Biodiversity, climate and health benefits from urban green spaces

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Multi-functional urban Green space planning based on transdisciplinary learning (MultiGreen)

Abstract
Green infrastructure (GI) like urban farm and green roofs could provide many beneficial functions in cities.

Twitter feed

MultiGreen   7 Oct
@MultiGreen3

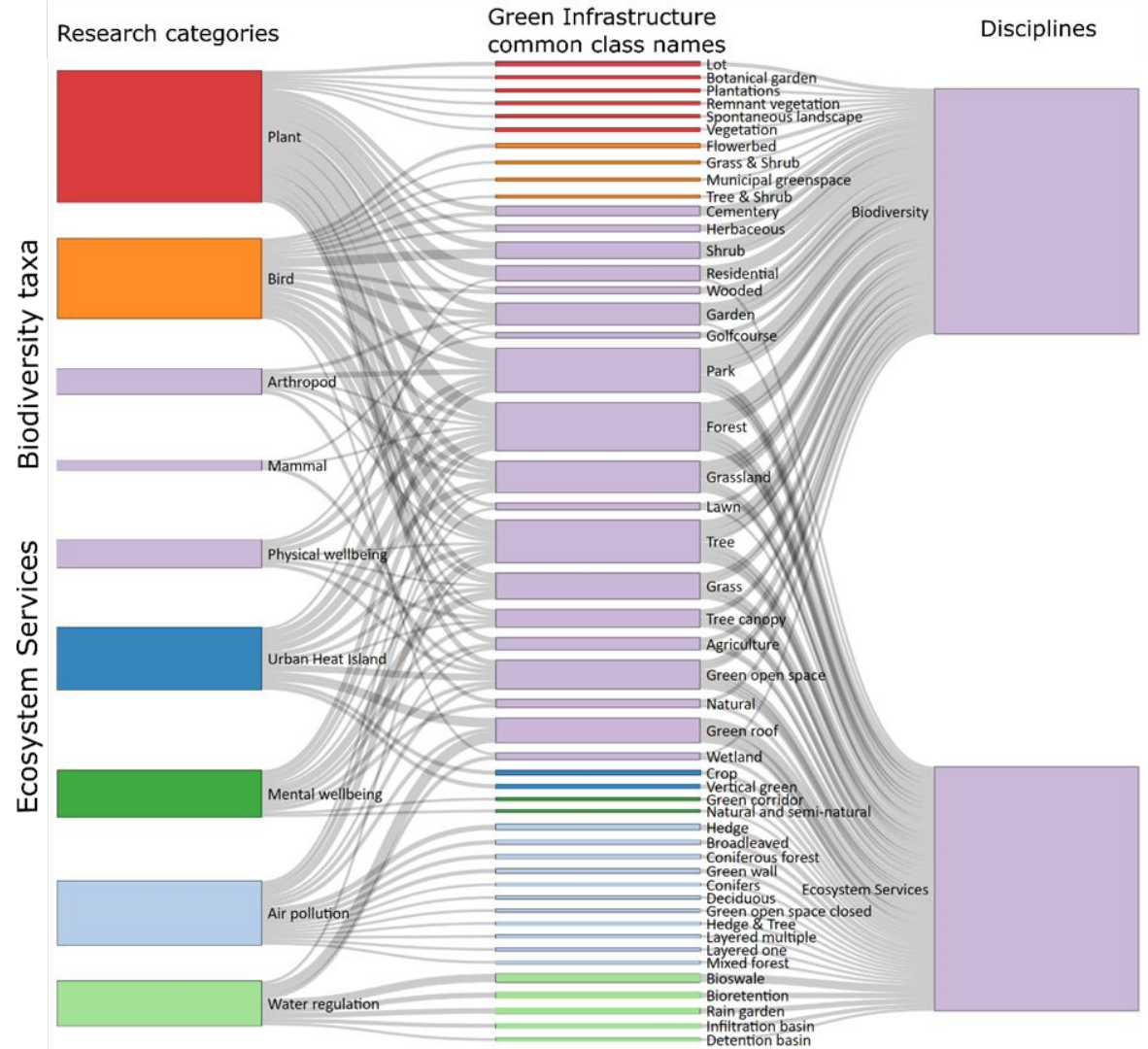# How do we monitor Urban Nature globally, and consistent?

