

EO for monitoring sponge cities

Copernicus data products and beyond

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Umwelt 
Bundesamt

Climate change affecting cities



Increasing temperature

Annual mean temperature increased by 1.9 °C between 1881 and 2024.



Soil sealing

Expanding land use for settlements and transportation seals 51 ha of land every day.



Extreme rainfall

Heat increases the likelihood of extreme rainfall events: 30% of all settlements affected in 2021.



Damage from extreme weather

Extreme rain events caused € 8.1 bn of insured damage in 2021.



Drought

Increased and longer drought spells dry up urban green and lower groundwater tables.



Heat

During the record year of 2018, an average of 20 hot days were counted. Frankfurt a.M. experienced a whopping 42 days.

Climate resilient sponge cities



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Cooling through evapotranspiration



Green roofs and facades



Restore urban water bodies



Public urban green spaces



Unsealing of surfaces



Mitigate effects from extreme rains

An aerial satellite view of a city, likely London, with a purple overlay. The image shows a dense urban area with a grid of streets, a large airport terminal in the center, and a river winding through the city. The text is overlaid on this image.

How could earth observation help?

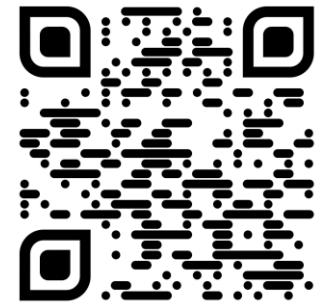
**Monitoring & targeting
adaptation measures**

EO data products: Copernicus Land Monitoring Service (CLMS)

Potential use case	Data product	Coverage	Spatial resolution	Update interval	Note
Monitoring of urban green networks	Small Woody Features	Europe	5 m	3-yearly	linear structures such as hedgerows, shrubs
Monitoring of urban green networks	Urban Atlas Street Tree Layer	Europe	10 m	6-yearly	contiguous rows or patches of trees covering $\geq 500 \text{ m}^2$
Identifying unsealing potential	High Resolution Layer (HRL): Imperviousness	Europe	10 m	3-yearly	range: 0 - 100%, incl. build-up layer

CLMS:

- One of six thematic Copernicus services
- Jointly implemented by European Environment Agency (EEA) & Joint Research Centre (JRC)
- Data are free of charge, harmonized and European-wide



CLMS data products - examples

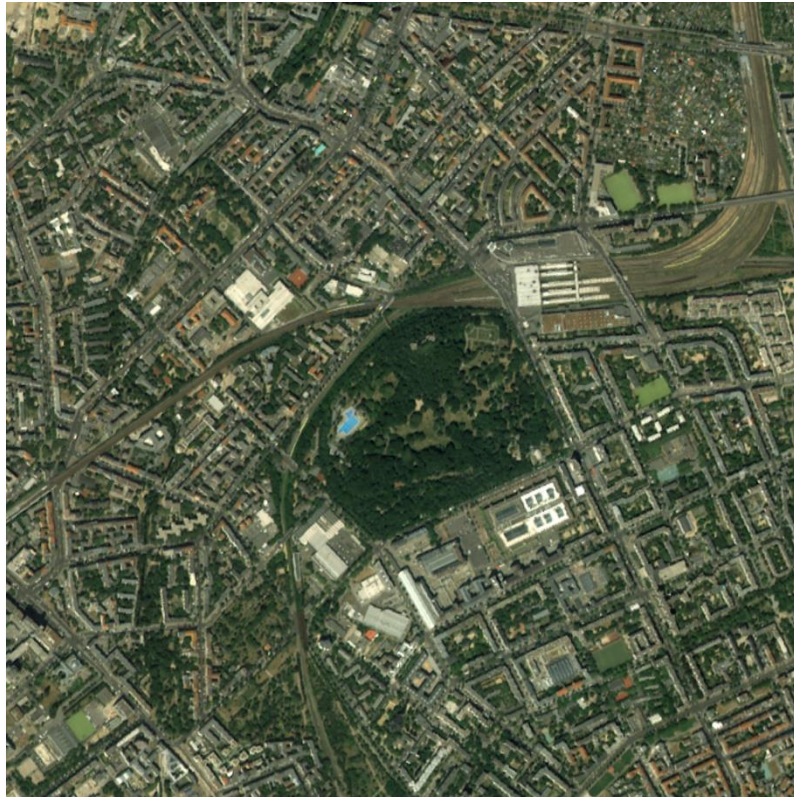
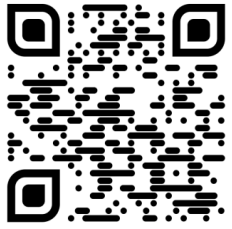


