The GreenUr project

Creating an application in QGIS

to manage the impacts of urban green spaces

on human health

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What is GreenUr?

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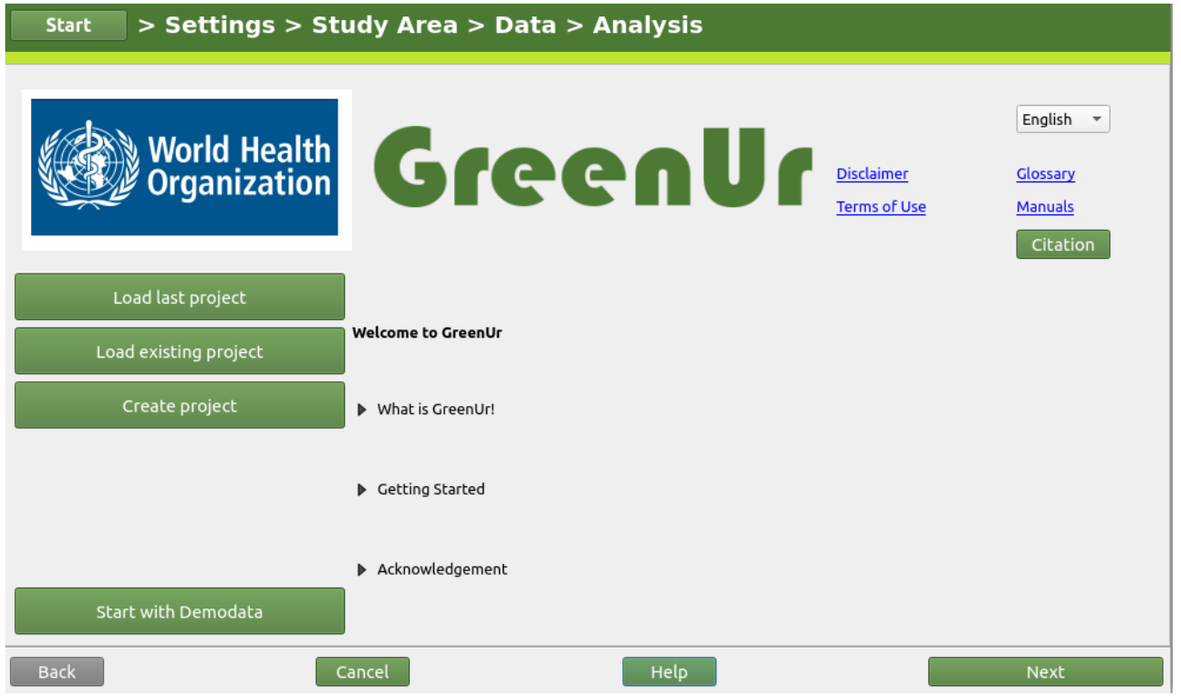
GreenUr



QGIS

WHO GreenUr web page

Tool to support the investigation of the impacts of green spaces on health

Why are green spaces important to the health?

- "… inverse association between the proximity to green spaces and **all-cause mortality**" (Rojas-Rueda et al., 2019)

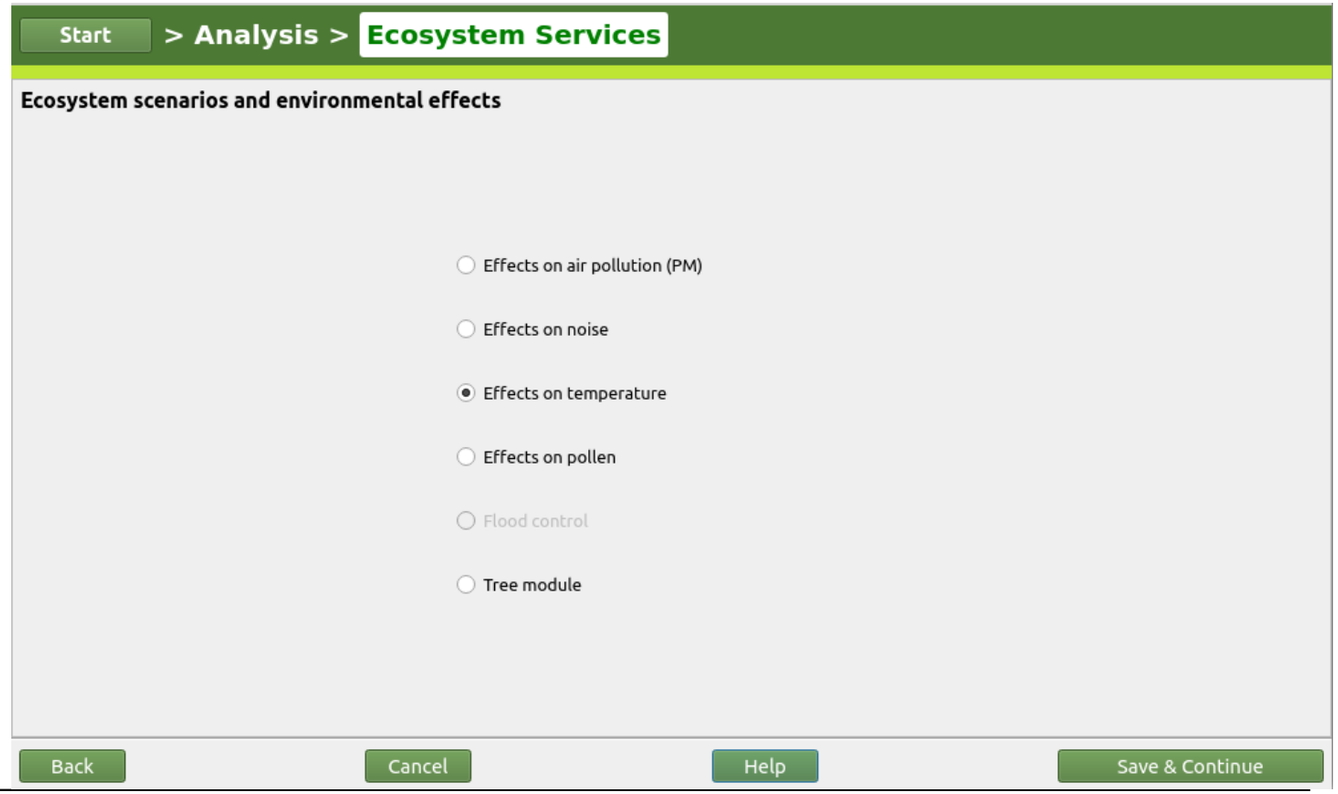
- "… consistent negative association between urban green space exposure and **mortality**, **heart rate**, and **violence**, and positive association with **attention**, **mood**, and **physical activity**." (Kondo et al., 2018)

- "… greenspace can benefit health" because there are "three general functions of greenspace: **reducing harm**, **restoring capacities** and **building capacities**." (Markevych et al., 2017)

