



ISTAMBUL
April 22, 11-12.30 pm

Global Urban Data Initiative
Global Urban and DRM Unit

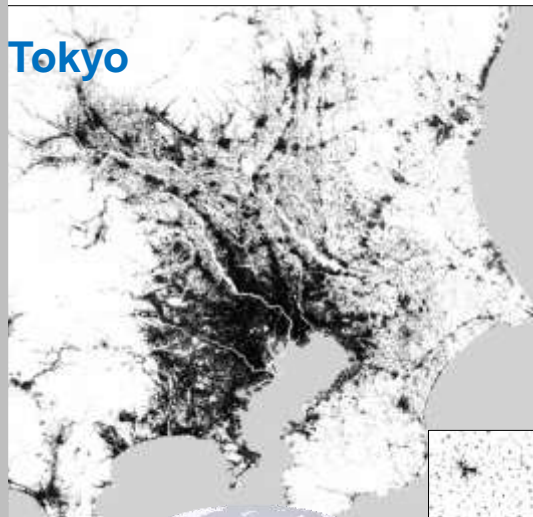
LEARN ABOUT:

- Data Access through PUMA Portal and ESA Urban Thematic Exploitation Platform (TEP)
- Urban mapping technical specifications

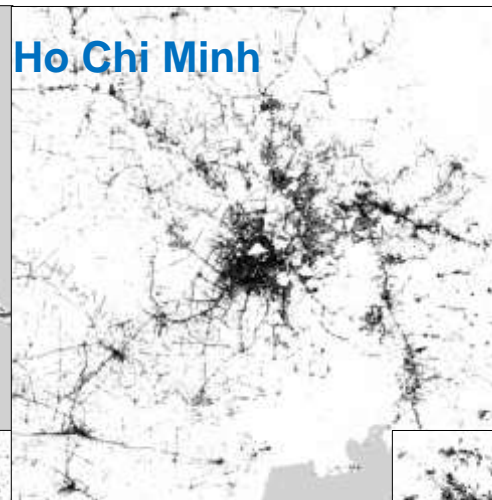
DISCUSS your data needs

DISCOVER possibilities to collaborate with technical partners and data developers

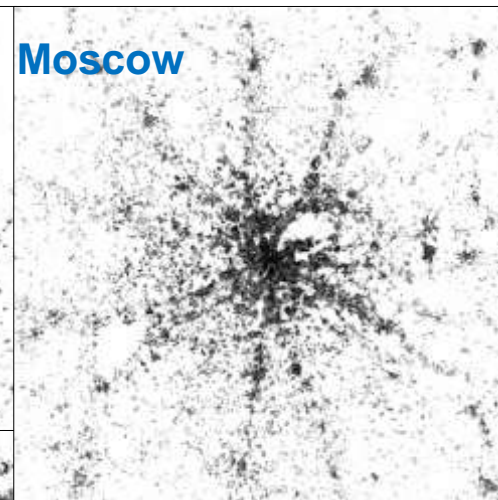
Tokyo



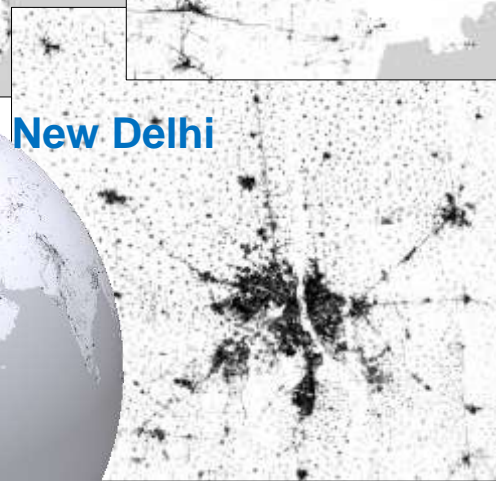
Ho Chi Minh



Moscow



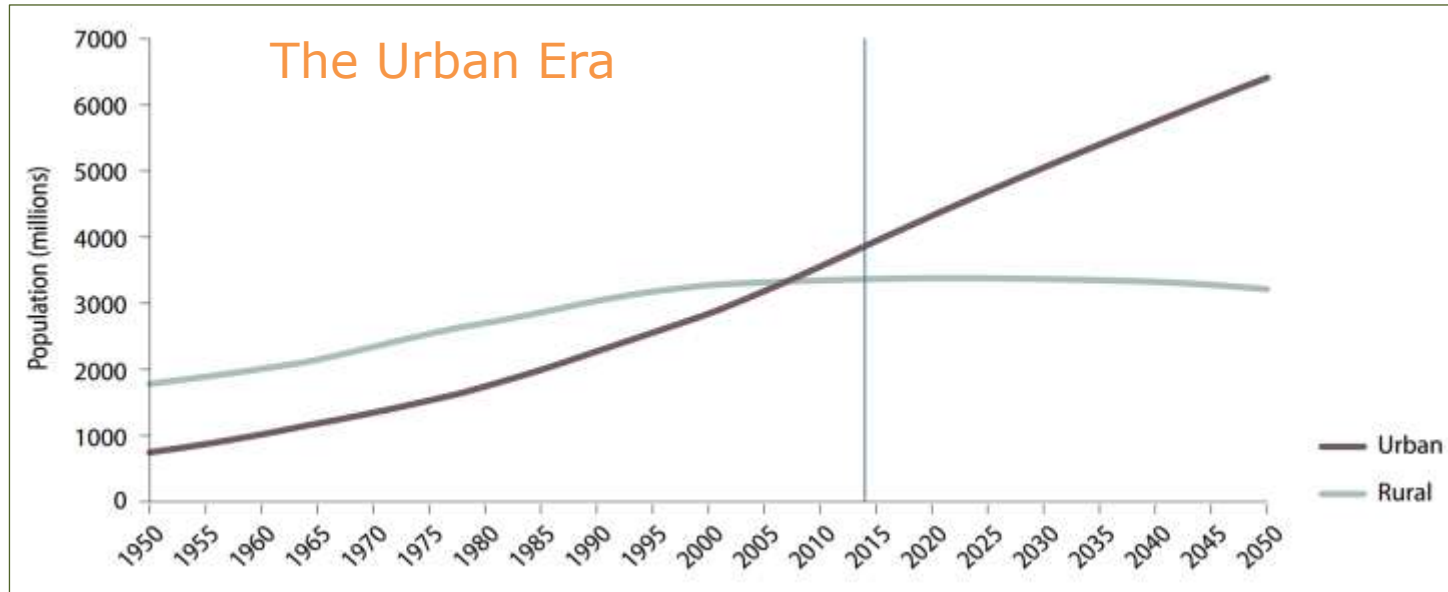
New Delhi



Sao Paulo



Urbanization and sustainable development



Source: United Nations Department of Economic and Social Affairs/Population Division 5. World Urbanization Prospects The 2014 Revision.

In future, urban areas will account for:

- 90% of population growth,
- 80% of increased prosperity ,
- 60% of energy consumption.

Measuring Urban Growth

- At present there is no global source of information to consistently and reliably monitor urban expansion and population change
 - Wide variety of inconsistent methods in the past resulted in estimations of urban land cover between 0.2 to 3% of land mass
 - Existing sources of data are not comparable because countries define urban extents differently
 - Redefinition of areas from rural to urban frequently lacks actual change in land use and population density

Measuring Urban Growth

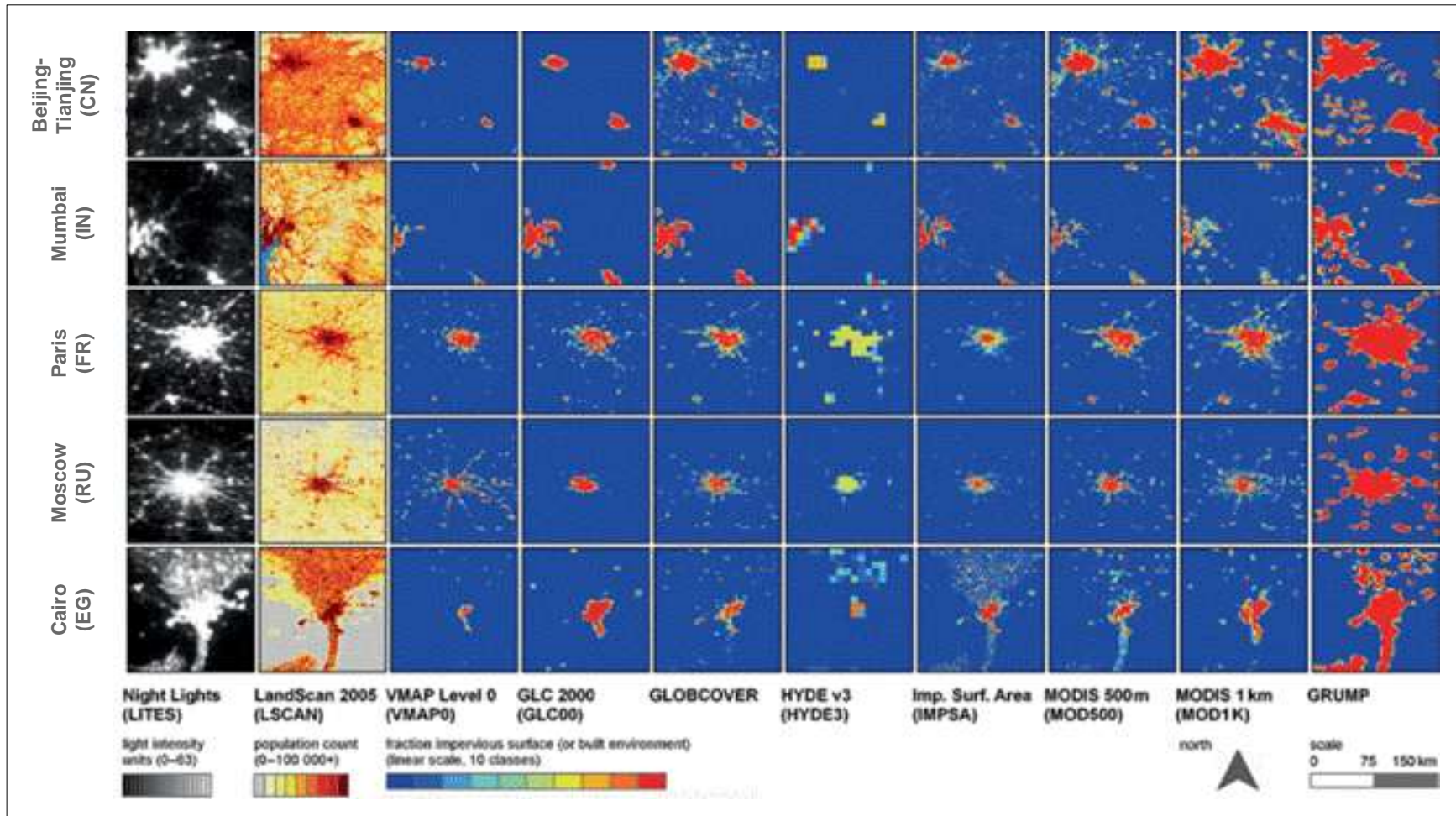
Human Settlements layers

Ongoing efforts worldwide indicate a global demand

- Global Rural-Urban Mapping Project
 - Nightlights and ~1km resolution – Lower resolution
 - 1990, 1995, 2000
 - Sample of cities
- Global Urban Expansion Atlas/”Solly Angel” (200 cities, 1990, 2000, 2013)
- European Commission / OECD
 - Europe + some of the OECD countries
- World Bank Regional Urbanization Reviews East Asia using MODIS 500(250m) and South Asia using nightlights
- Global Human settlements Layer (JRC / EC) (currently in process)
- Urban Land C 2000 and Urban Expansion 2000-2010 – University of Wisconsin, Madison
 - Now extended to cover the world at 250 m spatial resolution
- NOAA’s Nightlights Data
- ASTER Global Urban Area map, AGURAM
- And others....

Measuring Urban Growth

Currently available Global Human Settlements layers



Measuring Urban Growth

Currently available global Human Settlements layers

- In the last decade several **Global Human Settlements Layers (GHSL)** have been produced to map human settlements worldwide.

NASA MODIS 500 (493 m spatial resolution) and **ESA GlobCover 2009** (309 m spatial resolution)



Key Policy Questions:

- How are cities changing over time?
- How much, and in what proportion of uses, is land being consumed for urban development?
- Where are the areas with the most significant land use change?
- What are the drivers of urban and other land development, and what new infrastructure will be needed to support this development?
- What are the possible effects of natural disasters and climate change, and how much of the population and assets will be affected?

