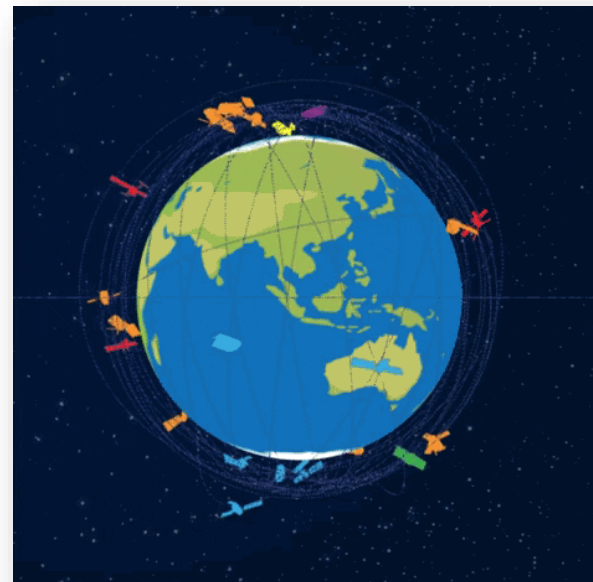


Yearly Urban Tree Canopy Cover and Urban Green Space Coverage Indicators for Germany from Sentinel-2

05 - 07 May 2026, StatEO26, ESA-ESRIN, Frascati (IT)

An Operational Workflow for Deriving Indicators for the EU Nature Restoration Regulation



LUP – Who we are?

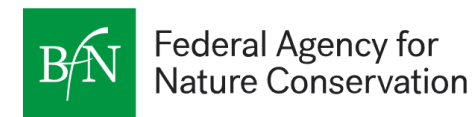
- **SME, founded in 1996, based in Potsdam**
- **40 employees** from the fields of environmental and landscape planning, remote sensing, biology, ecology, geography, cartography, computer science, and geoinformation

Core competencies

- **REMOTE SENSING** - Collection of environmental data from aerial and satellite imagery, as well as monitoring concepts
- **GEO-IT** - Digital processing of geodata, spatial environmental analysis, geodata infrastructures
- **ENVIRONMENTAL MANAGEMENT** - Landscape planning, nature conservation, regional planning, climate adaptation
- **POLICY SERVICES** - Implementing remote sensing products for policy support and regulatory guidelines



Article 8 – Nature Restoration Regulation



- **Objective:** Restore urban ecosystems by strengthening urban green space and tree canopy cover.
- **By 2030:** Ensure no net loss at national level of urban green space and urban tree canopy cover in urban ecosystem areas, compared with 2024.
- **From 2031 onwards:** Achieve an increasing trend in the total national area of urban green space, measured every six years, until a satisfactory level is reached.
- **Urban tree canopy:** Each urban ecosystem area should show an increasing trend in tree canopy cover, also measured every six years, until a satisfactory level is reached.
- **Urban green space:** includes green areas integrated into buildings and infrastructure, such as green roofs and green walls.



