

Mapping high-resolution urban morphology for urban heat island studies and weather forecasting at intra-urban scale

JJ Attema, RJ Ronda, GJ Steeneveld, BG Heusinkveld, AAM Holtslag

netherlands

eScience center

by SURF & NWO



WAGENINGEN UNIVERSITY
METEOROLOGY AND AIR QUALITY

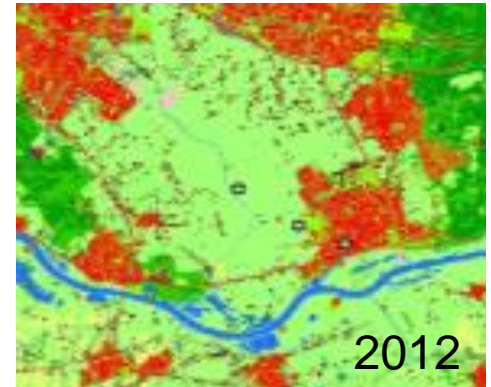


WAGENINGEN UR
For quality of life

Motivation

Weather conditions can be strongly influenced by the local environment. An accurate description of the local environment is therefore required.

- **urban heat island** cities are where people live
- **climate change** increased frequency of heatwaves
- **general demand for high resolution forecasts** (extremes in) temperature, thermal comfort, ...

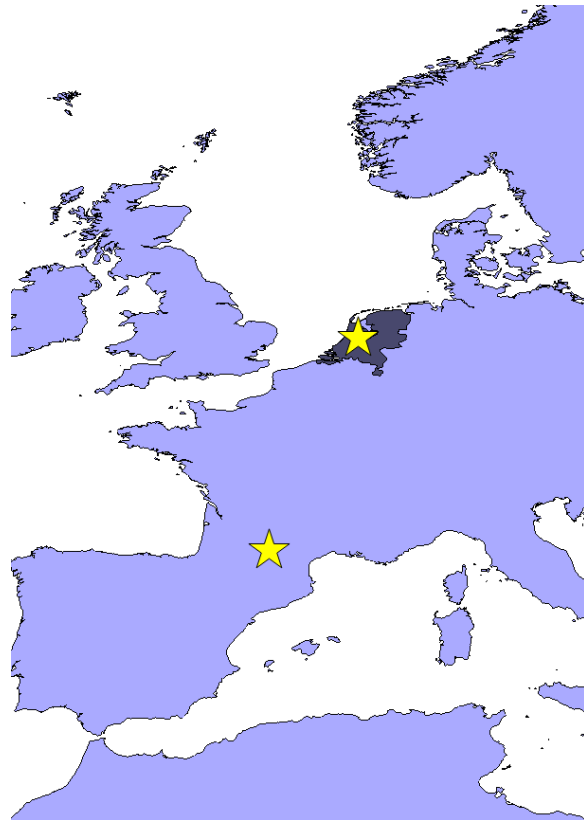


10 km

Research question

- *Can we create a consistent, 100m resolution national urban database for the Netherlands? (ie. nudapt-nl)*

Demonstrate its use for heat wave climatology, heat wave impact, and weather forecasting.

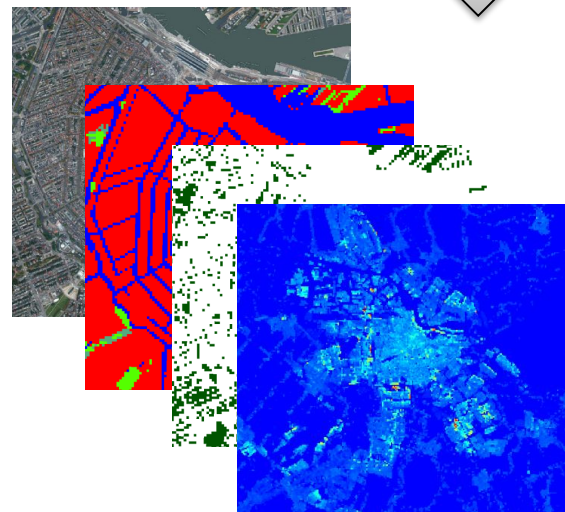


Methodology

- Inventory and combine datasets
- Process and convert to usable format
- Calculate relevant statistics (nudapt parameters)

Tools:

- GDAL (Geospatial Data Abstraction Library)
www.gdal.org
- PostgreSQL database
- PostGIS with raster extension www.postgis.net
- QGIS (visualization)

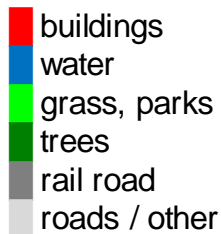


TOP10NL

Dutch Kadaster:

All buildings, roads, and for each land parcel the allowed land use.

file format: GML

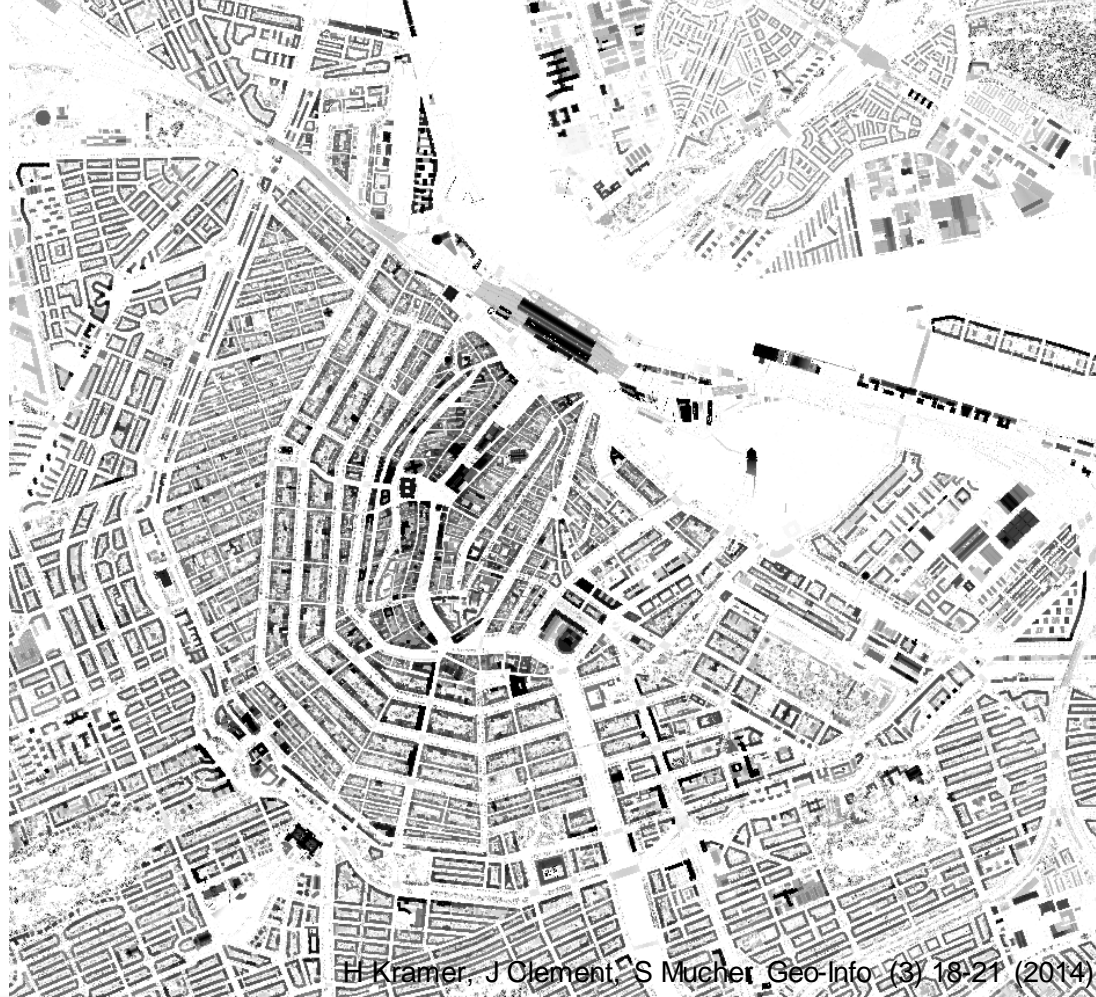


© Kadaster, november 2013

Height map of the Netherlands

- AHN / OHN
- Lidar based
- Separation in elevation and object height
- 50 cm resolution (5 cm vertical)