Key Data Needs:

- Detailed observation and monitoring
- Moving from Observing and Monitoring to the evaluation of the effectiveness of policy options and modeling
 - Ie. urban growth scenarios, extent/proximity of green urban areas, accessibility, urban heat islands, etc.
 - integration of geographic and statistical information into toolsets and models

Objective: Improved spatial planning based on the high quality and accurate data

Fundamental needs identified:

- Free or low cost data
- Better *resolution** & *accuracy** of measurements
- *Fast** and *operational** monitoring system to offset the limitations of the existing estimations such as:
 - variability of methodologies and mapping results,
 - their low spatial resolution (250m-2km), and
 - low frequency of updates.

Resolution: different urban scales: regional (250m-80m) / city level (30 m/10m/5m)

Accuracy: 75-90% , in situ data for validation is key

Fast: possibilities of updates every **3-5 years** on the regional level and every **1 year** on the national level

Operational: not R&D! based on the validated algorithms (automated) with quarantined long term (20+ years) data availability

Free or low cost data: EMODIS (NASA, free), Envisat (ESA, free), ERS (ESA, free), Landsat (NASA, free), Sentinels (ESA, free)

Resolution: different urban scales: regional (250m-80m) / city level (30 m/10m/5m)

Accuracy: 75-90% , in situ data for validation is key

Fast: decadal is a minimum but true need is in possibilities of updates every **3-5 years** on the regional level and every **1 year** on the national level

Operational: not R&D! based on the validated algorithms, automated system (cf. fast) with quarantined long term (20+ years) input data availability, ability to integrate different sources of data (EO and non EO)

Free or low cost data:

1km-10 m - **Open & Free** (Landsat, Sentinels)

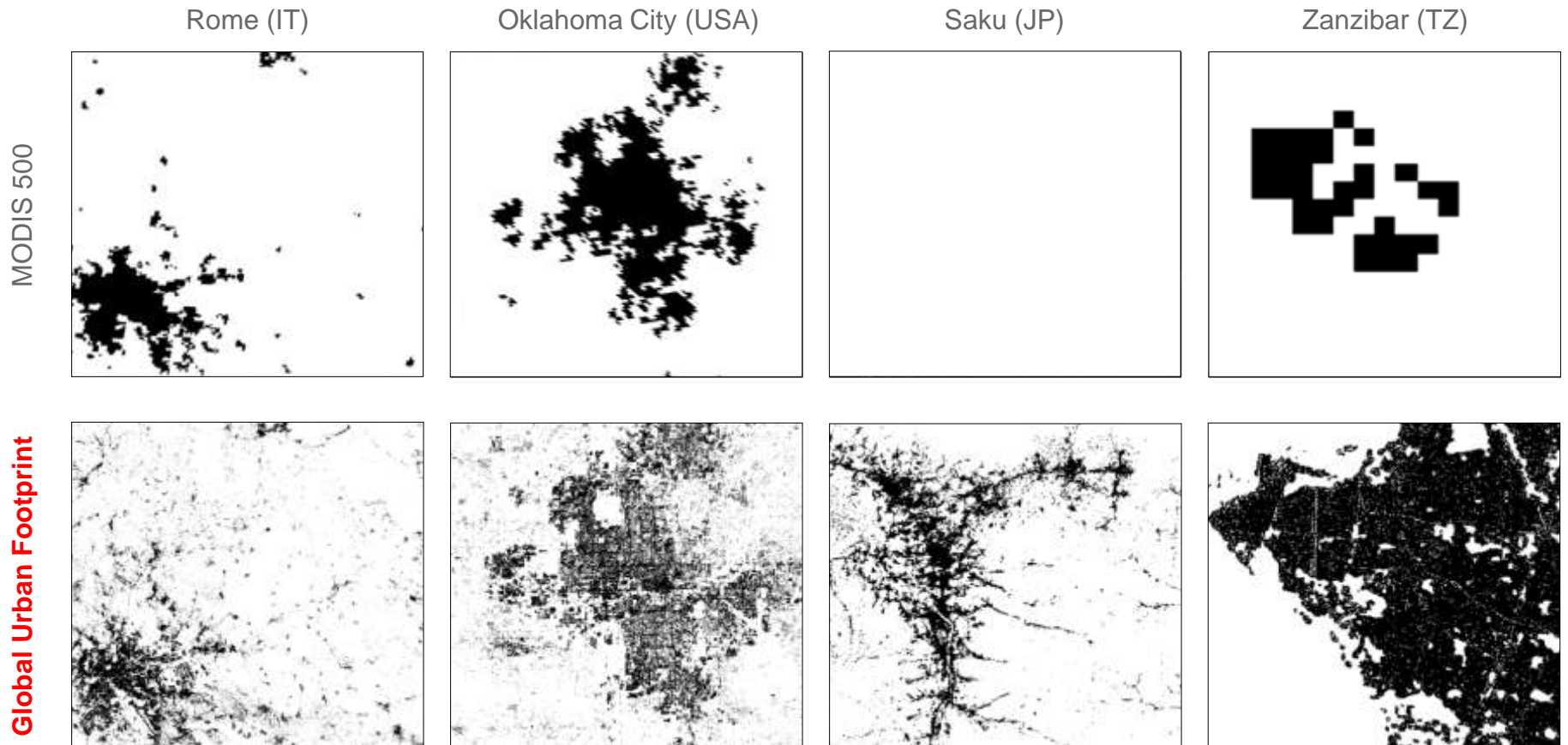
INFORMATION !

10-2,5m – Low cost, 1\$ sq km(high value) (SPOT, RapidEye, DMC, IRS, CBRES, ..., ...)

<1m – At cost, cost vary (high value) (WorldView, Pleiades, Kompsat, ...,...)

**Monitoring of human
settlements required a
breakthrough
in observational capacity
& analytic tools**

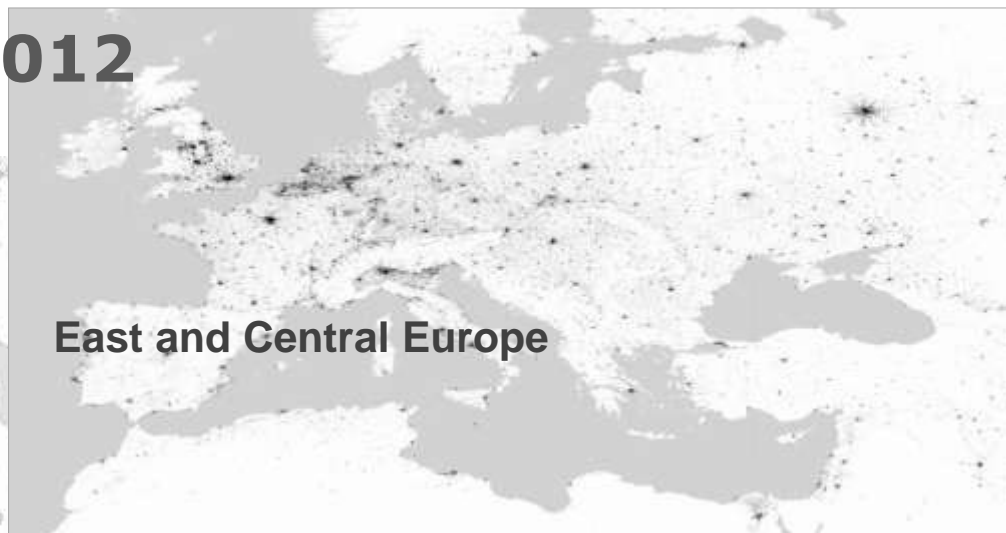
Global Urban Footprint vs. MODIS 500



Credit: DLR/German Space Agency Global Urban Footprint, Satellite data: TerraSarX/TandemX mission

Global Coverage 2011/2012

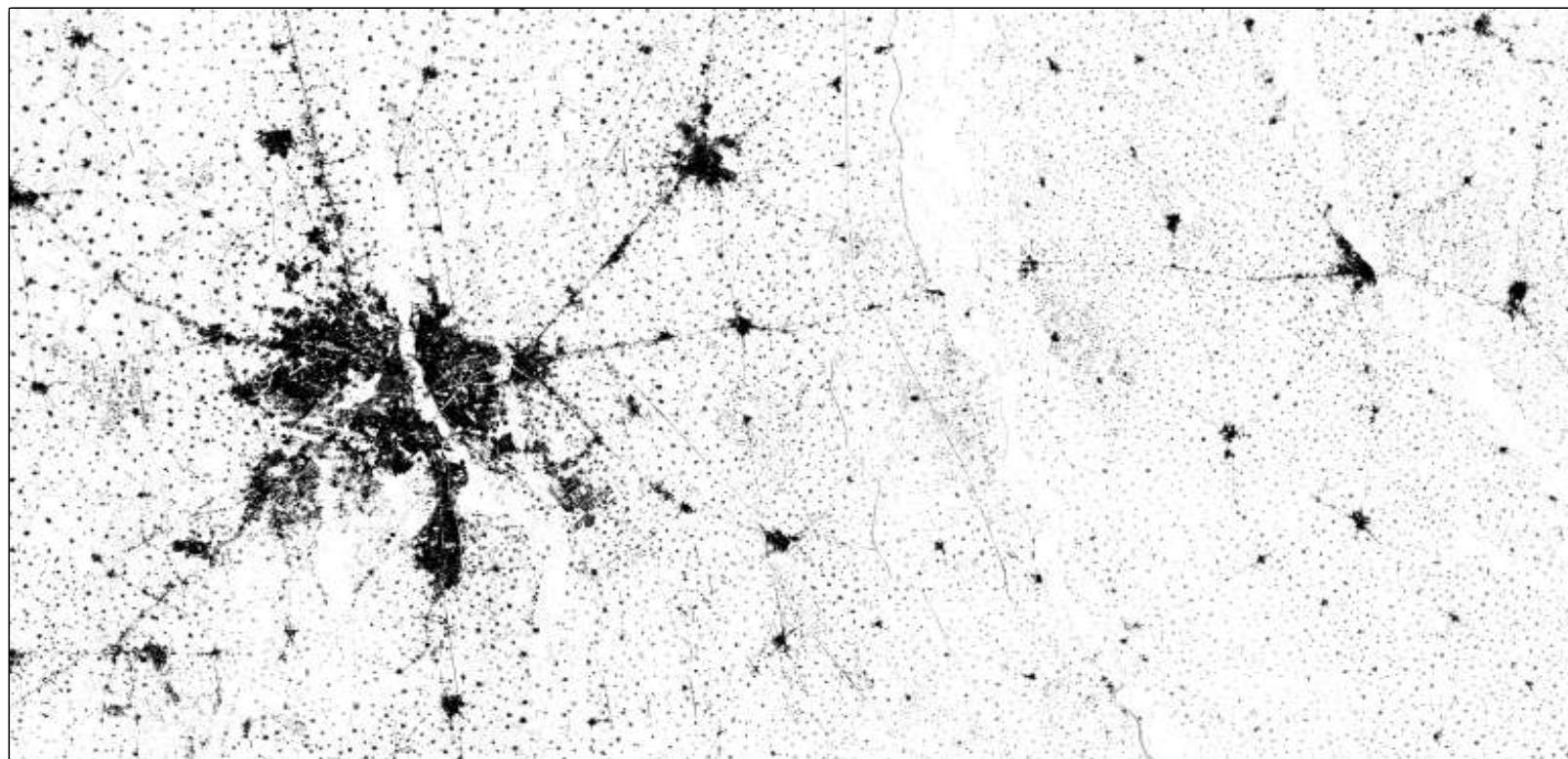
Baseline data



Credit: DLR/German Space Agency Global Urban Footprint, Satellite data: TerraSarX/TandemX mission

