An interactive web based tool for integration of urban **Green** and **Blue** Infrastructure

by Karsten Vennemann

TERRA GIS
TERRESTRIAL ENVIRONMENT REGIONAL ANALYSIS

The web tool is part of a larger project

An interactive web based tool

for integration of urban Green and Blue Infrastructure

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TERRESTRIAL ENVIRONMENT REGIONAL ANALYSIS

Overview

- What - the problem
- How to solve it
  - The Model
  - The Tool — OpenLayers, MapServer, GDAL, PHP, Python, R and PostGIS
  - Show Time

TERRA GIS INTERESS-I

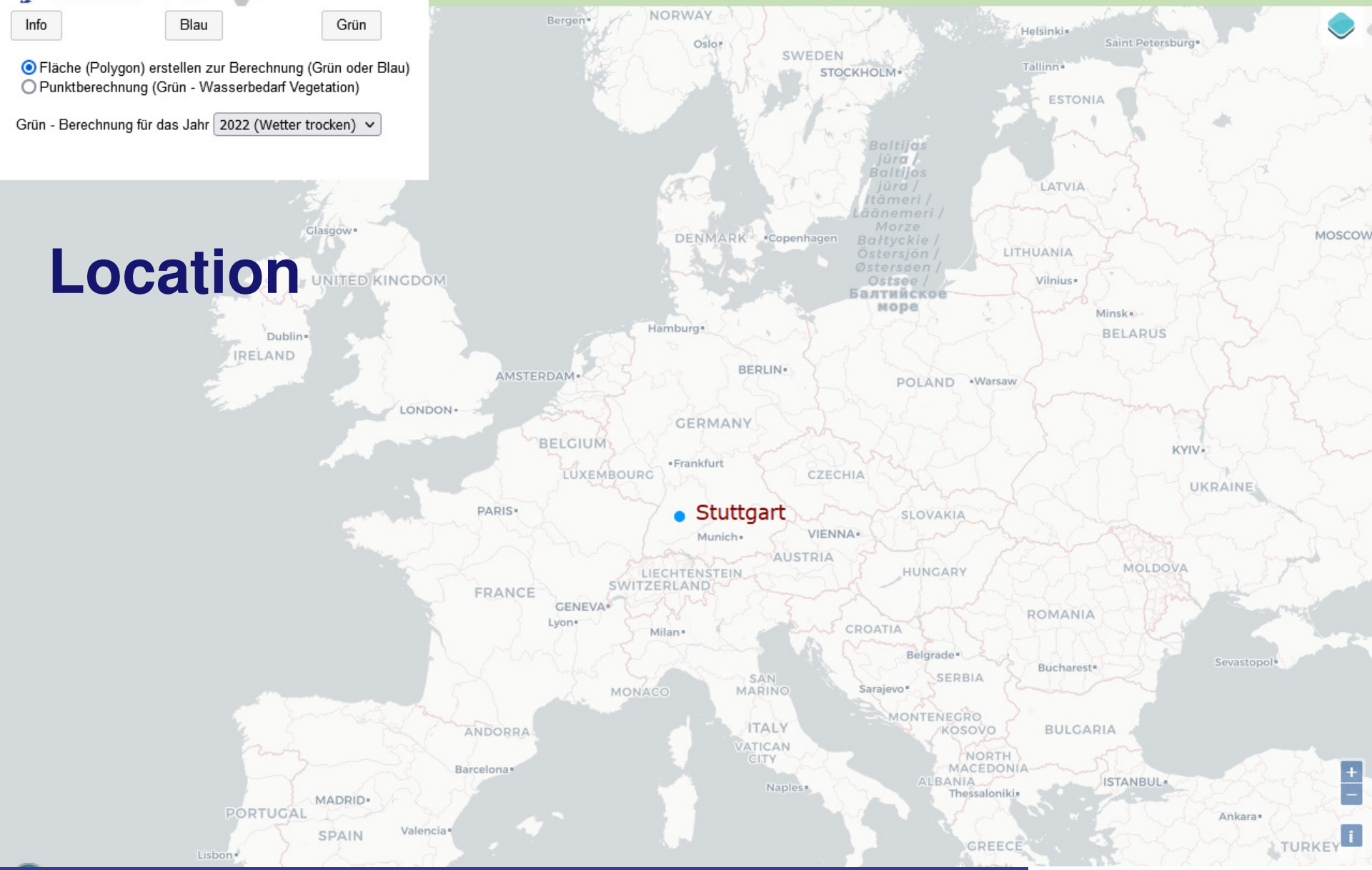
Web Tool Wasserhaushalt Blau-Grüne Infrastrukturen

