# UrbanGreenEye

## Remote Sensing Indicators for Monitoring of Urban Areas for Climate Change Adaptation


Kathrin Wagner[1], Annett Frick[1], Benjamin Stöckigt[1], Sascha Gey[1], Sebastian Lehmler[1], Nastasja Scholz[1], Sebastian Schubert[2], Mohamed Salim[2], Franziska Löffler[3], Viktoria Engnath[3], Stefan Heiland[3]

[1] LUP – Luftbild Umwelt Planung GmbH, Große Weinmeisterstraße 3a, 14469 Potsdam | [2] Technische Universität Berlin, Stadtökologie, Ernst-Reuter-Platz 1, 10587 Berlin | [3]Stadt Leipzig, Amt für Stadtgrün und Gewässer, Prager Str. 118-136, 04317 Leipzig


Sharing is encouraged

www.urbangreeneye.de


***Contact***
**Dr. Annett Frick**
*annett.frick@lup-umwelt.de*
**Kathrin Wagner**
*kathrin.wagner@lup-umwelt.de*


Urban Green Eye


01/2022 – 12/2024
**FKZ: 50EW2201A**

Gefördert durch: Bundesministerium für Digitales und Verkehr aufgrund eines Beschlusses des Deutschen Bundestages


Stadt Leipzig · TU berlin · LUFTBILD UMWELT PLANUNG · DLR

## Context and aims

In the context of climate change adaptation, sustainable urban development, and environmental justice, **local civil services** must meet a range of dynamic demands. To do so, municipalities require both qualitative and quantitative knowledge about the current state and the development of urban structures such as vegetated areas, urban green volume and vitality as well as impervious surfaces within their administrative boundaries. However, obtaining this data through surveys is costly and time-consuming, and the frequency of these surveys is too low to capture changes consistently.

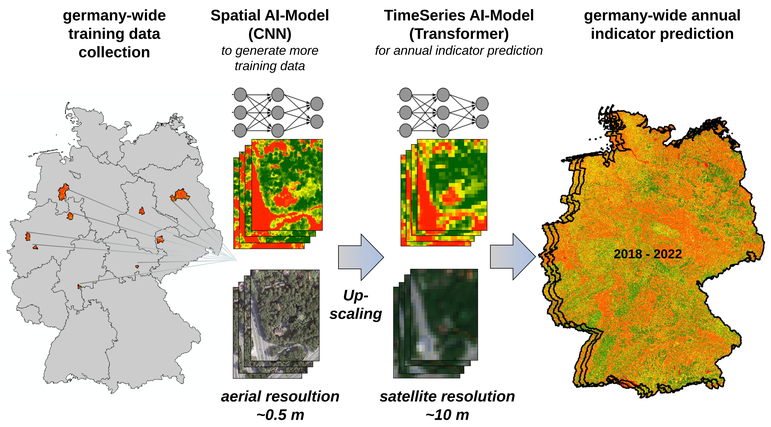
The UrbanGreenEye project **aims** to bridge this gap by developing urban climate indicators based on Earth Observation data that meet the needs of local authorities, demonstrate the use and implementation of these indicators in monitoring and planning processes as well as strategies. The project will also help to create digital twins for urban planning applications by providing a free, national consistent and regularly updated indicator geodatabase for Germany on CODE-DE, as well as a browser-based visualization tool, as basis of information and to support decision-making.

## Methods

**Requirement Analysis** with 10 partner-cities and municipalities in Germany (workshops) regarding indicators for thermal stress, thermal and hydrological release and deficit analysis

### Method Development for Indicators

Based on aerial and satellite images (Sentinel, Landsat, MODIS) and ground trouth data





### References

Frick, A., Wagner, K., Kiefer, T., Tervooren, S. (2020): Wo fehlt grün ? – Defizitanalyse von Grünvolumen in Städten. In: Meinel, G., Schumacher, U., Behnisch, M. & Krüger, T. (Hrsg.): *Flächennutzungsmonitoring XII mit Beiträgen zum Monitoring von Ökosystemleistungen und SDGs*. IÖR Schriften Band 78: 223-238. Rhombos-Verlag. Berlin.