Global Coverage 2011/2012

Baseline data – New Delhi, India



original backscattering amplitude

extracted speckle divergence

Global Urban Footprint

New Delhi Area: **88 images (~90,000 km²)**

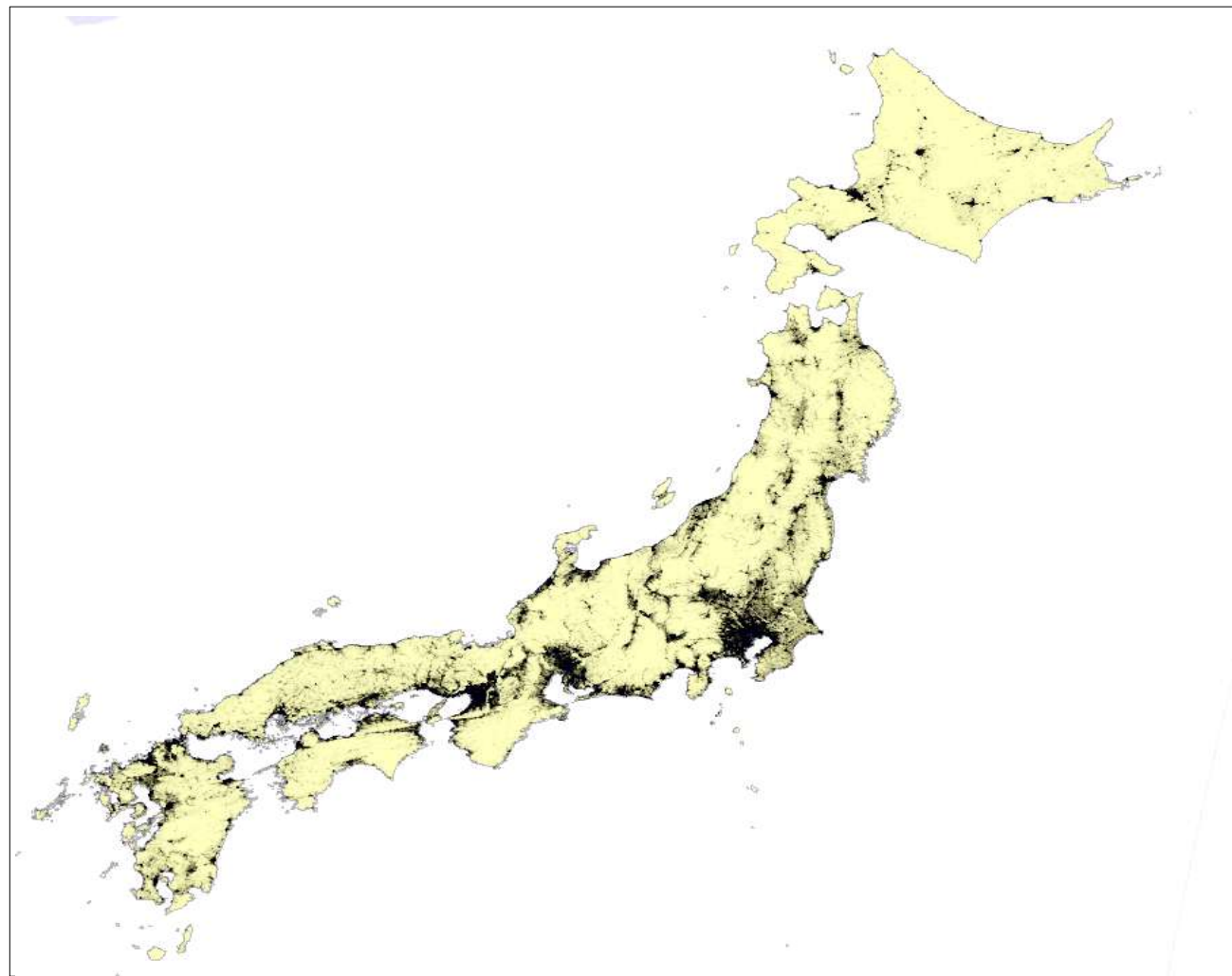
Validation (evaluated over 2000 randomly distributed samples): **OA% 86.6, Kappa 0.73**

Credit: DLR/German Space Agency Global Urban Footprint, Satellite data: TerraSarX/TandemX mission

Global Coverage 2011/2012

Baseline data – National Demonstrator - Japan

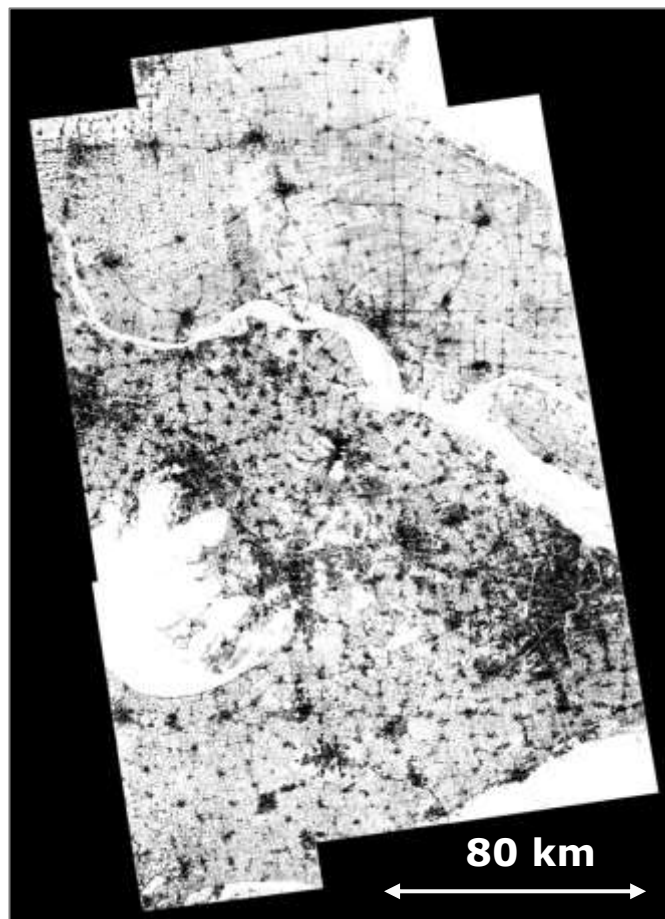
Japan: ~800 images



Credit: DLR/German Space Agency Global Urban Footprint, Satellite data: TerraSarX/TandemX mission

Global Coverage 2011/2012

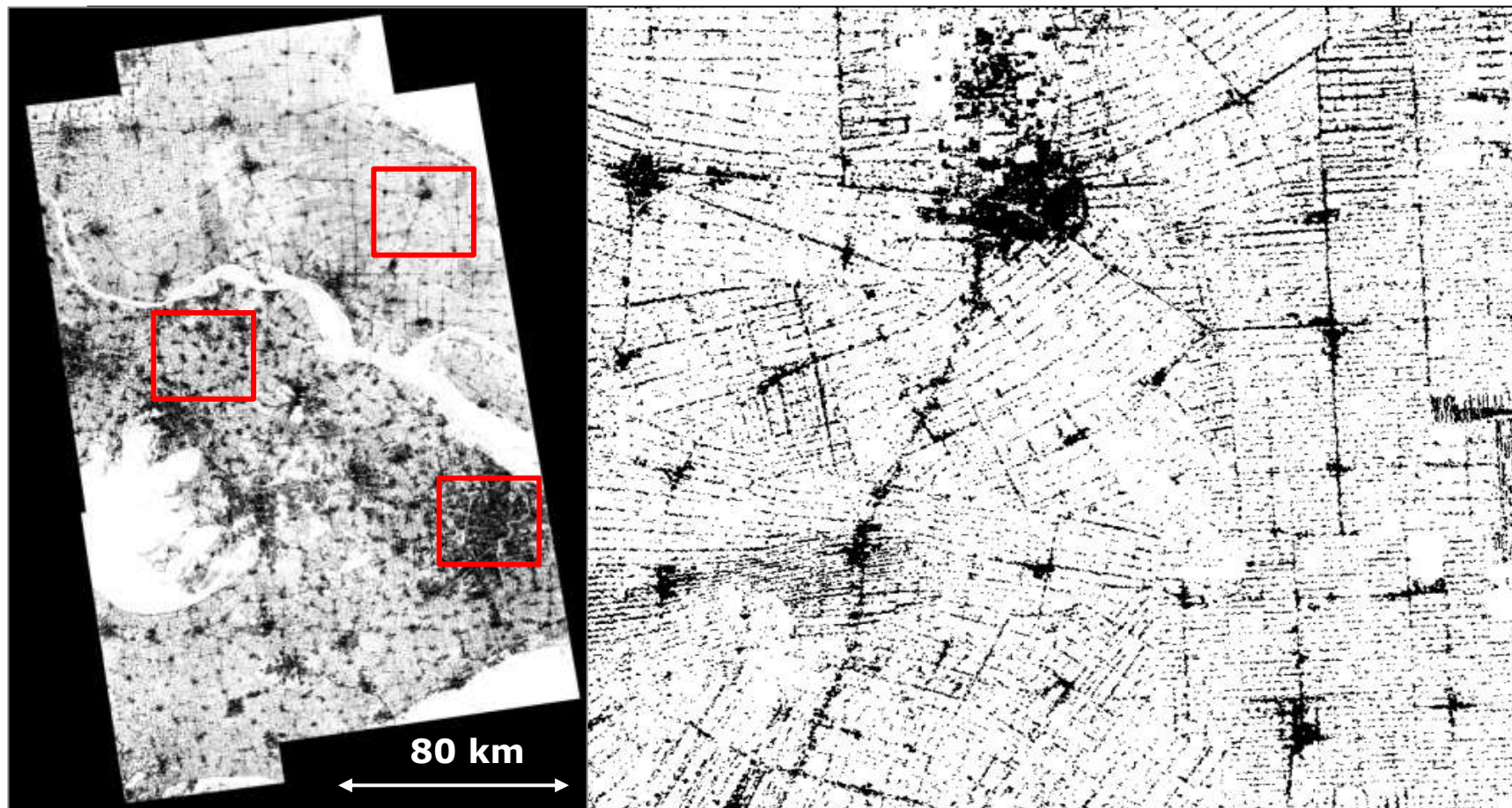
Baseline data – Shanghai, China



Credit: DLR/German Space Agency Global Urban Footprint, Satellite data: TerraSarX/TandemX mission

Global Coverage 2011/2012

Baseline data – Shanghai, China



Urban Footprint

Credit: DLR/German Space Agency Global Urban Footprint, Satellite data: TerraSarX/TandemX mission

Global Coverage 2011/2012

Historical data

Urban spatio-temporal development based on historical optical (Landsat MSS, TM and ETM+) and SAR (ERS, ASAR) data + Global Urban Footprint.

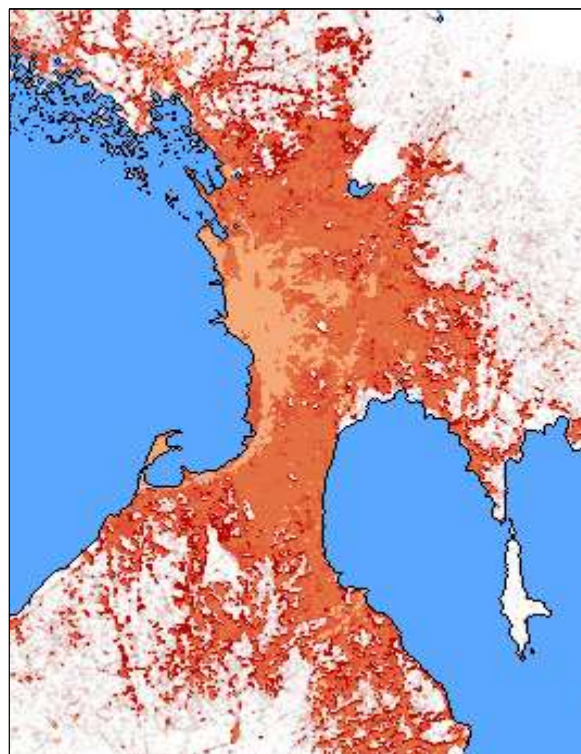
Manila
(Philippines)