raster data



H. Kramer, J. Clement, S. Mucher, Geo-Info (3) 18-21 (2014)

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Photos

Aerial photographs of the Netherlands in RGB+I

- Summer 2008
- NDVI: $(I-R)/(I+R)$
- 22 cm / 6m resolution

raster data



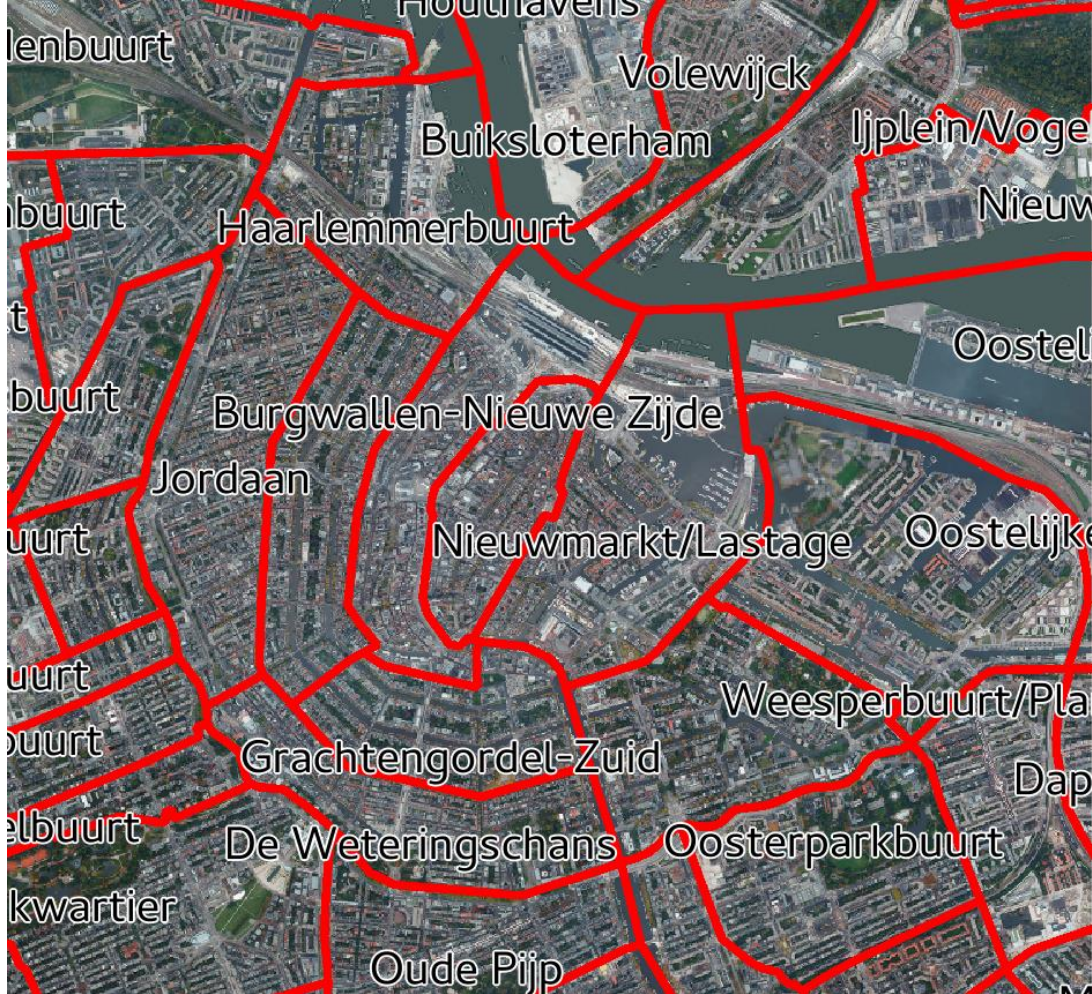
dkln2008 © Eurosense BV

Demographics

Demographic data from
the Dutch Statistical
Office (CBS)

- 12000 regions
- 200 statistics per region

ESRI shapefiles



Results

General surface data:

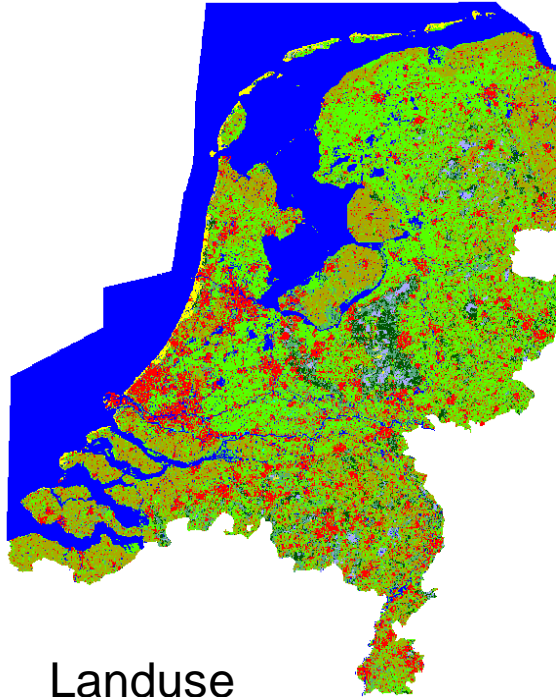
- landuse (25 m^2)
- soiltype (100 m^2)
- urban fraction (25 m^2)

Urban morphology (100 m^2):

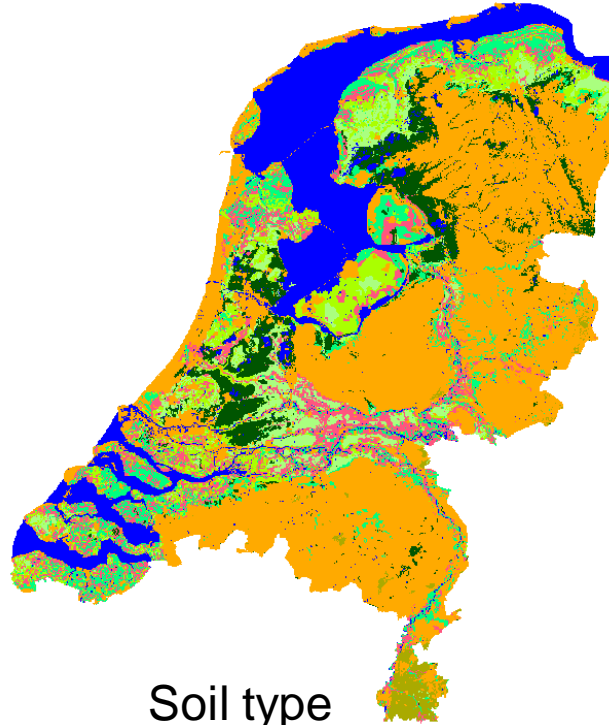
- mean building height
- std. dev. building height
- plan fraction
- frontal area (4 orientations)
- histogram of building height