Info Blau Grün

Fläche (Polygon) erstellen zur Berechnung (Grün oder Blau)
Punktberechnung (Grün - Wasserbedarf Vegetation)

Grün - Berechnung für das Jahr 2022 (Wetter trocken)

Location



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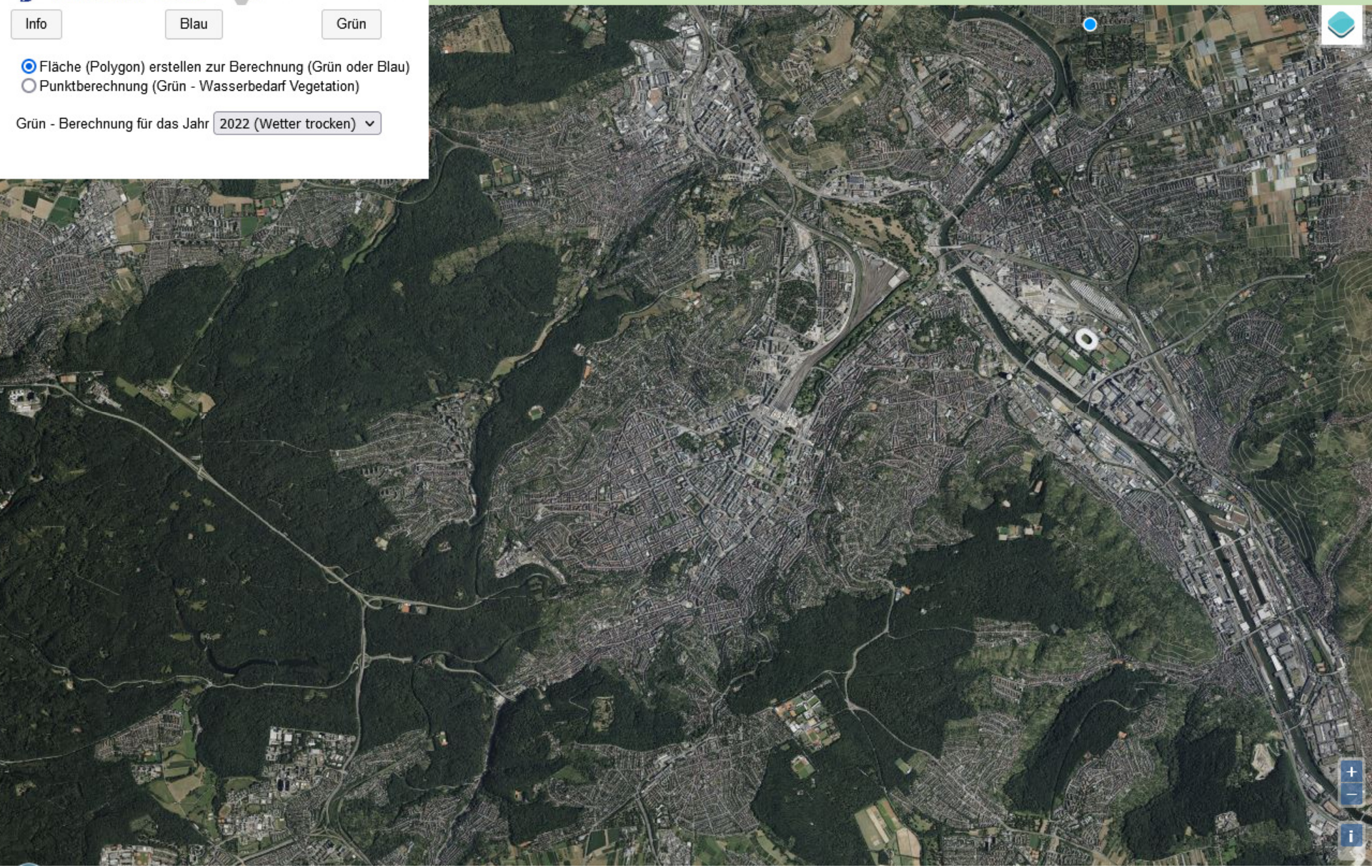