GreenUr Modules

GreenUr is a QGIS plugin which brings together stand alone methods as modules:

- Availability of Green Spaces
- Health Impacts
  - Mortality
  - Morbidity on mental health
    - Dementia (experimental!)
    - Reduced depression and stress
    - Stroke
- Ecosystem Services
- Active transport

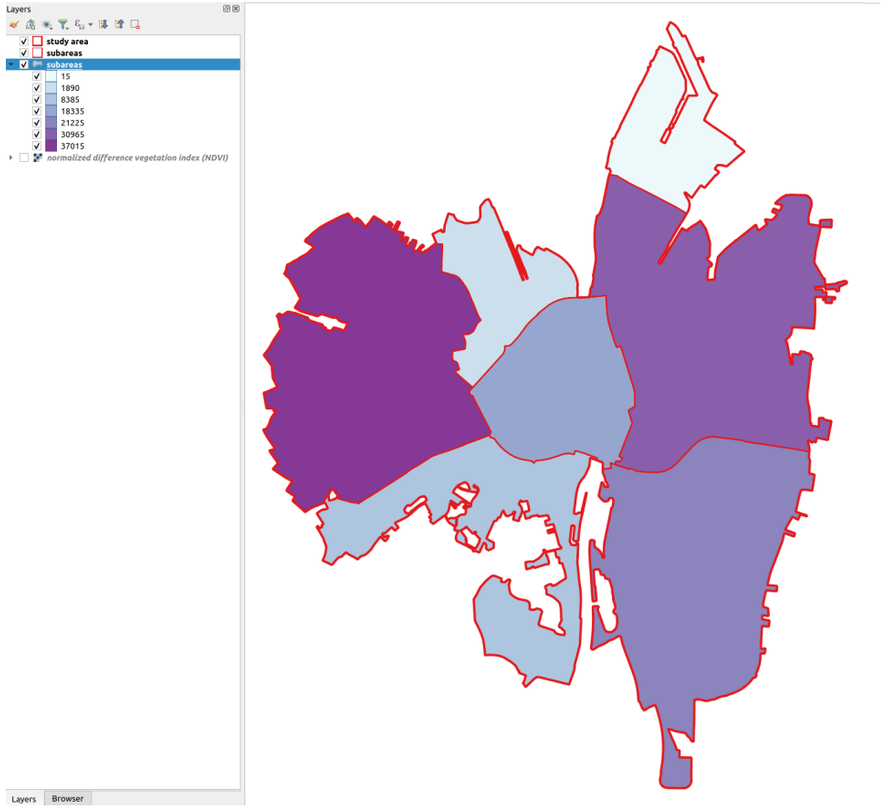


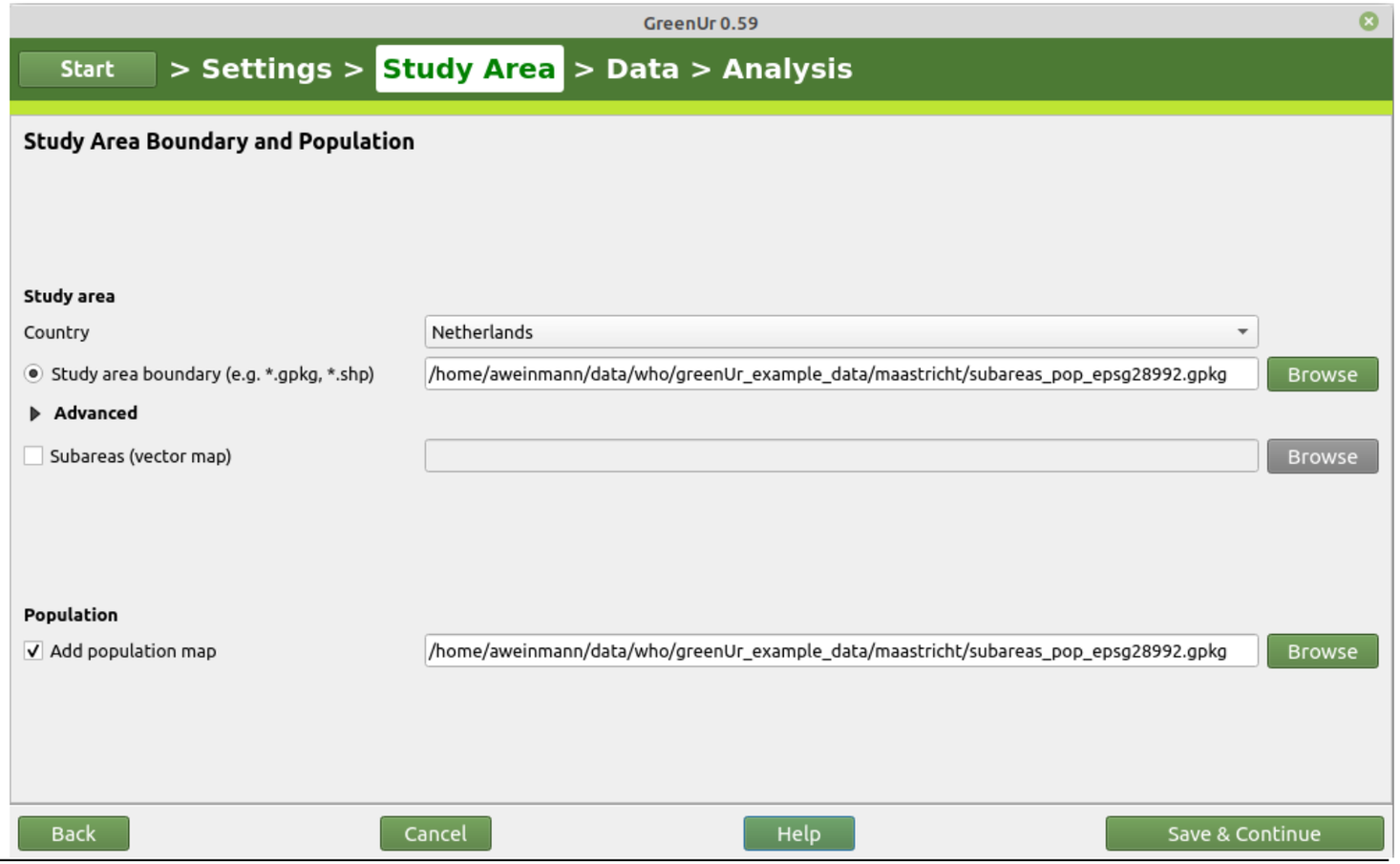
How much green space is available for the population of a specific city?