Introduction

Tree Canopy Cover

Aerial Image 2023



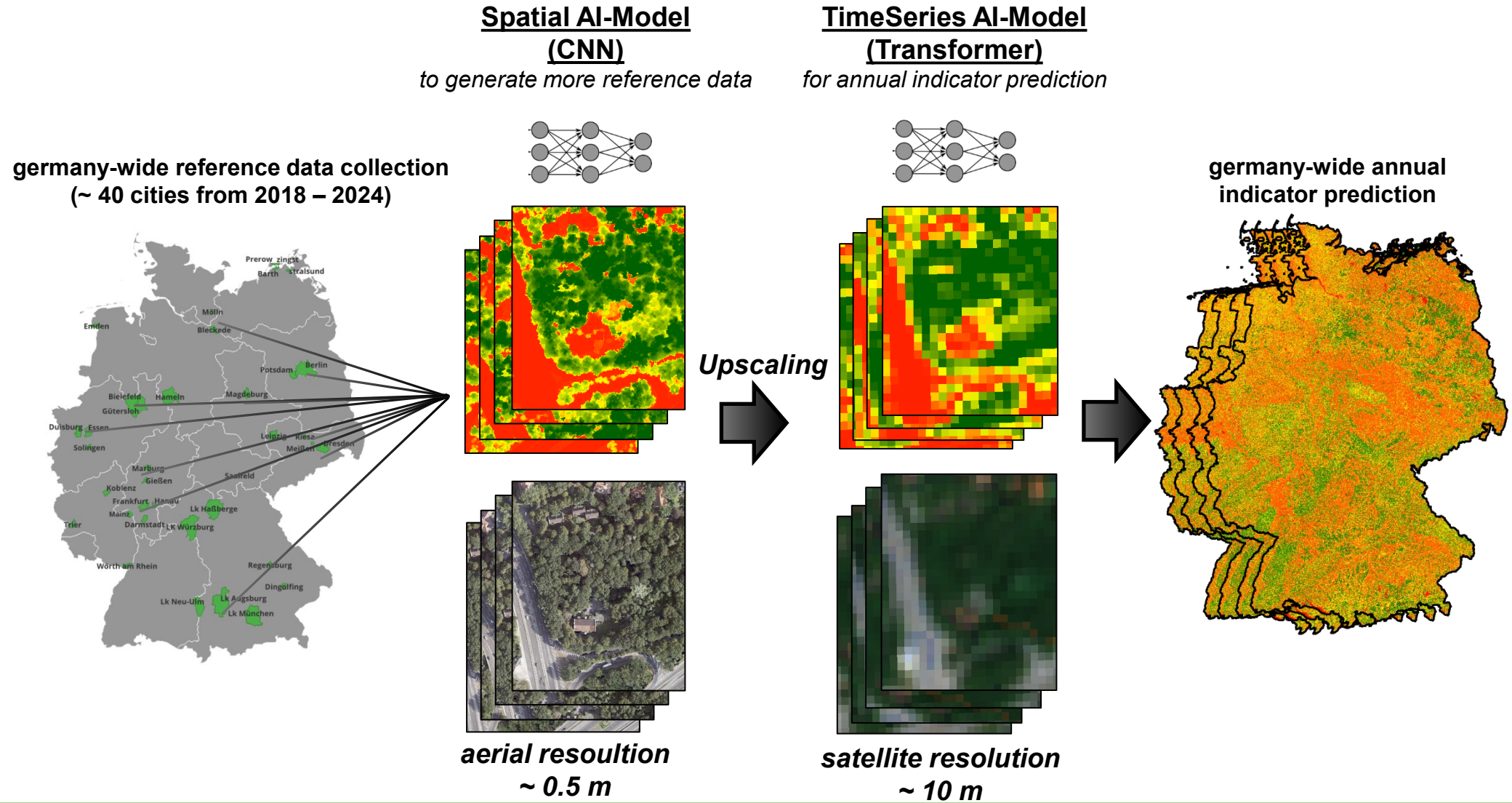
HRL Tree Cover Density 2023



% Area per Pixel



Method



Introduction

Tree Canopy Cover

Aerial Image 2023



HRL Tree Cover Density 2023



% Area per Pixel



LUP National Dataset 2023



% Area per Pixel





Urban Green Space

Aerial Image 2018



CLCplus Backbone 2018



- Keine Städtische Grünfläche (Sealed, Periodically herbaceous und Non and sparsely vegetated)
- Städtische Grünfläche (Woody trees, woody plants, permanent herbaceous, lichens/mosses, water)