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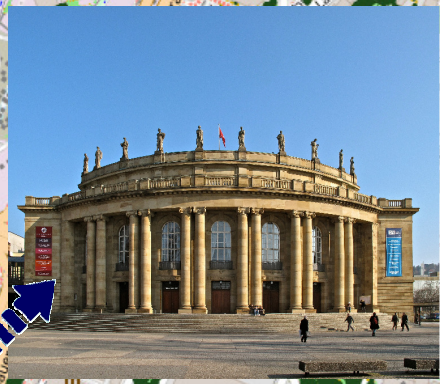

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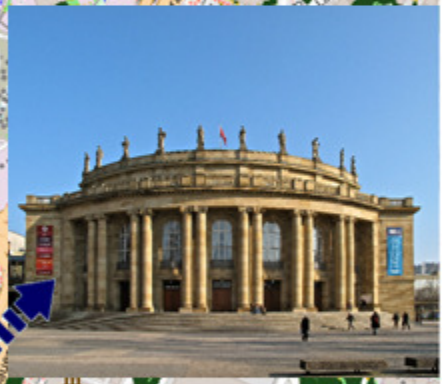

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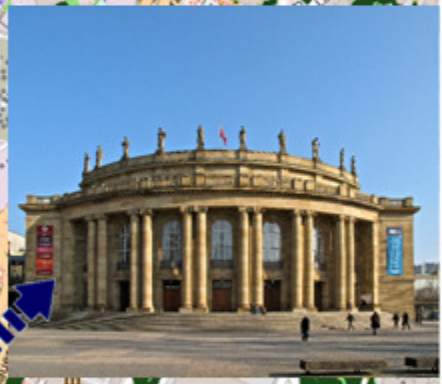

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Climate Change challenges the survival of urban green, and it's ecosystem functions

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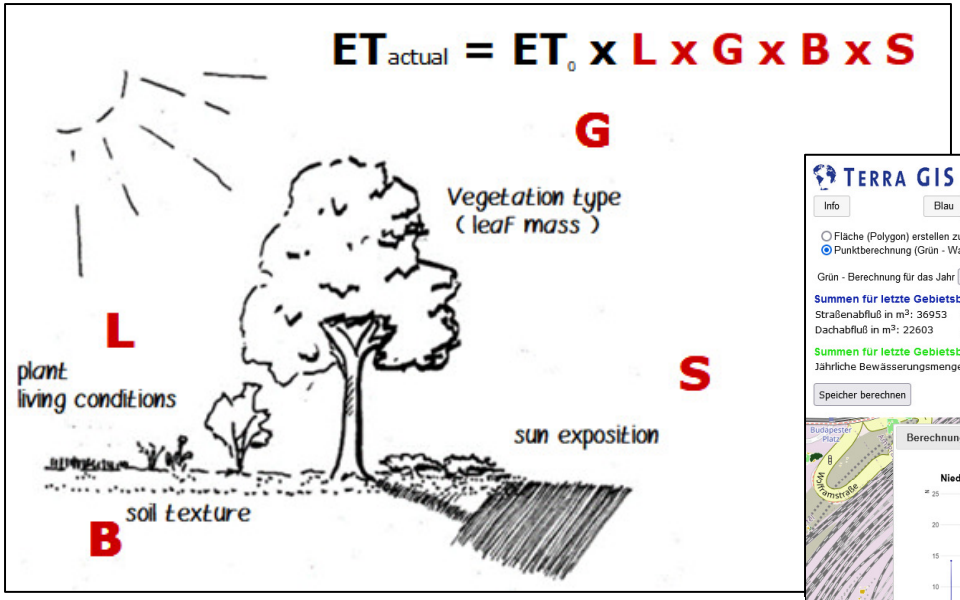
How to prevent this ?