Fig.: VHR Image mosaic 2021



Fig.: Urban Atlas Street Tree Layer + Small Woody Features



Fig.: High Resolution Layer (HRL): Imperviousness + build-up mask

Data access options: CLMS: download (manual, API, QGIS-plugin); Copernicus data space ecosystem (CDSE) – at a later stage: STAC, APIs (s3, OData)

Setting the scene

German climate change adaptation strategy (DAS)

- Climate change monitoring at national level
 - Indicator-based framework
 - Anchored in climate adaptation act (since 2024)
 - Regular reporting

Purpose of DAS-Monitoring

- Providing broad overview on climate change impacts and adaptation at national level
- Informing general public and policy makers

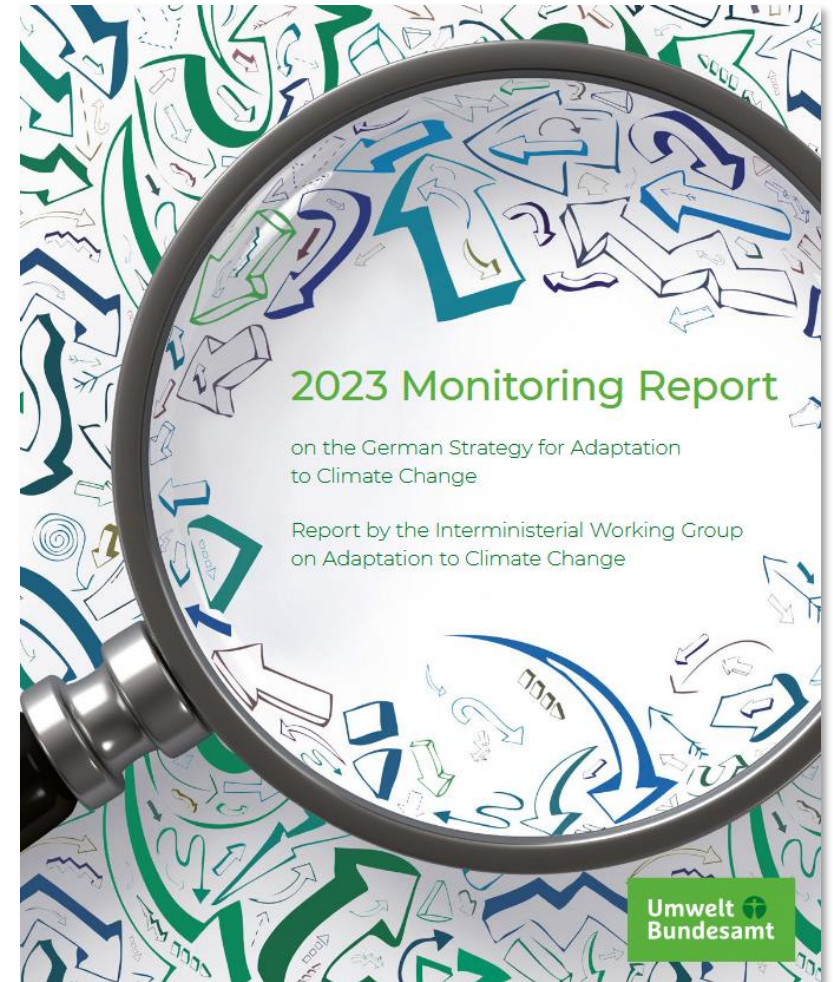


Fig.: Cover of 2023 DAS-Monitoring Report, UBA 2023

Response indicator: green roof area

Aim

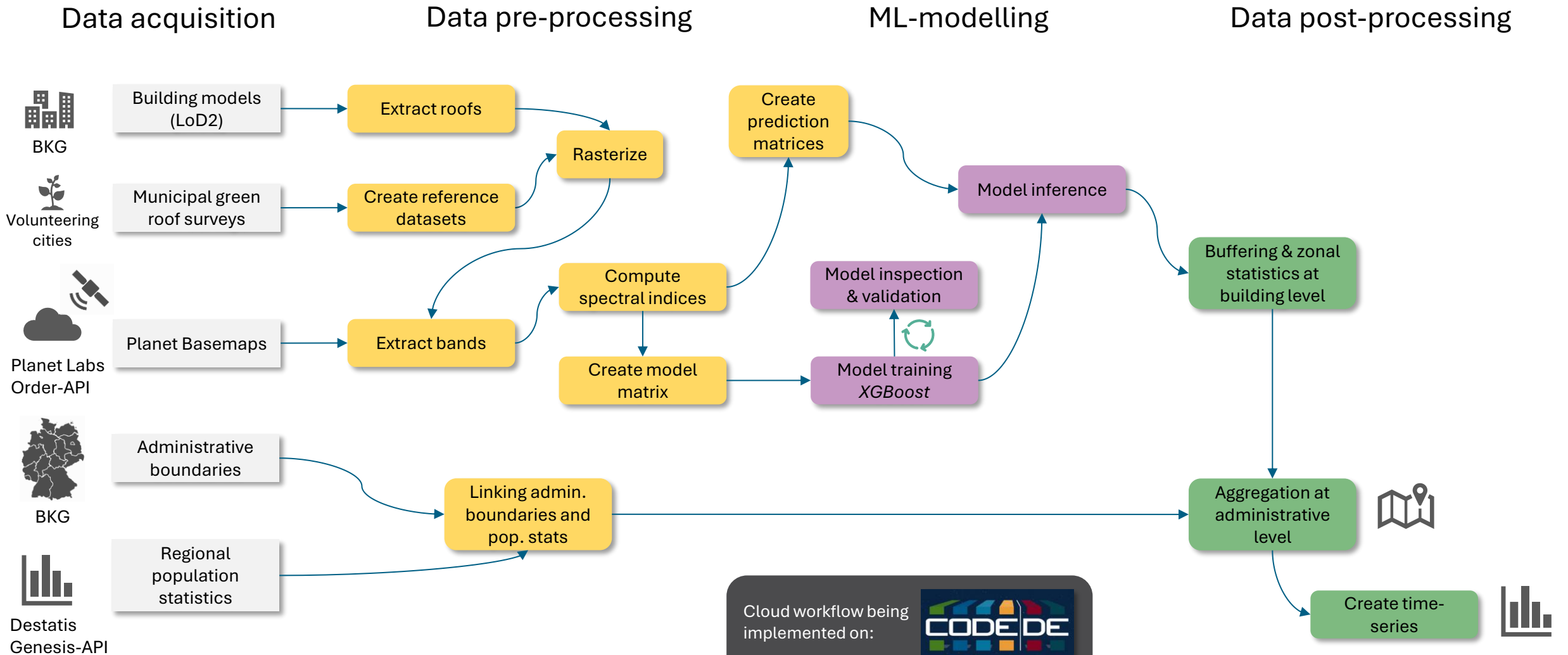
- Ability to answer questions, such as:
 - How much greened roof area is out there?
 - How is it changing over time?
- Objective: further develop & operationalize EO-based indicator to monitor green roof area at national level
 - Precursor project: DASIF
 - Approach: automated EO & ML-based green roof detection

