

# The European Commission's science and knowledge service

## Joint Research Centre



# **Degree of Urbanisation GRID (DUG)**

## **Pre Forum Training Sessions on GHSL Tool Suite**

**Aneta J Florczyk & GHSL team**

Geo HPI Forum 2017, Enschede (Netherlands), 13 Sept. 2017

# Overview

- The global harmonized definition of cities and settlements
- “Degree of Urbanisation GRID” main concepts
- GHSL data
- **Hands On**

# Global Definition of Cities and Settlements

- During the UN-Habitat III conference in October 2016, the European Union, the OECD and the World Bank launched a voluntary commitment to develop a global, people-based definition of cities and settlements.
- This commitment will support
  - the implementation of the new urban agenda.
  - the monitoring and the comparison of the urban Sustainable Development Goal (SDG). Several of the indicators linked to this goal are highly sensitive to where the boundary is drawn around a city.
- The goal of the commitment is to present a definition to the **UN Statistical Commission in 2019**.
- Two linked definitions are being tested:
  - **The degree of urbanisation**
  - The EU-OECD functional urban area definition.

# Global Definition of Cities and Settlements

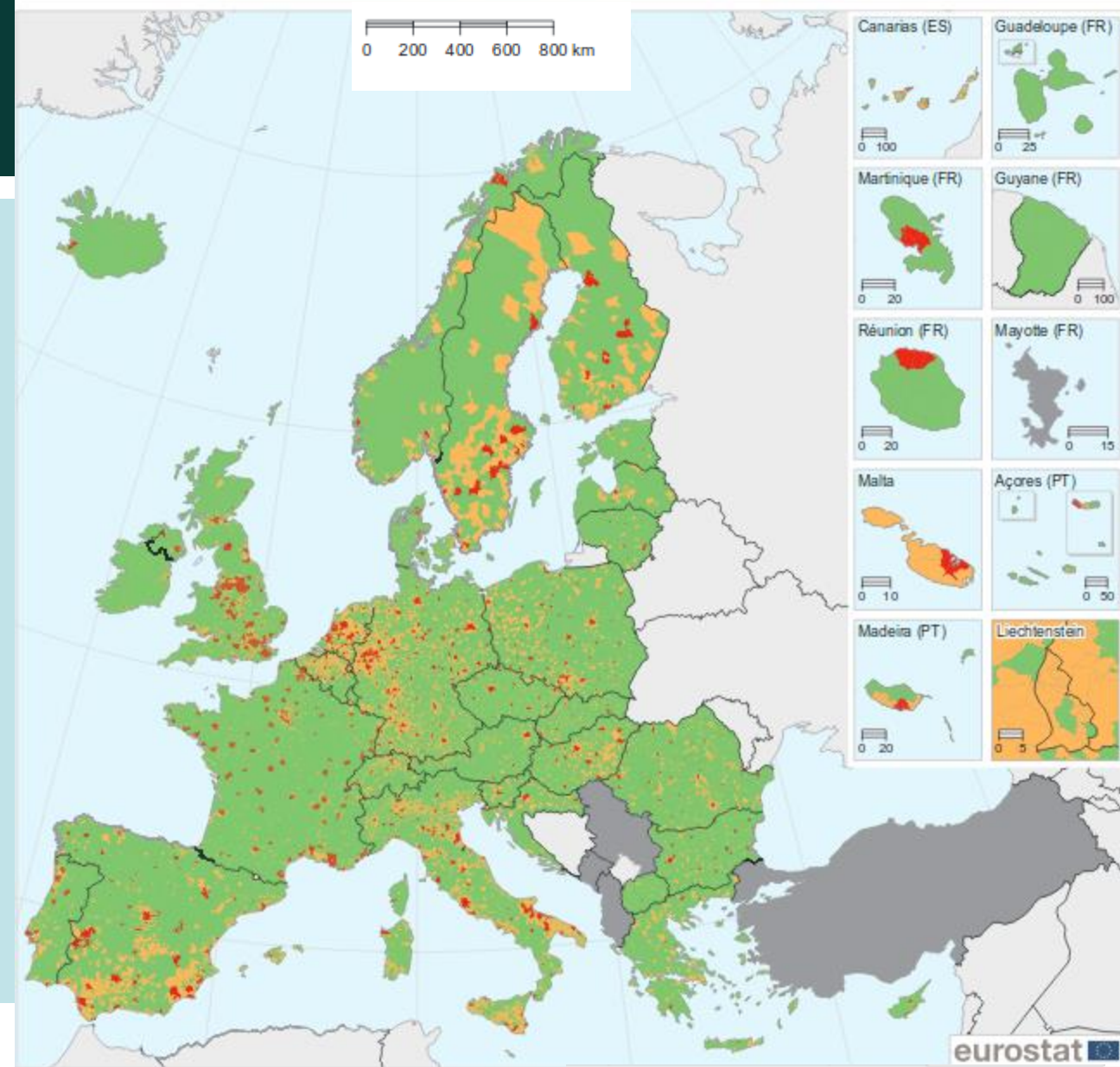
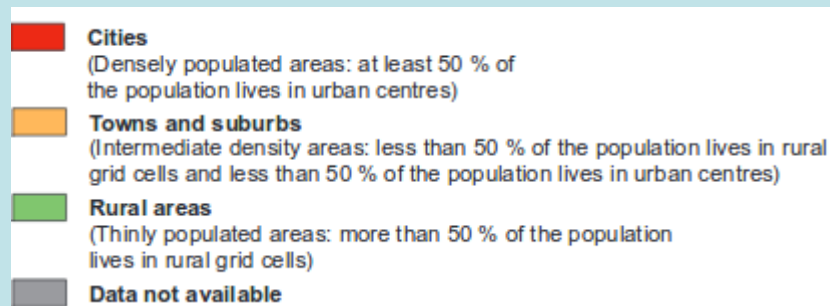
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- In 2017, the Food and Agricultural Organization (FAO) has joined this commitment linking it with the Global Strategy to improve Agricultural and Rural Statistics.

# Harmonized Definition of Cities and Rural Areas

- Degree of Urbanization (DEGURBA) - people-base definition
- Classification of municipalities:
  - **Cities** have the majority of their population in an urban centre;
  - **Towns and suburbs** have the majority of their population in an urban cluster, but are not cities;
  - **Rural areas** have the majority of their population in rural grid cells.

*Dijkstra, Lewis, and H. Poelmann. "A harmonised definition of cities and rural areas: the new degree of urbanization." European Commission Urban and Regional Policy. Working paper 1 (2014): 2014.*