Method

Spatial AI-Model for High Resolution Indicators

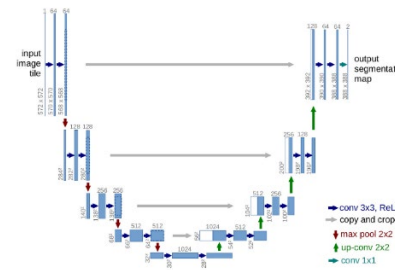
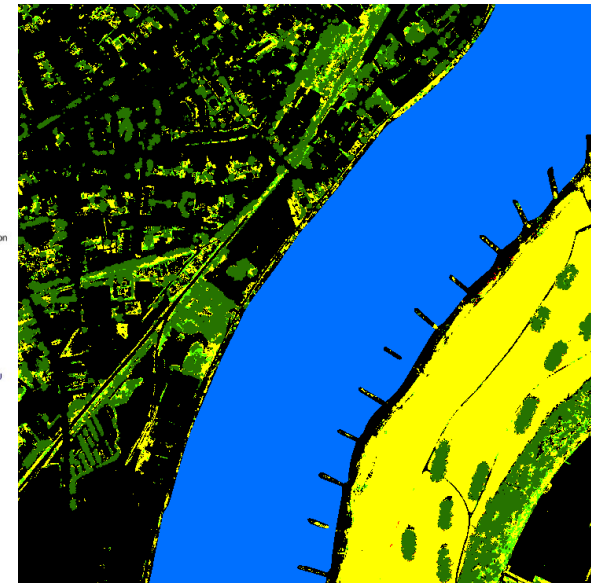
RGB(I) Aerial Image



Height Data



LU / LC Classification for NRL required Classes



Urban Green Space

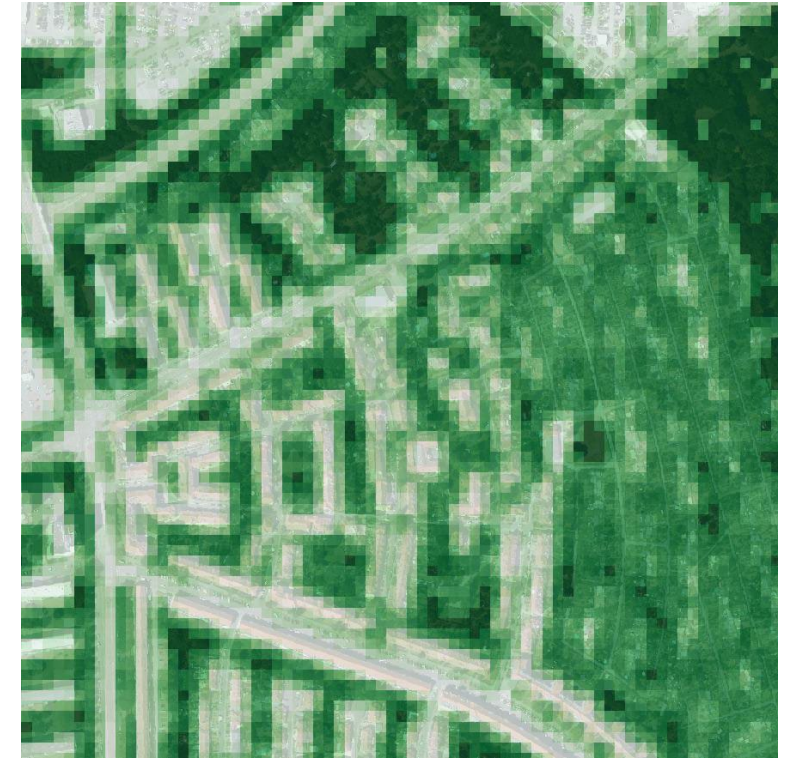
Aerial Image 2018



CLCplus Backbone 2018



LUP National Dataset 2018



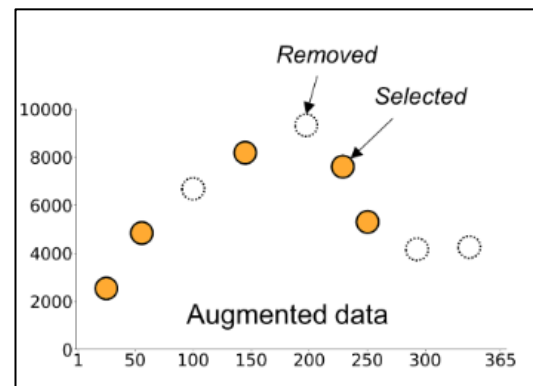
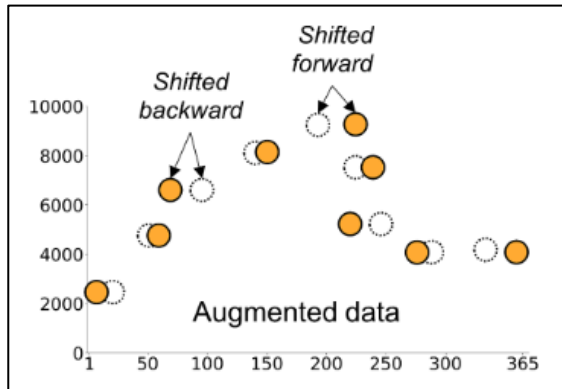
Keine Städtische Grünfläche (Sealed, Periodically herbaceous und Non and sparsely vegetated)
 Städtische Grünfläche (Woody trees, woody plants, permanent herbaceous, lichens/mosses, water)