Today: *presenting ongoing work, focusing on concept and data*



Fig.: Green rooftops © Heiner / stock.adobe.com

Cloud workflow



Satellite imagery

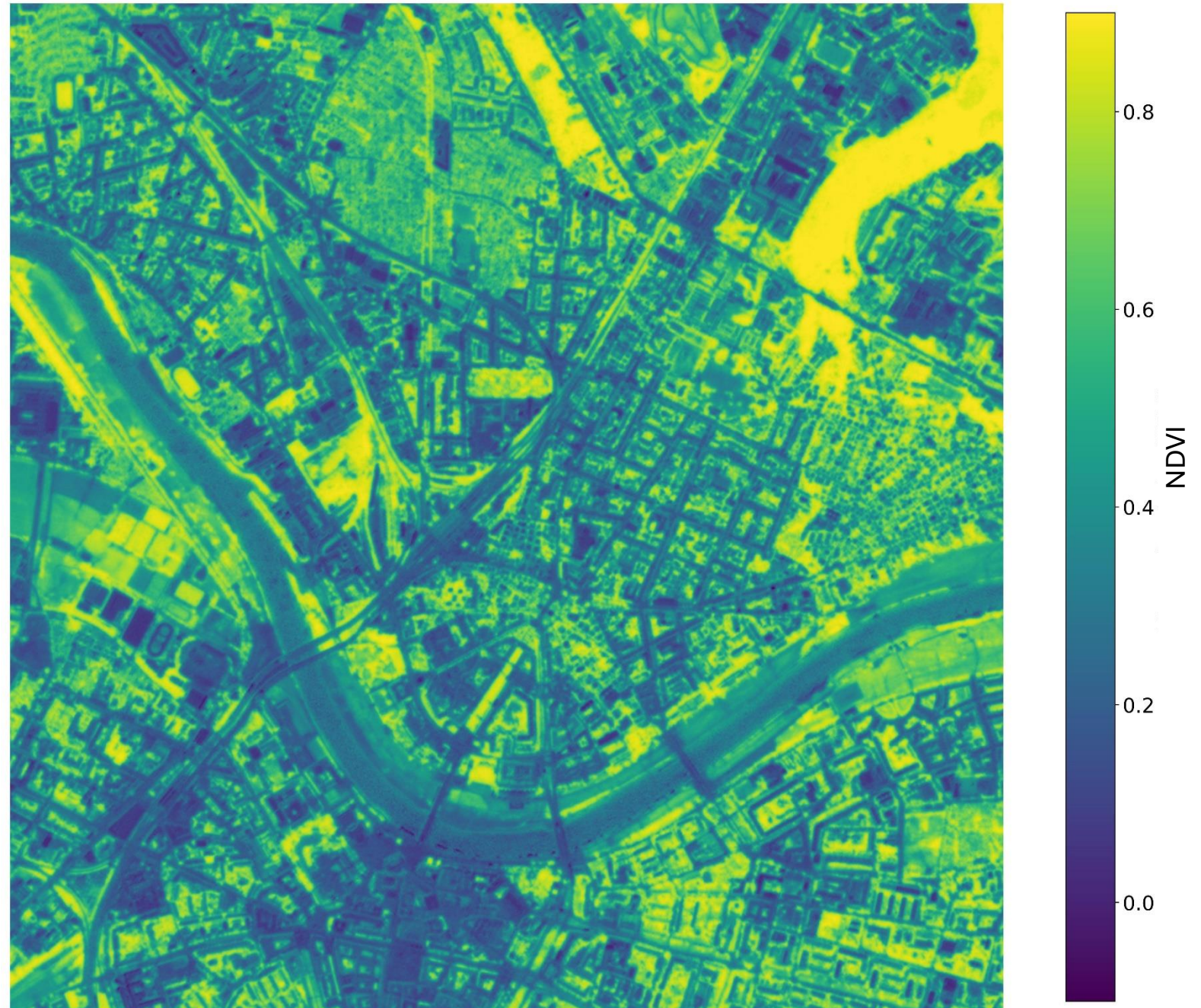
Multispectral Planet Basemaps

- Cloud-free, monthly mosaics with spatial resolution of 4.77 m (at equator)
→ Analysis-ready data

Tab.: Covariates used for binary classification

Grouping	Covariates
Spectral bands	RGB, yellow, red edge, NIR
Spectral indices (vegetation)	EVI, MSAVI2, MTVI2, NDVI
Spectral indices (impervious surfaces)	CBCI, NISI, PISI

Fig.: NDVI illustration for Dresden; Includes material © (2025) Planet Labs Netherlands BV. All rights reserved.