A model and



a tool to the rescue

recommendations for irrigation to save water

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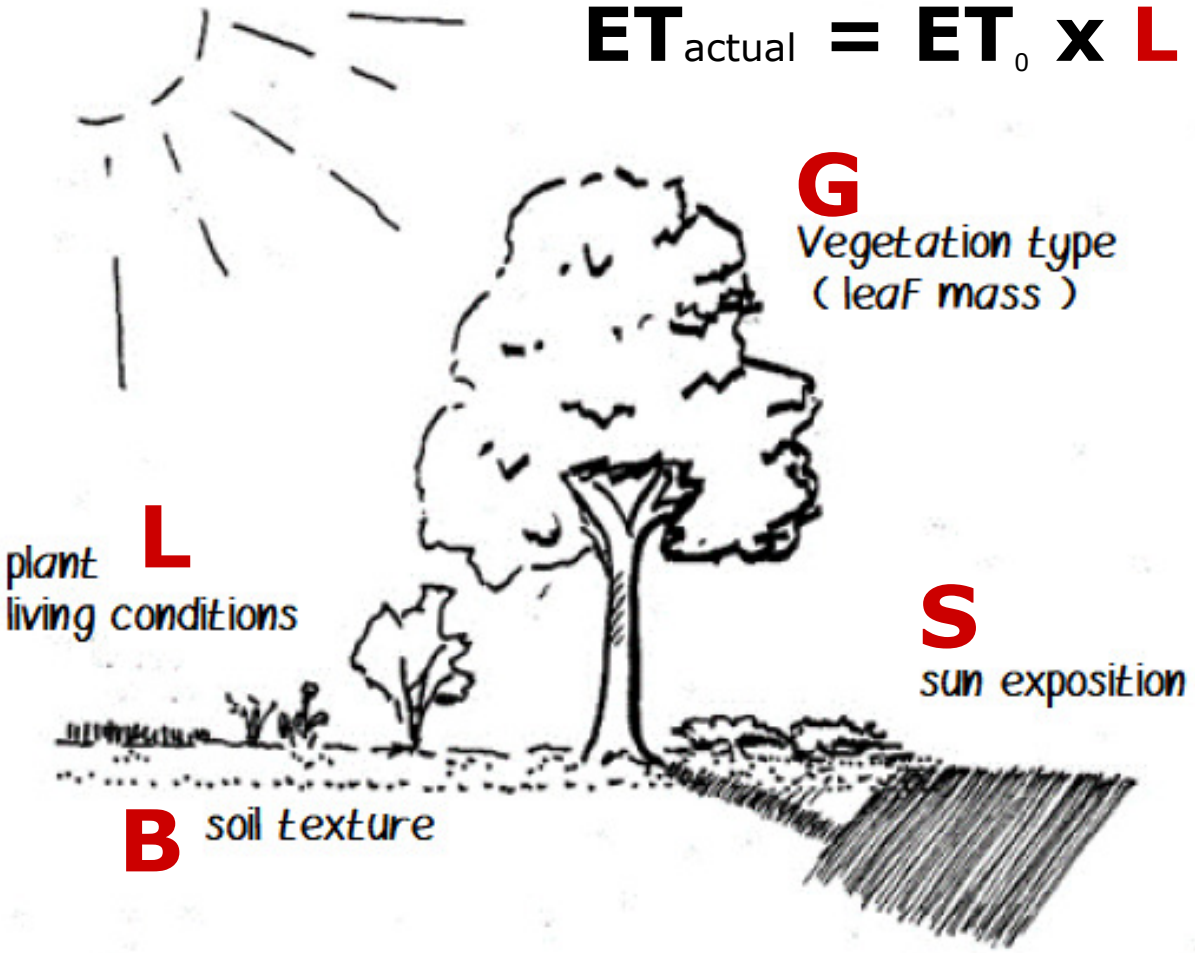
Green calculation – over the course of a year

Model factors determining Evapotranspiration

$$ET_{actual} = ET_0 \times L \times G \times B \times S$$



How much water is needed?