GreenUr Module: Availability of Green Spaces

GreenUr: Availability of Green Spaces

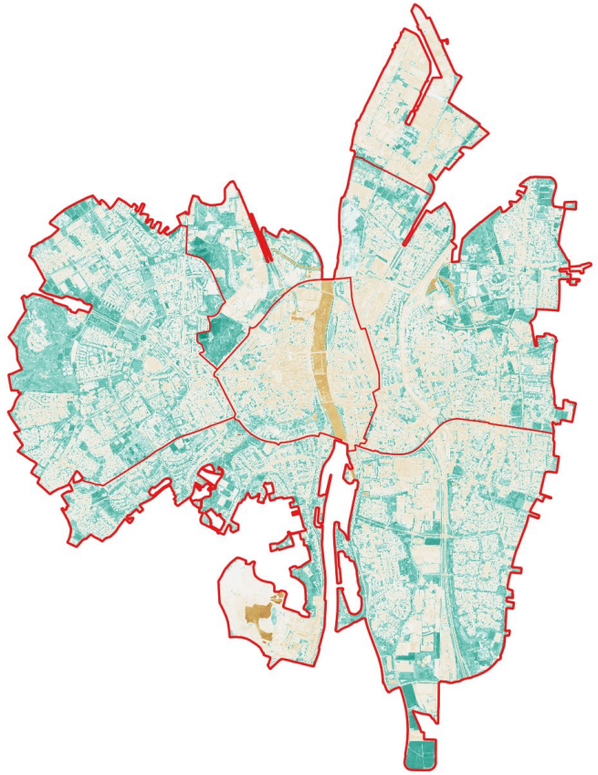
General Input Data





GreenUr: Availability of Green Spaces

General Input Data



Start > Settings > Study Area > **Data** > Analysis

Definition of Green Space

NDVI and LAI based maps (raster maps) — Thresholds

- [x] NDVI — /home/aweinmann/data/who/greenUr_example_data/maastricht/NDVI_epsg28992.tif — 0.250 — Browse
- [ ] LAI — 0.000 — Browse

OpenStreetMap (vector maps)

- [ ] Parks — /home/aweinmann/data/who/greenUr_example_data/maastricht/osm_parks_epsg28992.gpkg — Browse
- [ ] Gardens — /home/aweinmann/data/who/greenUr_example_data/maastricht/osm_garden_epsg28992.gpkg — Browse
- [ ] Parks & Gardens — /home/aweinmann/data/who/greenUr_example_data/maastricht/osm_parks_garden_epsg28992.gpkg — Browse

Municipality data

- [ ] Municipality data — Browse

Satellite based classified land-use/land-cover (raster maps)

- [ ] CORINE (European Region) — Browse
- [ ] Urban Atlas (European Region) — Browse

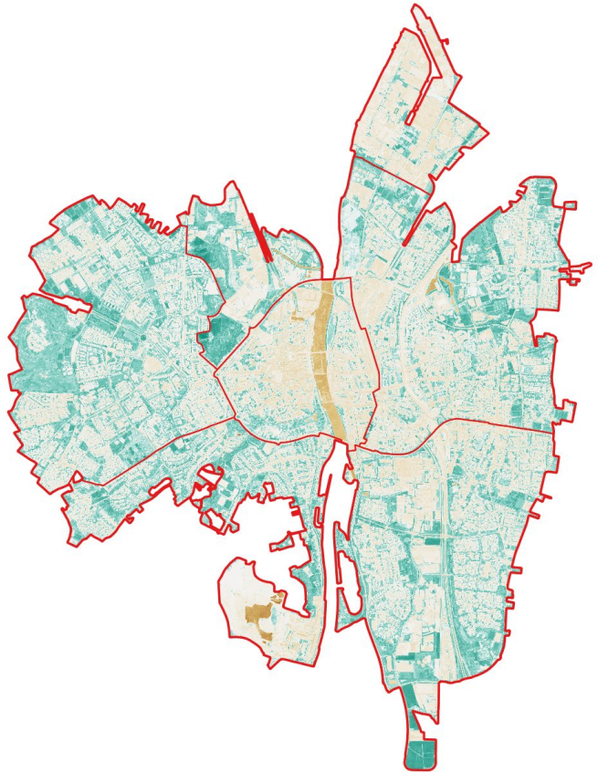
Vector tree map of tree module

- [ ] planned trees per polygon — i — Tree Calculation

Back | Cancel | Help | Save & Continue

GreenUr: Availability of Green Spaces

Calculating GS area of the city



Start > Analysis > Availability of Green Spaces

Availability of Green Space: Current situation: Calculation of % of green space versus total area

step 1 of 2

NDVI

Step 1 Results

Green space definition: NDVI_epsg28992.tif
Study area: subareas_pop_epsg28992.gpkg