Results



Landuse

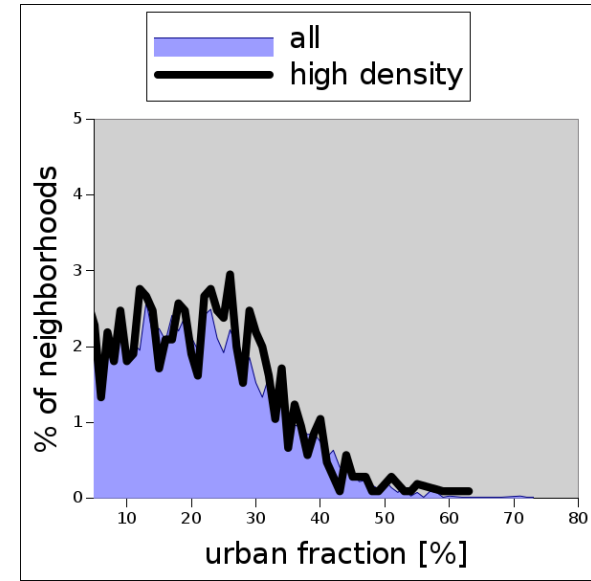
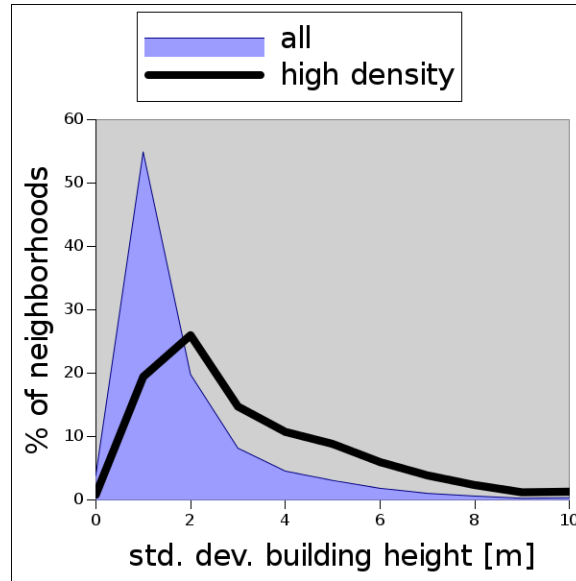
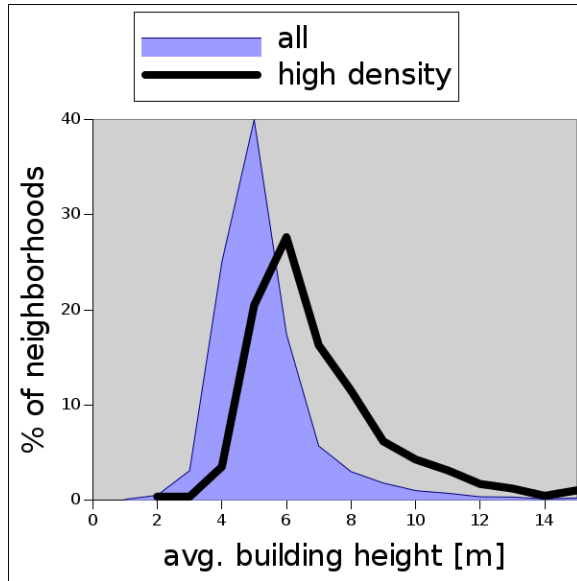


Soil type



Green fraction

Urban morphology



all: > 500 addresses per km^2
high density : > 2500 addresses per km^2



UHI statistics

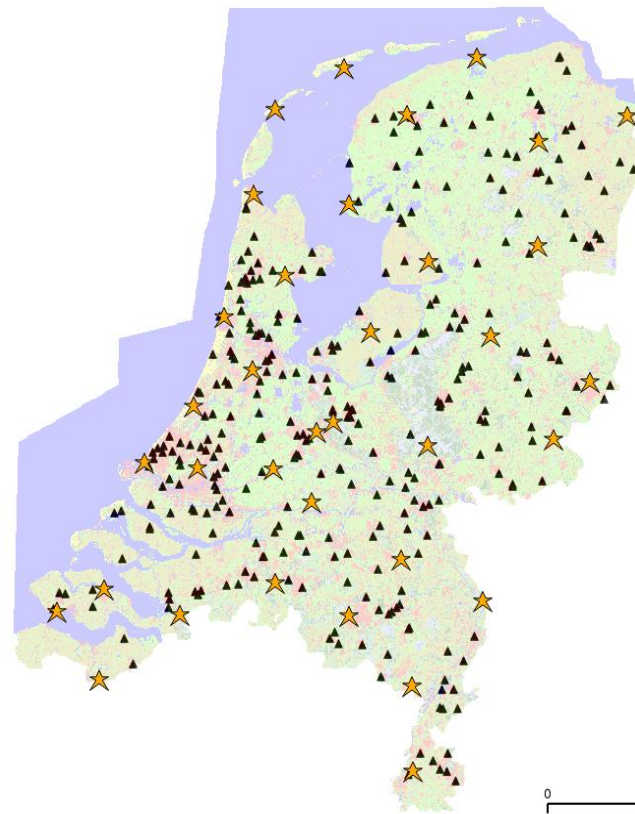
Statistics are derived from:

- a network of amateur meteorologists (Weather Underground)
- official KNMI weather stations