2010

2000

1990

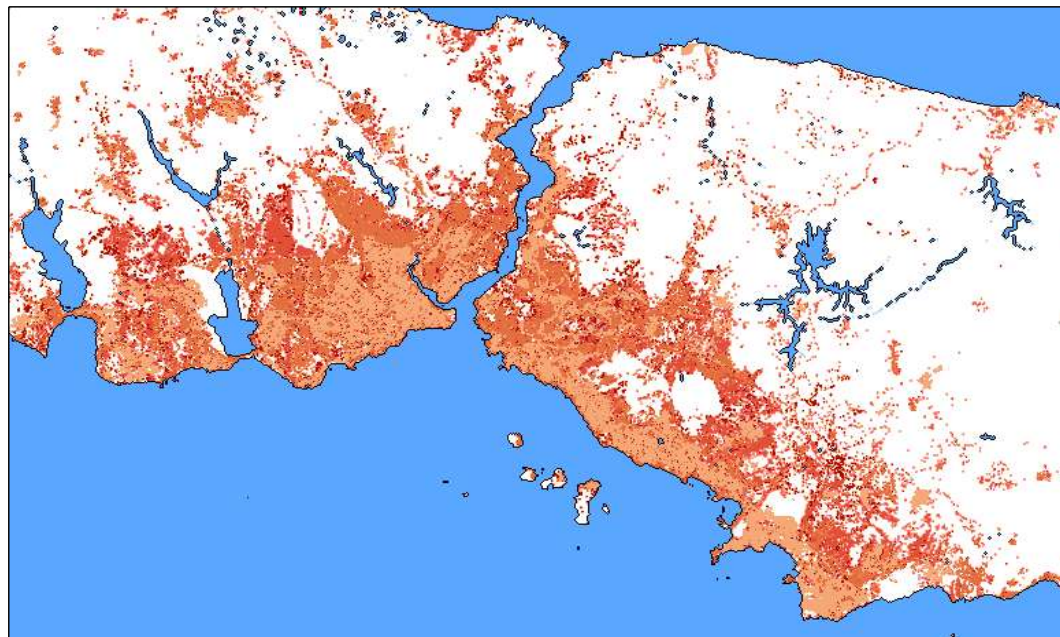
1975



Credit: DLR/German Space Agency, Satellite data: TerraSarX/TandemX mission, Landsat, ERS, Envisat

Global Coverage 2011/2012

Historical data



1975

1990

2000

2010

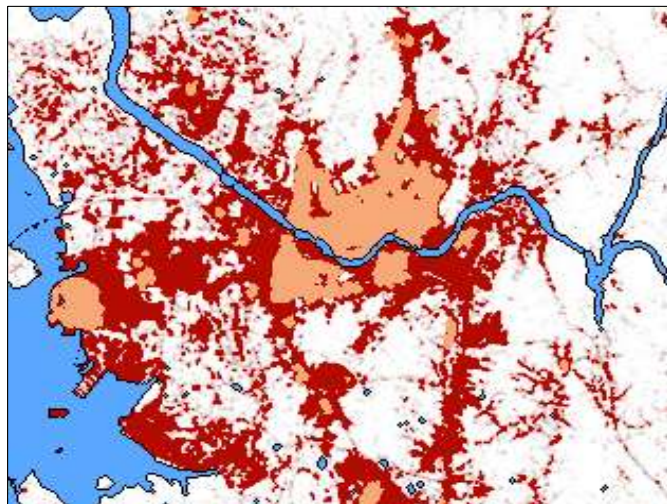
Istanbul (Turkey)



Global Coverage 2011/2012

Historical data

Seoul (South Korea)

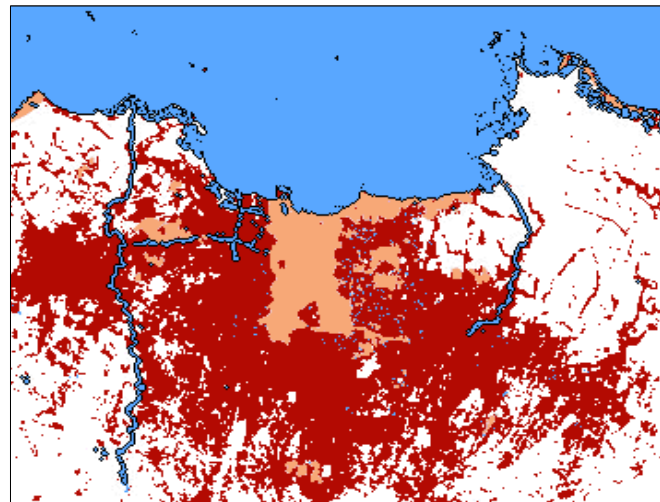


1975



2010

Jakarta (Indonesia)





WORLD BANK GROUP



2014 ESA Innovators Project led by DLR

Phase 1 (2015-2016) :

- i) **the past urban extent ([2002-2003](#)) with ASAR WSM data for East Africa;**
 - 75m spatial resolution built-up extent
 - It includes entire **Uganda, Rwanda, Burundi and Kenya** in addition to big parts of **Somalia, Ethiopia, South Sudan and Zambia**
- ii) **the current urban extent for [Addis Ababa, Dar es Salaam and Nairobi](#) from Sentinel-1 IW GRDH data acquired in [2014-2015](#).**

Phase 2 (2016-2017):

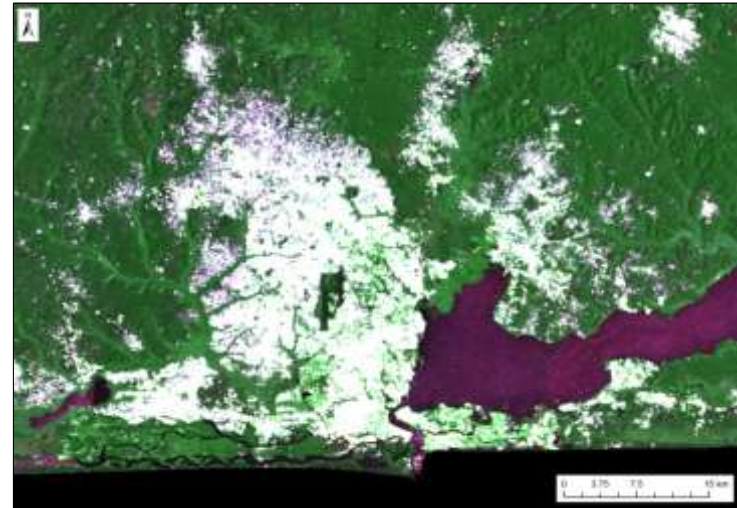
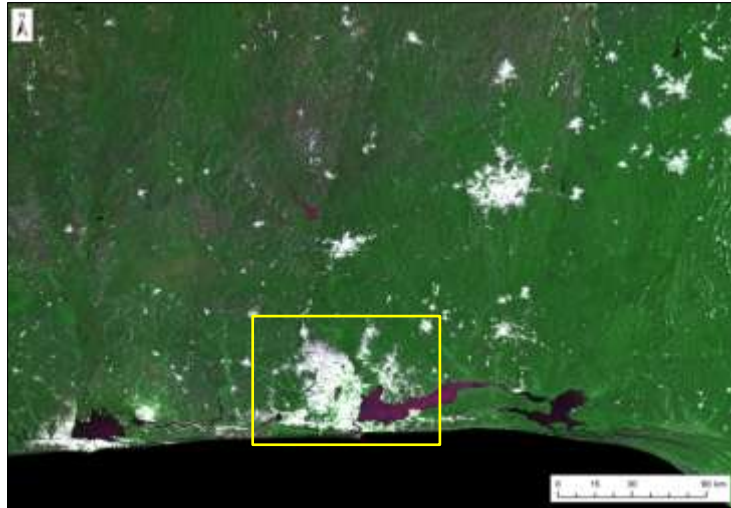
- i) **the past urban extent ([2002-2003](#)) with ASAR WSM data of the remaining part of the [African continent](#);**

- ii) **the current urban extent for [Kigali](#) and [entire Uganda](#) (including [Kampala](#)) from Sentinel-1 IW GRDH data acquired in [2014-2016](#)** European Space Agency

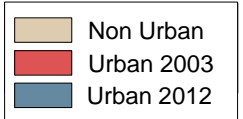
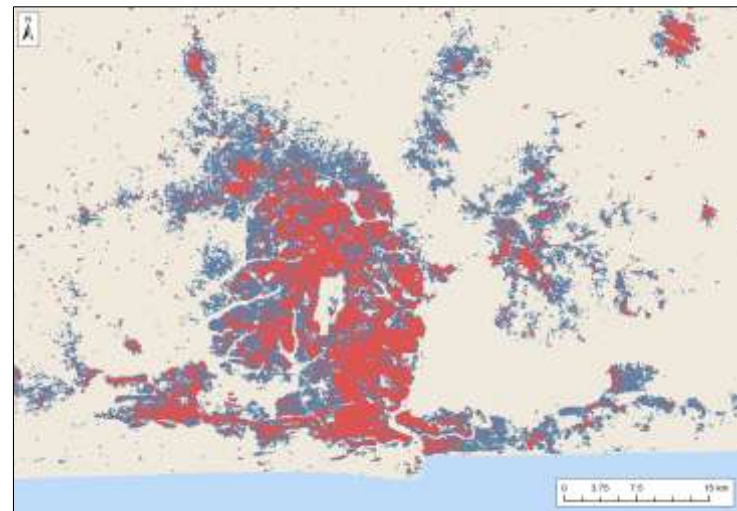
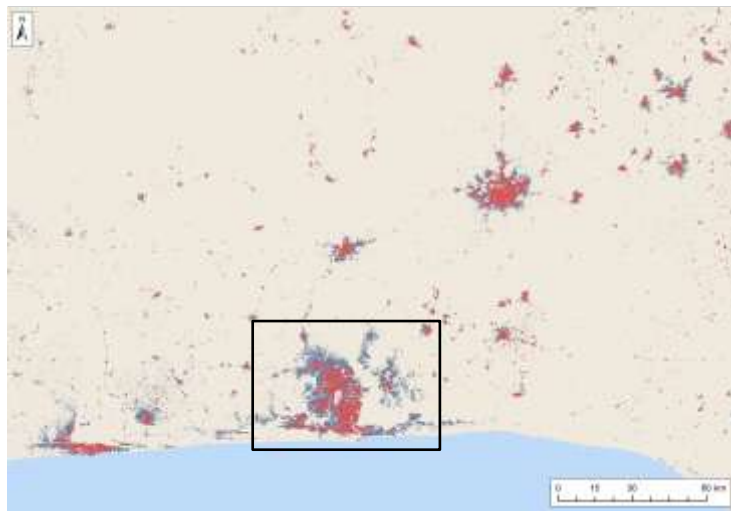
Benin



Nigeria



Lagos



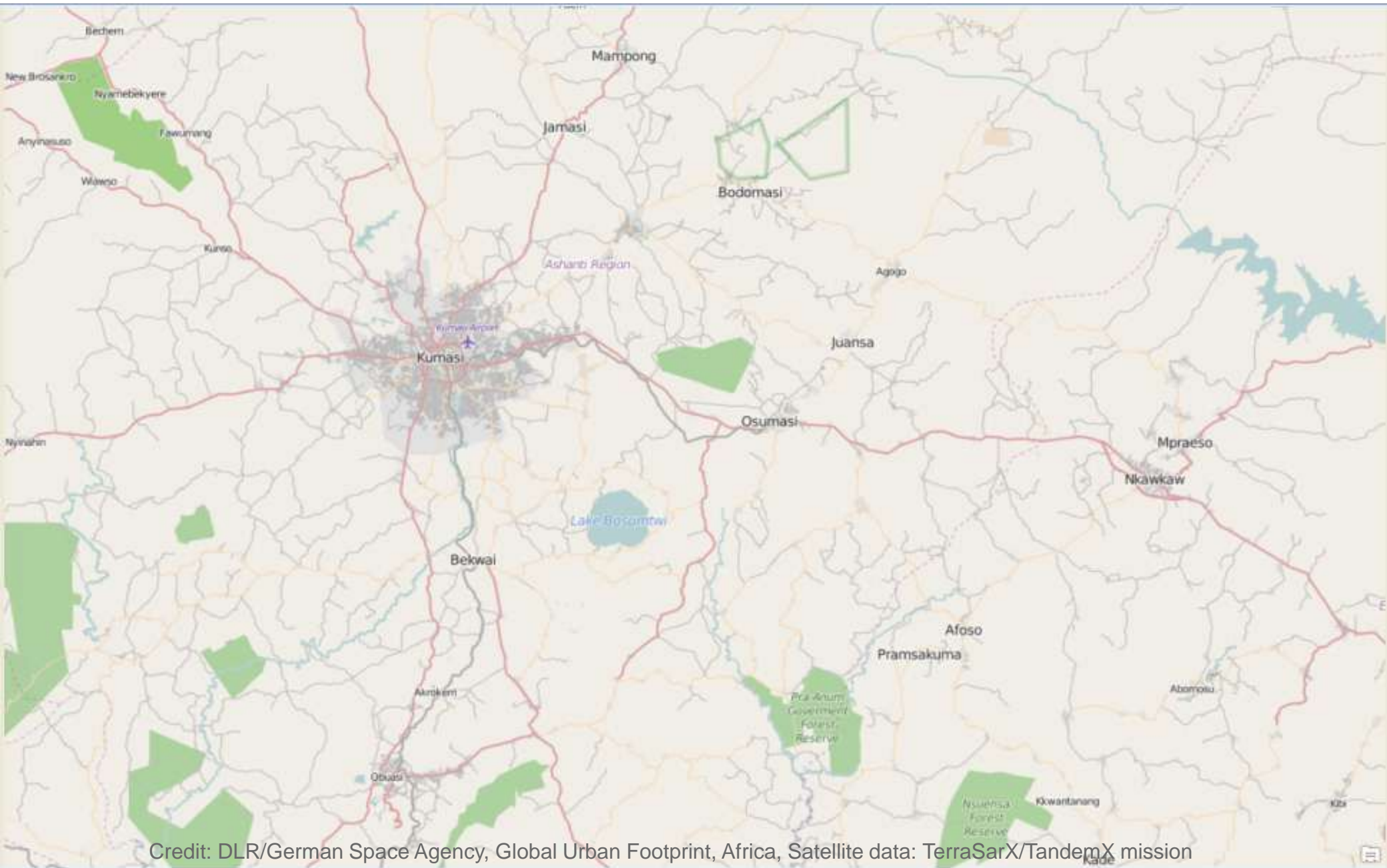
Credit: DLR/German Space Agency, Satellite data: TerraSarX/TandemX mission, Landsat, ERS, Envisat