Total study area: 32.803 km^2

Green space area: 5.218 km^2

% of green space: 15.91

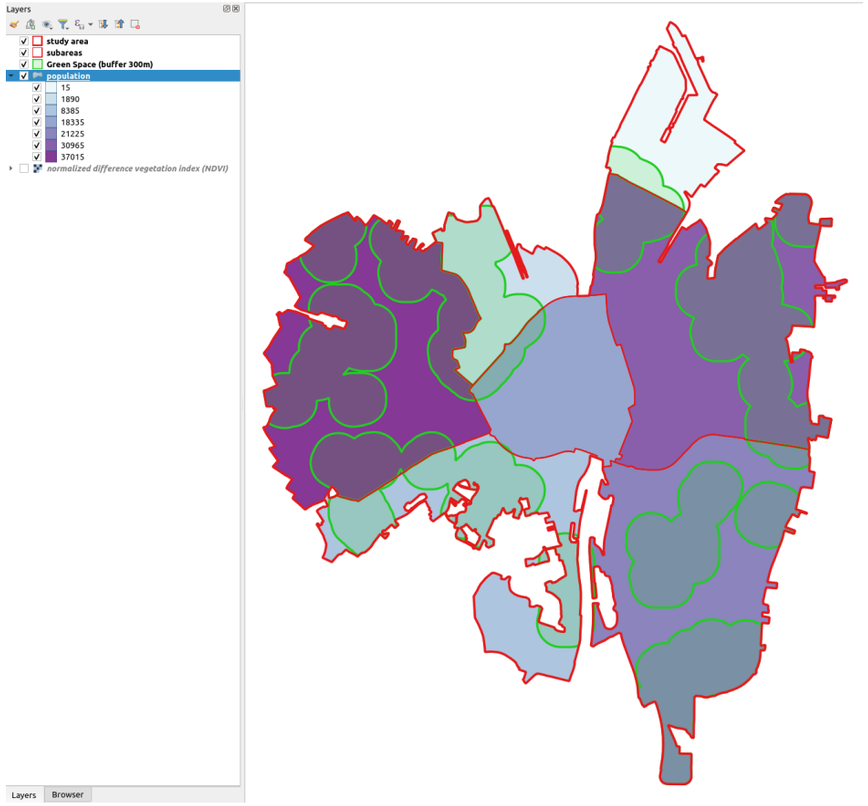
Step 1 execution time: 1026.4 seconds

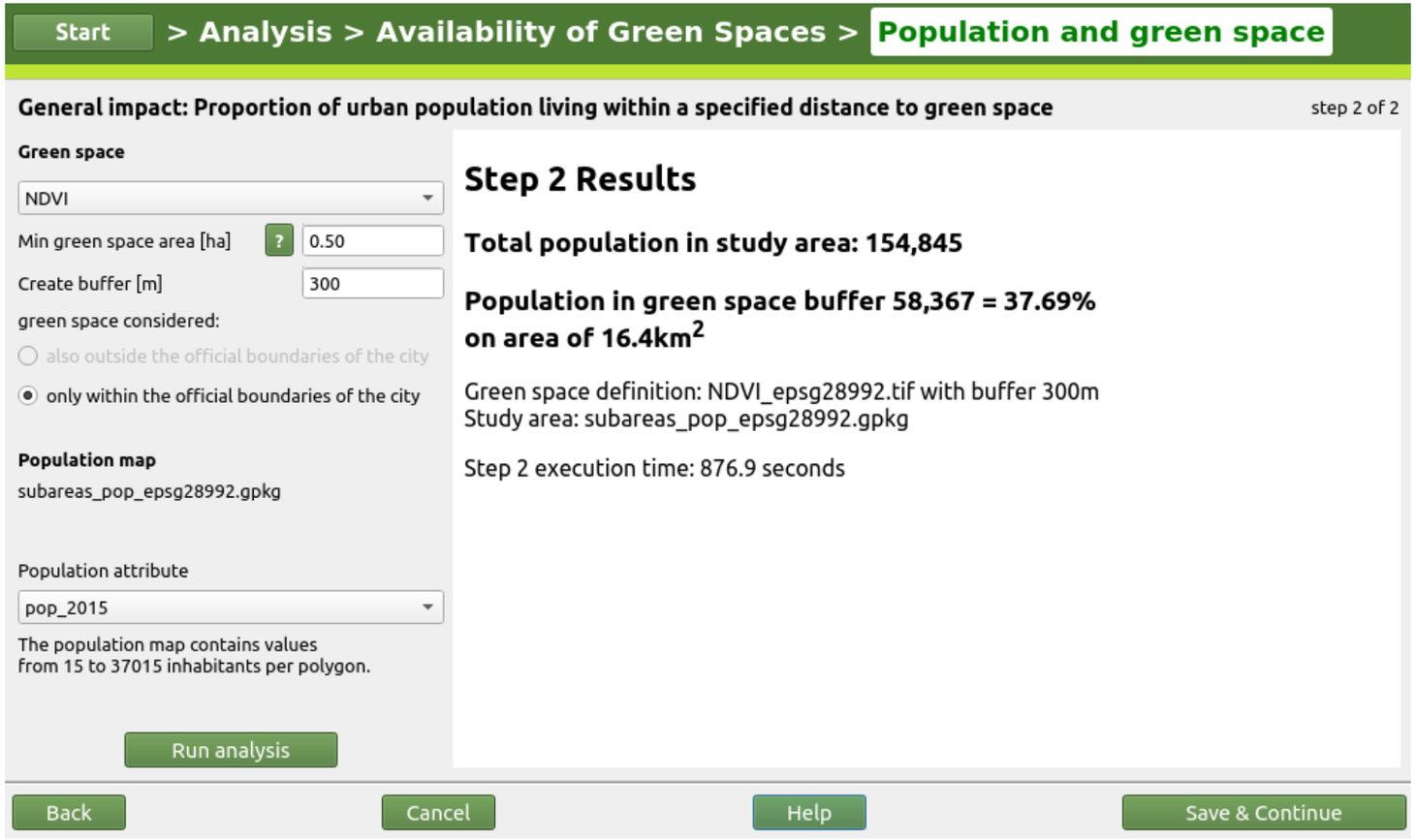
Run analysis

Back | Cancel | Help | Save & Continue

GreenUr: Availability of Green Spaces

Calculating Population within GS





How many death could be prevented due to the proximity to the green spaces?