% Area per Pixel

0 100

Augmentation and Integration of Meteorological Data for better spatial and temporal Generalization

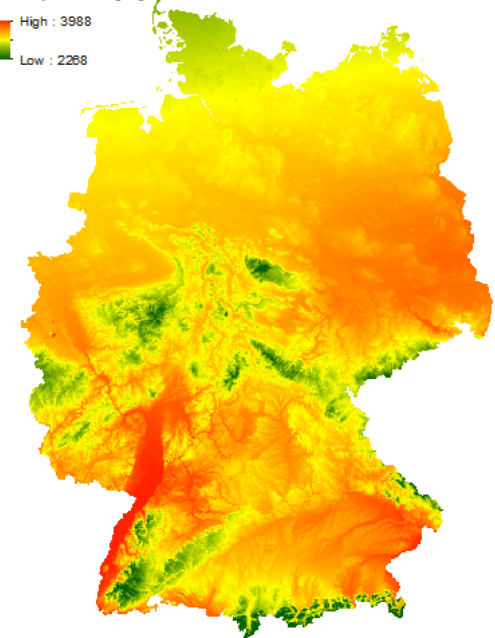
Time Series Augmentation^{2,3} Day Shifting & Annual Scaling & Zero Out



Thermal Time¹

31.08.2024

Accumulated
Soil Temperature [°C]
High : 3988
Low : 2288



¹Nyborg, J., Pelletier, C., & Assent, I. (2022). Generalized classification of satellite image time series with thermal positional encoding. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition* (pp. 1392-1402).

²Pham, V. D., Tetteh, G., Thiel, F., Erasmi, S., Schwieder, M., Frantz, D., & van der Linden, S. (2024). Temporally transferable crop mapping with temporal encoding and deep learning augmentations. *International Journal of Applied Earth Observation and Geoinformation*, 129, 103867.

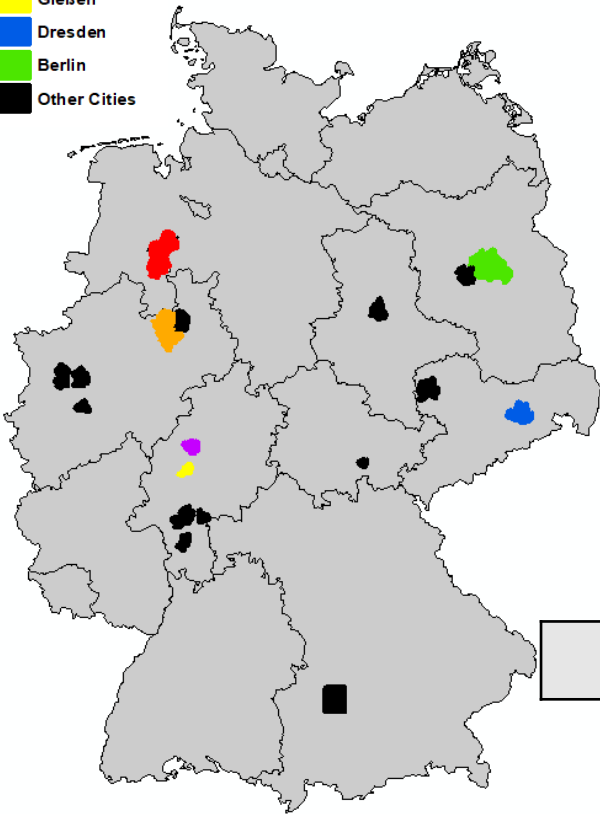
³Iwana, B. K., & Uchida, S. (2021). An empirical survey of data augmentation for time series classification with neural networks. *Plos one*, 16(7), e0254841.