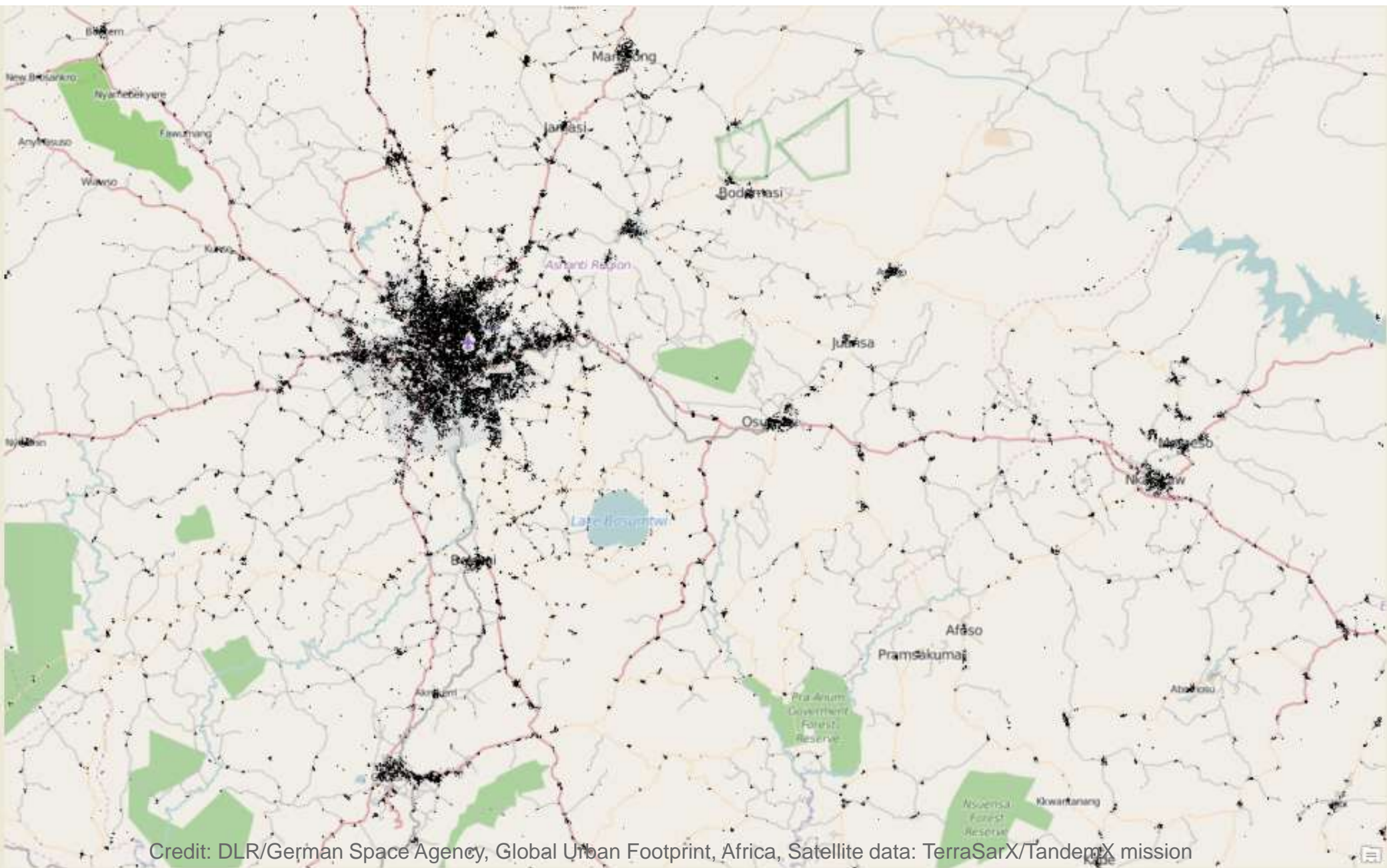
Credit: DLR/German Space Agency, Area of Interest in East Africa

World Bank	Data Type	Spatial Resolution	Data Temporal Range	Area of Interest
Phase 1 (01.04.2015 - 31.03.2016)	ASAR WSM	75m	2002-2003	East Africa
	Sentinel-1 IW GRDH	10m	2014-2015	Addis Ababa Dar Es Salaam Nairobi
Phase 2 (01.04.2016 – 31.03.2017)	ASAR WSM	75m	2002-2003	remaining part of the African continent
	Sentinel-1 IW GRDH	10m	2014-2016	Kigali Uganda (Addis Ababa) (Dar Es Salaam) (Nairobi)

Credit: DLR/German Space Agency



Credit: DLR/German Space Agency, Global Urban Footprint, Africa, Satellite data: TerraSarX/TandemX mission



Credit: DLR/German Space Agency, Global Urban Footprint, Africa, Satellite data: TerraSarX/TandemX mission

ESA Urban Thematic Exploitation Platform (Urban TEP)



IT4I

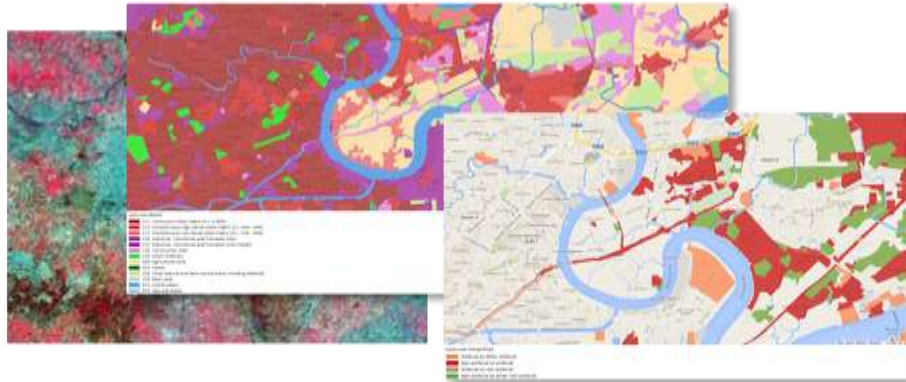


- Primary thematic fields of application for urban TEP
 - Global monitoring, analyses and products.
 - On-demand hot spot observations.
 - Comparative and historical studies.
 - Establishment of long-term urban observations.
- Key characteristics of urban TEP
 - Free and open use of state-of-the art infrastructure, algorithms and products.
 - Efficient exploitation of available data streams and archives (i.a., EO-based).
 - Use of high-performance computing and data management infrastructure.
 - Advanced analysis , data fusion and visualisation capabilities.
 - Validated and benchmarked techniques and products.
 - Profit from network of experts and best practice applications.
 - Functionalities for quick implementation and conversion of innovations and customized adaptations into services.



ESA Urban Thematic Exploitation Platform (Urban TEP)

From complex data...



Change Matrix 2005 [ha]

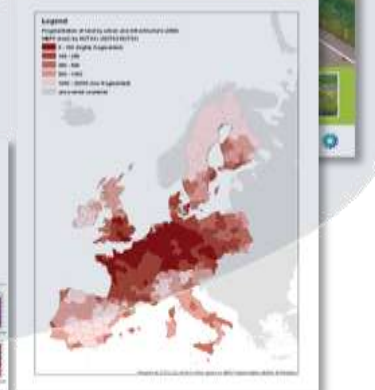
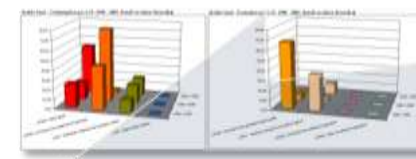
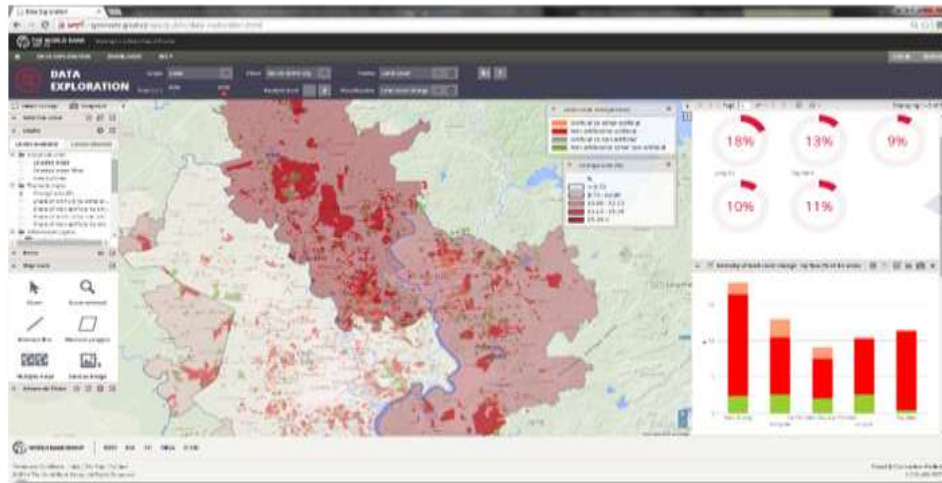
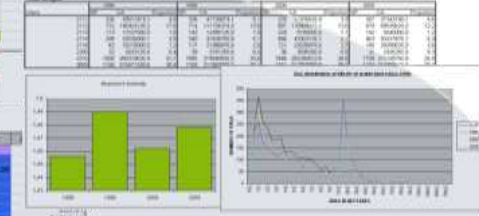
COG	1000	2111	2112	2113	2114	2115	2100	2110	2102	5100	SUM AREA_HA
1000	1000										8075.00
2111	1.25	308.00	1207.44	73.88	461.89	387.44		1134.75	0.31		2965.10
2112	7.75	1780.01	3777.06	361.91	1585.19	854.31		5043.13	32.00	0.00	14000.13
2113	6.88	308.13	342.51	182.00	181.30	105.25	6.28	317.89	0.99		1273.06
2114	16.38	271.68	1306.25	119.01	540.30	270.11	39.81	733.25	6.13		3073.34
2115	0.13	46.19	309.38	13.06	152.31	152.46		294.19	0.25		1000.00
2100	0.31	23.15	18.25					1.80			43.51
2110	88.00	1052.34	2032.44	582.63	1323.00	414.60	2.44	3772.10	155.75		12688.38
5100	89.00	6.38	26.50	1.44	2.63	1.19	0.00	343.31	2688.38	18.34	3239.94
SUM	8811.38	6043.38	10714.81	1185.23	4033.19	2101.28	215.11	25020.58	29469.10	58.44	80751.00