Methods

- Literature review
- Analysis at three levels
  - Name
  - Definitions
  - Characteristics
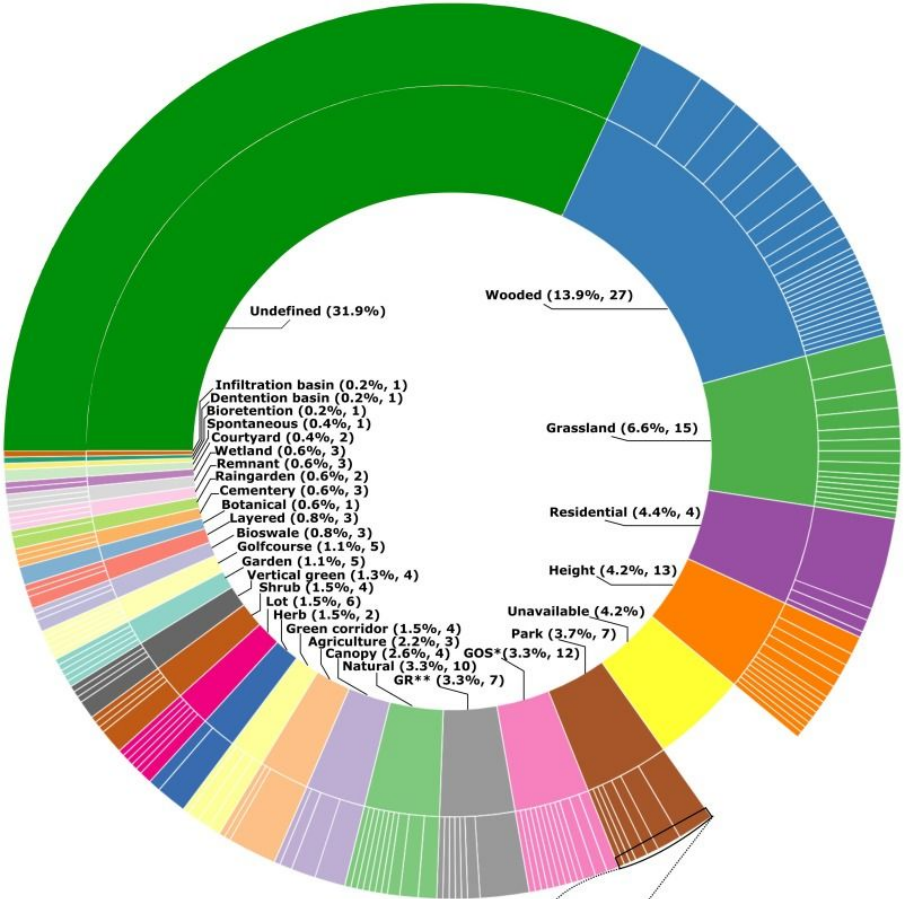- Creating harmonized framework
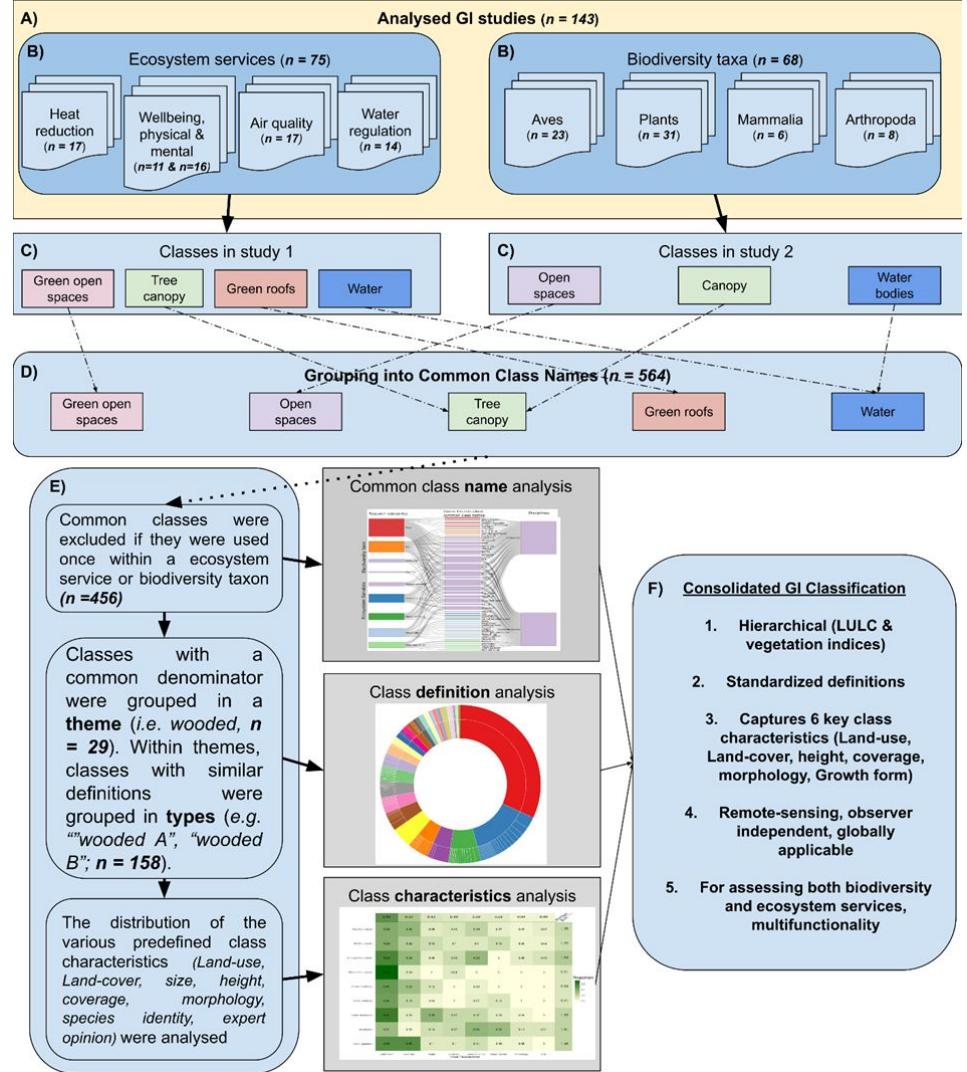
What lens does every discipline use when looking at urban green?