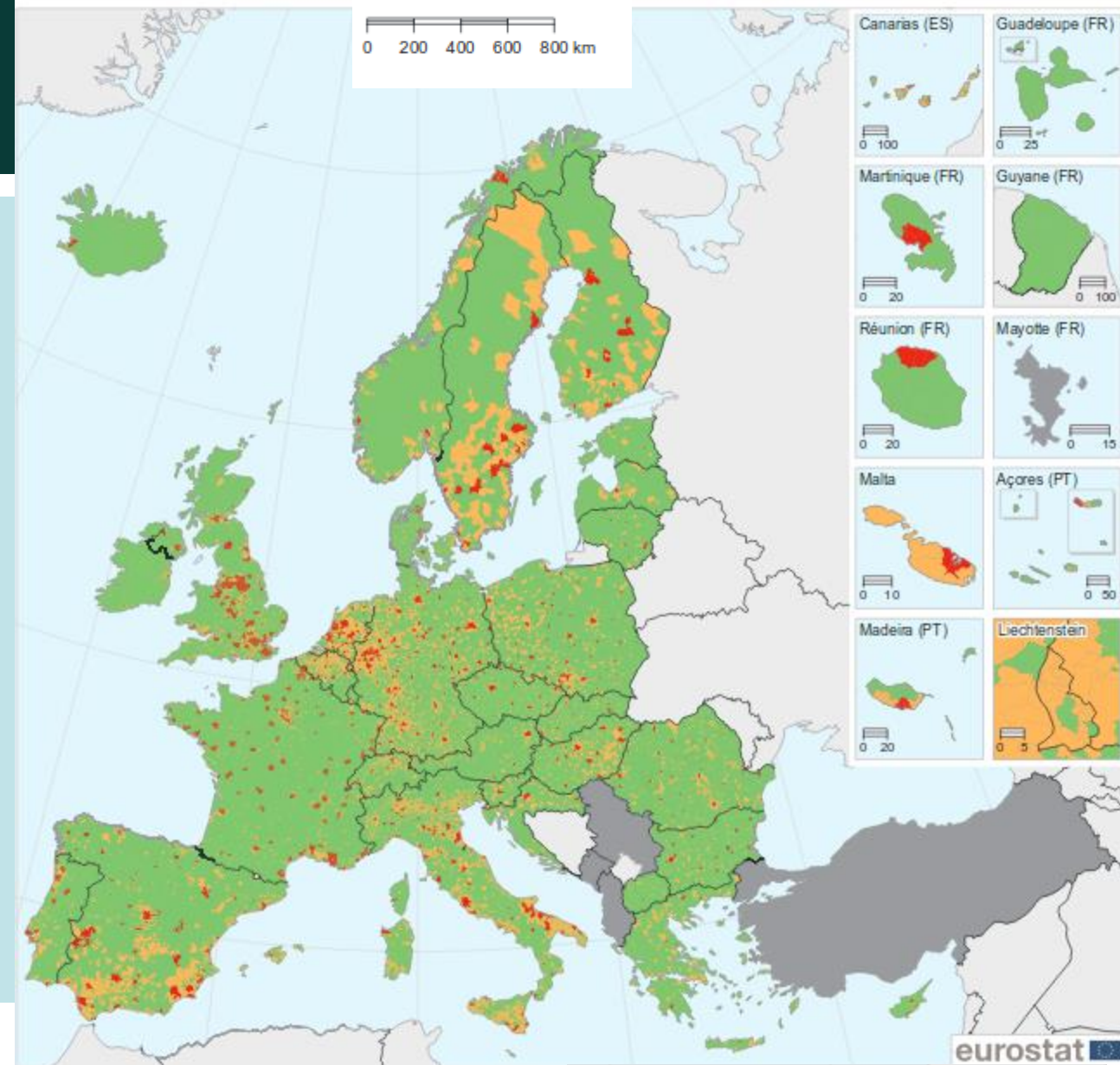
# Degree of urbanisation for local administrative units level 2 (LAU2) (')







9.00-10.30 hrs: Partner showcase session 1:  
**Global harmonized definition of cities and settlements** Lewis Dijkstra, Economic Analysis Unit at European Commission Directorate General for Regional and Urban Policy





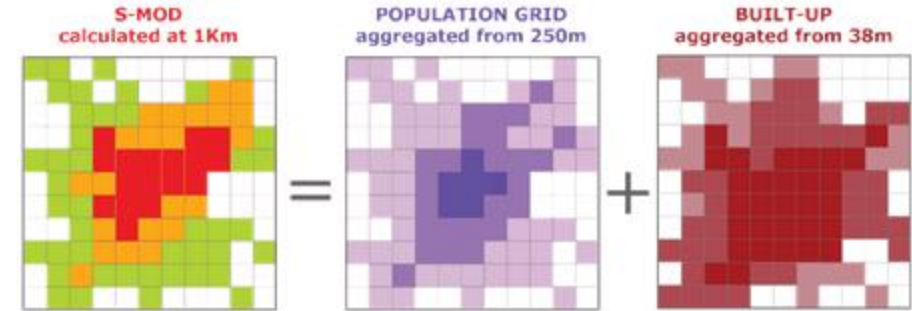
# DEGURBA at GRID

## DEGURBA at GRID

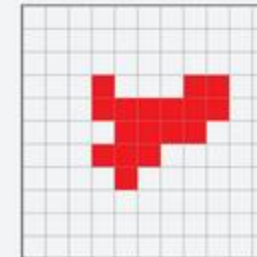
- Urban centre (HDC)
- Urban cluster (LDC)
- Rural cell area

### The GHSL Settlement Model

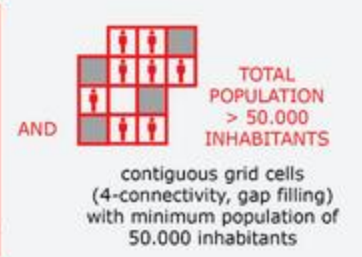
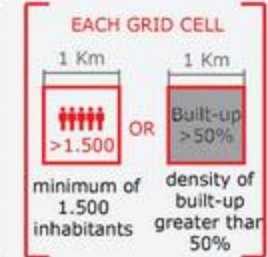
(Porting of the [Degurba model](#) in the GHSL framework)



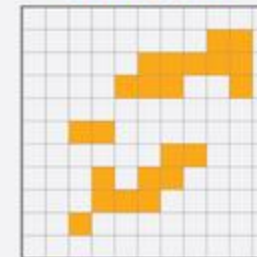
#### URBAN CENTRE



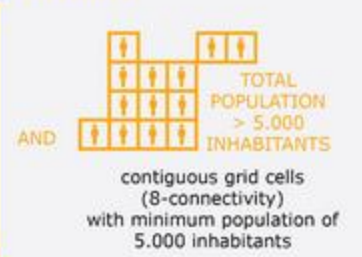
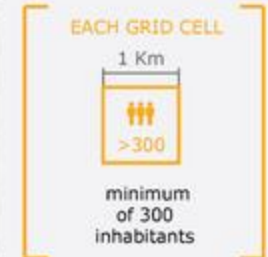
#### Required conditions



#### URBAN CLUSTER



#### Required conditions



# DEGURBA at GRID

## DEGURBA at GRID

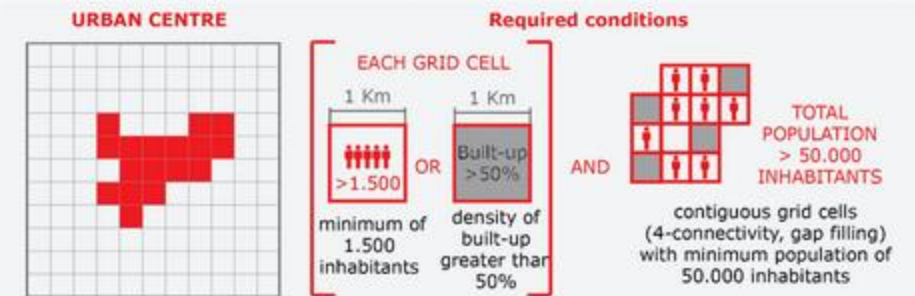
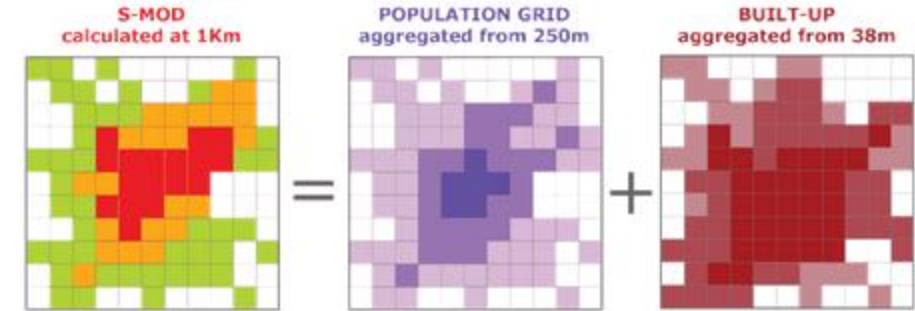
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- Urban cluster (LDC)
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Porting of the *Degree of urbanization (DEGURBA)* in the GHSL framework