Stock 1990
 Population (x)
 Consumption (x)
 Net change
 Stock 1995

Change Matrix & LC Flow, 1990 / 1995

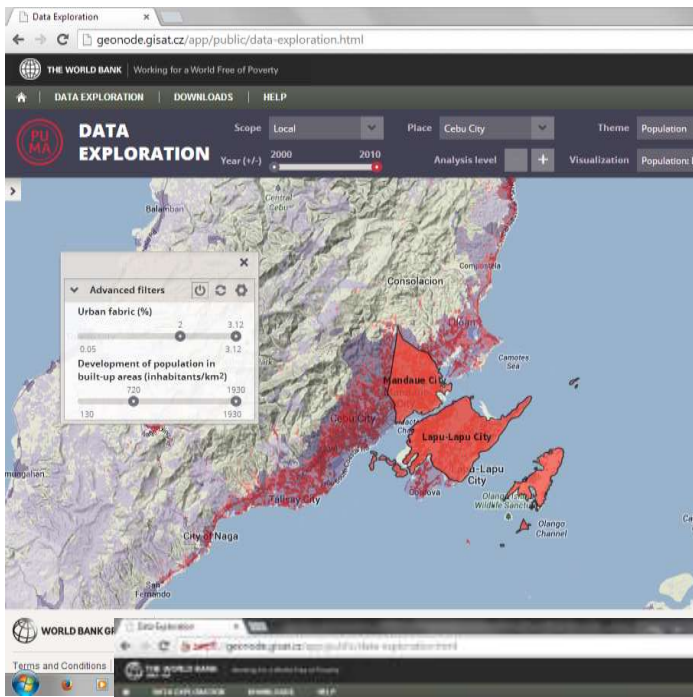
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1000	1000								
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2100	0.31	23.15	18.25					1.80	
2110	88.00	1052.34	2032.44	582.63	1323.00	414.60	2.44	3772.10	155.75
5100	89.00	6.38	26.50	1.44	2.63	1.19	0.00	343.31	2688.38
SUM	8811.38	6043.38	10714.81	1185.23	4033.19	2101.28	215.11	25020.58	29469.10

Stock 1990
 Population (x)
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 Net change
 Stock 1995



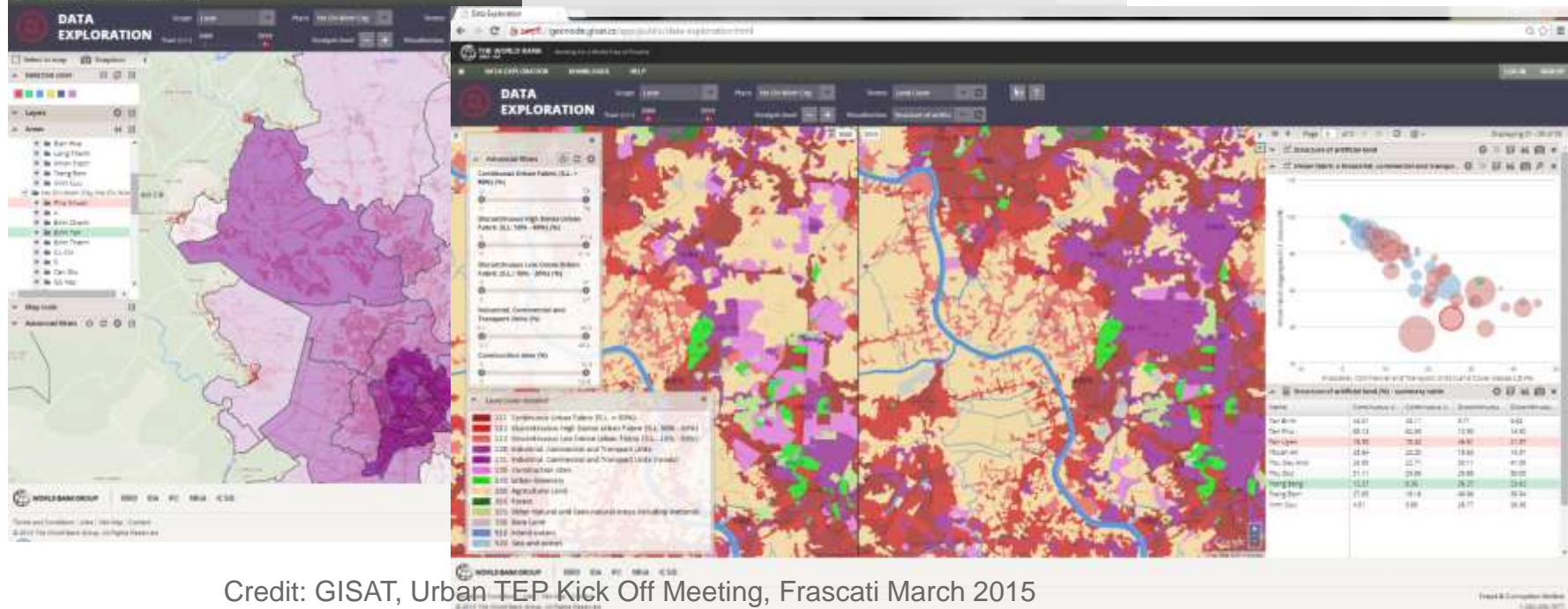
...into smart information

Credit: GISAT, Urban TEP Kick Off Meeting, Frascati March 2015



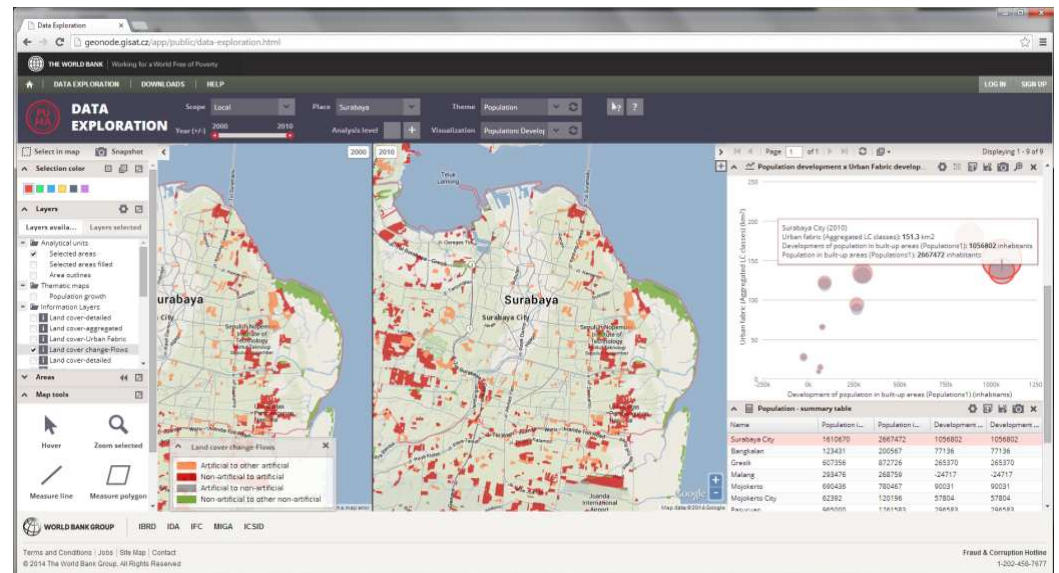
Back-end

- On-demand computation capabilities - modeling, what if support
- More power, more scalability – both for computation, and access demand
- Through sandboxes/parallel (cloud) computing
- More data - open data access
 - EO data and services (Copernicus, Landsat8) catalogues
 - open data using OpenLinkedData approaches (RDF, SPARC/STRABON) MELODIES



ESA Urban Thematic Exploitation Platform (Urban TEP)

- Multi-scale approach needed reflecting various scales of urban structures for information support.
- User communities on all levels:
 - Global
 - Regional
 - National
 - Local