Simple model: 3 values for each factor

L

Plant living conditions

L1 = 0.6 (dry)

L2 = 1.0 (fresh)

L3 = 1.6 (wet)

G

Vegetation type

G1 = 0.8 (grass)

G2 = 1.0 (bushes, shrubs)

G3 = 1.3 (trees)

B

Soil texture

L1 = 0.6 (dry)

L2 = 1.0 (fresh)

L3 = 1.6 (wet)

S

Sun exposition

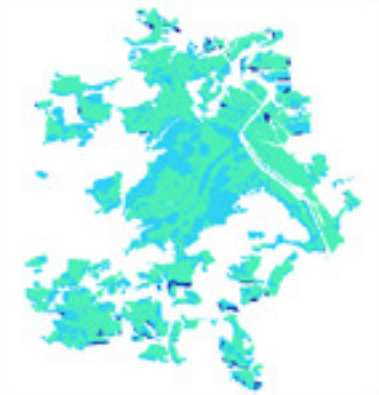
S1 = 0.7 (shadow)

S2 = 1,0 (half shadow)

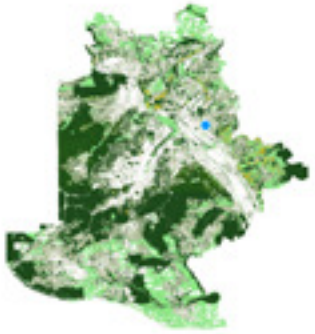
S3 = 1,3 (full sun)

LGB same all year, using three 0.5 m² raster files as input, but S changes daily

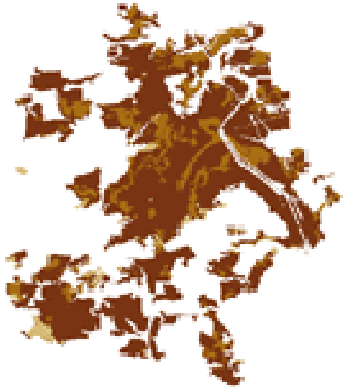
L Plant living conditions



G Vegetation type



B Soil texture



S Sun exposition

365 raster files
calc. in GRASS GIS

?

Simplification to deal with S

S **Sun exposition**

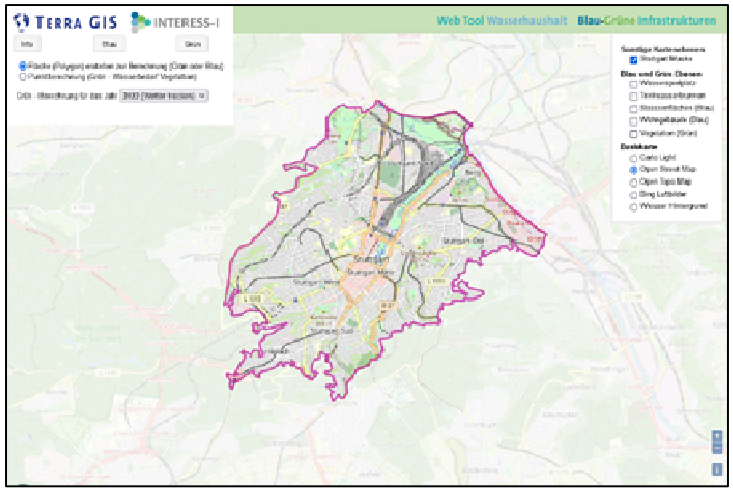
- instead of 365 rasters for as many days
  using 73 pentads (5 day periods) for the year
- further optimisation
  - approach using ternary system (0,1,2)
  - storing values of multiple pentads in one integer raster
    e.g. calculation for each raster cell for pentad [0 - 15]
    final_s = final_s + s(pentad[i]) * 3^(i)