And then fitted to green fraction (γ , [%]) and population density (ρ , [$\#/km^2$]):

$$\text{UHI } 50^{th} = -0.019 \gamma + 1.007 \rho^{0.124}$$

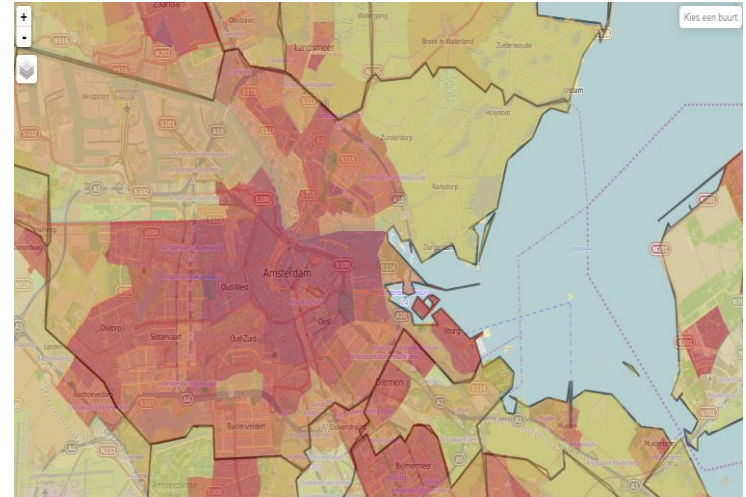
$$\text{UHI } 95^{th} = -0.032 \gamma + 1.965 \rho^{0.138}$$



G Steeneveld, R van Haren, personal communication

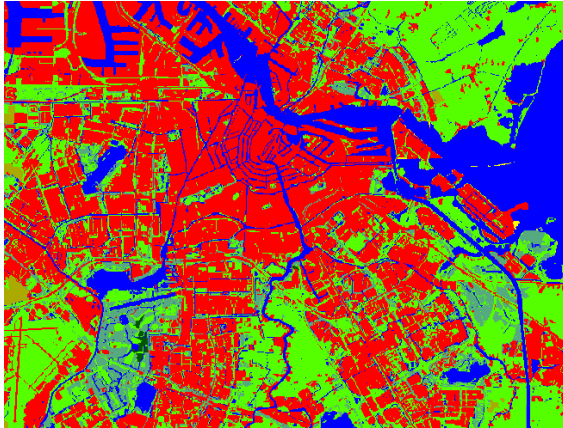
Heat wave impact

demographic	Percentage <i>UHI</i> 95 th > 4°C	<i>UHI</i> 95 th
all ages	31%	3.4°C
younger than 14	31%	3.4°C
older than 65	26%	3.3°C



www.met.wau.nl/SummerInTheCity

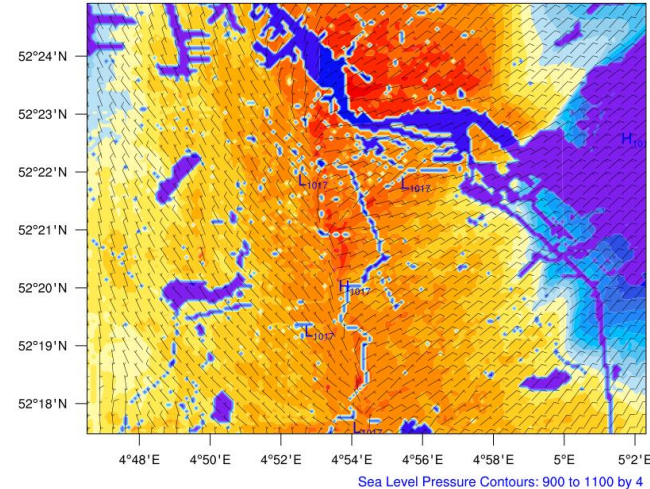
High resolution forecasts



REAL-TIME WRF

Init: 2015-07-01_00:00:00
Valid: 2015-07-02_16:00:00

T - Tavg (C)
Sea Level Pressure (hPa)
Wind (kts)



T - Tavg (C)