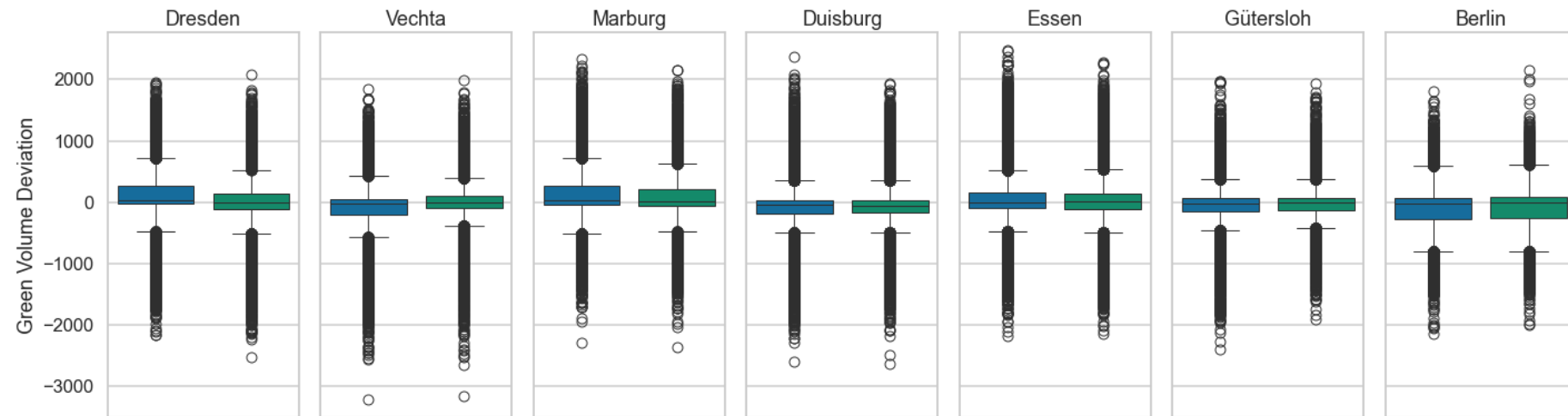
Method

Spatial Generalization

- Vechta
- Marburg
- Gütersloh
- Gießen
- Dresden
- Berlin
- Other Cities



■ No Generalization ■ Generalization



R^2	Dresden		Vechta		Marburg		Duisburg		Essen		Gütersloh		Berlin	
	0.69	0.73	0.77	0.83	0.80	0.83	0.81	0.83	0.82	0.82	0.88	0.88	0.80	0.81



Urban Tree Canopy

	CLMS CLCplusBackbone	LUP National Dataset
Resolution	Aggregating not fitting Classes	NRR-Definition & Subpixel
Extent	Europe	Germany
Status	Recommended Dataset	Approved Alternative

Urban Green Space

	HRL Forest TCD	LUP National Dataset
Resolution	Forest Specific & Smoothed	NRR-Definition & Subpixel
Extent	Europe	Germany
Status	Recommended Dataset	Improvement in Progress

✓ **Current State and Development of Indicators for Germany**



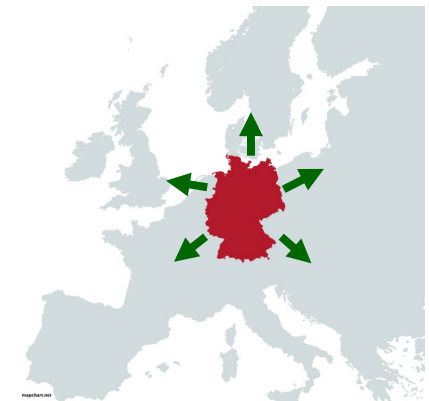
Next Steps

○ **Optimizing Indicators with Constraints & Costs**

Where are potential areas for Measures to achieve the NRR Goals?