Frick, A. & S. Tervooren (2019): A framework for the long-term monitoring of urban green volume based on multi-temporal and multi-sensoral remote sensing data. *Journal of Geovisualization and Spatial Analysis* (2019) 3: 6. https://doi.org/10.1007/s41651-019-0030-5

Klirke, R.; Kuechly, H.; Frick, A.; Förster, M.; Schmidt, T.; Holtgrave, A.-K.; Kleinschmit, B.; Spengler, D.; Neumann, C. (2018): Indicator-Based Soil Moisture Monitoring of Wetlands by Utilizing Sentinel and Landsat Remote Sensing Data. *PFG – Journal of Photogrammetry, Remote Sensing and Geoinformation Science*. https://doi.org/10.1007/s41064-018-0044-5

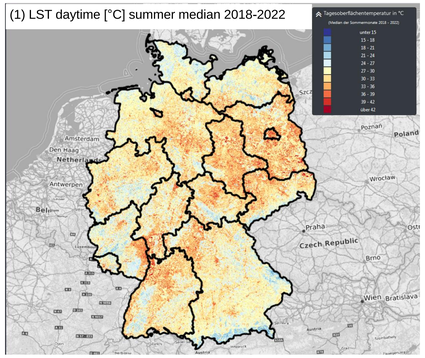
Tunon, M. (2023): Assessing the capability of Sentinel-2 time series for the monitoring of urban tree vitality. Master thesis

Grossmann, M., Pohl, W., & Schulze, H. D. (1984). Grünvolumenzahl und Bodenfunktionszahl in der Landschafts- und Bauleitplanung. Schriftenreihe der Behörde für Bezirksangelegenheiten, Naturschutz und Umweltgestaltung, (9).


## Indicators

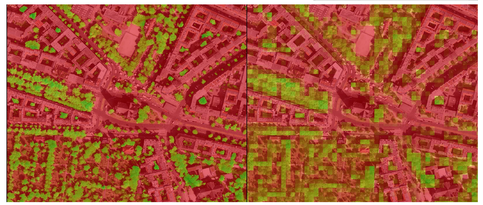
### Thermal Stress

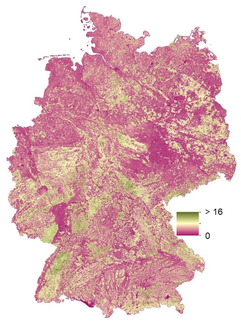
**L**and **S**urface **T**emperature (LST)
(median LST of summer months)
(1) LST daytime
(2) LST nighttime
(3) albedo
(4) shadowing effects




### Thermal Release

(5) green volume [m³/m²]


(6) tree vitality (Disease Water Stress Index DSWI)
(7) soil moisture index (SMI)
(8) tree canopy cover [%]

### Hydrological Release

(9) imperviousness [%]


### Urban Climate Model

**PALM-4U**, a micro-scale climate model
- ➢ implementation of indicators in model environment
- ➢ validation and sensitivity analysis of green volume uncertainties
- ➢ evaluation of deficit analysis and quantification of thermal stress
- ➢ scenario and impact calculation of measures in partner cities

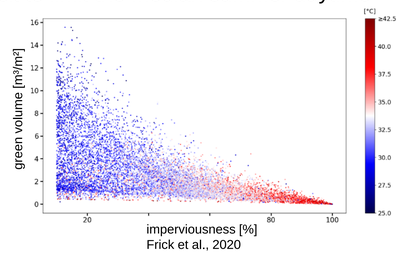
## Communal usage of indicators

### Hotspot and Deficit Analyses

Modelling of urban green volume deficit to limit the median summer daytime temperature to a specific threshold.

Model parameters:
(1) LST daytime
(5) green volume
(9) imperviousness

$$\Delta g\left[\frac{m^3}{m^2}\right] = 2.49 * (T_{act.}[°C] - T_{aim}[°C])$$



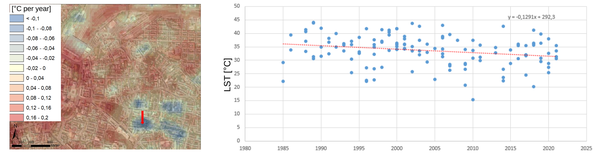

Frick et al., 2020

green volume deficit [m³/m²]

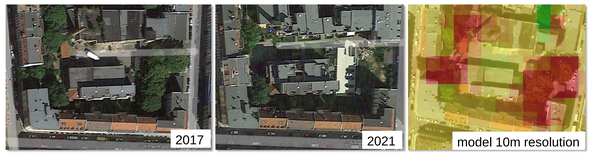

### Monitoring and Decision Making Support

Change detection for planning of adaptation measures
In context of climate change adaptation, sustainable urban development, compensation of infrastructure projects, environmental justice, digital twins etc.

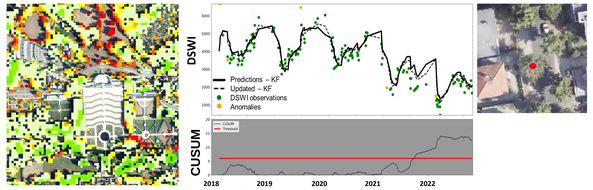
temperature change




green volume change




tree vitality change




Potsdam Sanssouci
model 10m - 2017- 2022

State-space model with kalman filter
for urban tree vitality analysis (Tunon, 2023)