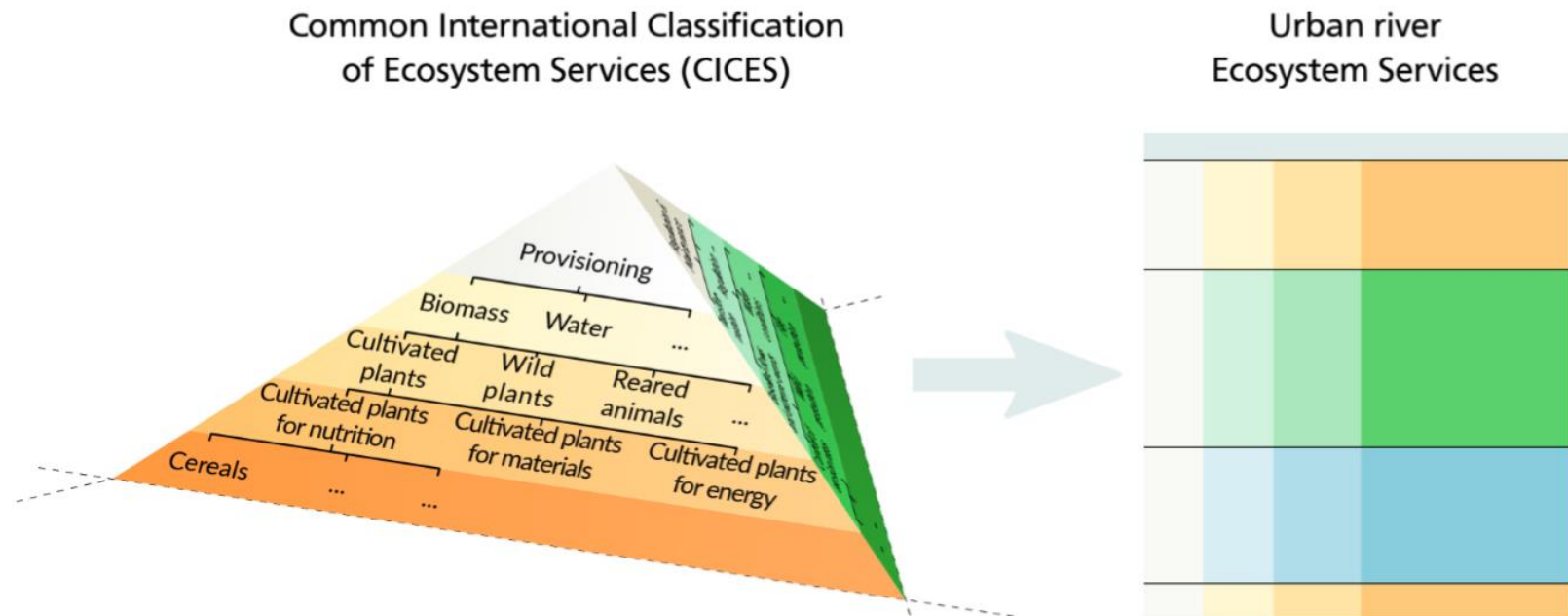# Ecosystem Services - Categorization

- Common International Classification of Ecosystem Services (CICES) Hierarchy (adapted from Haines-Young and Potschin, 2018)
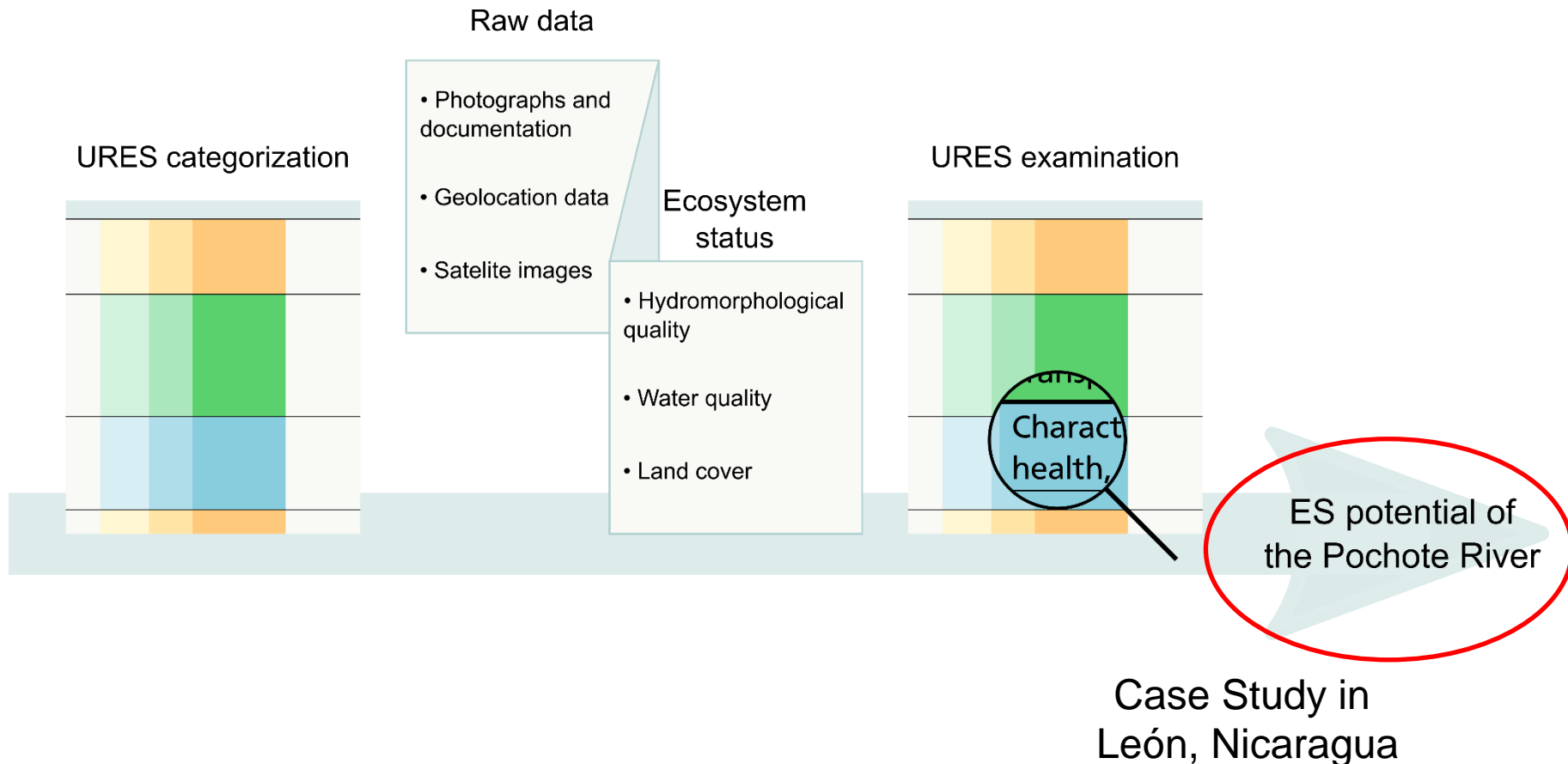
Ecosystem Services - Categorization