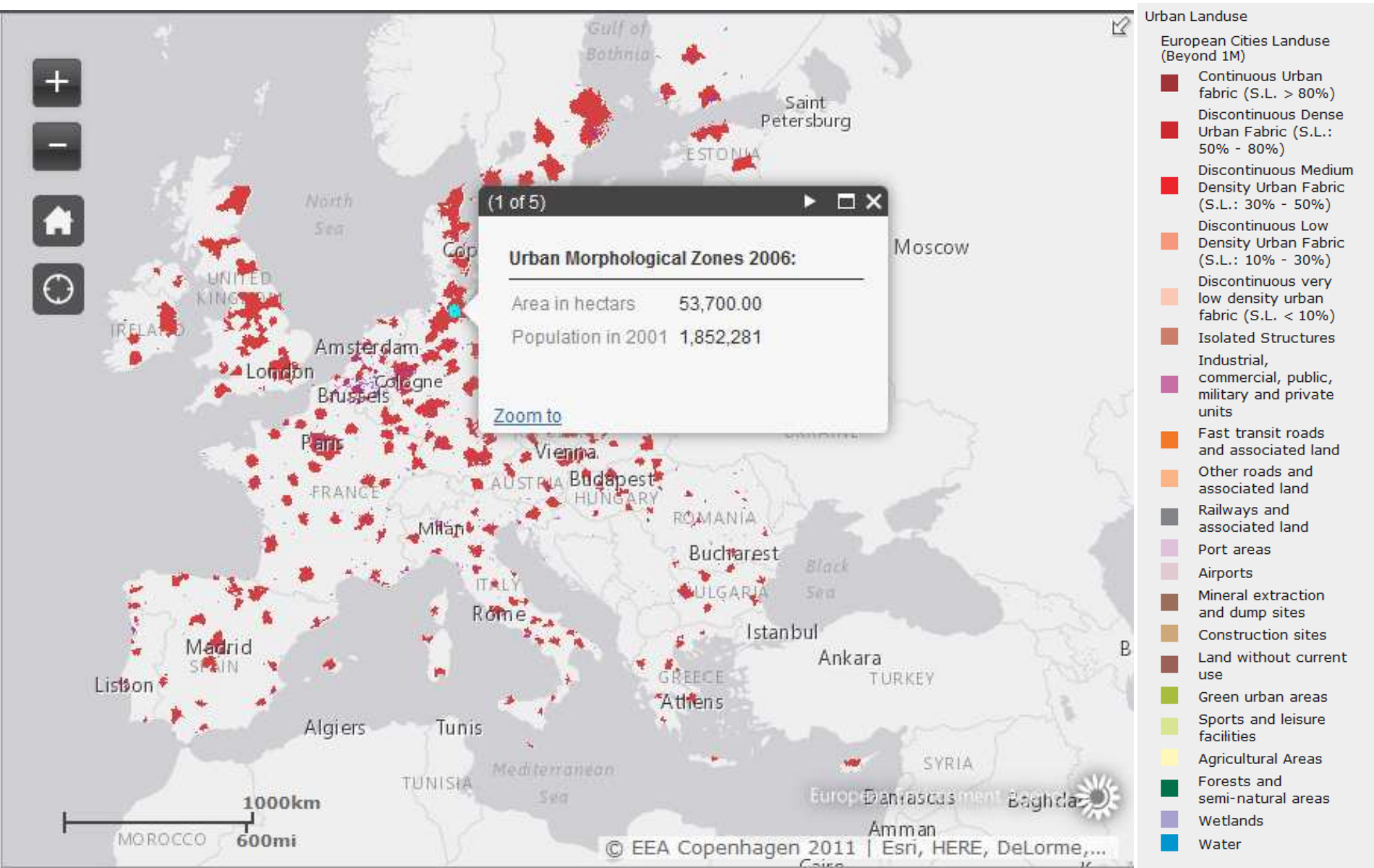
Example of regional / local dataset

European Urban Atlas



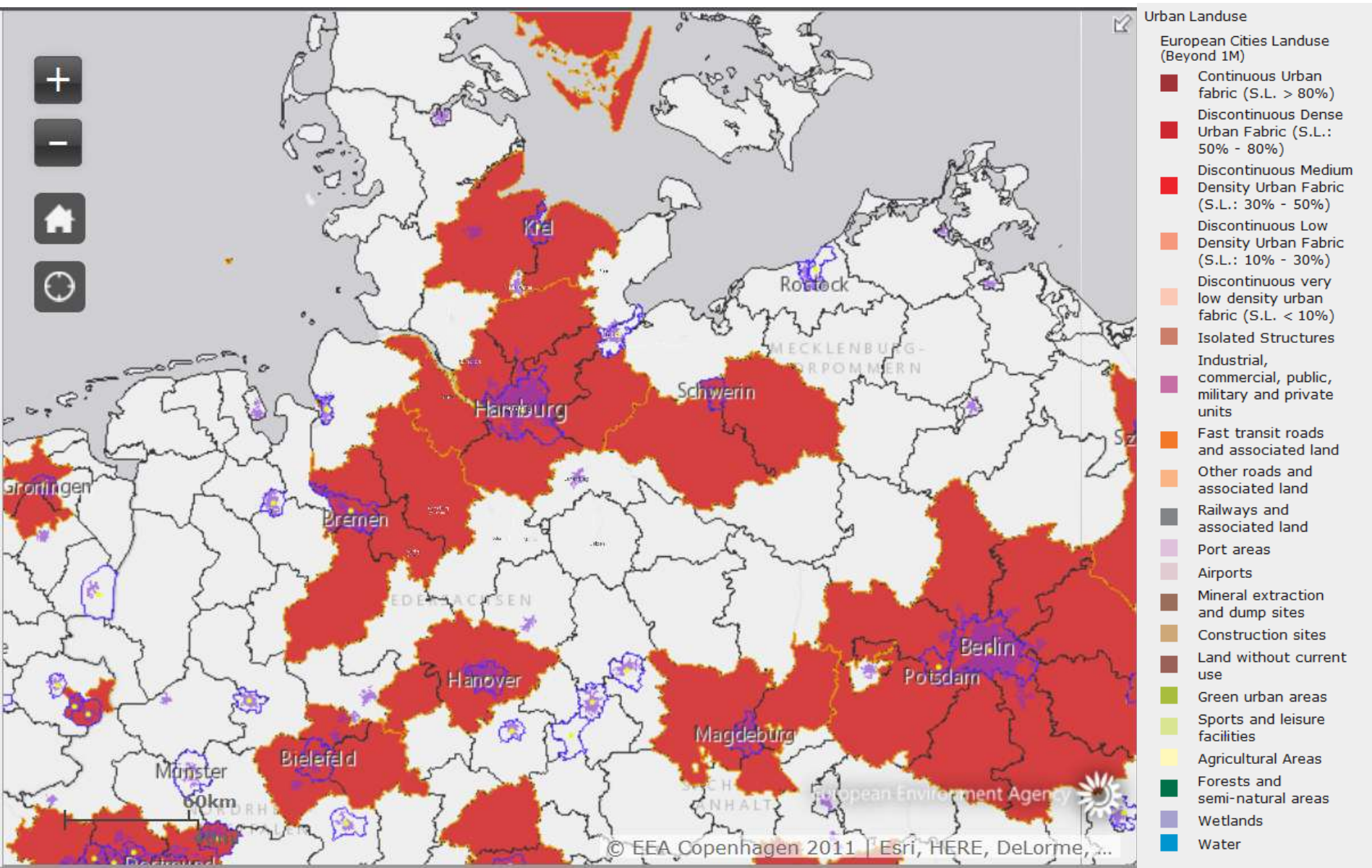
Example of regional / local dataset

European Urban Atlas



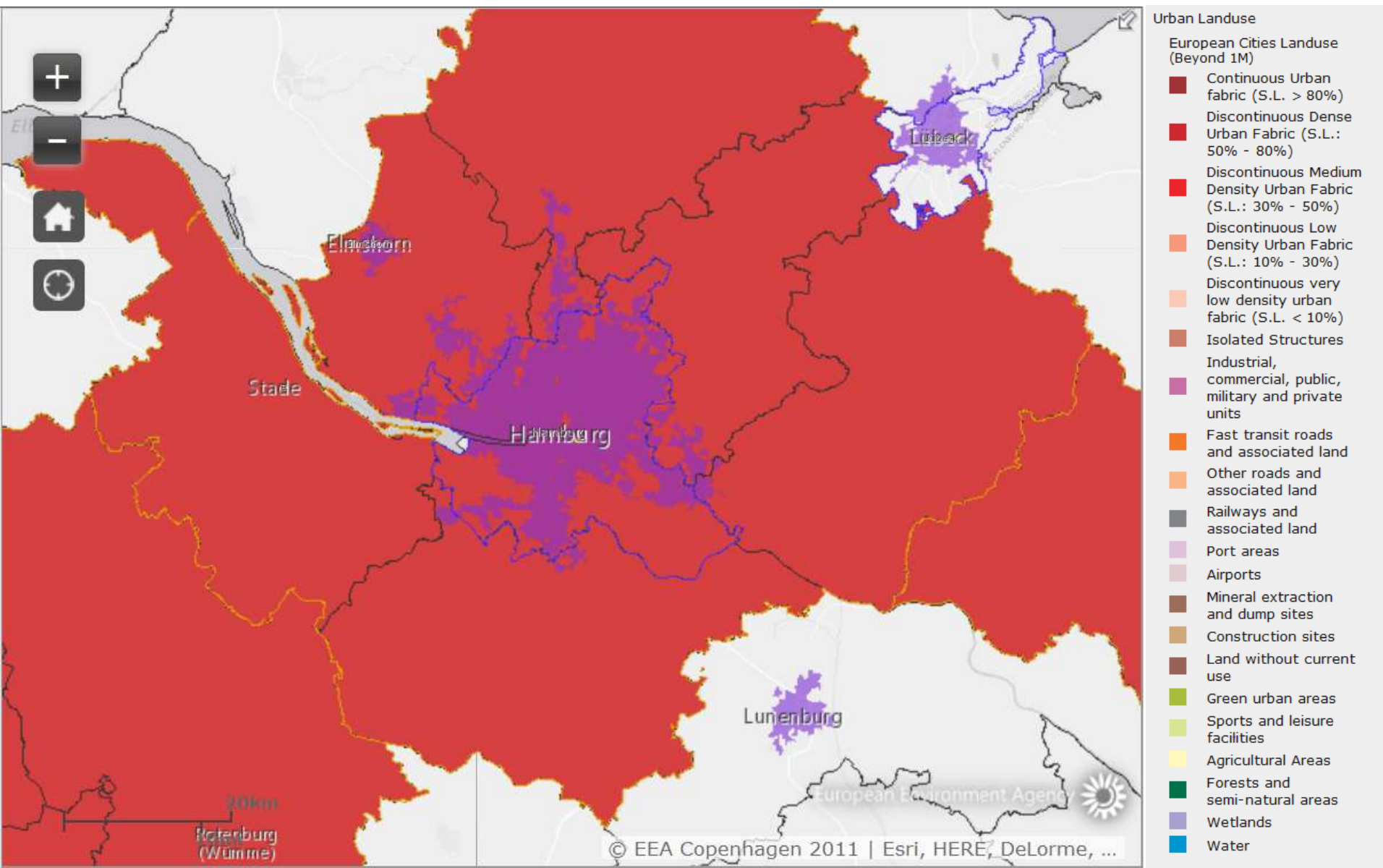
Example of regional / local dataset

European Urban Atlas



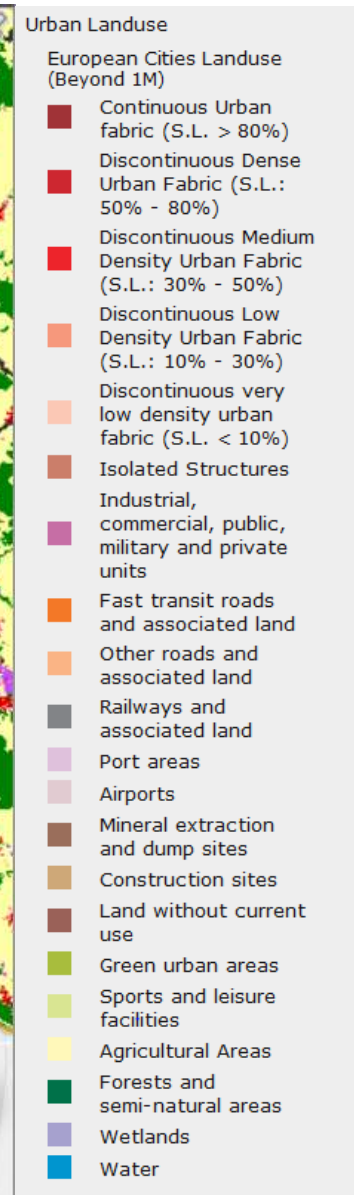
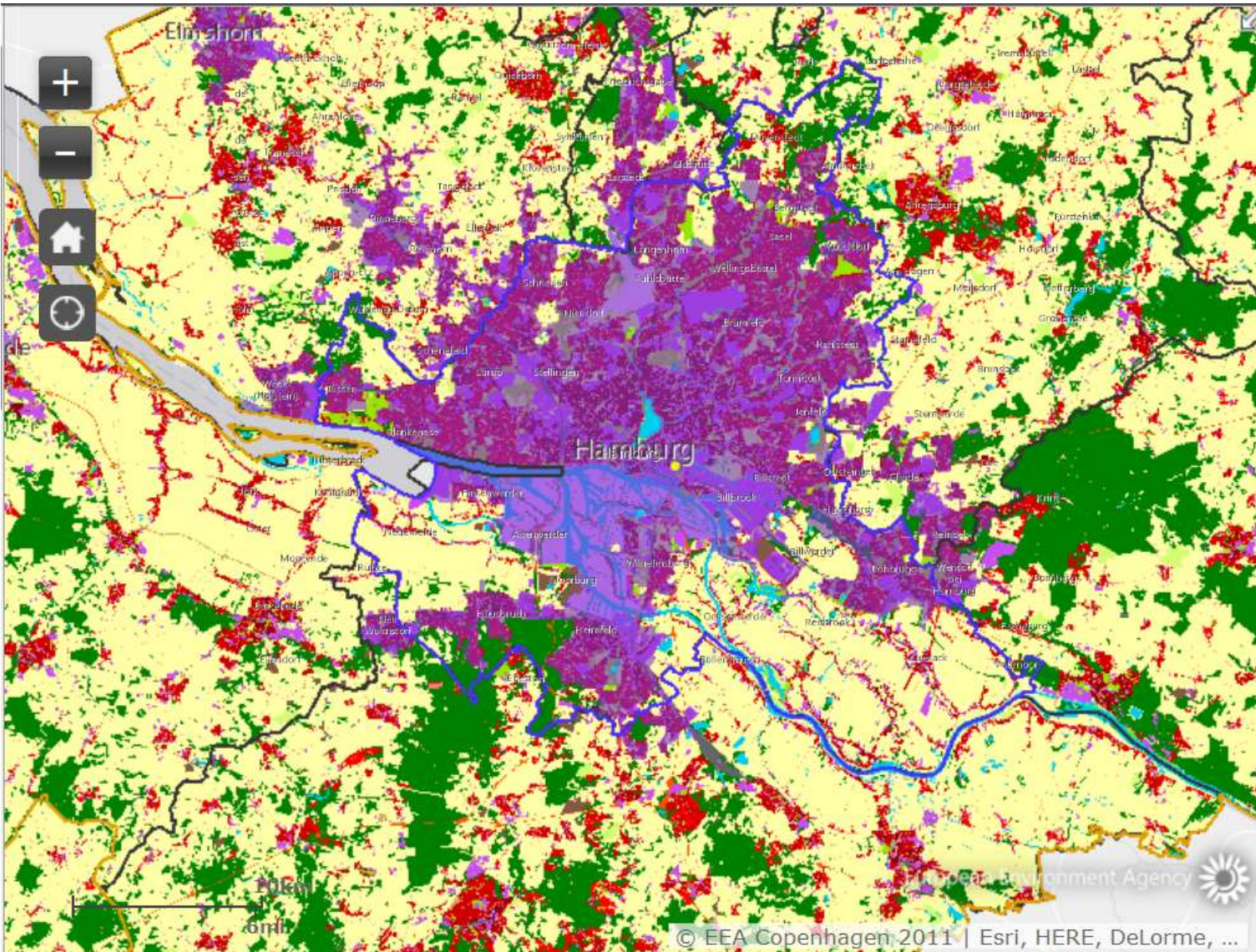
Example of regional / local dataset