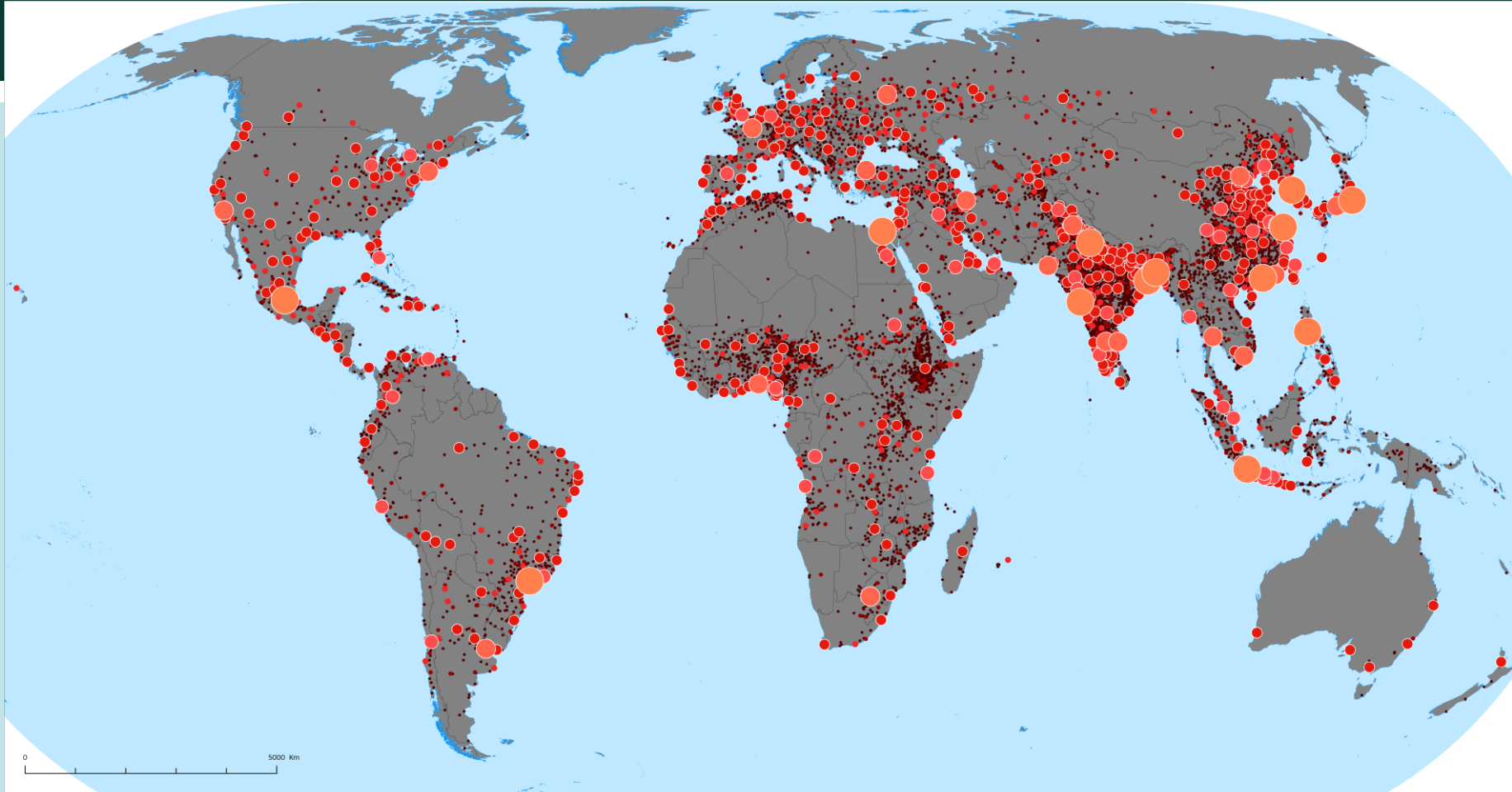
- GHSL Settlement Model – Global harmonized definition of cities and settlements at cell 1km GRID

### The GHSL Settlement Model

(Porting of the *Degree of urbanization* model in the GHSL framework)