GreenUr Module: All-cause Mortality

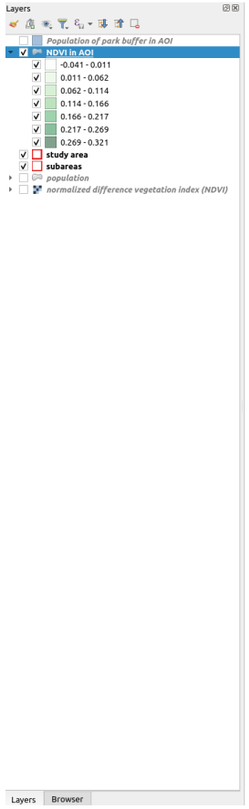
GreenUr: All-cause Mortality

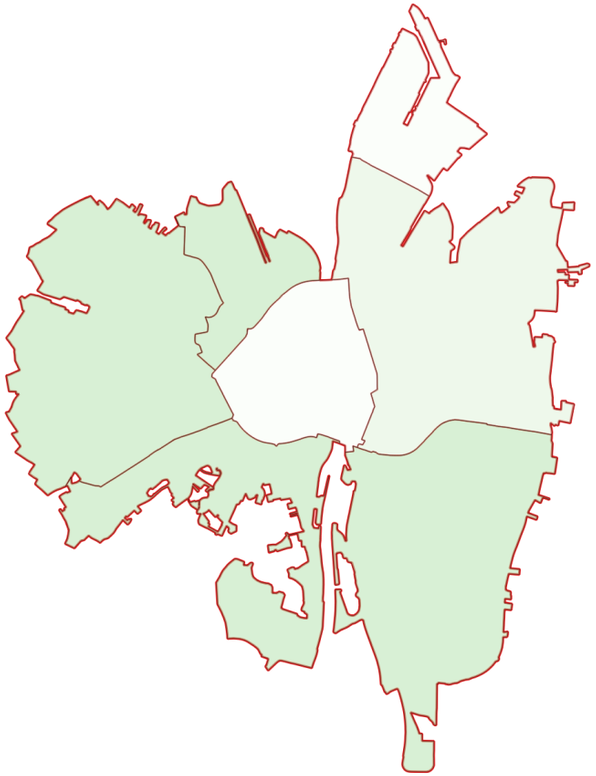
Correlation between GS and mortality

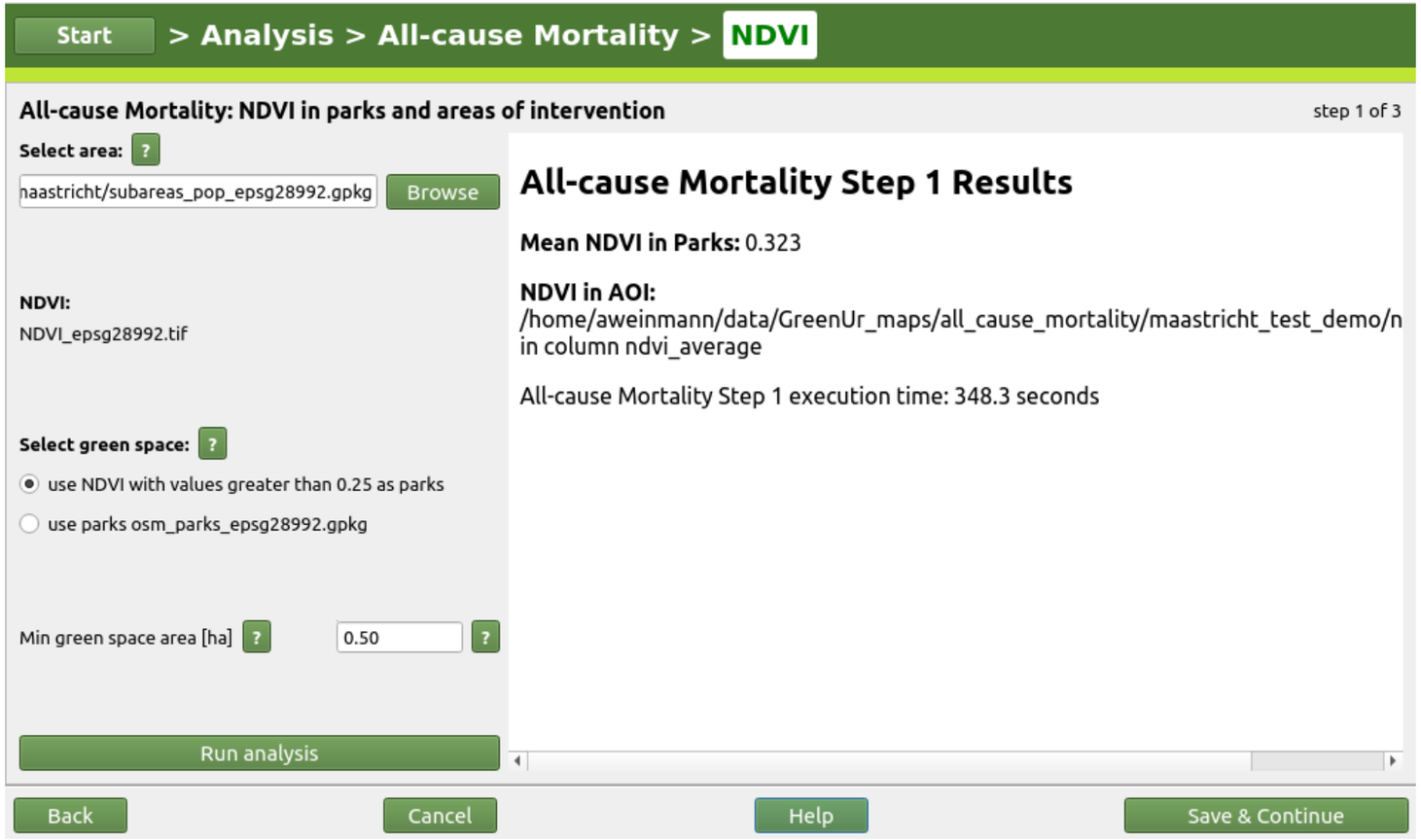
- "… inverse association between surrounding greenness and all-cause mortality" (Rojas-Rueda et al., 2019).
- "… mortality rates were lower in areas with higher levels of greenness" (Fong, Hart and James 2018).
- "… strong evidence for significant positive associations between the quantity of green space (objectively measured around the residence) and perceived mental health and all-cause mortality" (van den Berg et al., 2015).

GreenUr: All-cause Mortality

Input Data & mean NDVI





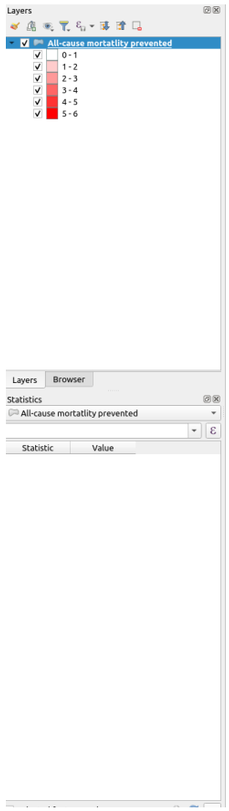


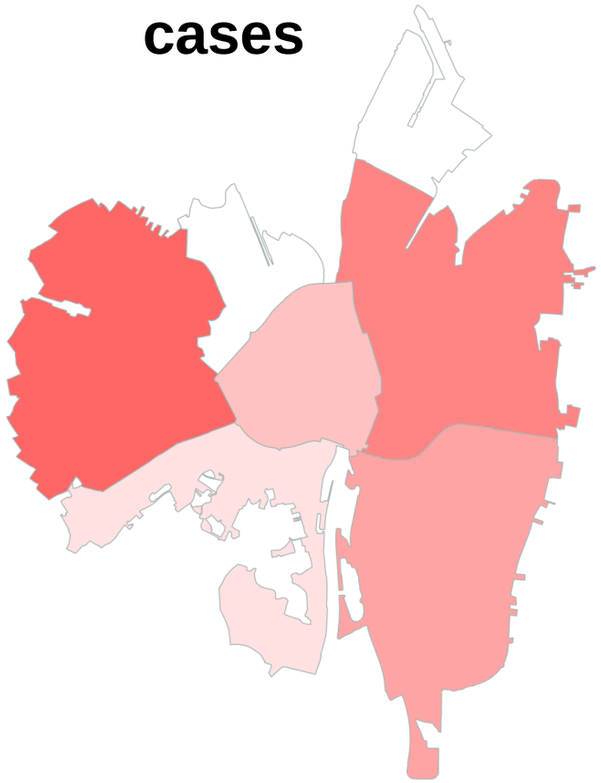
GreenUr: All-cause Mortality

Calculating Population within the park buffer in the AOI

GreenUr: All-cause Mortality

Prevented premature mortality cases





Start > Analysis > All-cause Mortality > Attributable cases

All-cause Mortality: Attributable cases step 3 of 3

Mortality rate (over 20 years)	900.00
Dose-response	0.9900
LCI	0.9800
UCI	1.0100
Unit of Risk	0.12

Run analysis

All-cause Mortality Step 3 Results

All-cause Mortality in AOI:

/home/aweinmann/data/GreenUr_maps/all_cause_mortality/maastricht_test_demo/all_cause_mortality.gpkg in columns:

- population: Population in the used range
- ndvi_average: Average NDVI
- cases: Attributable cases
- cases_lci: LCI of the attributable cases
- cases_uci: UCI of the attributable cases

All-cause Mortality prevented

Attributable Cases	LCI Attributable Cases	UCI Attributable Cases
22.202	21.519	45.115

All-cause Mortality Step 3 execution time: 12.0 seconds

Back | Cancel | Help | Save & Continue

How many death could be prevented due to the effects of temperature?