Definition of **Urban River Ecosystem Services (URES)** based on:

- Common International Classification of Ecosystem Services (CICES)
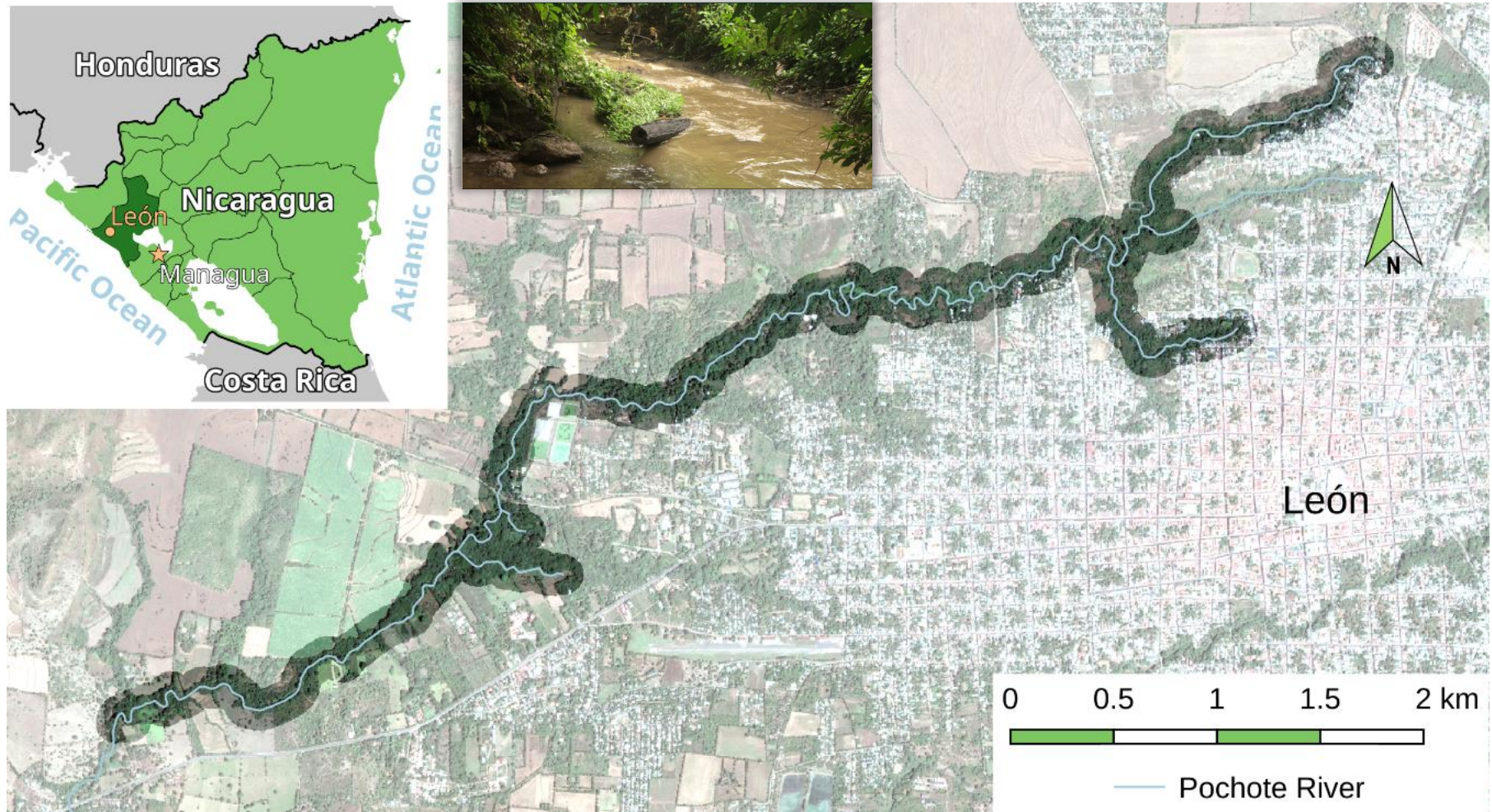- Mapping and Assessment of Urban Ecosystems (Maes et al., 2016)

Methodology

Raw data

URES categorization

- Photographs and documentation

- Geolocation data

- Satelite images

Ecosystem status

- Hydromorphological quality

- Water quality

- Land cover

URES examination

Charact
health,

ES potential of
the Pochote River

Case Study in
León, Nicaragua

Case Study – Pochote River in León, Nicaragua

Raw data for Ecosystem Status Assessment

- Geo-referenced photo documentation (Kipp and Bach 2017)