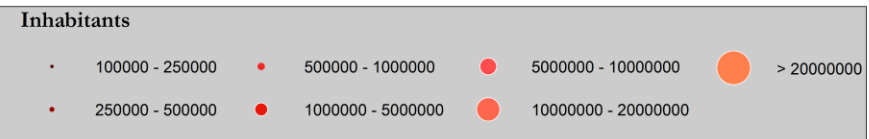


# Cities in the world

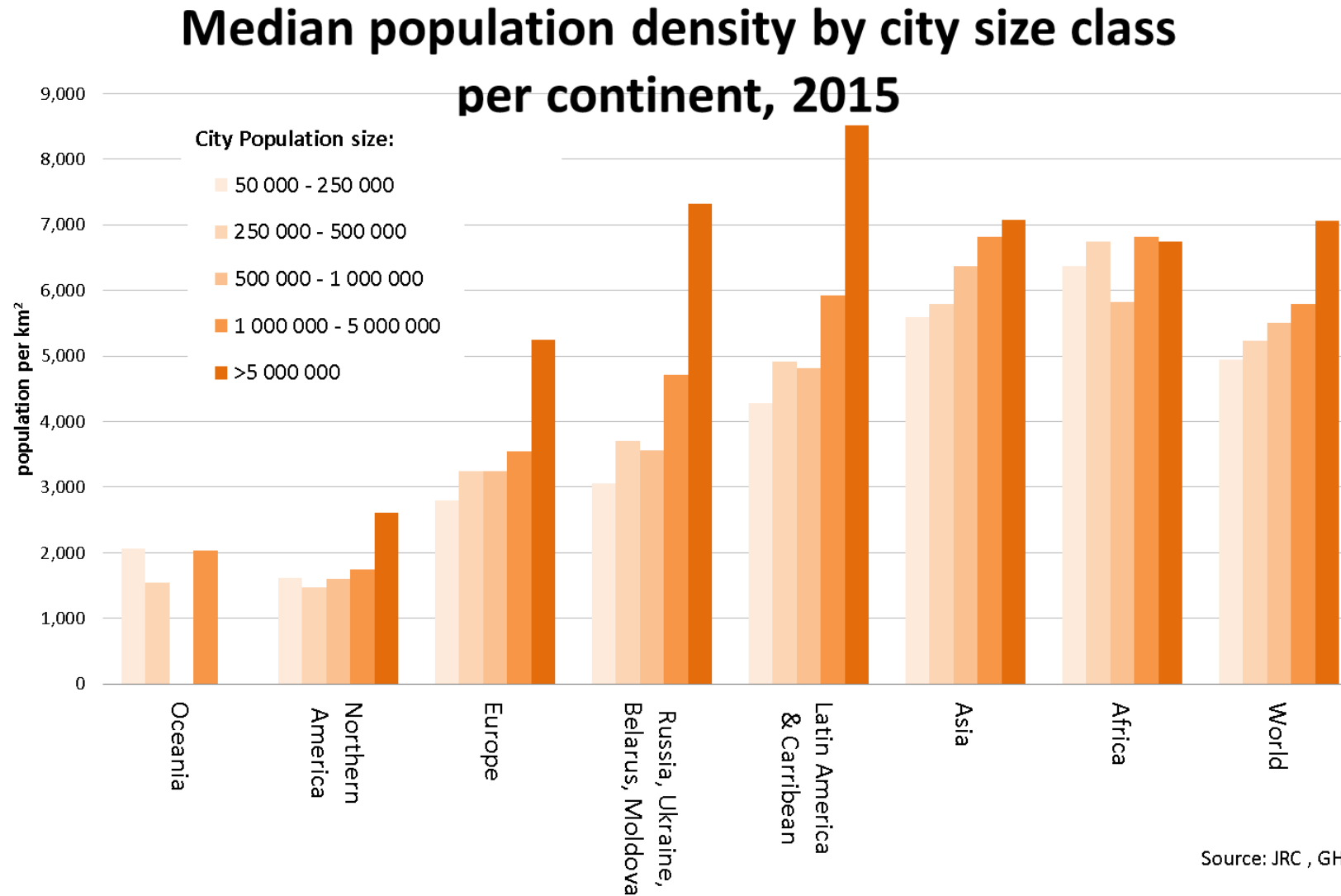


**Urban Centres in the world by population size, 2015**

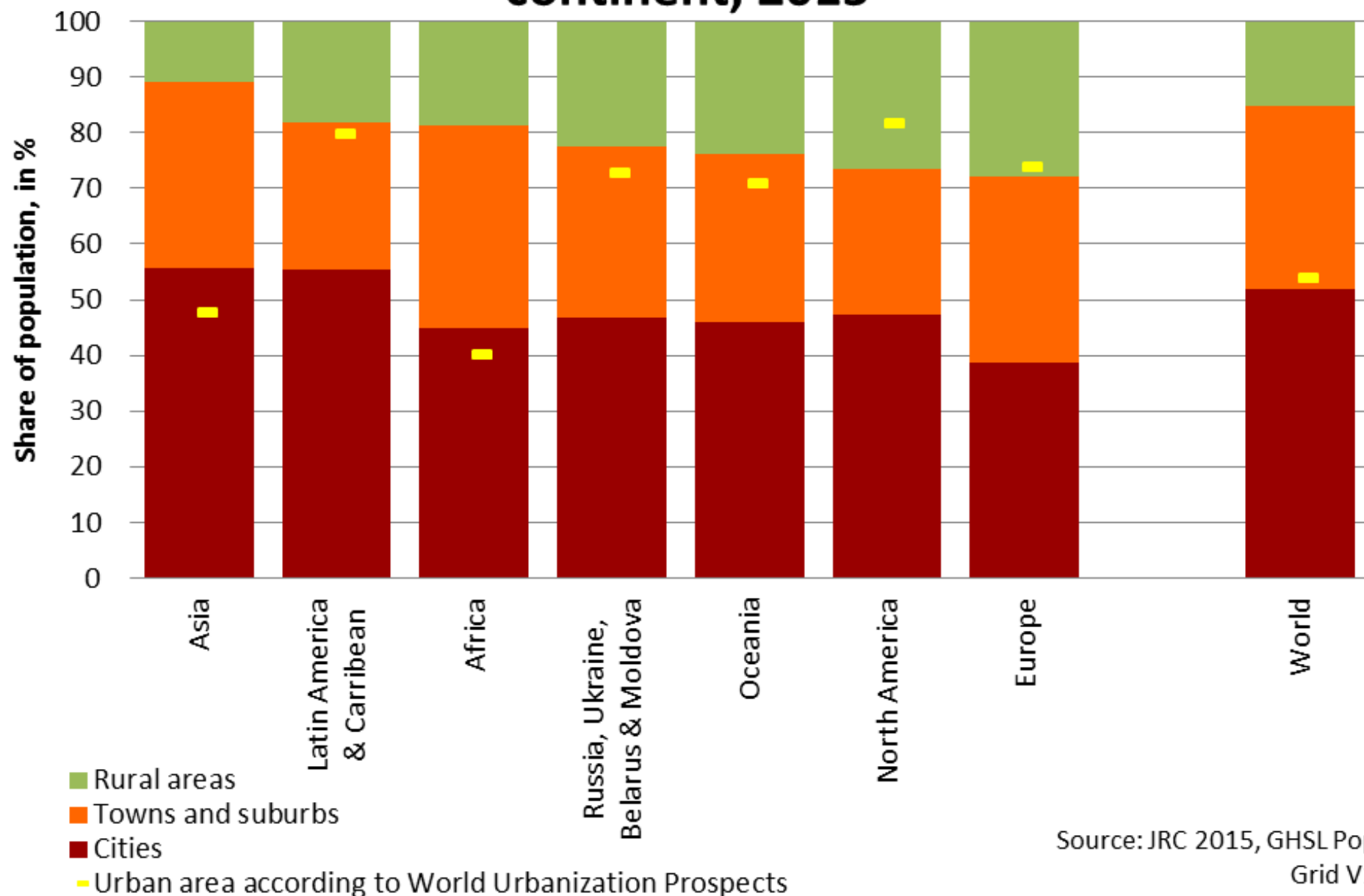
Source : JRC (GHS - POP Global Settlement Model)



# Population density by continent



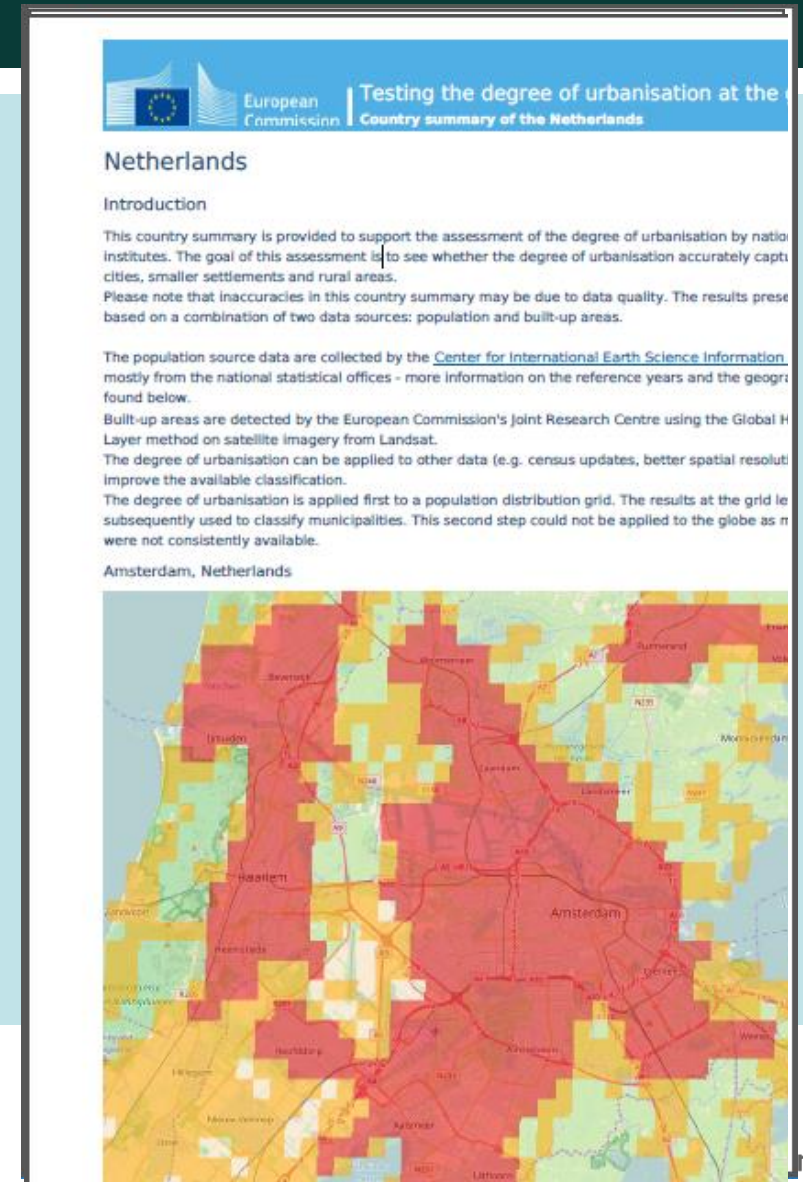
## Population by degree of urbanisation per continent, 2015