- Specialist name, likely mechanistic role
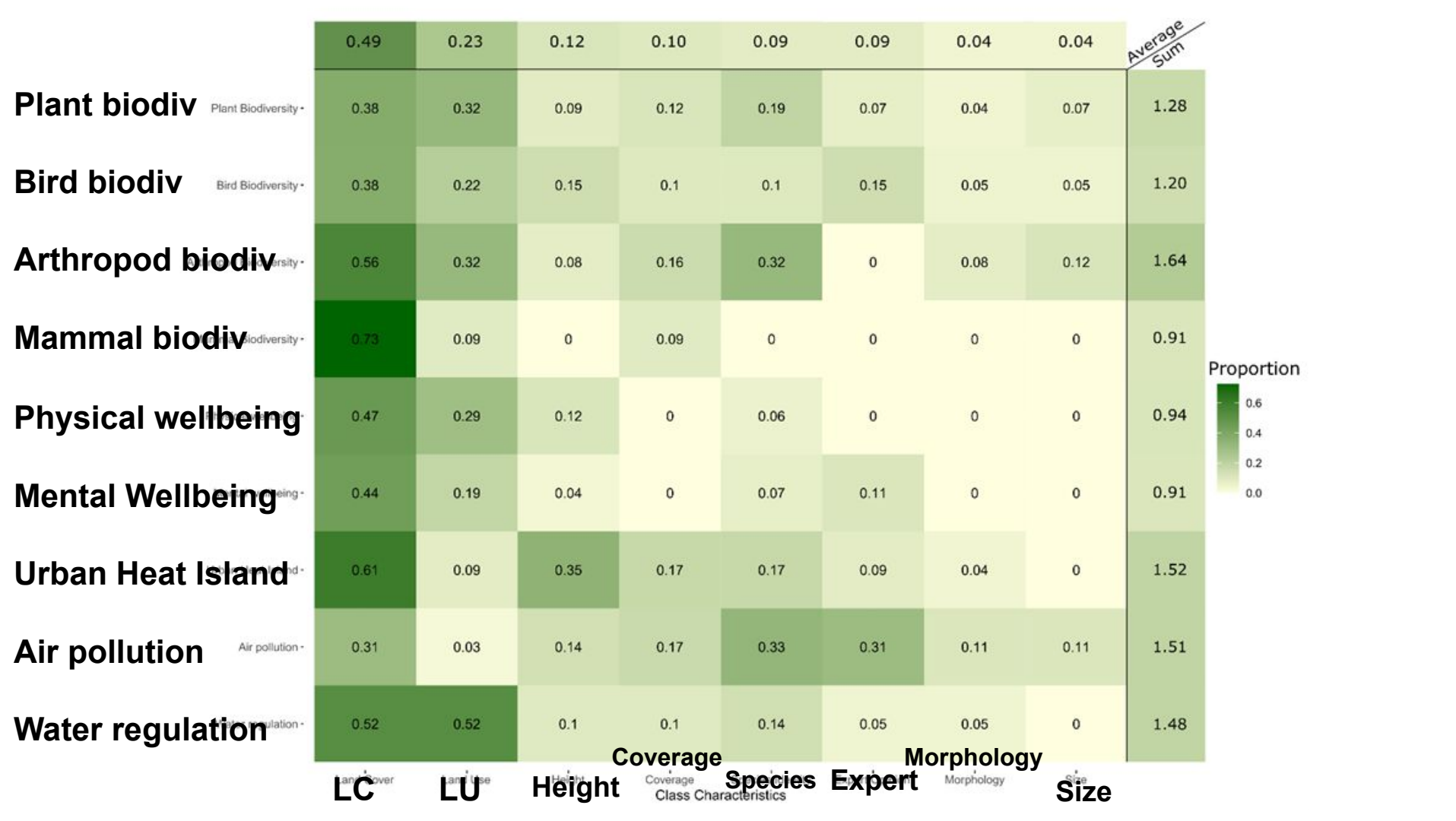- Generalistic name, likely data availability

Are we talking about the same stuff?