Aggregation of green roof statistics

pixel level inference

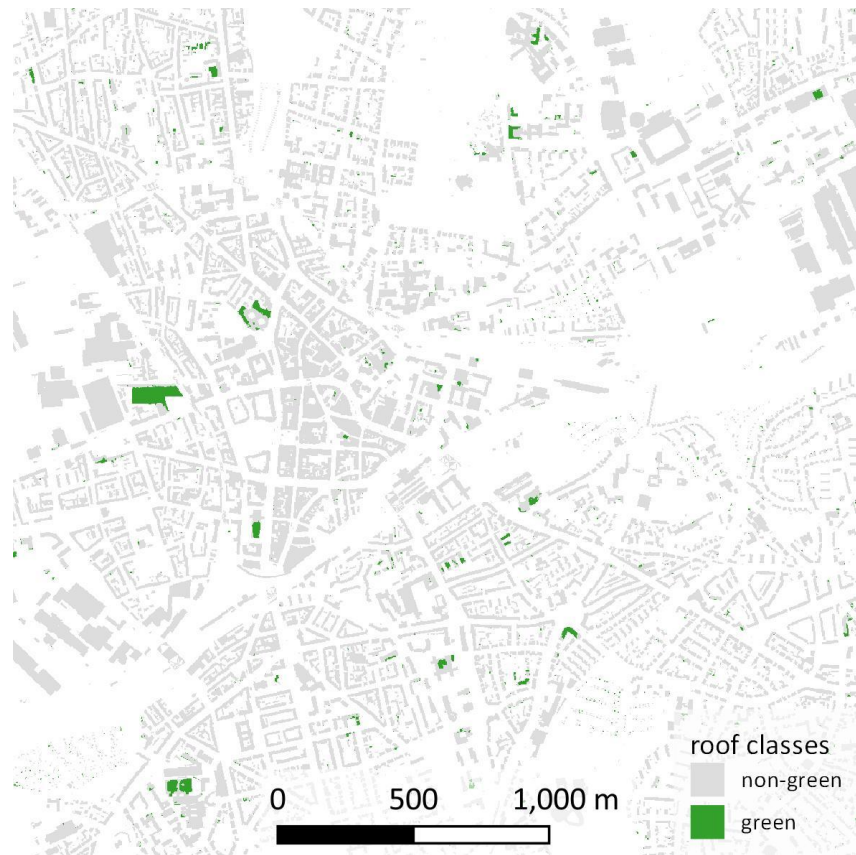


Fig.: Example illustrations for 2021;
Geobasis-daten: © GeoBasis-DE / BKG (2025)