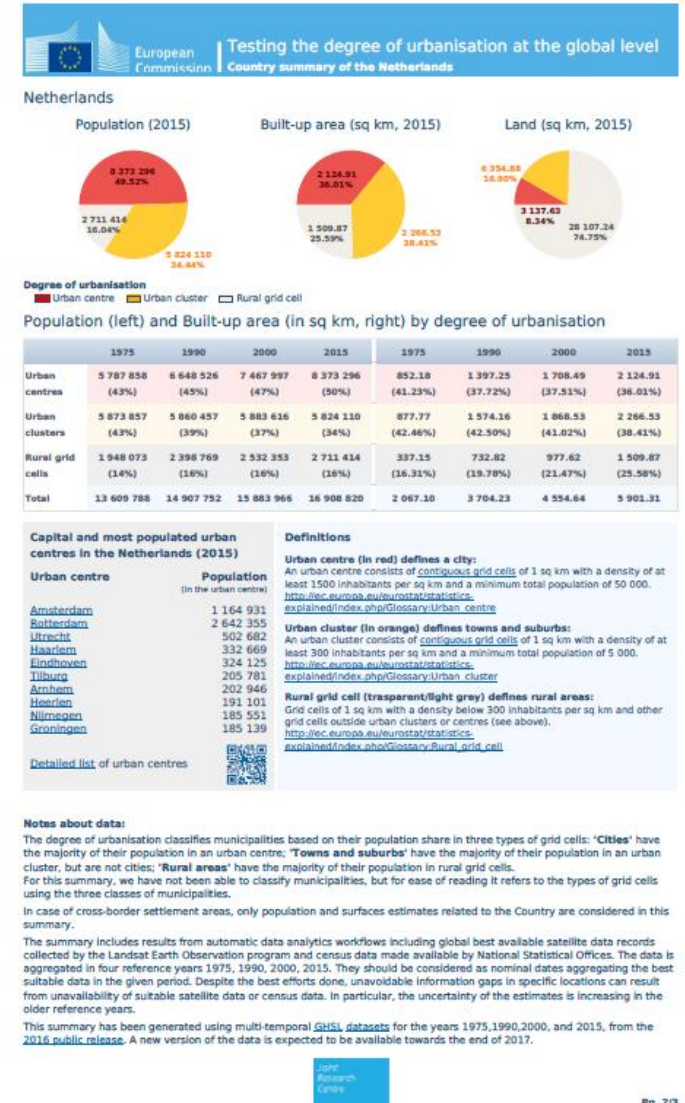
# Global Definition of Cities and Settlements

- The country fact sheets in the Degree of urbanisation page are used to inform the discussion on the "global harmonized definition of cities and settlements".



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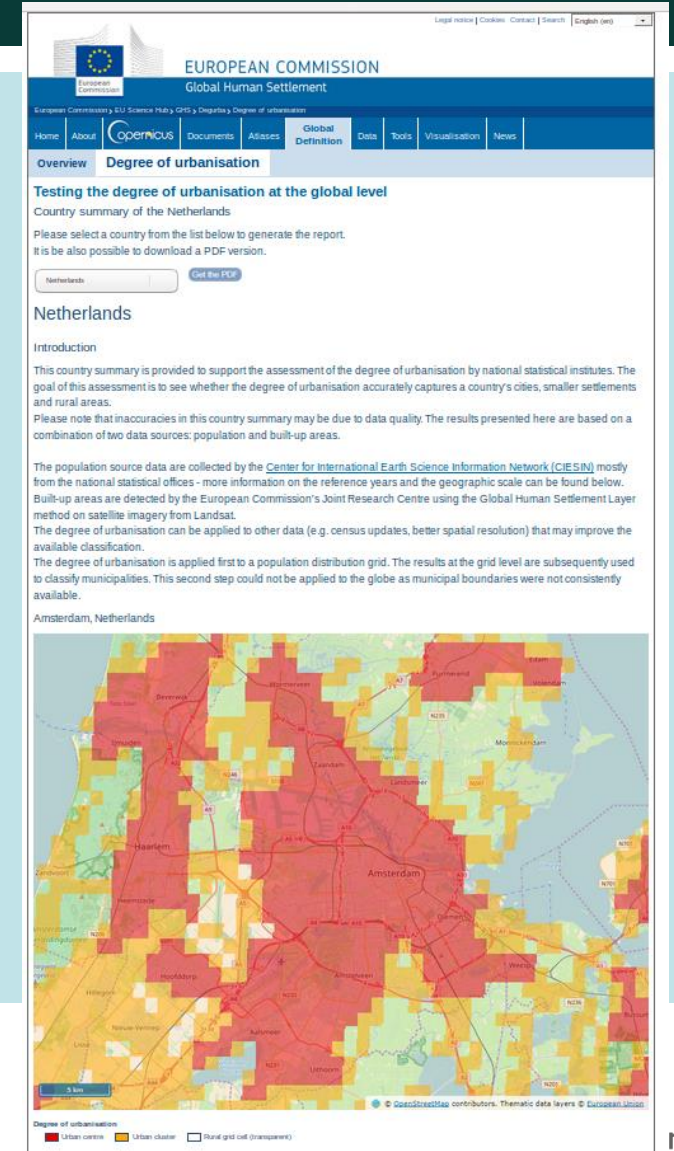
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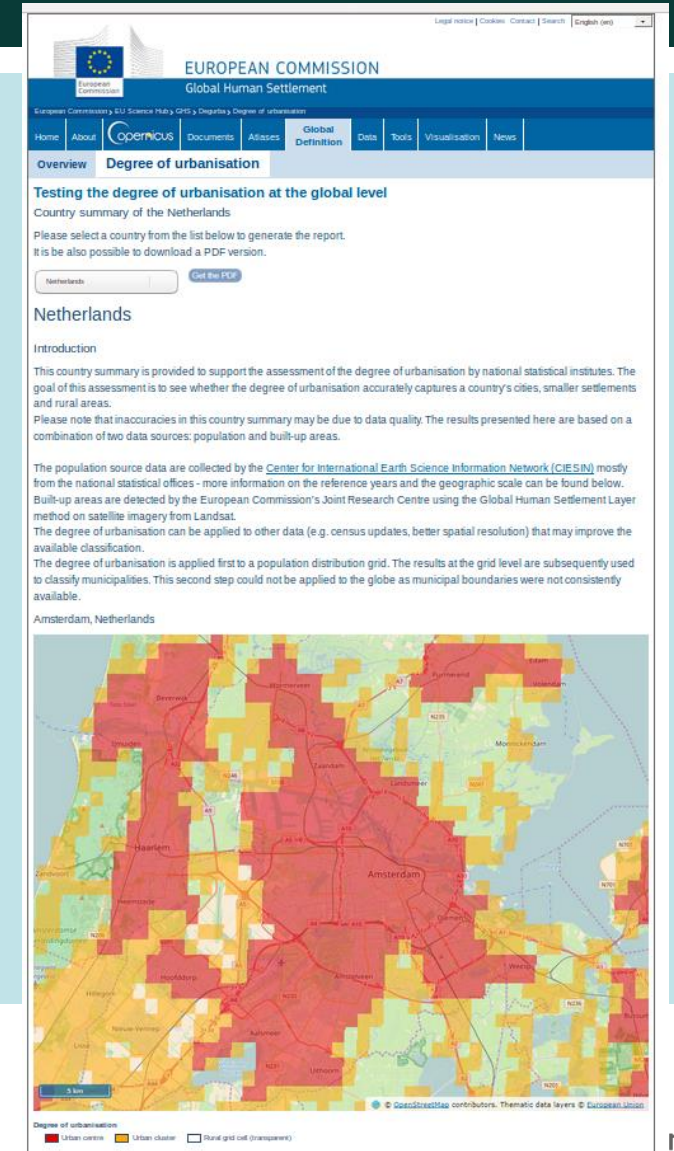
- The country fact sheets in the Degree of urbanisation page are used to inform the discussion on the "global harmonized definition of cities and settlements".
- The data supporting the new global definition of the degree of urbanisation can be visualised on this interactive map





# Global Definition of Cities and Settlements

- The country fact sheets in the Degree of urbanisation page are used to inform the Degree discussion on the "global harmonized definition of cities and settlements".
- The data supporting the new global definition of the degree of urbanisation can be visualised on this interactive map
- Degree of Urbanisation GRID (DUG) tool
  - GHSL tool suite





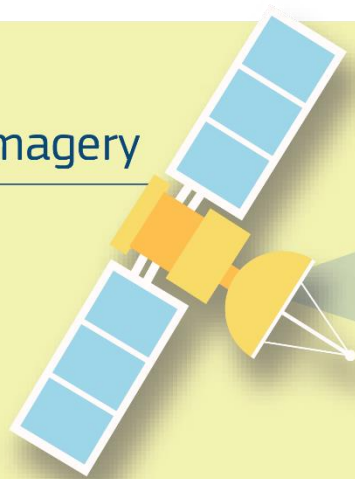


# the Global Human Settlement Layer

the most **complete**, **consistent**, **global**, **free** and **open** dataset  
on human settlements – from the village to the megacity