- Lack of definitions in general
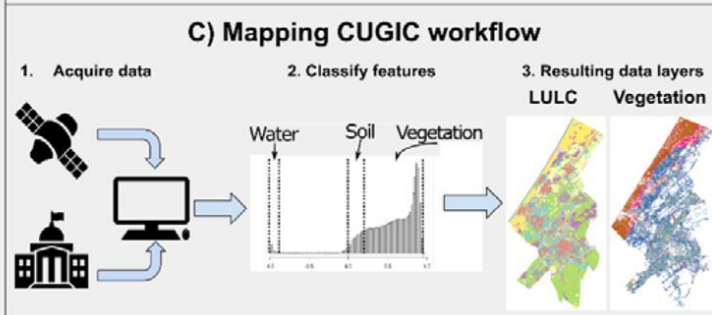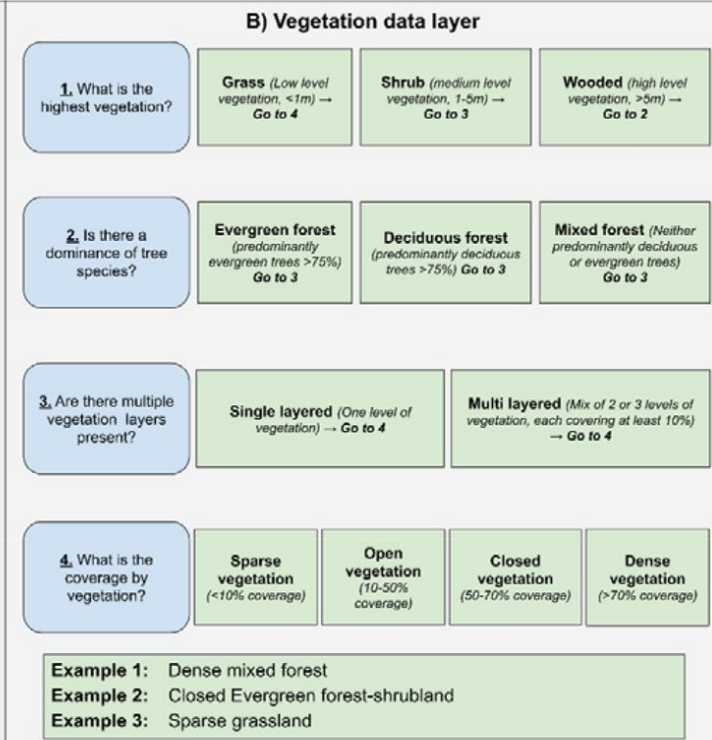- Massive variety of definitions

	LC	LU	Height	Coverage (Class Characteristics)	Species	Expert	Morphology	Size	Average Sum
	0.49	0.23	0.12	0.10	0.09	0.09	0.04	0.04	
Plant biodiv	0.38	0.32	0.09	0.12	0.19	0.07	0.04	0.07	1.28
Bird biodiv	0.38	0.22	0.15	0.1	0.1	0.15	0.05	0.05	1.20
Arthropod biodiv	0.56	0.32	0.08	0.16	0.32	0	0.08	0.12	1.64
Mammal biodiv	0.73	0.09	0	0.09	0	0	0	0	0.91
Physical wellbeing	0.47	0.29	0.12	0	0.06	0	0	0	0.94
Mental Wellbeing	0.44	0.19	0.04	0	0.07	0.11	0	0	0.91
Urban Heat Island	0.61	0.09	0.35	0.17	0.17	0.09	0.04	0	1.52
Air pollution	0.31	0.03	0.14	0.17	0.33	0.31	0.11	0.11	1.51
Water regulation	0.52	0.52	0.1	0.1	0.14	0.05	0.05	0	1.48

Consolidated Urban Green Infrastructure Classification (CUGIC)

- **Bi-layered system (more variation)**
- **Globally applicable**
- **Evidence based**
- **Observer-independent**
- **Holistic nature approach (Both ES and BIO)**

A) Land use/ Land cover data layer

Remnant vegetation *(vegetation without evident use or management, leading to spontaneous or unmanaged vegetation)*

Natural Land *(Land maintained in its natural state, little to no management, only passive recreation possible)*

Park *(Green spaces designated for a wide variety of passive and active recreation. Are usually designed and intensely managed)*

Agriculture *(Land used for agriculture, usually large in size)*

Botanical garden *(Garden used for scientific purposes)*

Cemetery *(Land used as cemetery, involving low management.)*

Golf course *(Land designed for golfing)*

Wetland *(Engineered systems that regulates water next to permanent water bodies)*

Rain Garden *(Vegetation with permeable earth next to impermeable surfaces)*

Bioswale *(Street scale linear vegetated mulches with a gentle slope. Placed next to impervious surface)*

Detention basin *(* - land excavated next to flooding water bodies)*

Infiltration basin *(* - constructed apparatus to regulate water)*

Residential green & garden *(Vegetation in private yards, or close to residential housing; generally decorative purposes)*

Green buffer zones *(Strips of grass and scattered trees, can involve shrubs. Placed next to canals, roads, cycling path, etc.)*

Green roof *(vegetation that partially or fully covers a roof)*

Green wall *(vegetation along a vertical surface)*

B) Vegetation data layer

1. What is the highest vegetation?

Grass *(Low level vegetation, <1m)* → Go to 4

Shrub *(medium level vegetation, 1-5m)* → Go to 3

Wooded *(high level vegetation, >5m)* → Go to 2

2. Is there a dominance of tree species?

Evergreen forest *(predominantly evergreen trees >75%)* Go to 3

Deciduous forest *(predominantly deciduous trees >75%)* Go to 3

Mixed forest *(Neither predominantly deciduous or evergreen trees)* Go to 3

3. Are there multiple vegetation layers present?

Single layered *(One level of vegetation)* → Go to 4

Multi layered *(Mix of 2 or 3 levels of vegetation, each covering at least 10%)* → Go to 4

4. What is the coverage by vegetation?

Sparse vegetation *(<10% coverage)*

Open vegetation *(10-50% coverage)*

Closed vegetation *(50-70% coverage)*

Dense vegetation *(>70% coverage)*

Example 1: Dense mixed forest
Example 2: Closed Evergreen forest-shrubland
Example 3: Sparse grassland

C) Mapping CUGIC workflow

1. Acquire data
2. Classify features — Water, Soil, Vegetation
3. Resulting data layers — LULC, Vegetation

How does CUGIC compare to other systems?