Ecosystem Status:
Water quality

water quality

- ○ 0 not or barely polluted
- ○ 1 seasonally polluted
- ○ 2 polluted
- ○ 3 seasonally highly polluted
- ● 4 highly polluted

→ *Based on a method of the German state working committee LAWA*

Ecosystem Status:
Water quality
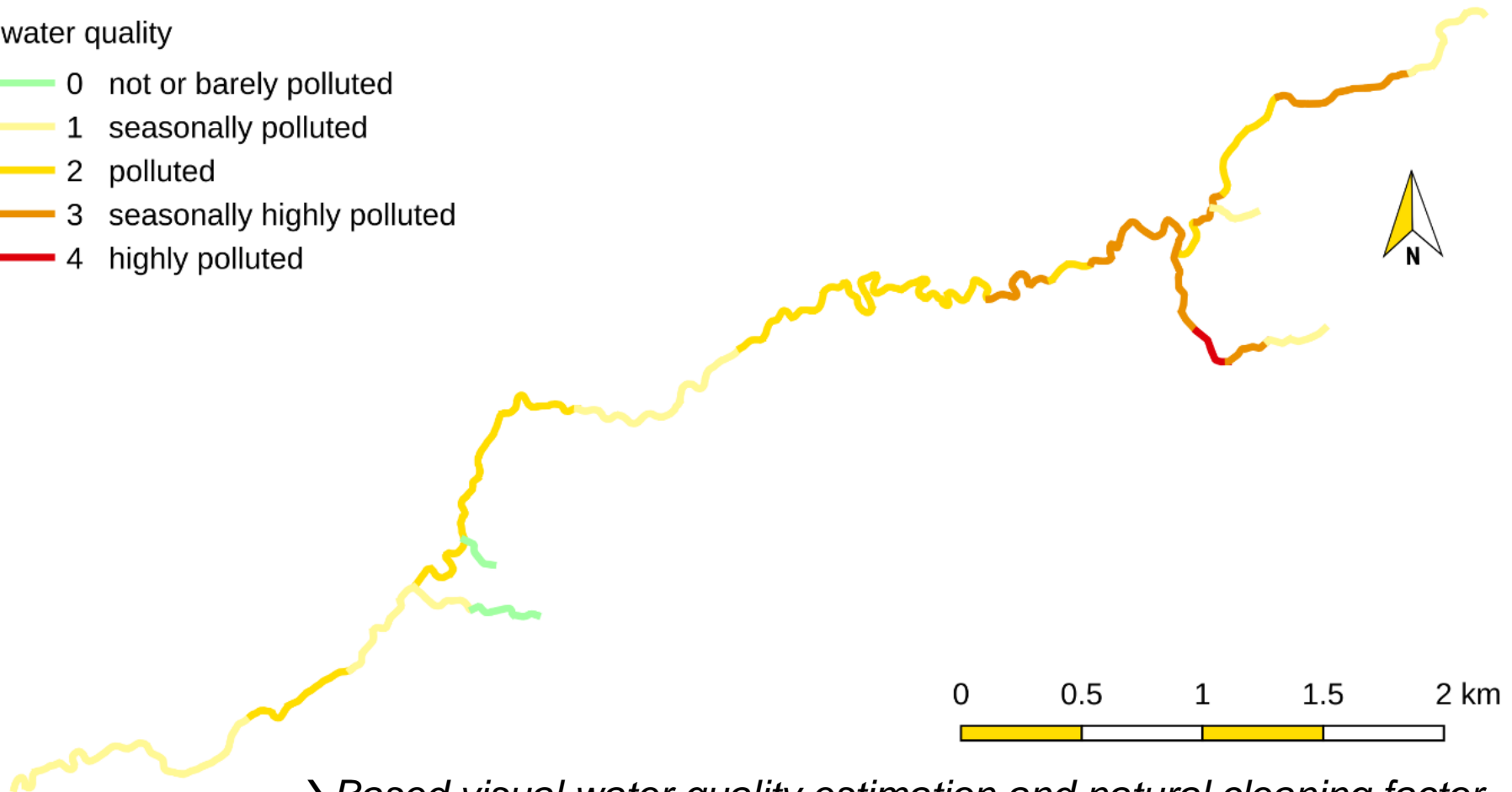
→ *Based visual water quality estimation and natural cleaning factor*