## Spatial info

Satellite imagery



Built-up areas

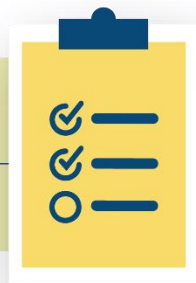


Green areas



Night lights

Census data



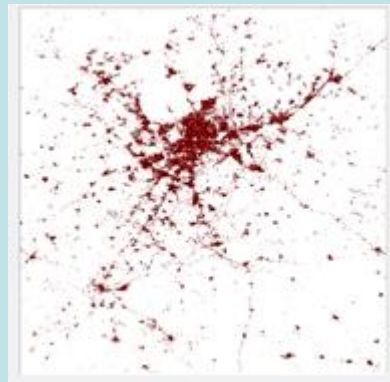
Population

# Creating a global built-up grid

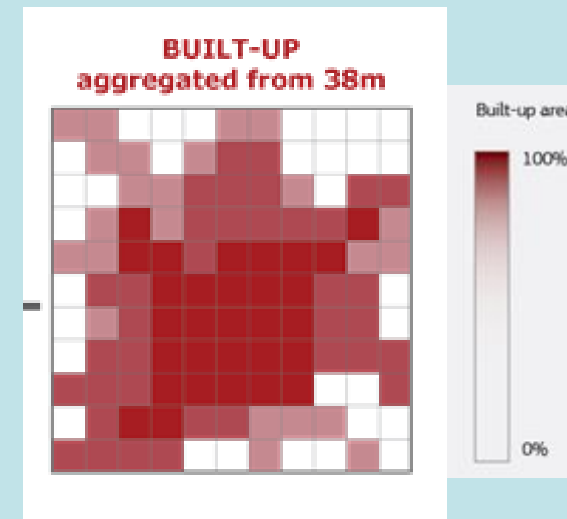
**Satellite imagery is processed to extract buildings**



**Share of area covered by buildings based on satellite imagery**

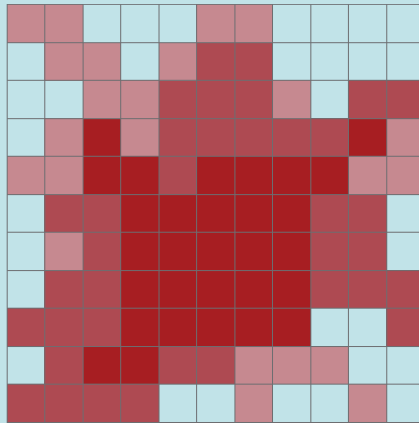


**Share of area covered by buildings aggregated to 1 km grid cells**



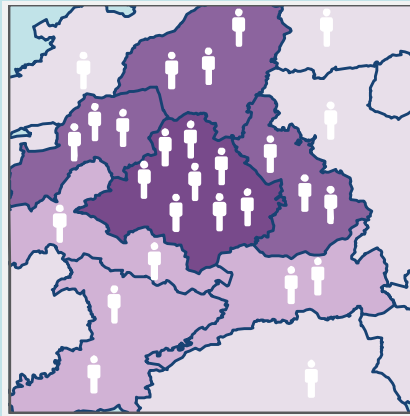
# Creating a global population grid

**Share of area  
covered by  
buildings based  
on satellite  
imagery**



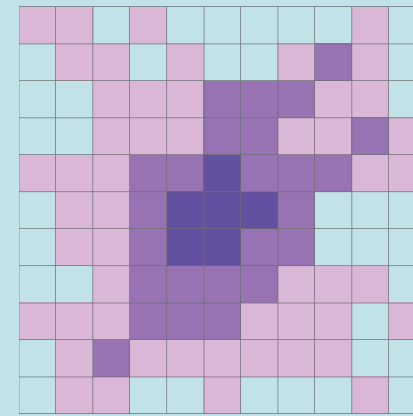
*Source: JRC GHSL*

**Census data  
on population**



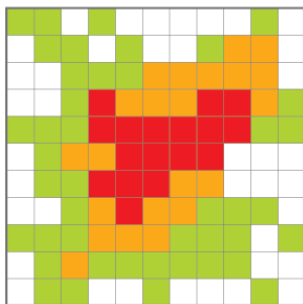
*Source: CIESIN,  
Columbia University*

**Total population  
by 1km grid cell**



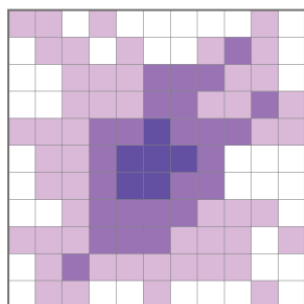
*Source: JRC GHS Pop*

S-MOD  
calculated at 1Km



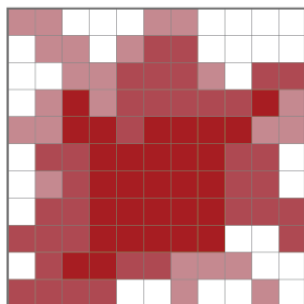
=

POPULATION GRID  
aggregated from 250m

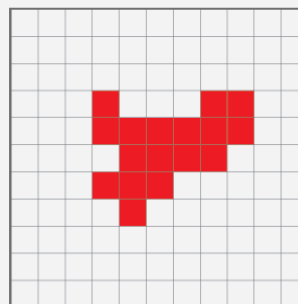


+

BUILT-UP  
aggregated from 38m

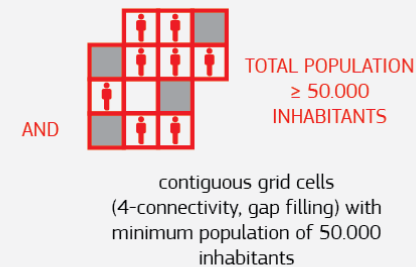
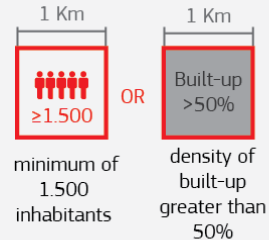


## URBAN CENTRE

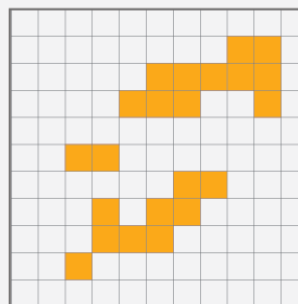


## Required conditions

### EACH GRID CELL

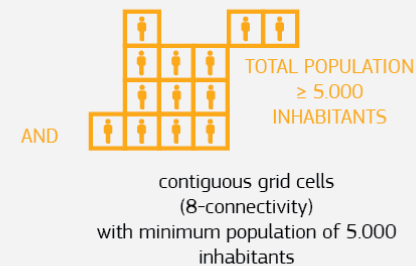
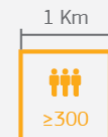


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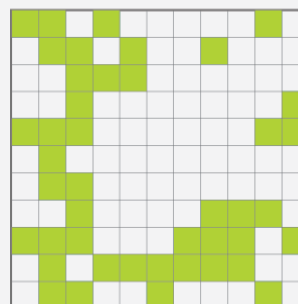