- LULC vs. Remote Sensing
- What is the difference between them?
- Which system captures more variation?

The resulting maps: CUGIC

Vegetation CUGIC
- No Vegetation
- Dense Grassland
- Closed Grassland
- Open Grassland
- Sparse Grassland
- Dense Shrub
- Closed Shrub
- Open Shrub
- Sparse Shrub
- Dense Forest
- Closed Forest
- Open Forest
- Sparse Forest
- Dense Grass/Forest
- Closed Grass/Forest
- Open Grass/Forest
- Dense Shrub/Forest
- Closed Shrub/Forest
- Open Shrub/Forest
- Dense Mixed
- Closed Mixed
- Open Mixed
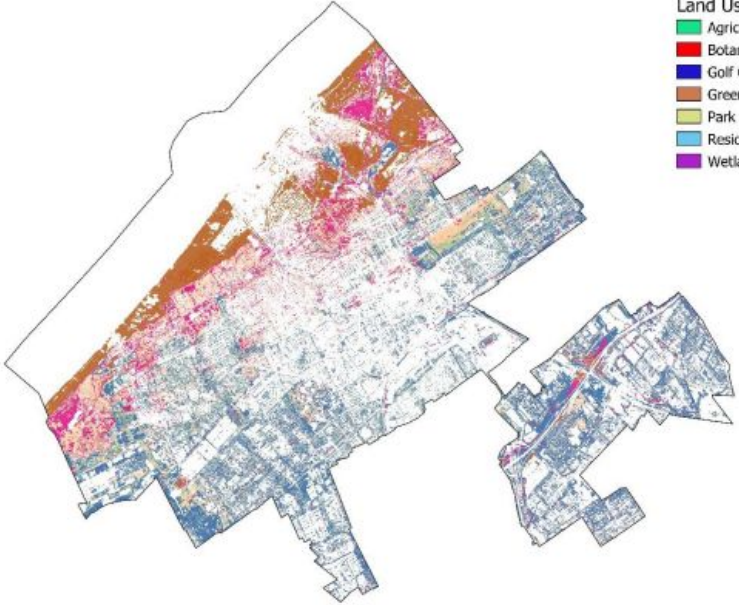
Land Use Land Cover CUGIC
- Agriculture
- Botanical Garden
- Golf Course
- Green Buffer Zones
- Park
- Residential Green & Garden
- Wetland

Remote Sensing is important!

Top 10% Values by Proportion

- -8997.0: No LULC Data_Open Grassland
- -8981.0: No LULC Data_Open Shrub/forest
- -8989.0: No LULC Data_Open Forest
- -8996.0: No LULC Data_Sparse Grassland
- -8993.0: No LULC Data_Open Shrub
- -8000.0: Residential Green & Garden_No Vegetation
- -8900.0: Park_No Vegetation
- -8977.0: No LULC Data_Open Mixed
- 103.0: Park_Open Grassland
- 1019.0: Residential Green & Garden_Open Shrub/forest
- -8800.0: Agriculture_No Vegetation

Figure 4. The top 10% of most occurring values ranked by count of occurrence and labeled by share (meaning the most occurring value overall was −8997: No LULC Data + Open Grassland).