GreenUr Module: Effects on Temperature

GreenUr: Effects on Temperature

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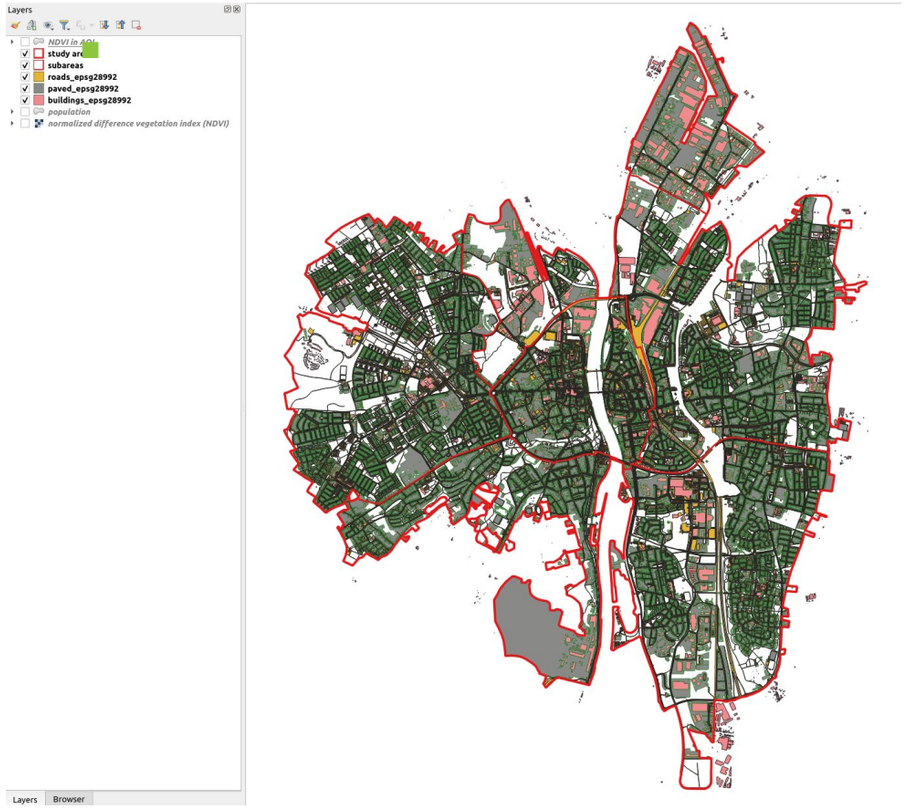
Correlation between GS and Temperature

- "… both grass and trees can effectively **cool surfaces** and so can provide **regional cooling**, helping reduce the urban heat island in hot weather" (Armson, Stringer and Ennos 2012)

- "In areas with more impervious surfaces, reducing the size of impervious patches, increasing the dominance of small vegetation patches, and enhancing landscape diversity can work efficiently to **decrease surface temperature**." (Xie et al., 2013)

GreenUr: Effects on Temperature

Input Data: Landuse



Start > Analysis > Ecosystem Services > **Urban Heat Island Effect Specification**

Effects on temperature: Data definitions step 1 of 3

raster cell size: 100.0

Landuse (vector maps)

- roads: /home/aweinmann/data/who/greenUr_example_data/maastricht/roads_epsg28992.gpkg — Browse
- paved surfaces: /home/aweinmann/data/who/greenUr_example_data/maastricht/paved_epsg28992.gpkg — Browse
- buildings: ome/aweinmann/data/who/greenUr_example_data/maastricht/buildings_epsg28992.gpkg — Browse

Weather

- Weather data (csv file): /home/aweinmann/data/who/greenUr_example_data/maastricht/Maastricht_Weather.csv — Browse

Input variable:

date	YYYYMMDD	YYYYMMDD
daily windspeed	FG	0.1 m/s
daily rural temperature	TG	0.1 degree Celsius
global radiation	Q	J/cm²

- Temperature data (folder with GeoTIFF-files):

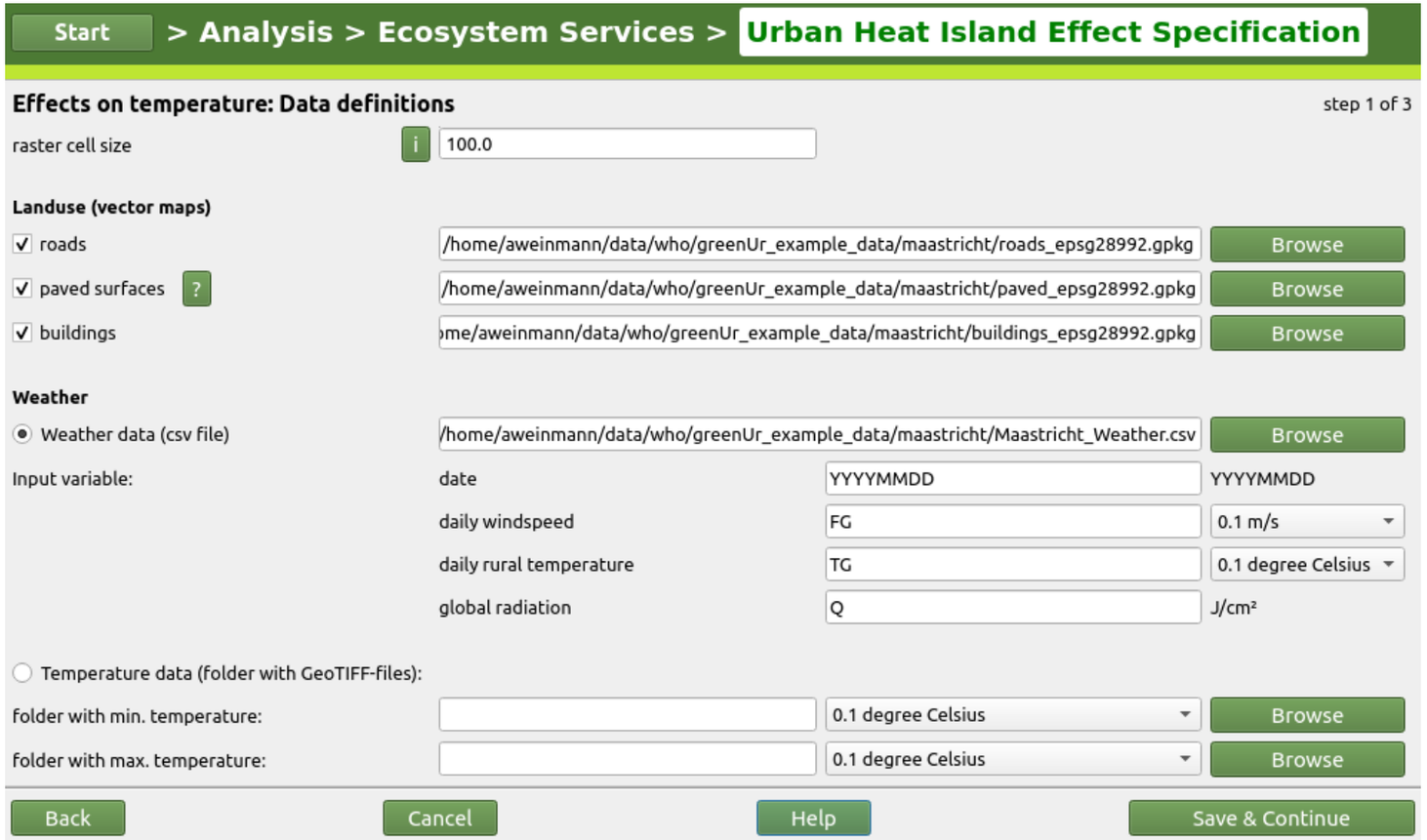
folder with min. temperature:		0.1 degree Celsius — Browse
folder with max. temperature:		0.1 degree Celsius — Browse