## Required conditions

### EACH GRID CELL

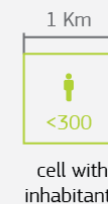


## RURAL



## Required conditions

### EACH GRID CELL

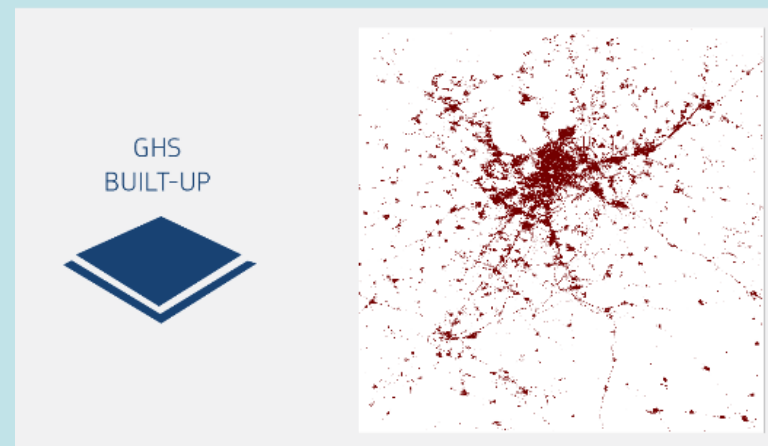


# GHSL Data production workflow

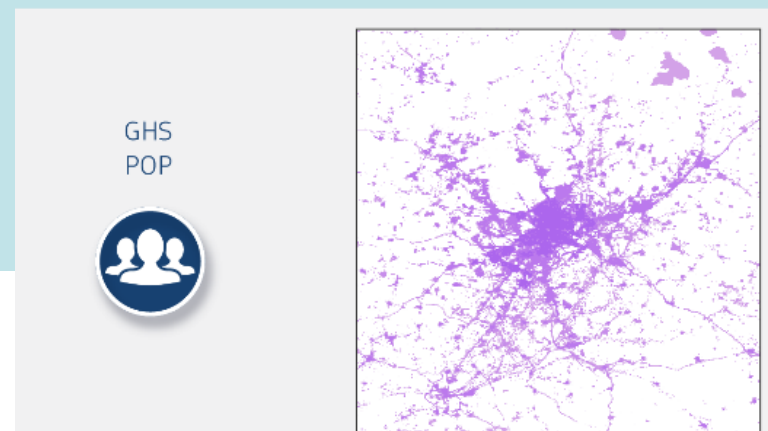
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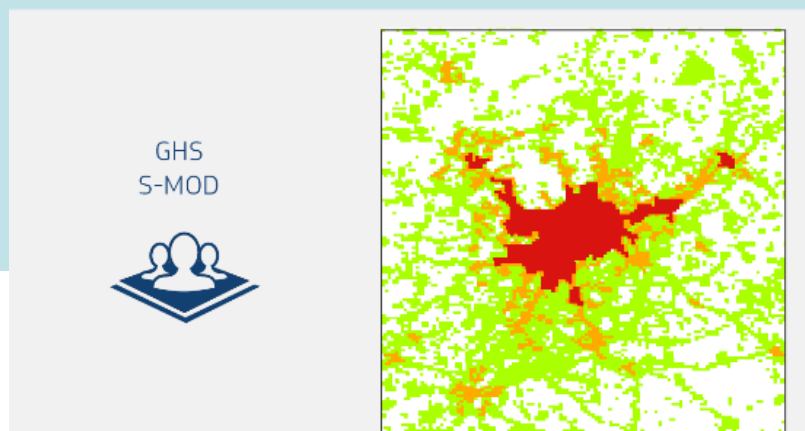
2



3

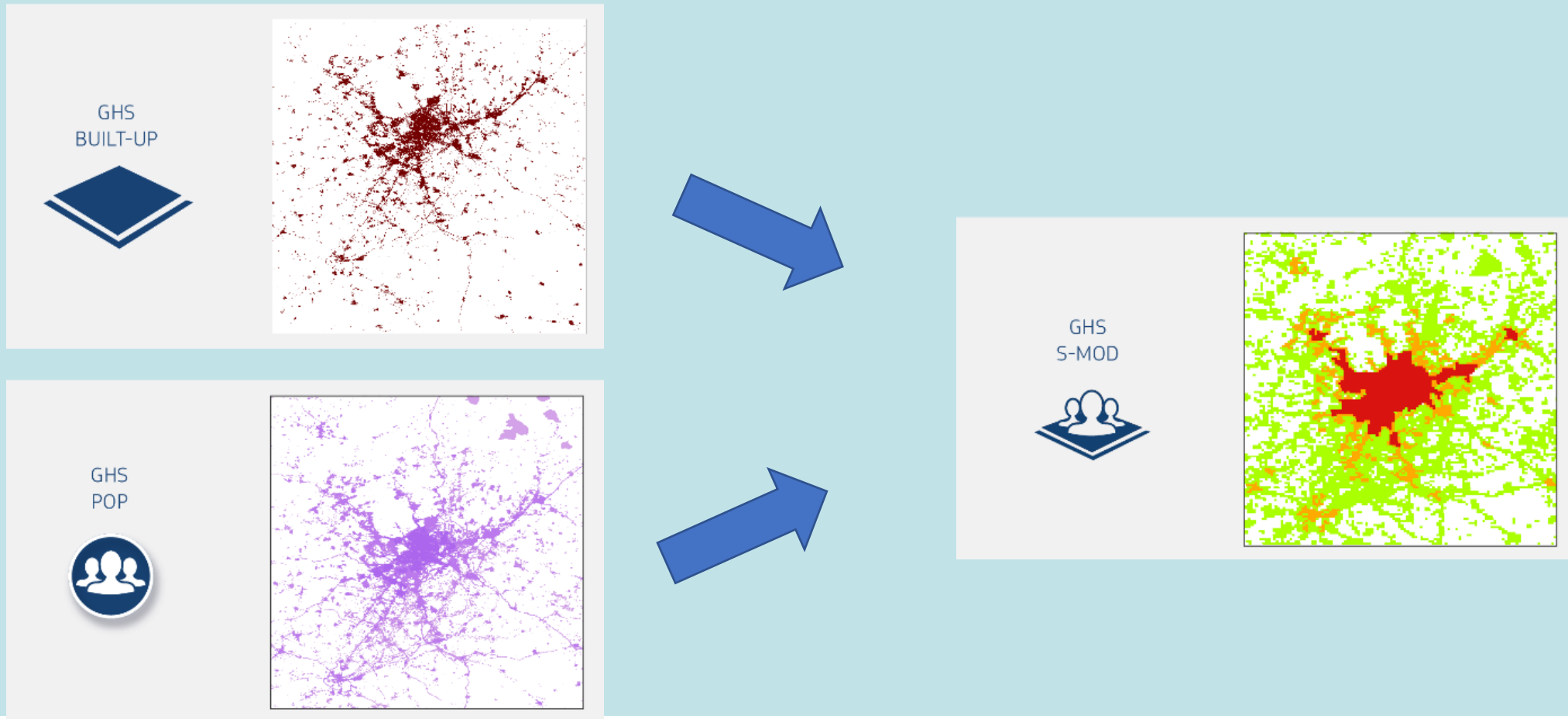


4



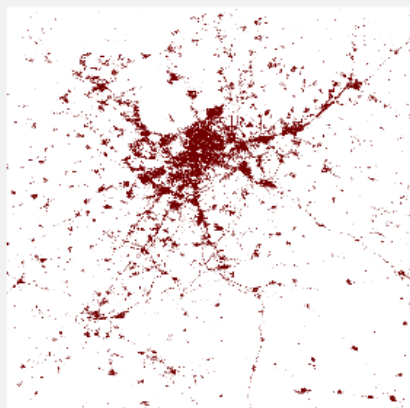


# DUG tool

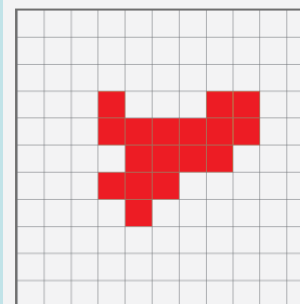


# DUG tool

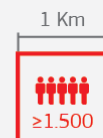
GHS  
BUILT-UP



URBAN CENTRE

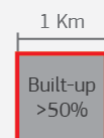


EACH GRID CELL



minimum of  
1.500  
inhabitants

OR



Built-up  
>50%  
density of  
built-up  
greater than  
50%

Required conditions

AND



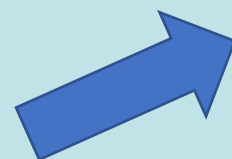
TOTAL POPULATION  
≥ 50.000  
INHABITANTS

contiguous grid cells  
(4-connectivity, gap filling)  
with minimum population of 50.000  
inhabitants