Ecosystem Status: Hydromorphological quality

hydromorphological quality

— 1 unchanged
— 2 slightly changed
— 3 moderately changed
— 4 significantly changed
— 5 strongly changed
— 6 very strongly changed
— 7 totally changed
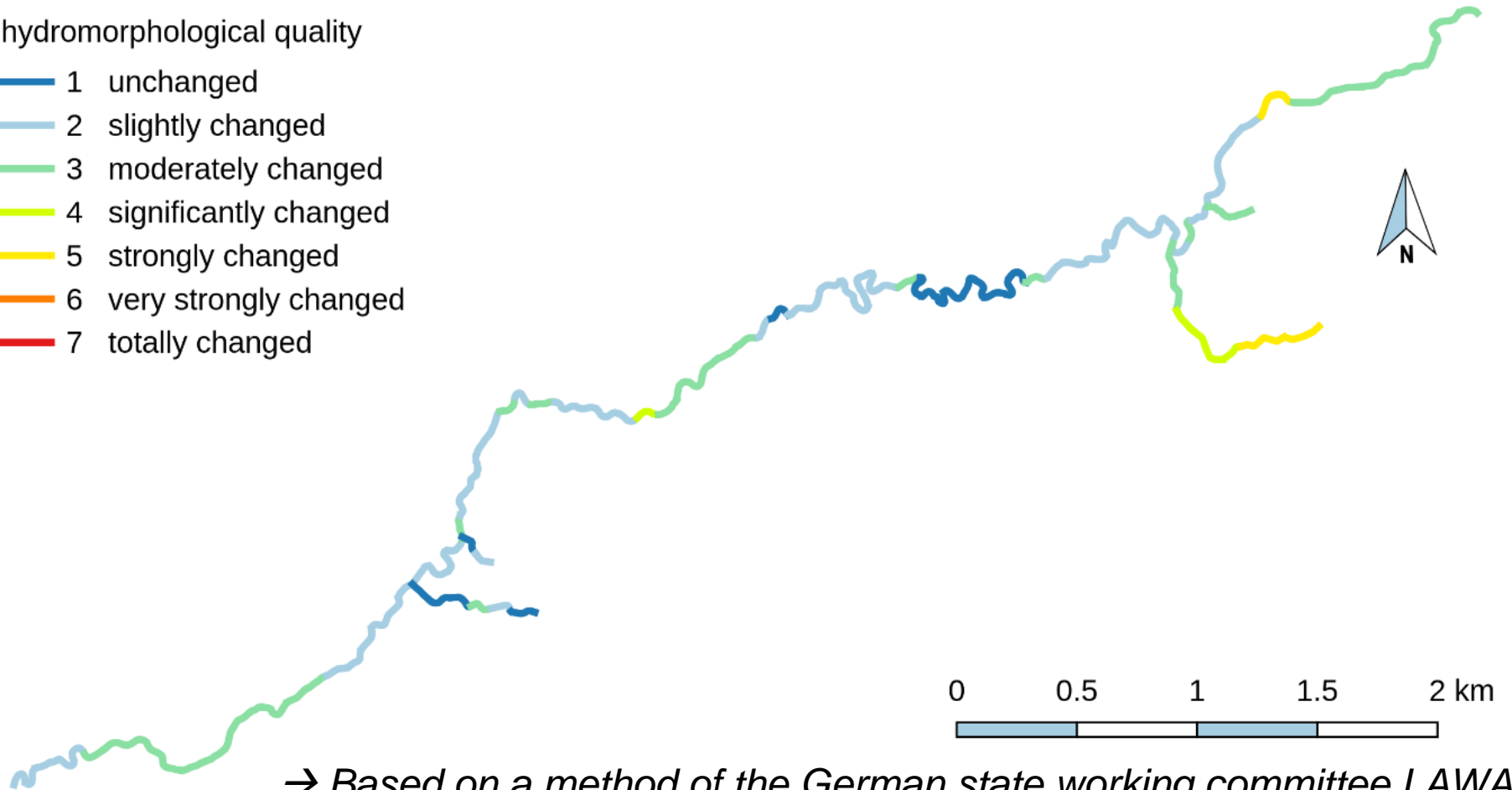
→ *Based on a method of the German state working committee LAWA*