Back | Cancel | Help | Save & Continue

GreenUr: Effects on Temperature

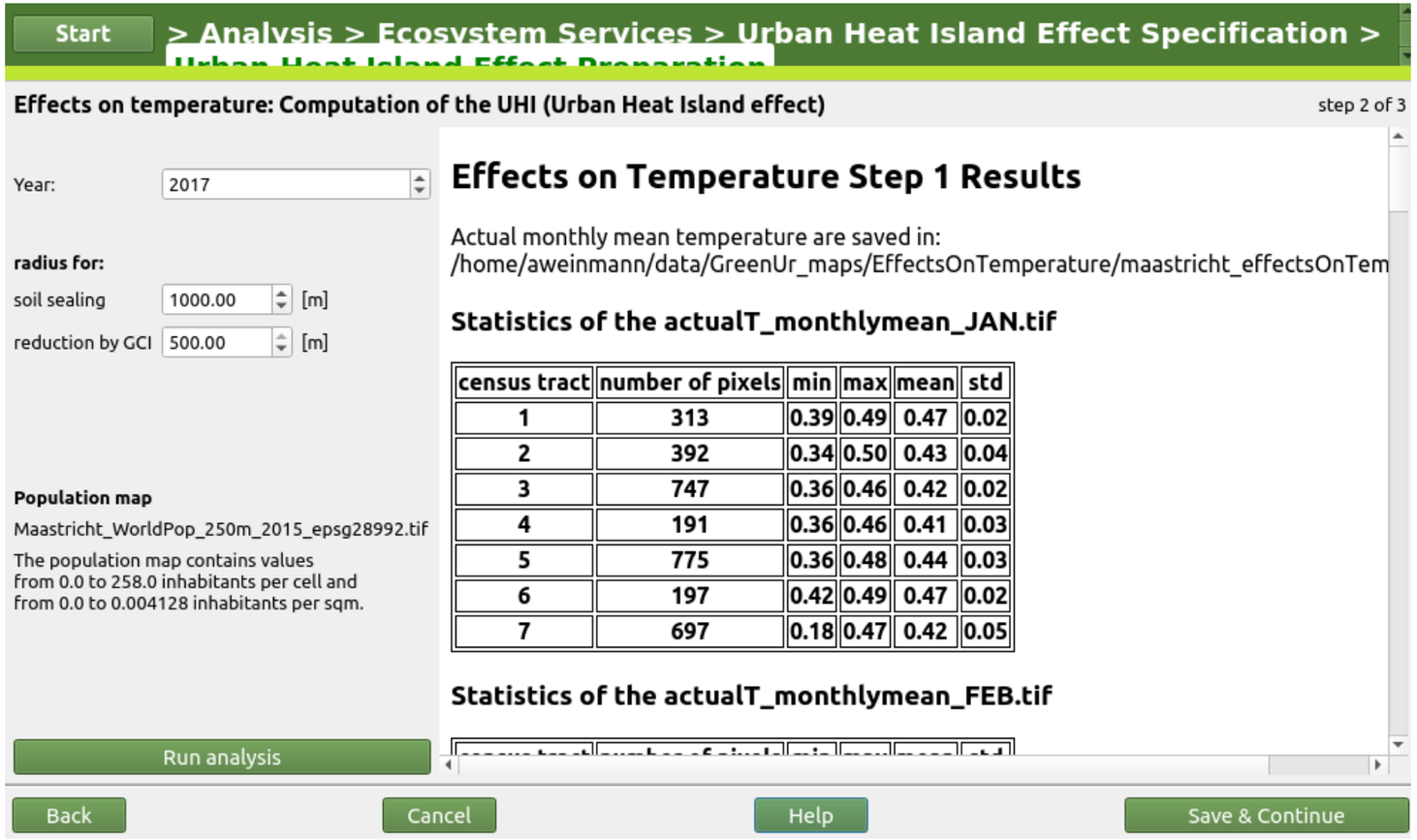
Input Data: Weather

	A	B	C	D	E
1	STN	YYYYMMDD	FG	TG	Q
2					
3	380	20170101	52	-13	410
4	380	20170102	32	-2	215
5	380	20170103	50	14	255
6	380	20170104	44	33	230
7	380	20170105	33	-6	379
8	380	20170106	24	-39	490
9	380	20170107	52	-19	107
10	380	20170108	22	15	123
11	380	20170109	44	35	175
12	380	20170110	36	39	198
13	380	20170111	56	55	56
14	380	20170112	57	44	262
15	380	20170113	56	13	239