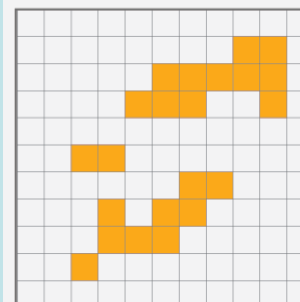
S-MOD



GHS  
POP



URBAN CLUSTER



EACH GRID CELL



minimum of  
300  
inhabitants

Required conditions

AND



TOTAL POPULATION  
≥ 5.000  
INHABITANTS

contiguous grid cells  
(8-connectivity)  
with minimum population of 5.000  
inhabitants



European  
Commission

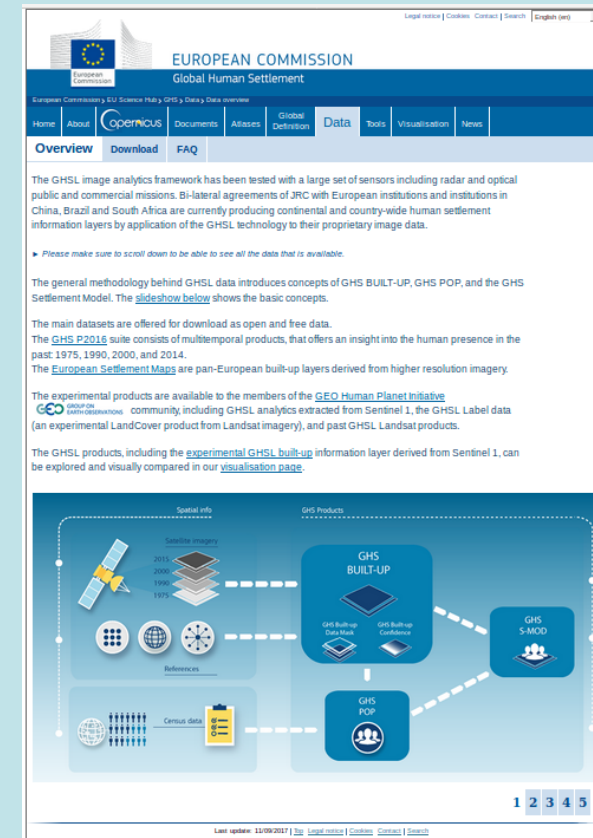
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European Commission  
Global Human Settlement

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**Overview** Degree of urbanisation

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This UN-Habitat [Global Urban Lecture](#) explains why such a definition is needed.

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The data supporting the new global definition of the degree of urbanisation can be visualised on this [interactive map](#).

Further reference

This [schema](#), extracted from the [Atlas of the Human Planet 2016 - Mapping Human Presence on Earth](#), shows the methodology used for the application of the model to the GHSL data.

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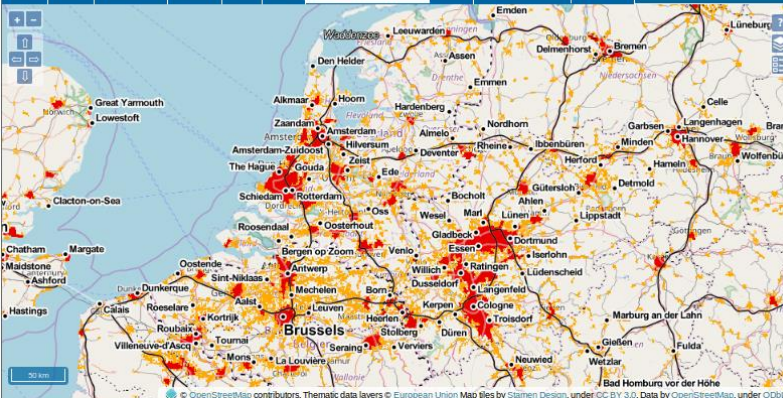
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Layers selected:

- Built-up - Sentinel-1 (resolution: approx. 20m): none
- Built-up - P2016 (resolution: approx. 38m): none
- Residential population - P2016 (resolution: 250m): none
- Degree of urbanisation\* - P2016 (resolution: 1km): SMod 2015
- Base: Marker, OSM, Place names

\*Porting of the Degurba model in the GHSL framework (SMOD).

Disclaimer:

The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the European Union concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Kosovo: This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.

Palestine: This designation shall not be construed as recognition of a State of Palestine and is without prejudice to the individual positions of the Member States on this issue.

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**Overview** Degree of urbanisation

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### AAXY - Associative Analysis between X and Y

AAXY stands for associative analysis between X and Y. The AAXY is a general tool allowing to perform associative analysis between any spatial data instances (continuous, or symbolic) X and abstract (symbolic) spatial data instances Y.

In the AAXY the analytics task is done by Symbolic Machine Learning (SML) operating on the X data instances translated to data sequences and by implementation of an objective data association interestingness measure called Evidence-based Normalized Difference Index (ENDI).

The AAXY tool is the core technology that was used to solve the problem to translate the global remote sensing data records from heterogeneous sensors available since the epoch 1975, to the abstract class of "built-up area" as required by the GHSL baseline data production.

The SML approach was introduced in [A New Method for Earth Observation Data Analytics Based on Symbolic Machine Learning](#).

The SML was demonstrated superior to the state-of-the-art machine learning approaches in remote sensing data scenarios where larger noise is present in the learning set and abstract classes are ill-defined in the feature space ([Benchmarking of the Symbolic Machine Learning classifier with state of the art image classification methods - application to remote sensing imagery](#)).

The SML is considered a suitable solution for spatial big data analytics tasks [Analyzing big remote sensing data via symbolic machine learning](#).

#### Downloads

- AAXY Tool (29.2 MB)
- End User License Agreement (181 KB)
- User Guide (1 MB)
- Tutorial (2.45 MB)
- Tutorial files (32.6 MB)

#### References

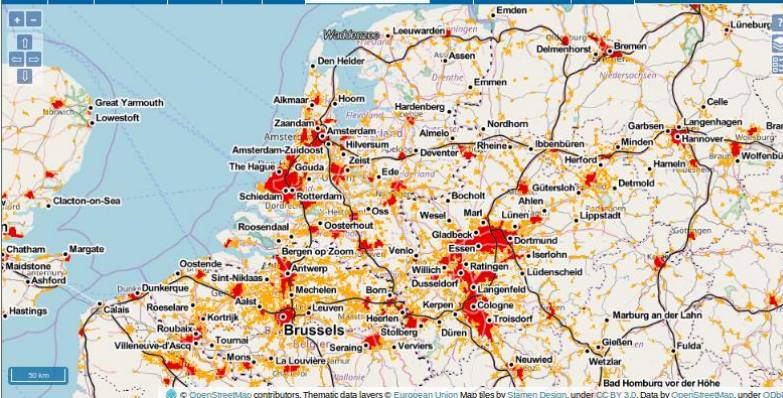
- [A New Method for Earth Observation Data Analytics Based on Symbolic Machine Learning](#)
- [Analyzing big remote sensing data via symbolic machine learning](#)
- [Benchmarking of the Symbolic Machine Learning classifier with state of the art image classification methods - application to remote sensing imagery](#)
- [Operating procedure for the production of the Global Human Settlement Layer from Landsat data of the epochs 1975, 1990, 2000, and 2014](#)

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Layers selected:

- Built-up - Sentinel-1 (resolution: approx. 20m): none
- Built-up - P2016 (resolution: approx. 38m): none
- Residential population - P2016 (resolution: 250m): none
- Degree of urbanisation\* - P2016 (resolution: 1km): SMod 2015
- Base: Marker, OSM, Place names
- \*Porting of the Degurba model in the GHSL framework (SMOD).

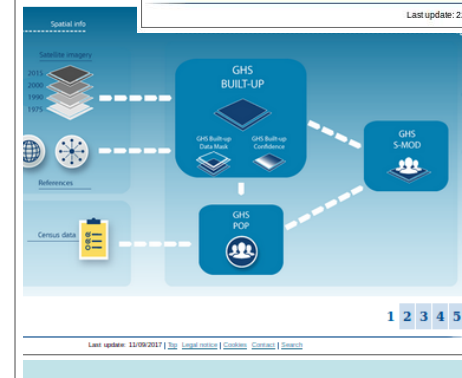
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# Any questions?

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