Ecosystem Status:
Land cover of stream corridor

Ecosystem Status:
Land cover of stream corridor
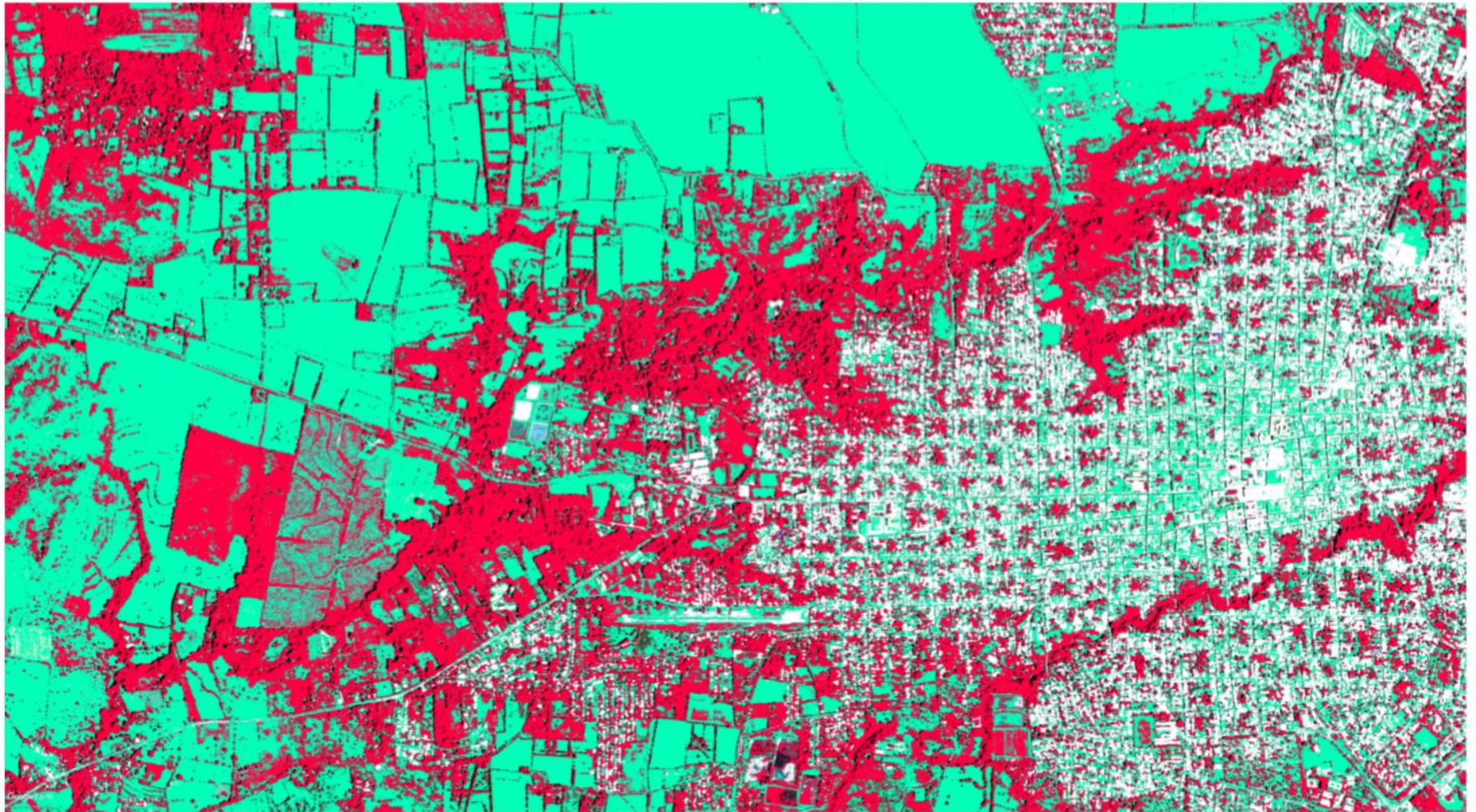
Ecosystem Status:
Land cover of stream corridor
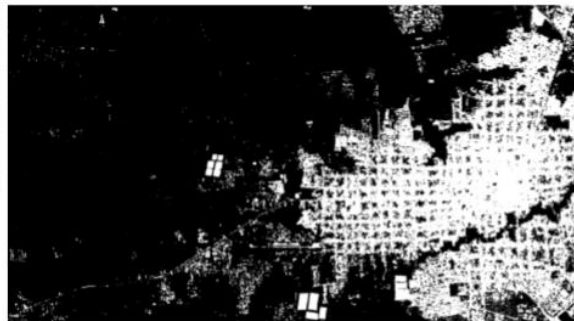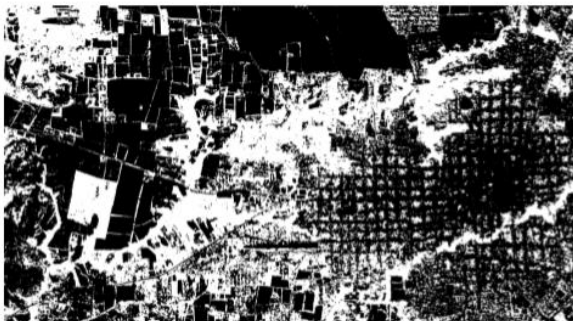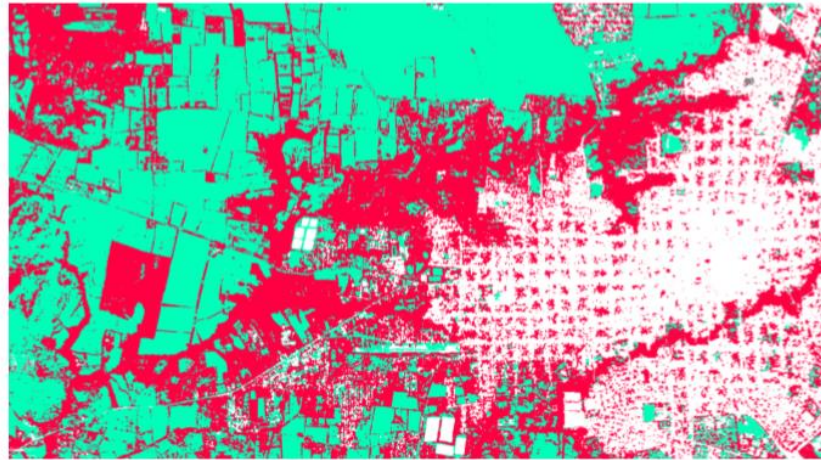
Ecosystem Status:
Land cover of stream corridor

land cover

- ■ high vegetation
- ■ low vegetation
- ■ build-up area

0   0.5   1   1.5   2 km

N

Results – Lowest URES potential
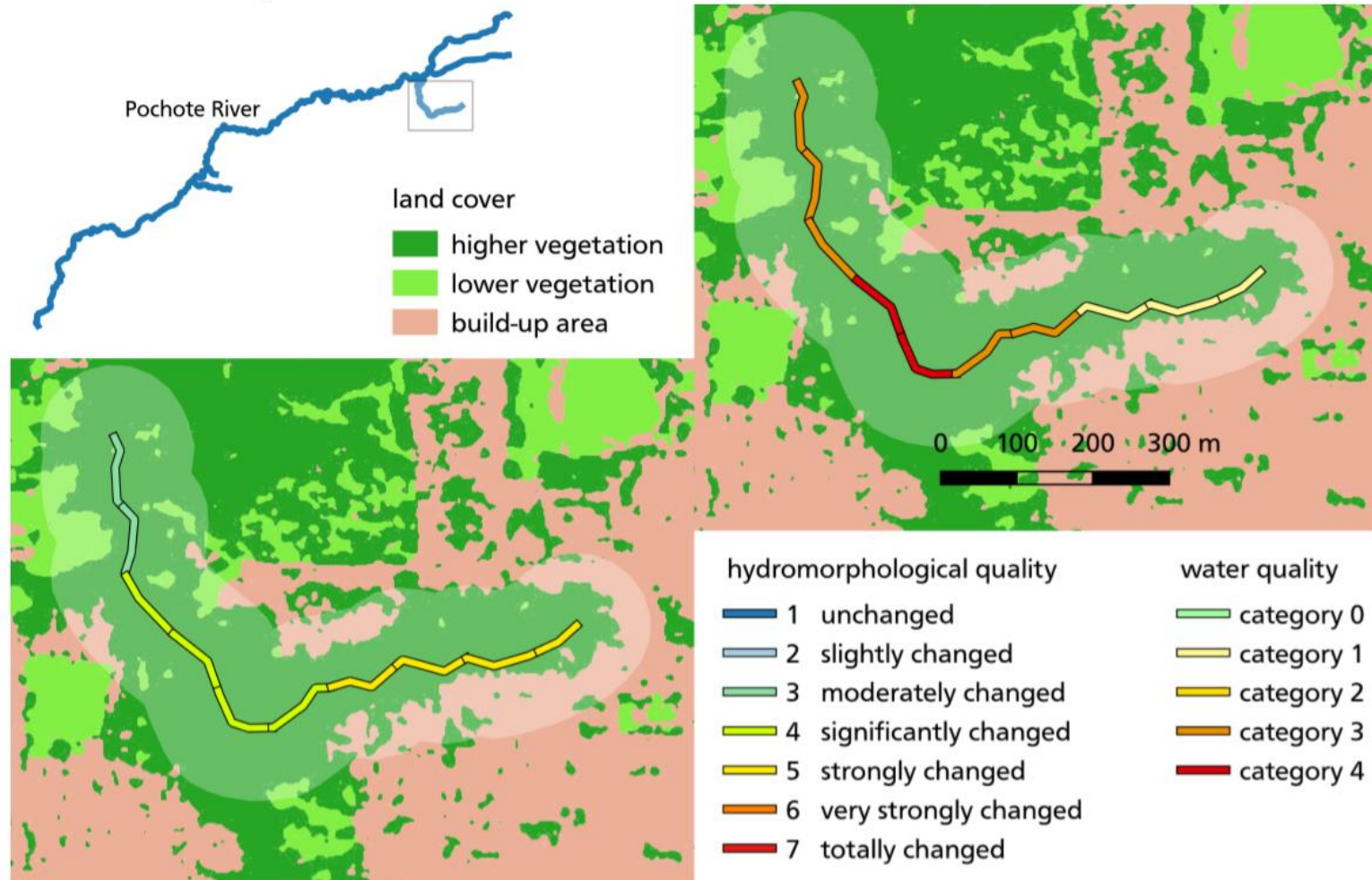
Results – Highest URES potential