Aggregation of green roof statistics

building level

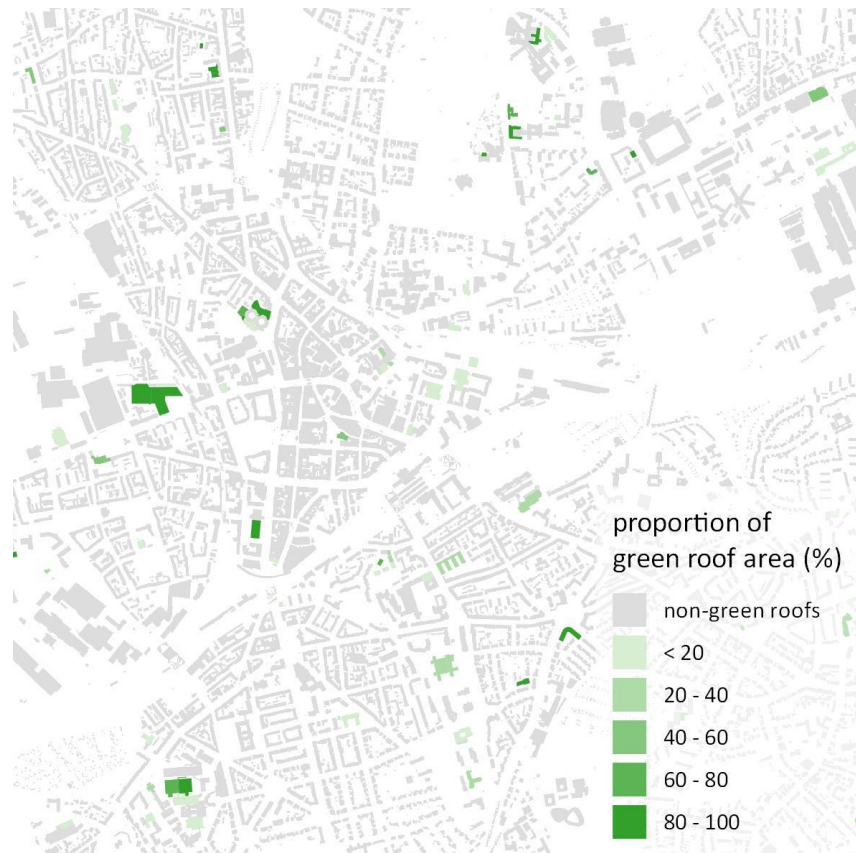


Fig.: Example illustrations for 2021;
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Aggregation of green roof statistics

building level



lower administrative level

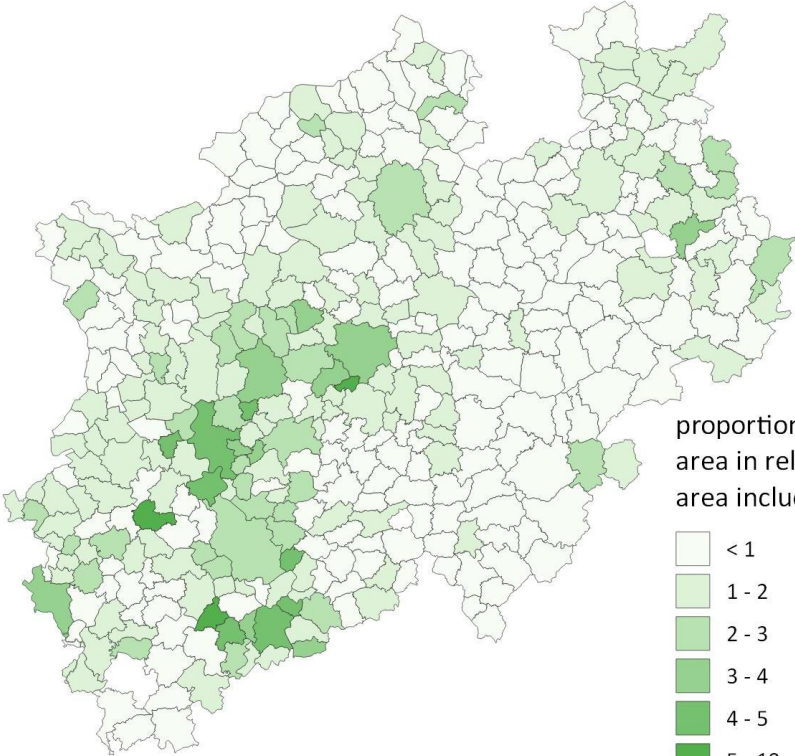


Fig.: Example illustrations for 2021;
Geobasis-daten: © GeoBasis-DE / BKG (2025)