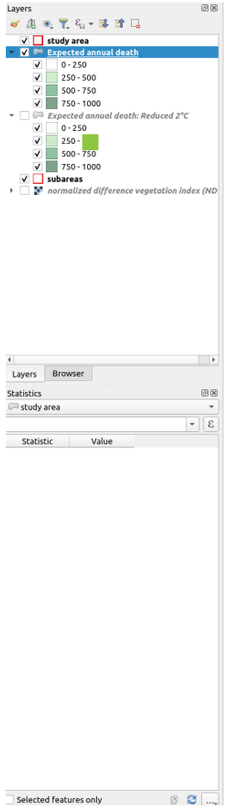
GreenUr: Effects on Temperature

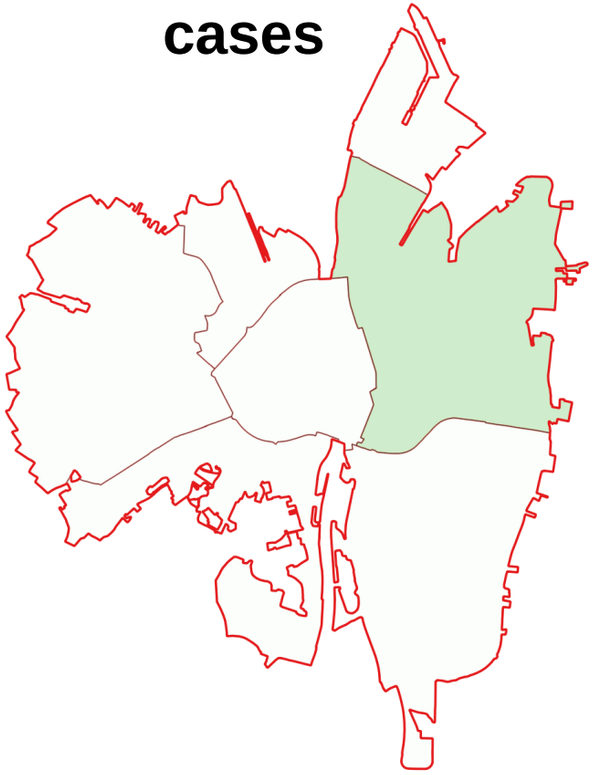
Calculating Monthly Mean Temperature



GreenUr: Effects on Temperature

Prevented premature mortality cases





Start > Analysis > Ecosystem Services > Urban Heat Island Effect Specification > Urban Heat Island Effect Preparation > Urban Heat Island Effect

Effects on temperature: Total deaths prevented step 3 of 3

Change scenario

Scenario name: changed

Expected temperature change [°C]: 0.00

reduce temperautre

increase temperature

Temperature percentil

Minimum Mortality Temperature Percentile (MMTP): 75

Mortality incidence rate	1108.00
Relative risk (RR)	1.1900
RR lower	1.2300
RR upper	1.1600
Population	Maastricht_WorldPop_250m_2015_epsg28992.tif
Attribute	

The population map contains values
from 0.0 to 258.0 inhabitants per cell and
from 0.0 to 0.004128 inhabitants per sqm.

Run Analysis

Effects on Temperature Step 2 Results

Total deaths prevented

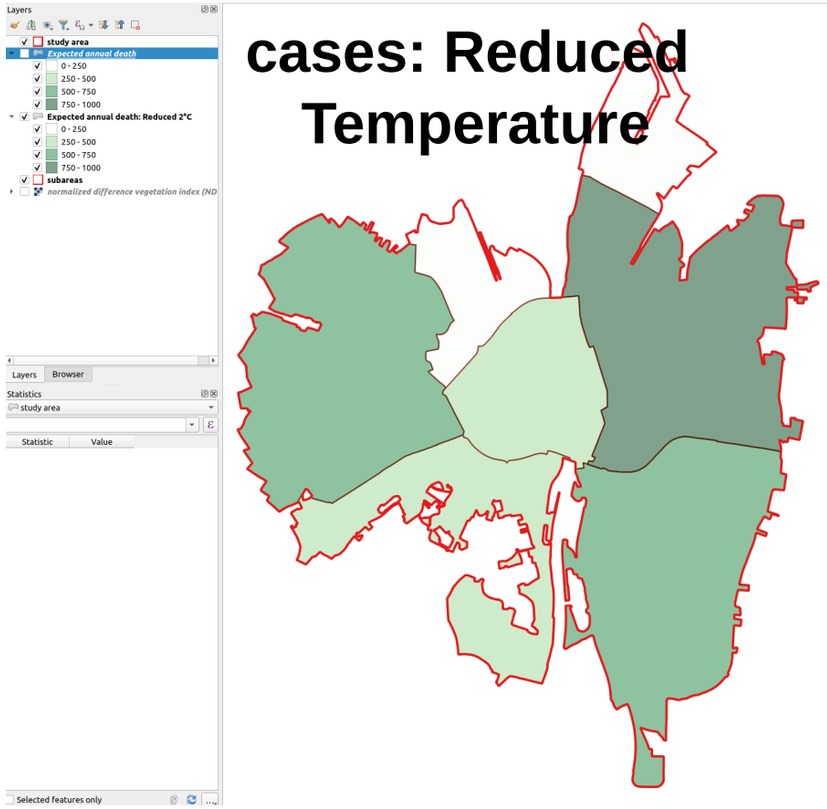
Mortality and heat	LCI of Mortality and heat	UCI of CVD Mortality and heat
1158.753	1001.532	1356.211

Effects on Temperature Step 2 execution time: 26.3 seconds

Back | Cancel | Help | Save & Continue

GreenUr: Effects on Temperature

Prevented premature mortality cases: Reduced Temperature



Start > Analysis > Ecosystem Services > Urban Heat Island Effect Specification > Urban Heat Island Effect Preparation > Urban Heat Island Effect

Effects on temperature: Total deaths prevented step 3 of 3

Change scenario

Scenario name: changed

☑ Expected temperature change [°C]: 2.00

◉ reduce temperautre

○ increase temperature

Temperature percentil

Minimum Mortality Temperature Percentile (MMTP): 75

Mortality incidence rate: 1108.00

Relative risk (RR): 1.1900

RR lower: 1.2300

RR upper: 1.1600

Population: Maastricht_WorldPop_250m_2015_epsg28992.tif

Attribute:

The population map contains values
from 0.0 to 258.0 inhabitants per cell and
from 0.0 to 0.004128 inhabitants per sqm.

Run Analysis

Effects on Temperature Step 2 Results

Total deaths prevented

Mortality and heat	LCI of Mortality and heat	UCI of CVD Mortality and heat
3604.790	3224.595	4040.640

Effects on Temperature Step 2 execution time: 26.5 seconds

Back | Cancel | Help | Save & Continue

Summary and Outlook

Summary

- The GreenUr is a QGIS plugin in beta version which brings together stand alone methods for the investigation of the relation between green spaces and health impacts
- It is easy to use/test these methods for other cities

Outlook

- It is planned to release the plugin in 2023
- More modules should be added
- The usability and functions of the plugin will be extended

Acknowledgements

GreenUr

WHO GreenUr web page

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WHO European Center for Environment and Health in Bonn

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and the

Climate and Clean Air Coalition (CCAC)

* Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV)

Maastricht Data References

- Study area provided by from Bram Oosterbroek, Maastricht University
- Population data created from Raster data CBS, 2016. "Kaart van 100 meter bij 100 meter met statistieken" (https://www.cbs.nl/nl-nl/dossier/nederland-regionaal/geografische%20data/kaart-van-100-meter-bij-100-meter-met-statistieken)
- NDVI from from Beeldmateriaal Nederland, 2018. 'Luchtfotografie in lage resolutie' (http://www.beeldmateriaal.nl/common-nlm/lage-resolutie.html)
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Thanks

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Slides available at:
https://mundialis.github.io/foss4g2022/