Relating Ecosystem Status to Urban River Ecosystem Services

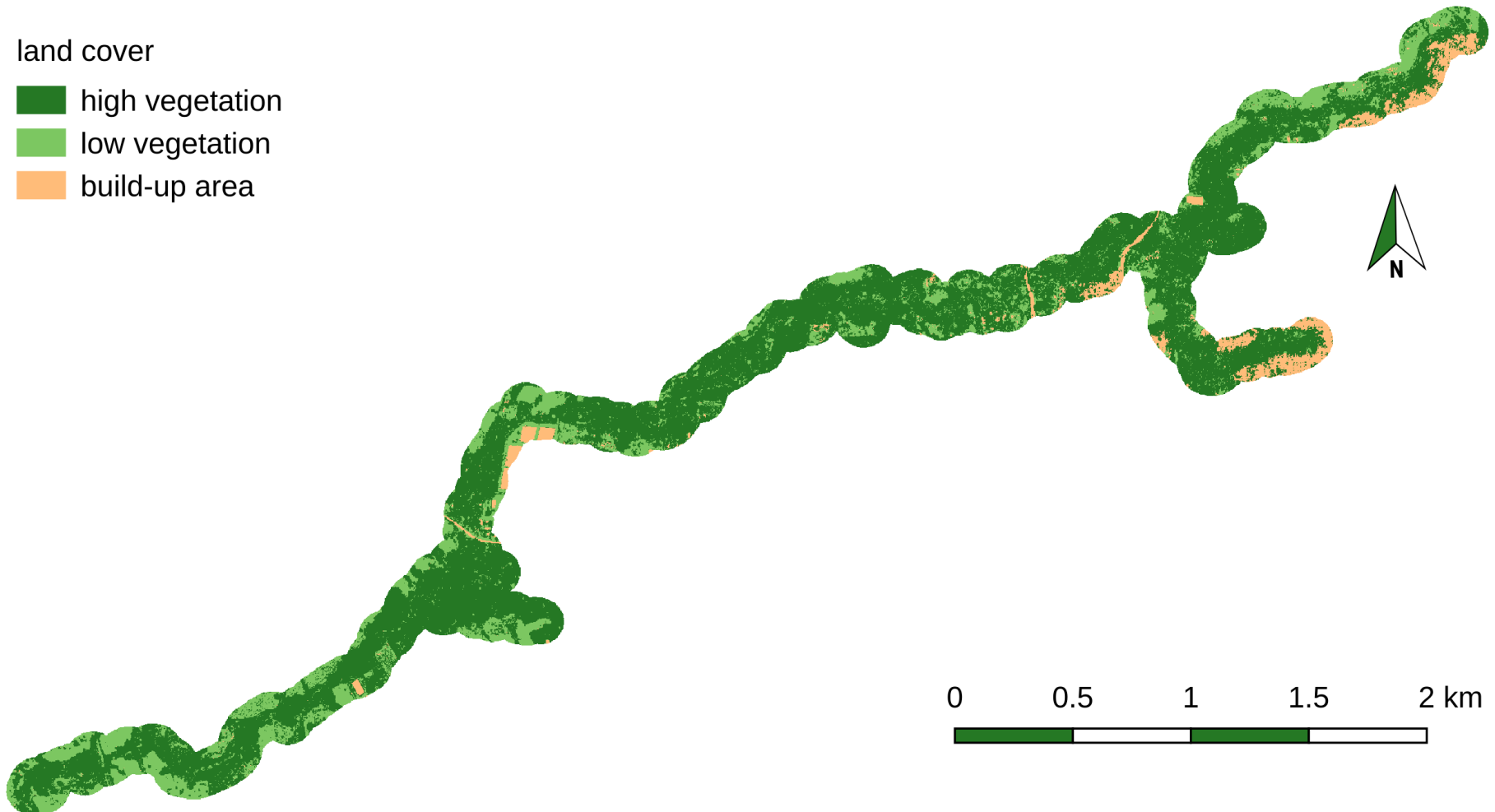# Relating Ecosystem Status to Urban River Ecosystem Services

hydromorphological quality		water quality		land cover	
category	value	category	value	category	value
1 unchanged	1.0	category 0	1.0	higher vegetation	1.0
2 slightly unchanged	0.83	category 1	0.9		
3 moderately unchanged	0.67	category 2	0.6	lower vegetation	0.6
4 significantly unchanged	0.50				
5 strongly unchanged	0.33	category 3	0.3		
6 very strongly unchanged	0.17				
7 totally changed	0.0	category 4	0.0	build-up area	0.0