Variation is key

CUGIC
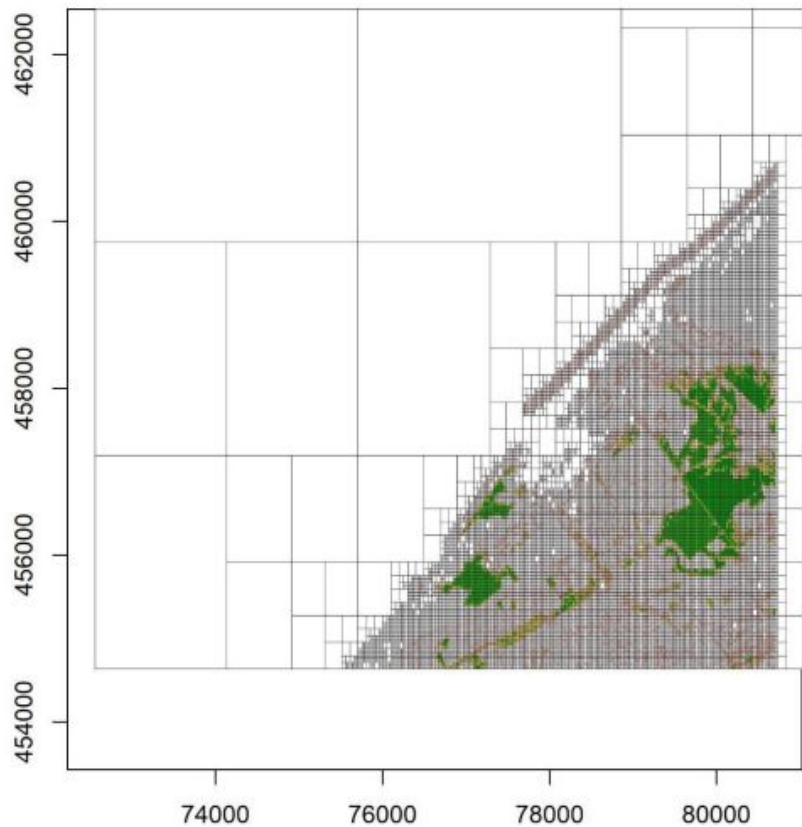
ESA World Cover
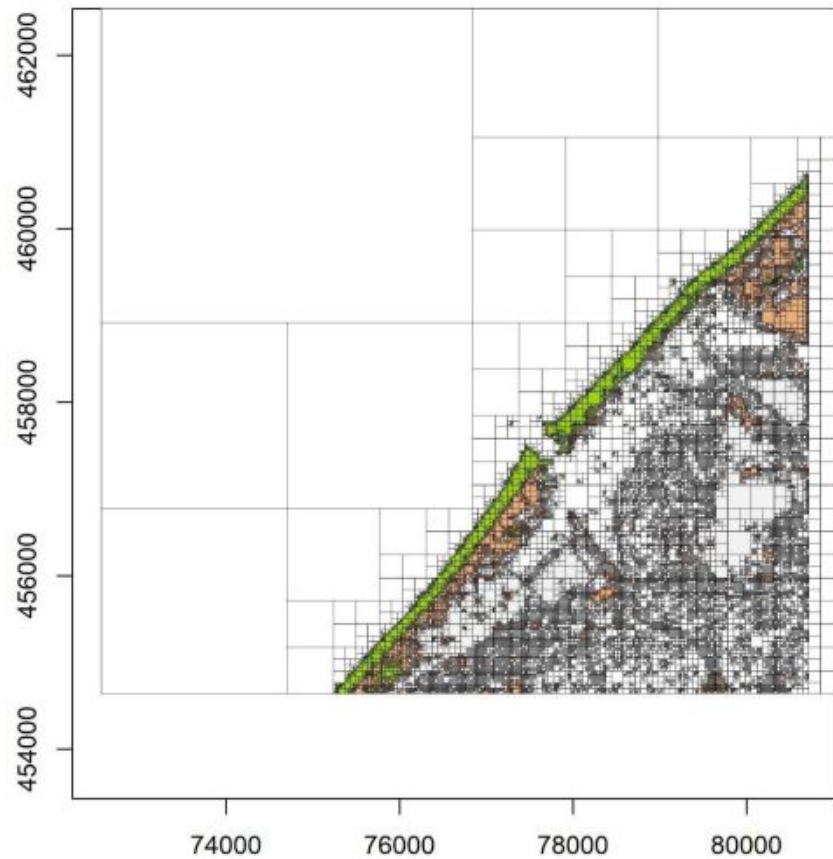
Applications

- Mapping Urban Green Spaces near real-time
- Investigating intra-LULC variation
- Elucidating synergies and trade-offs for multifunctional urban green infrastructure

Available (or coming)

- Article providing evidence
- Flexibility of CUGIC
- R-code for vegetation mapping
- Global instant CUGIC mapping tool (coming 1-2 yrs.)

My applications - biodiversity
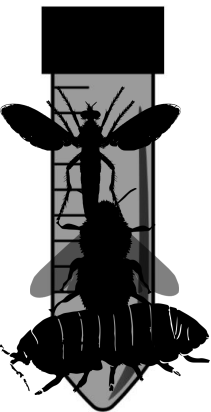
Bulk & soil

DNA techniques
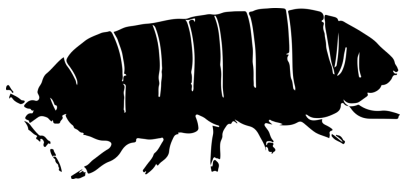
Species

Spatial mapping

Species Occurrence Points

Terrain

Climate

Soils

Land Cover

Environmental Predictors

Predicted Suitability
Low: 0   Hig

Species Occurrence Points

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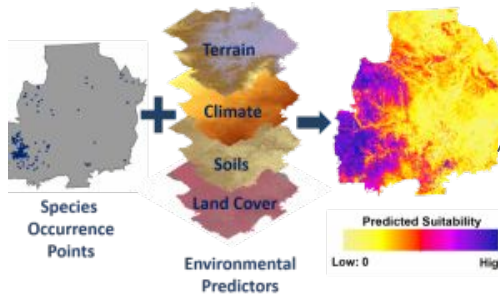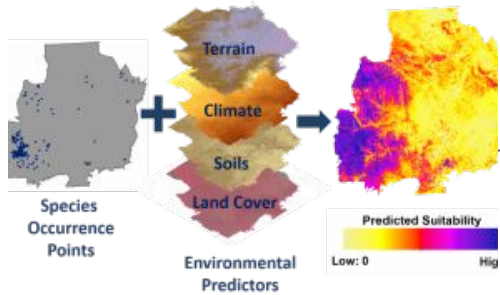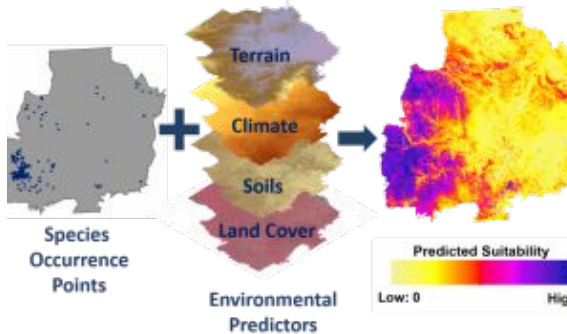
Predicted Suitability
Low: 0   Hig