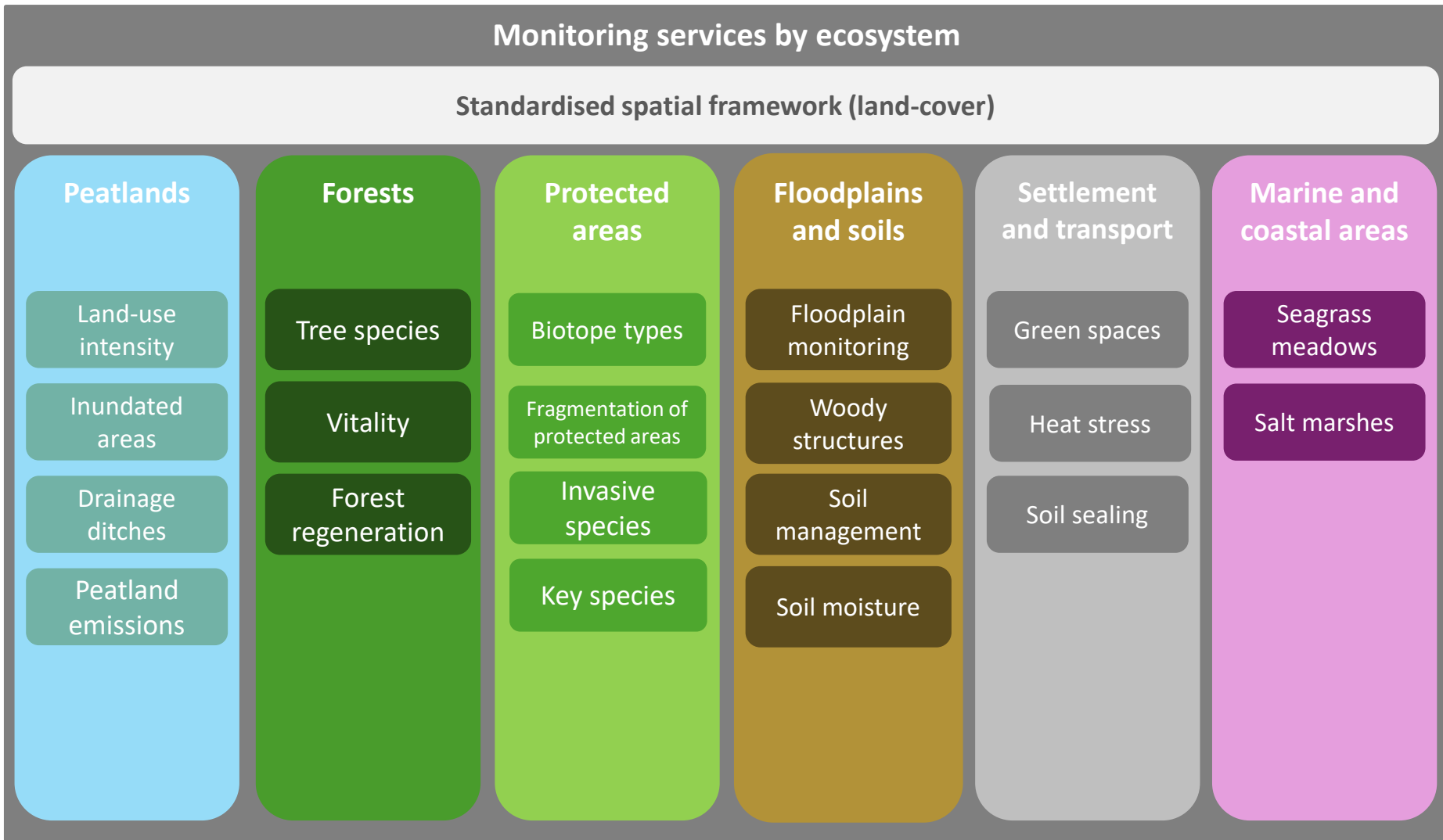
○ **Test & Rollout for other Nations**

○ **Integration into a user friendly platforms**






EO4Nature – Monitoring services



Tomorrow:
 06/May/2026
 Big Hall
 11:00 – 11:10 a.m.

EO4Nature: From Earth Observation time series to statistics-ready indicators for nature-based climate action

The background of the slide is an aerial photograph of a peatland, showing a complex, textured landscape with various shades of red, pink, and grey, indicating different vegetation and soil types. The text is overlaid on this image.

Thank you
Questions?



michael.foerster@lup-umwelt.de

Image: 5 cm aerial image (CIR), Subset: Peatland