Relating Ecosystem Status to Urban River Ecosystem Services
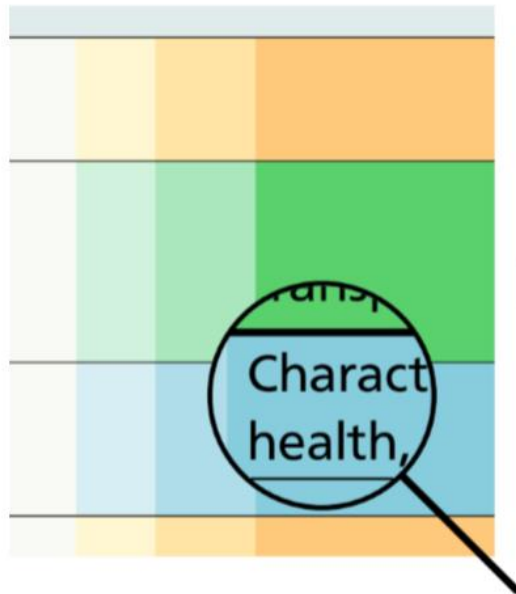
Pochote River Ecosystem Service

- Bio-remediation by micro-organisms, algae, plants, and animals
- Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals
- Noise attenuation
- Hydrological cycle and water flow regulation (Including flood control, and coastal protection)
- Maintaining nursery populations and habitats (Including gene pool protection)
- Regulation of the chemical condition of freshwaters by living processes
- Regulation of temperature and humidity, including ventilation and transpiration
- Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions
- Characteristics of living systems that enable aesthetic experiences
- Surface water for drinking
- Surface water for non-drinking purposes