Resulting in

- total of 4 rasters storing ternary S values
  (pentads 1–16, 17-35, 36-54, and 55-73)
  created via an R-Script

The tool *is based on*

Web Interface



Results calculation

python

R

OGR

GDAL

PostGIS
Spatial PostgreSQL

APACHE

php

OpenLayers

WMS

Cartography

MapServer

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Scripts/tools called by php

OpenLayers	Digitize area (e.g. green)
PostGIS Spatial PostgreSQL	Check if inside project area & intersects vegetation
OGR GDAL	Export raster of target area LGBS values
R	Extract LGBS value from ternary raster Get frequency of the (possible 81) combinations LGBS occurrence in target area & write to matrix/csv
python	Calculate water/ irrigation needs over the year from meteo files (daily values P, ET) and matrix from above
R	Create histograms of precipitation, irrigation and storage needs over the year for area/point

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Info | Blau | Grün

- (•) Fläche (Polygon) erstellen zur Berechnung (Grün oder Blau)
- ( ) Punktberechnung (Grün - Wasserbedarf Vegetation)

Grün - Berechnung für das Jahr: 2022 (Wetter trocken)

Summen für letzte Gebietsberechnung - Blau

Straßenabfluß in m³: 36953 Straßenfläche in m²: 56503
Dachabfluß in m³: 22603 Dachfläche in m²: 34561

Summen für letzte Gebietsberechnung - Grün

Jährliche Bewässerungsmenge (l): 88877414 (~88877 m³)

Speicher berechnen

Calculation for digitized areas

Green – vegetation water needs

Blue – water available from runoff (streets, roofs, gray water)

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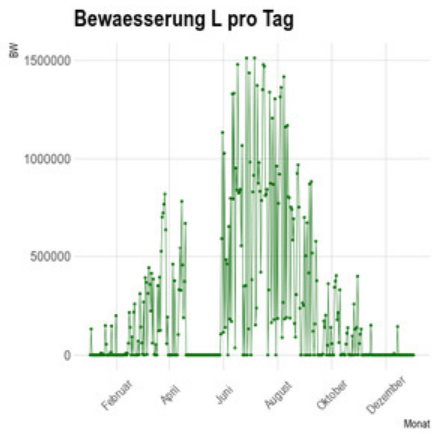
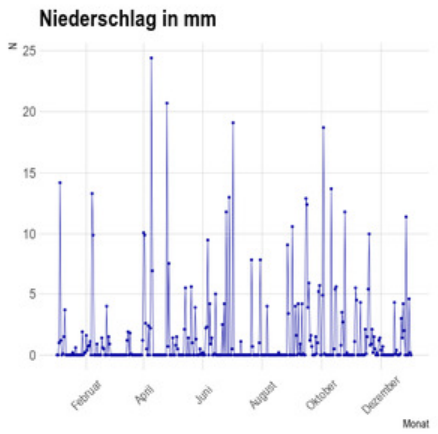
Summen für letzte Gebietsberechnung

Jährliche Bewässerungsmenge (l): 88877

Speicher berechnen

Jahresverlauf Auswahl





Ok

Histogram for digitized areas

Irrigation needs over the year

Precipitation

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Summen für letzte Gebietsberechnung - Grün

Jährliche Bewässerungsmenge (l): 96452061 (~96452 m³)