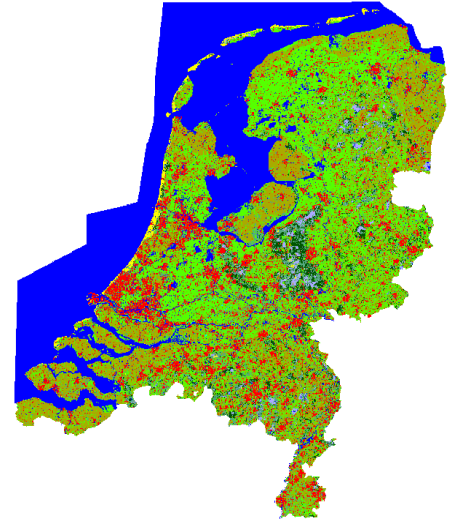


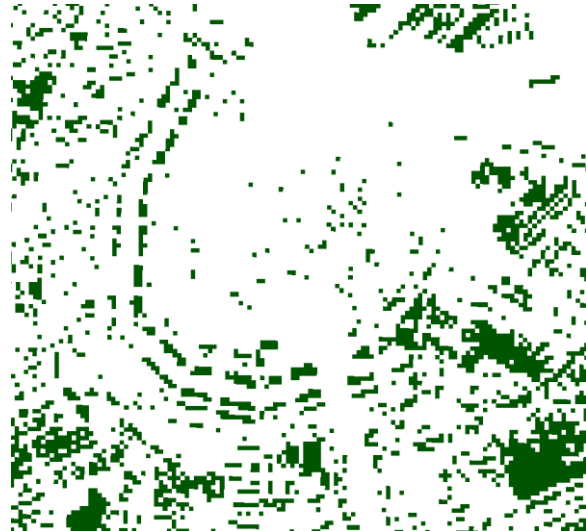
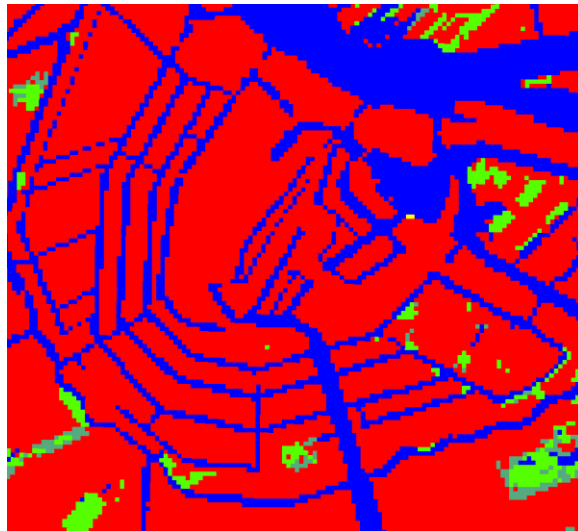
For details, see presentation this morning by RJ Ronda

Summary

- Created a consistent, high-resolution (100 m^2), data collection for the Netherlands.
- It contains static surface data and urban morphological data.

Lots of high quality data has become available in the last years, allowing new applications. Weather forecasts at an intra-urban scale are now possible.





Datasets

Kadaster TOP10NL:

- All buildings, roads, and for each landparcel the allowed land use.
- 30 GB of GML (1.7 GB zipped)
- Imported using GDAL

PostgreSQL database size:

1 GB for buildings (~3 million entries)

2 GB for landuse (~2 million entries)



Datasets2

Aerial photographs of the Netherland in RGB+I

- 22 cm resolution, ~TB of TIFFS
- Using an overview at 6m resolution 7GB
- imported using raster2pgsql

PostgreSQL database:

- 6 GB (300K tiles of 516mx558m)



Dataset3

CBS demographic data

- 50 MB ESRI shapefile
- 12K regions
- 200 demographic indicators per region.
- Imported using shp2psql

PostgreSQL database:

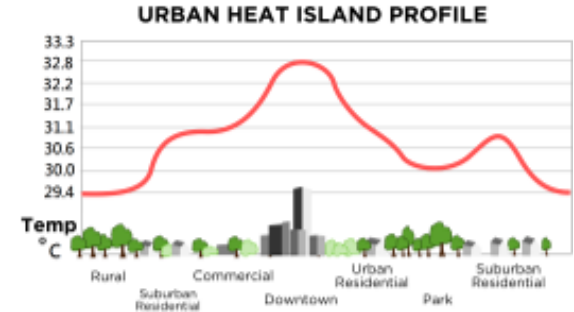
- 150 MB



Heatwaves in a city

The construction of modern cities leads to an amplification of a heat wave:

- **Concrete and (black) asphalt** absorb sunlight and stay warm during the night.
- **The urban canyon** formed by the high rise buildings reduces wind and prevents radiative cooling at night.
- **Human activity** like transport and air conditioning increase temperature further.



nudapt-NL

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- landuse (25m2)
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Urban morphology (100m2):

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