Relating Ecosystem Status to Urban River Ecosystem Services

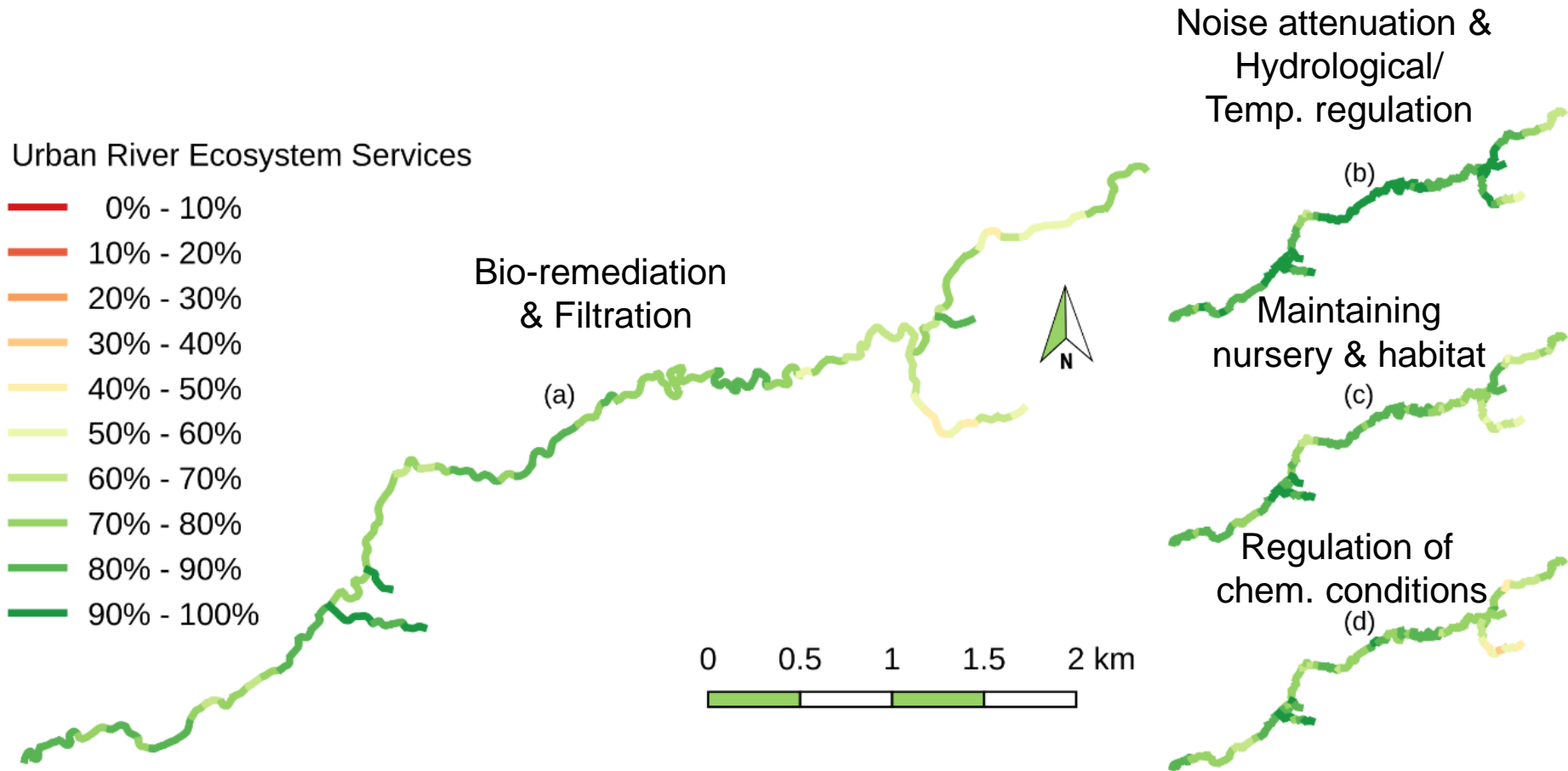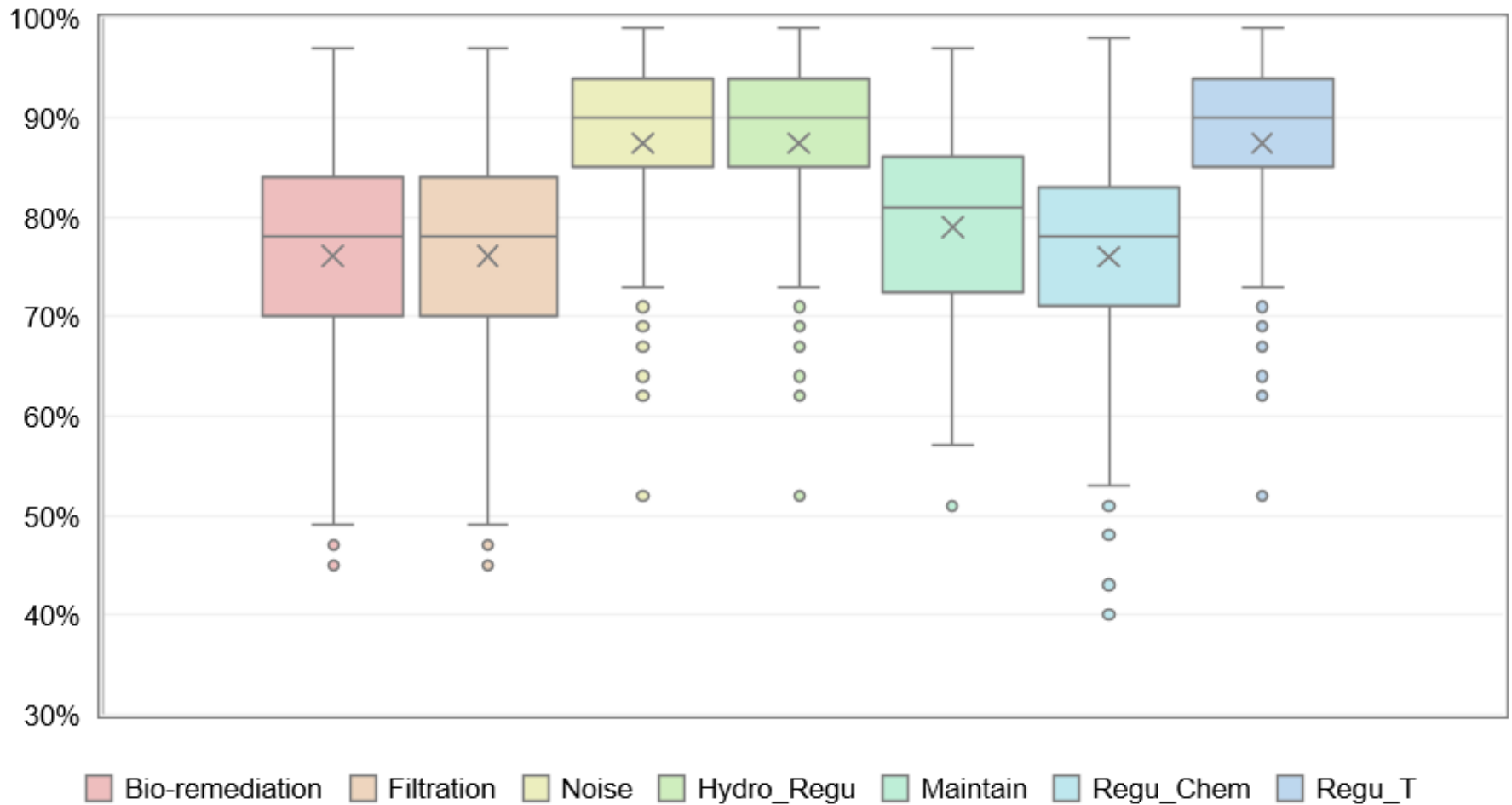| Pochote River Ecosystem Service	Ratio of ecosystem status data		
	Hydromorpho-logical quality	Water quality	Land cover
Bio-remediation by micro-organisms, algae, plants, and animals	1	1	1
Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals	1	1	1
Noise attenuation	-	-	1
Hydrological cycle and water flow regulation (Including flood control, and coastal protection)	-	-	1
Maintaining nursery populations and habitats (Including gene pool protection)	1	1	2
Regulation of the chemical condition of freshwaters by living processes	3	1	1
Regulation of temperature and humidity, including ventilation and transpiration	-	-	1
Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions	-	-	-
Characteristics of living systems that enable aesthetic experiences	-	-	-
Surface water for drinking	-	-	-
Surface water for non-drinking purposes	-	-	-

Results

Urban River Ecosystem Services

- 0% - 10%
- 10% - 20%
- 20% - 30%
- 30% - 40%
- 40% - 50%
- 50% - 60%
- 60% - 70%
- 70% - 80%
- 80% - 90%
- 90% - 100%

Noise attenuation &
Hydrological/
Temp. regulation
(b)

Bio-remediation
& Filtration
(a)

Maintaining
nursery & habitat
(c)

Regulation of
chem. conditions
(d)

0   0.5   1   1.5   2 km

Results

Conclusions

- Mapping and Assessment of Urban River Ecosystem Services still at the beginning → Definition as first step

- Methodology based on combined use of field and remote sensing data developed and tested
  → adapted to resource constraints in dev. country

- Ecosystem status assessment as basic decision-making support
  → Qualitative information

- URES maps highlight potential to derive societal benefits

- Further development needed in defining relationship between ecosystem status and URES

Thank you very much for your attention!

Raw data for Ecosystem Status Assessment

- Land cover map based on Google Earth satellite images (Beißler, 2018)