Speicher berechnen

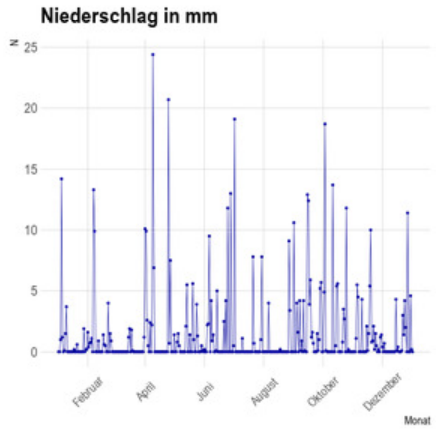
Calculation for one Point – one m²

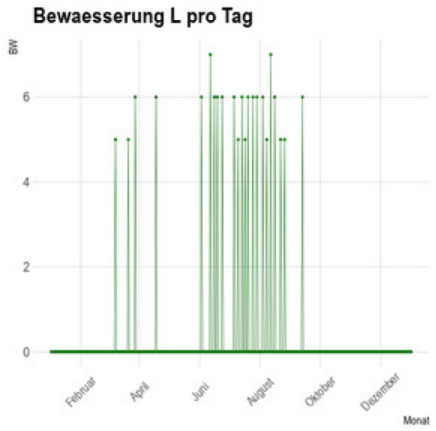
Precipitation

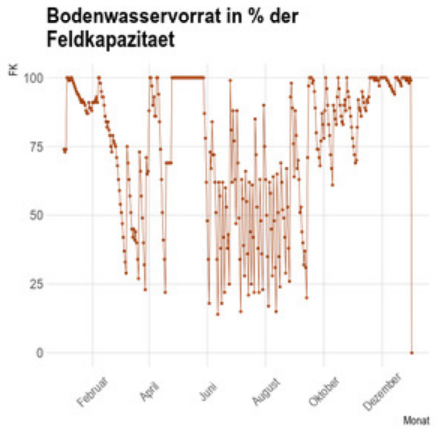
Irrigation needs over the year

Soil Water Holding Capacity (% full)

Berechnung für Punkt 9.19099,48.7898







Schliessen

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Grün - Berechnung für das Jahr: 2022 (Wetter trocken)

Summen für letzte Gebietsberechnung - Blau

Straßenabfluß in m³: 42178 Straßenfläche in m²: 64492

Dachabfluß in m³: 21655 Dachfläche in m²: 33111

Summen für letzte Gebietsberechnung - Grün

Jährliche Bewässerungsmenge (l): 87923122 (~87923 m³)

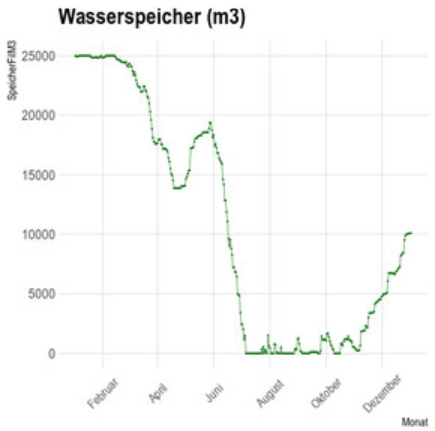
Speicher berechnen

Calculation of water storage

water storage in m³ over the year

Wasserspeicher für Grün/Blau Gebietekombination

Tage	Anzahl	Speicher (L)	Speicher (m³)
8	0	47680653	47681
9	0	46972856	46973
10	0	46705040	46705
11	0	46006808	46007
12	0	45509437	45509
13	0	45318141	45318
14	0	25174619	25175
15	0	25002453	25002
16	0	-1	0
17	0	-1	0
18	0	-1	0
19	0	-1	0
20	0	-1	0
21	0	-1	0



Ok

Contact karsten@terragis.net

Tool http://bgtool.terragis.net

Literature

- **H.G. Schwarz-v.Raumer, T. Jaworski, R.Schenk, K. Vennemann (2023):** Integration of urban Green and Blue Infrastructure by an interactive and geo-spatial Webmap-Tool. Journal of Digital Landscape Architecture. 8-2023.
- **ALB (ed.) (2020):** Watering by the rules - water requirements of urban green spaces. ALB advisory leaflet bef7- Issue 1 - 5/2020. Freising, Germany

Next Steps

- **Fall 2023: apply for grant by the city of Stuttgart:** Citizen science project to recommend irrigation amounts for your garden. Including soil texture test, soil moisture sensors and an app to recommend irrigation water amounts based on weather forecast.