Aggregation of green roof statistics

building level



lower administrative level



national level

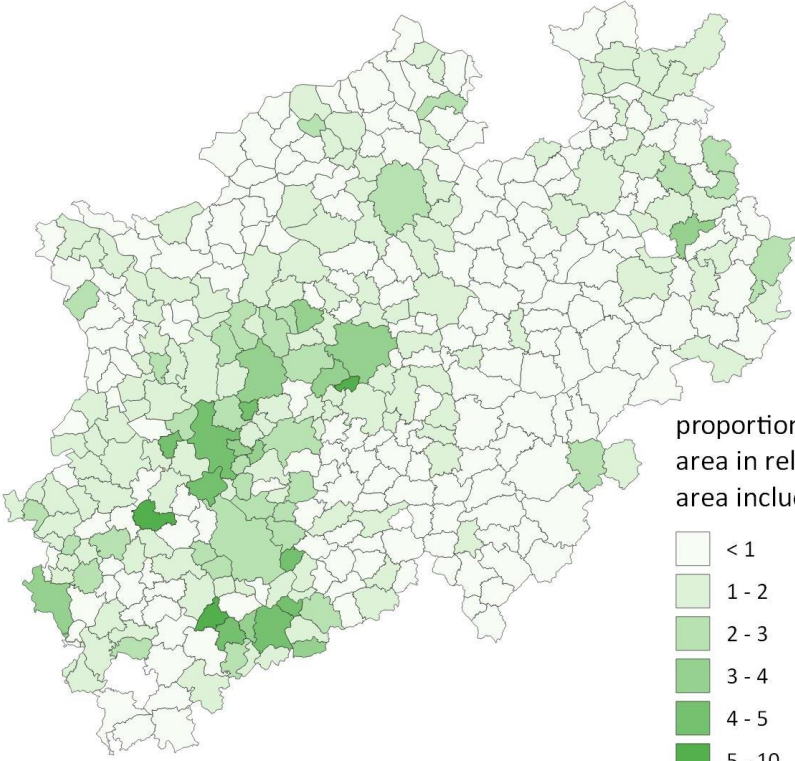
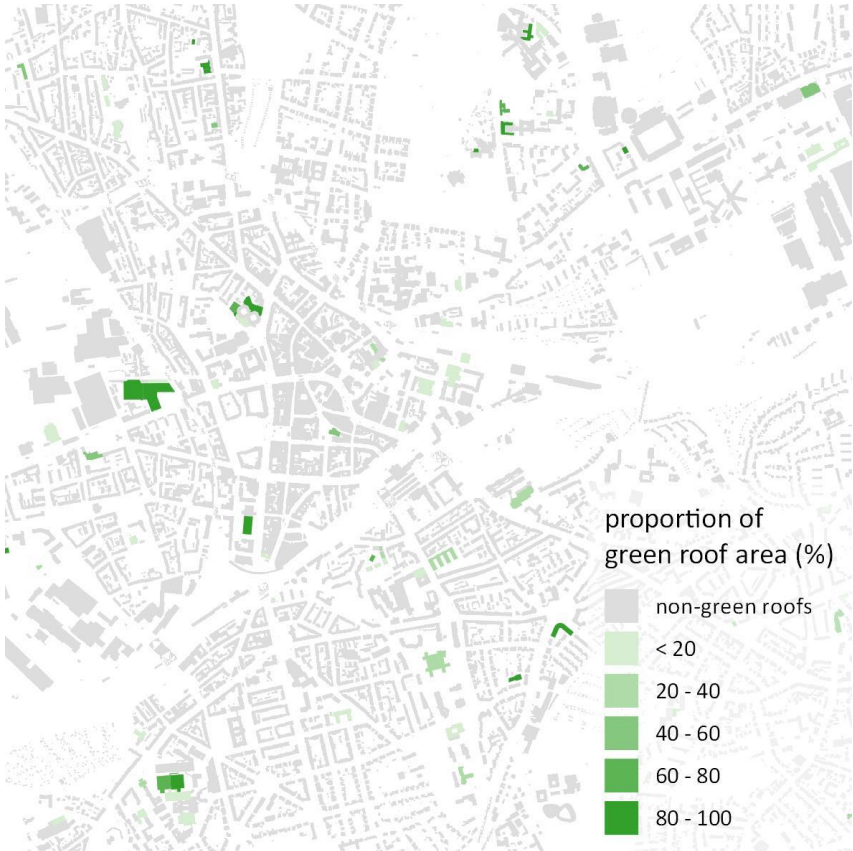


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Take home

Copernicus Land Monitoring Service

- EO data products supporting monitoring and implementation of sponge city measures moving forward
- Watch out for CLMS updates!

Climate change monitoring at national level

- Increasing role of remote sensing → monitoring indicators
- Green roof monitoring
 - Work in progress but preliminary validation results look promising
 - Challenges remain: testing various mitigation measures
 - Results planned to feed into upcoming DAS-reporting in 2027



Thanks so much for your attention!

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