Regions of common profile
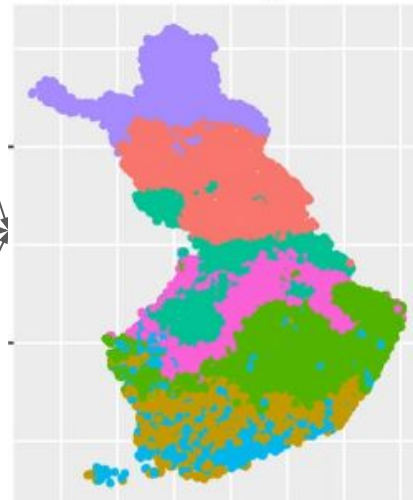
1
2
3
4
5
6
7

Predicting and understanding

My applications - climate

Happy to help with setting-up CUGIC!

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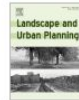✉ **j.morpurgo@cml.leidenuniv.nl**

in JoeriMorpurgo

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ELSEVIER

Research Paper
CUGIC: The Consolidated Urban Green
Infrastructure Classification for assessing
ecosystem services and biodiversity

Joeri Morpurgo [a] 👤 ✉, Roy P. Remme [a b], Peter M. Van Bodegom [a]

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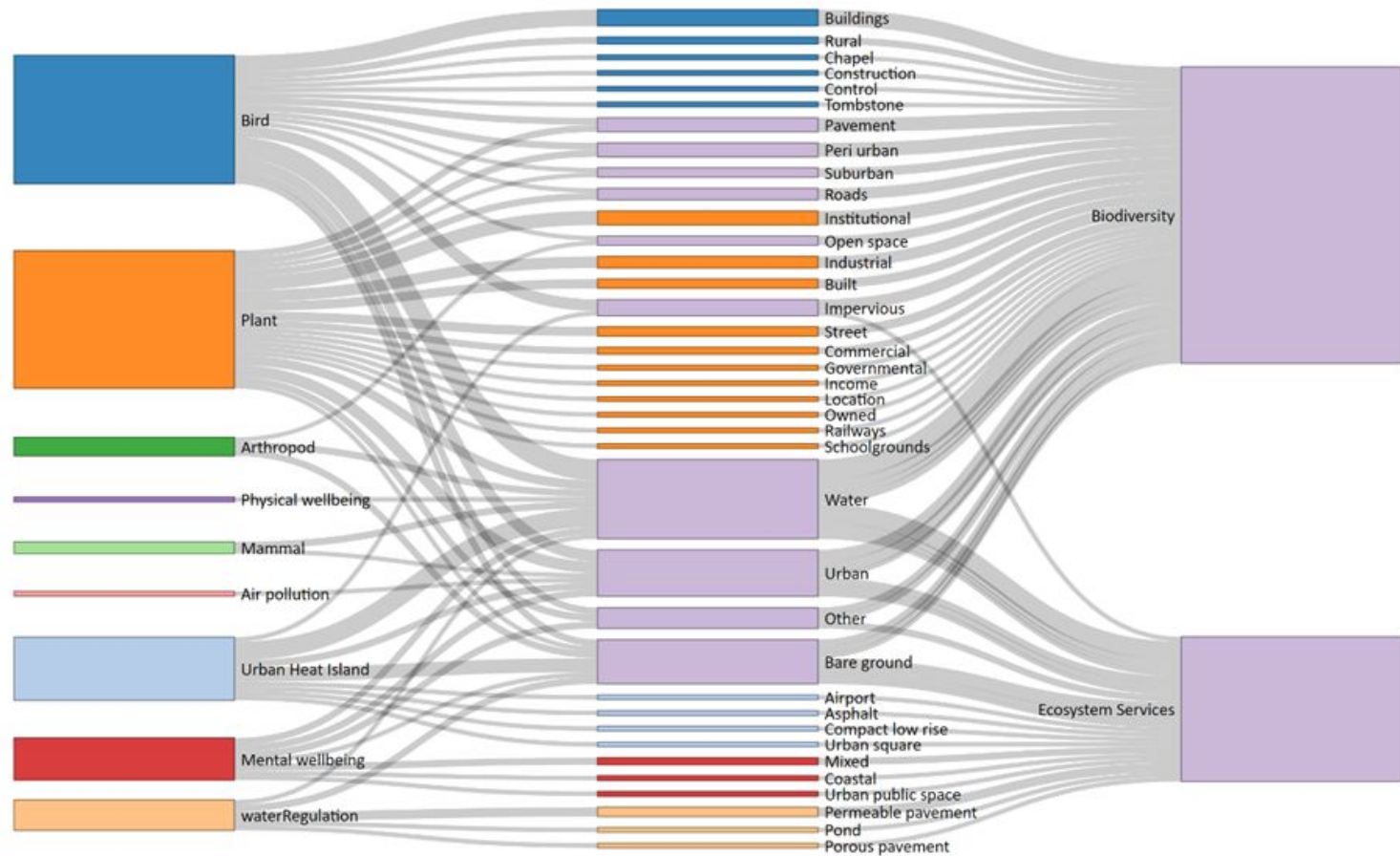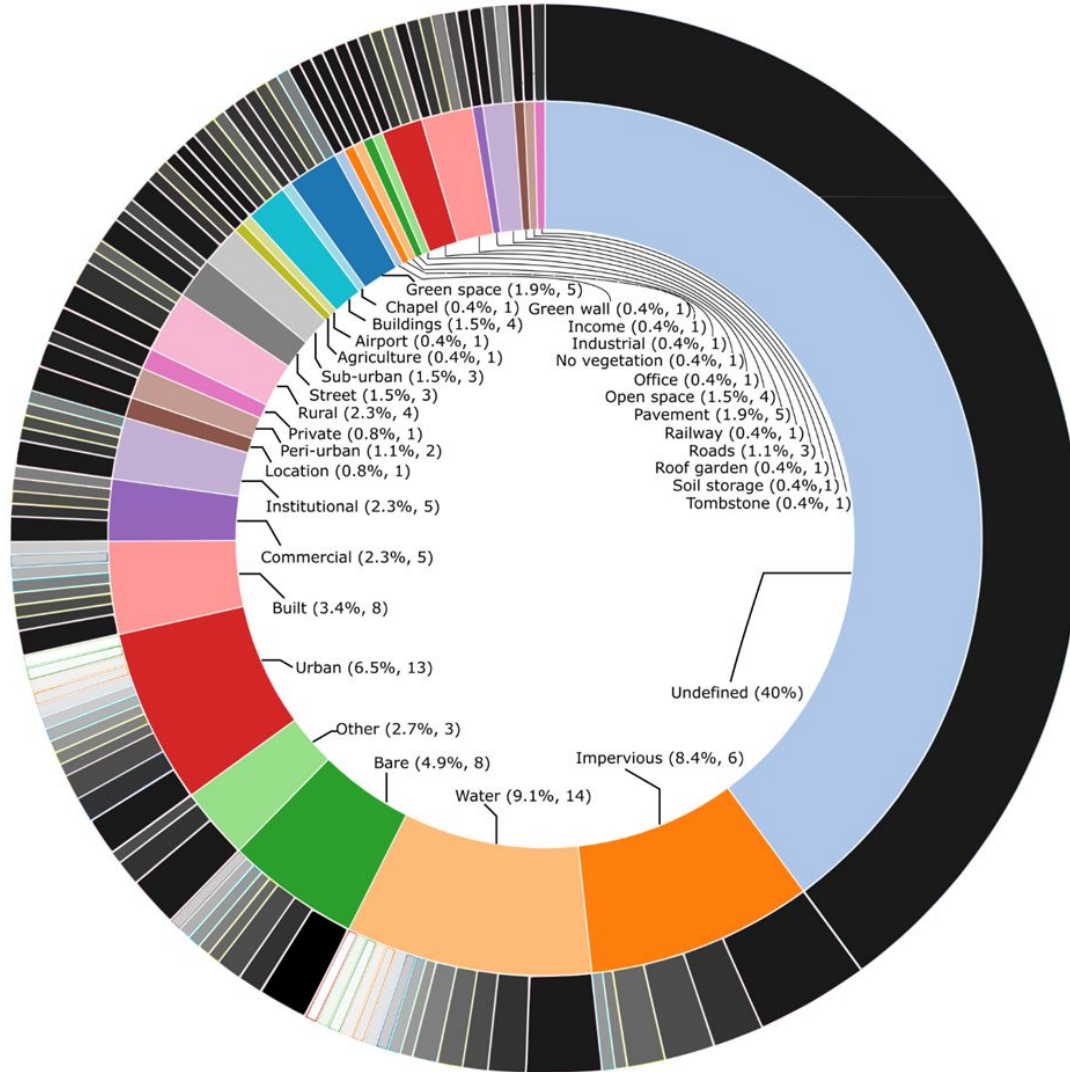
Prof. Dr. Peter van
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Supervisor

Grey infrastructure

Green space (1.9%, 5)
Chapel (0.4%, 1) Green wall (0.4%, 1)
Buildings (1.5%, 4) Income (0.4%, 1)
Airport (0.4%, 1) Industrial (0.4%, 1)
Agriculture (0.4%, 1) No vegetation (0.4%, 1)
Sub-urban (1.5%, 3) Office (0.4%, 1)
Street (1.5%, 3) Open space (1.5%, 4)
Rural (2.3%, 4) Pavement (1.9%, 5)
Private (0.8%, 1) Railway (0.4%, 1)
Peri-urban (1.1%, 2) Roads (1.1%, 3)
Location (0.8%, 1) Roof garden (0.4%, 1)
Institutional (2.3%, 5) Soil storage (0.4%, 1)
Tombstone (0.4%, 1)
Commercial (2.3%, 5)
Built (3.4%, 8)
Urban (6.5%, 13)
Other (2.7%, 3) Undefined (40%)
Bare (4.9%, 8)
Water (9.1%, 14) Impervious (8.4%, 6)

Methods sampling – Where?

- Random Stratification based on conditional Latin Hypercube Sampling (cLHS).
- Using variables of interest:
  - Road (Railway, Highway, Main, Residential, Bicycle, walk)
  - Water
  - Noise pollution
  - Temperature
  - Building height
  - Private vs municipal space
  - LAI
  - Building use (Office, Shops, Industry, Institutes, Residential)
  - Urbanization (UA categories)
  - Light pollution (At least 100m)
  - Litter (Not added in yet)
- Resample to large scale? (10m current)
- VIF score checking for collinearity?