European Urban Atlas



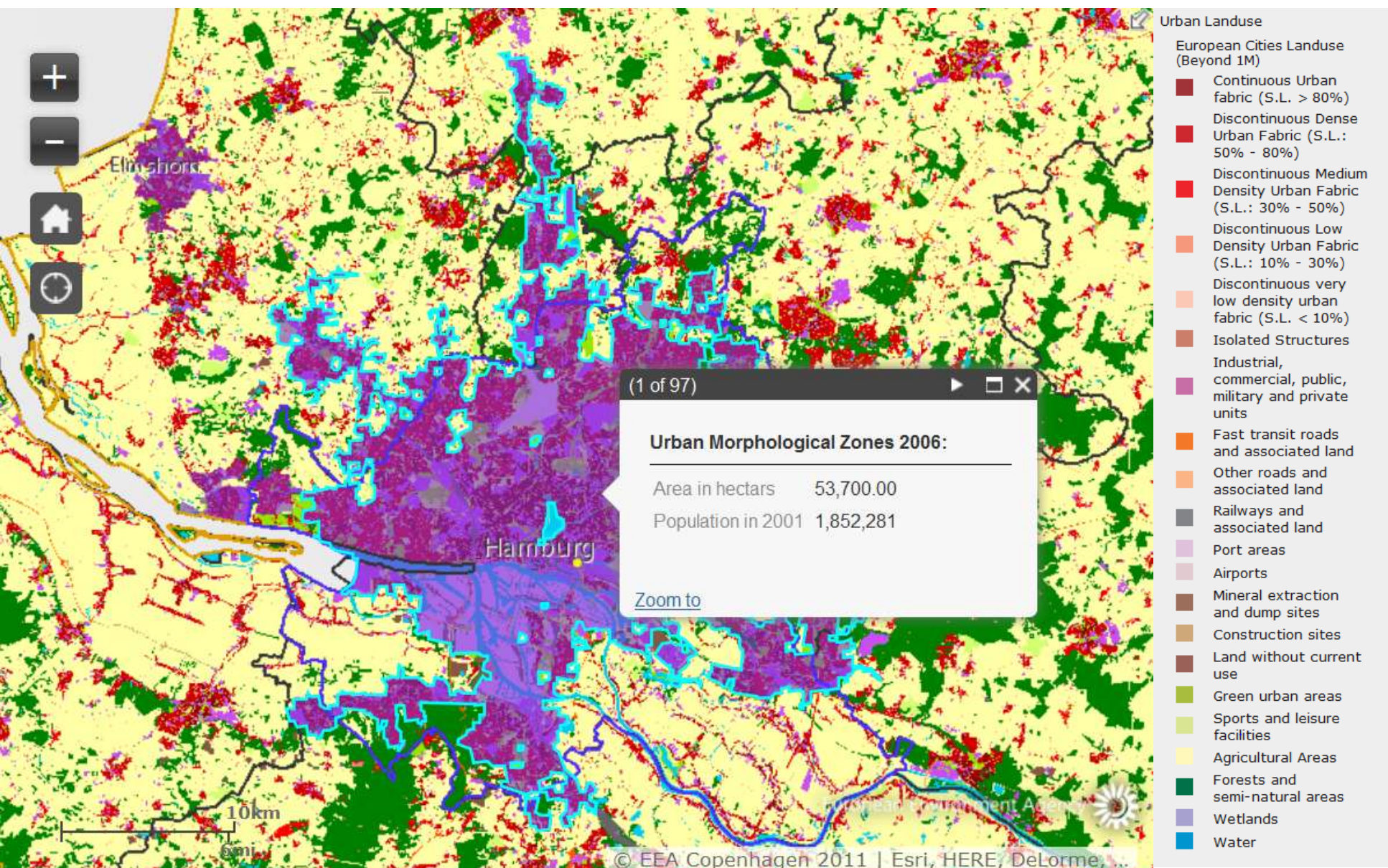
Example of regional / local dataset

European Urban Atlas



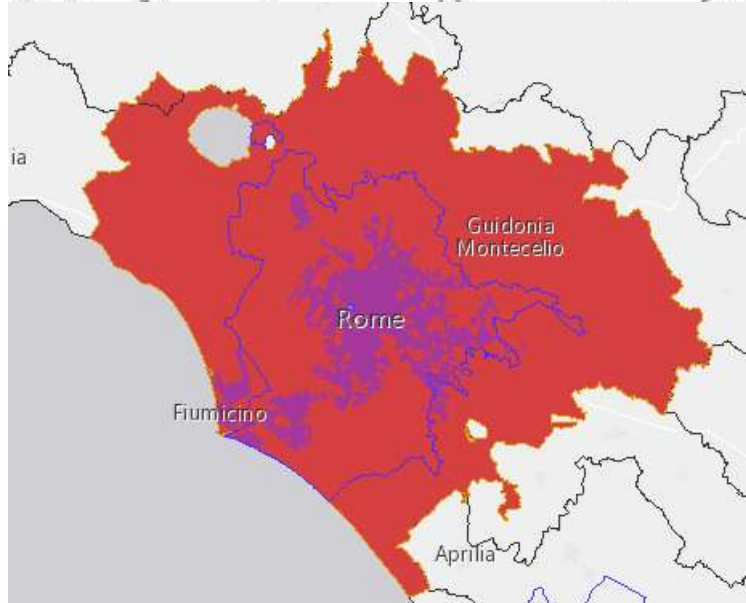
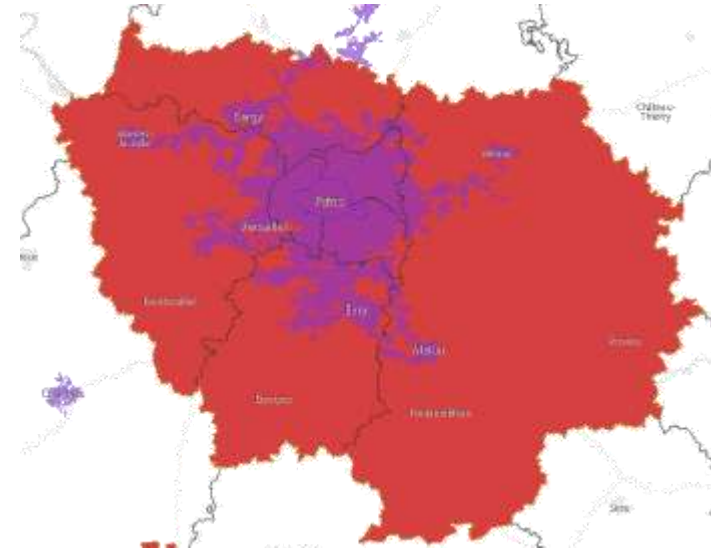
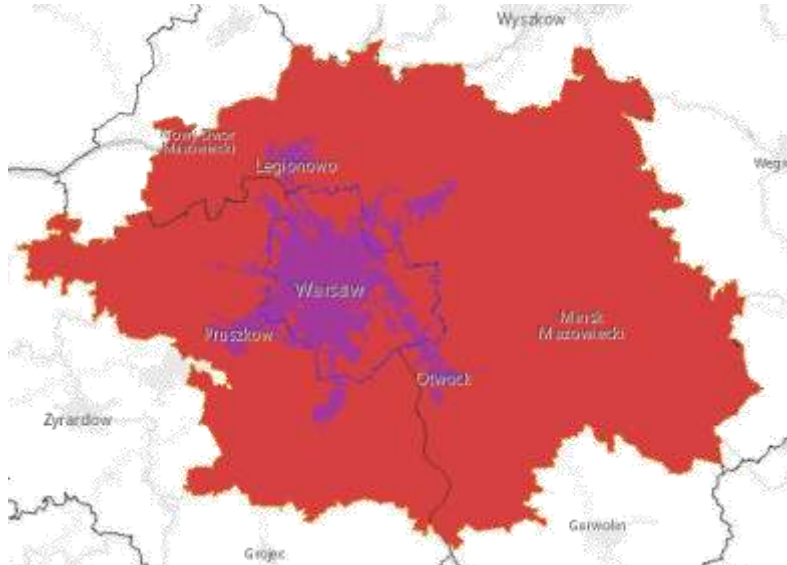
Example of regional / local dataset

European Urban Atlas



Example of regional / local dataset

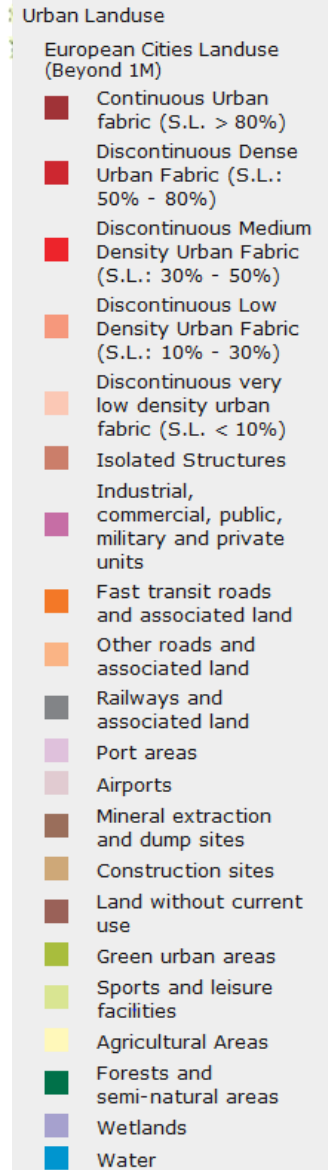
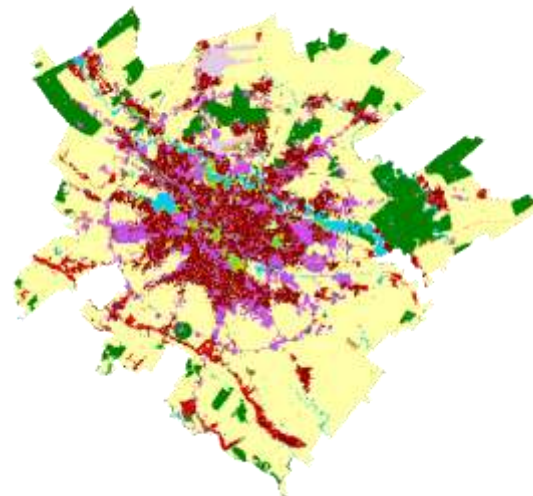
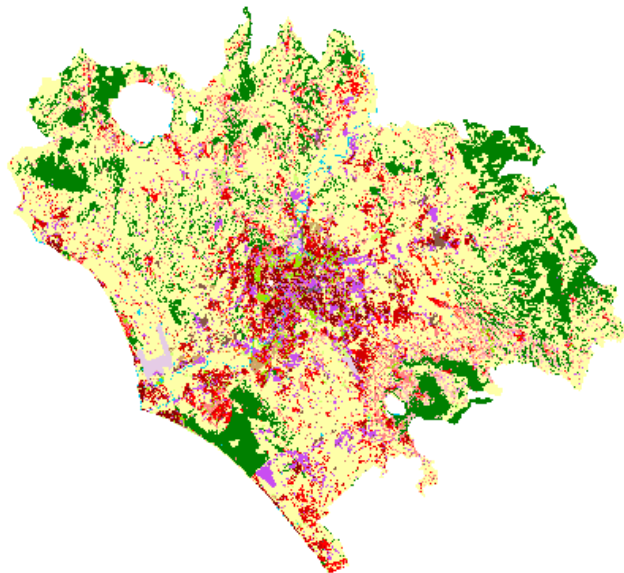
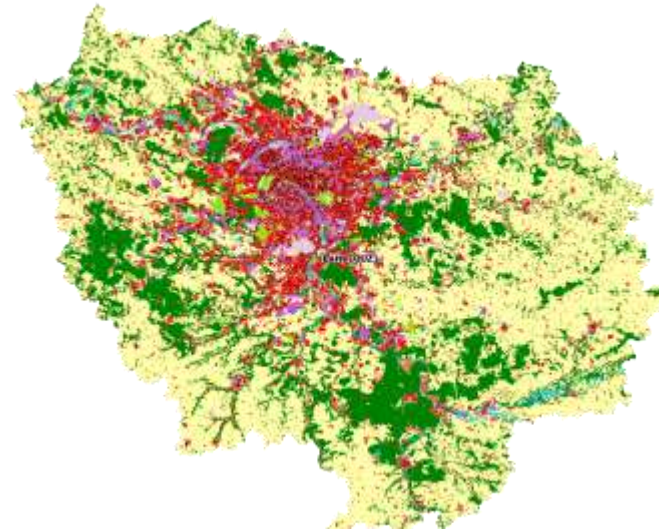
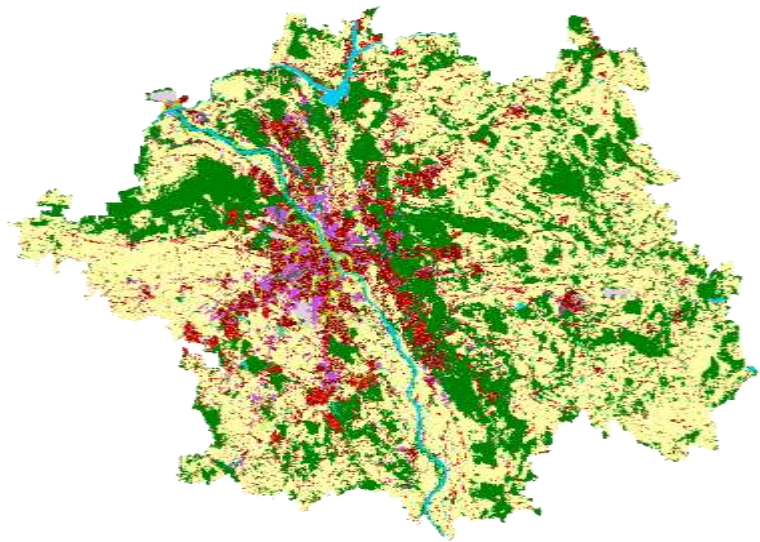
European Urban Atlas

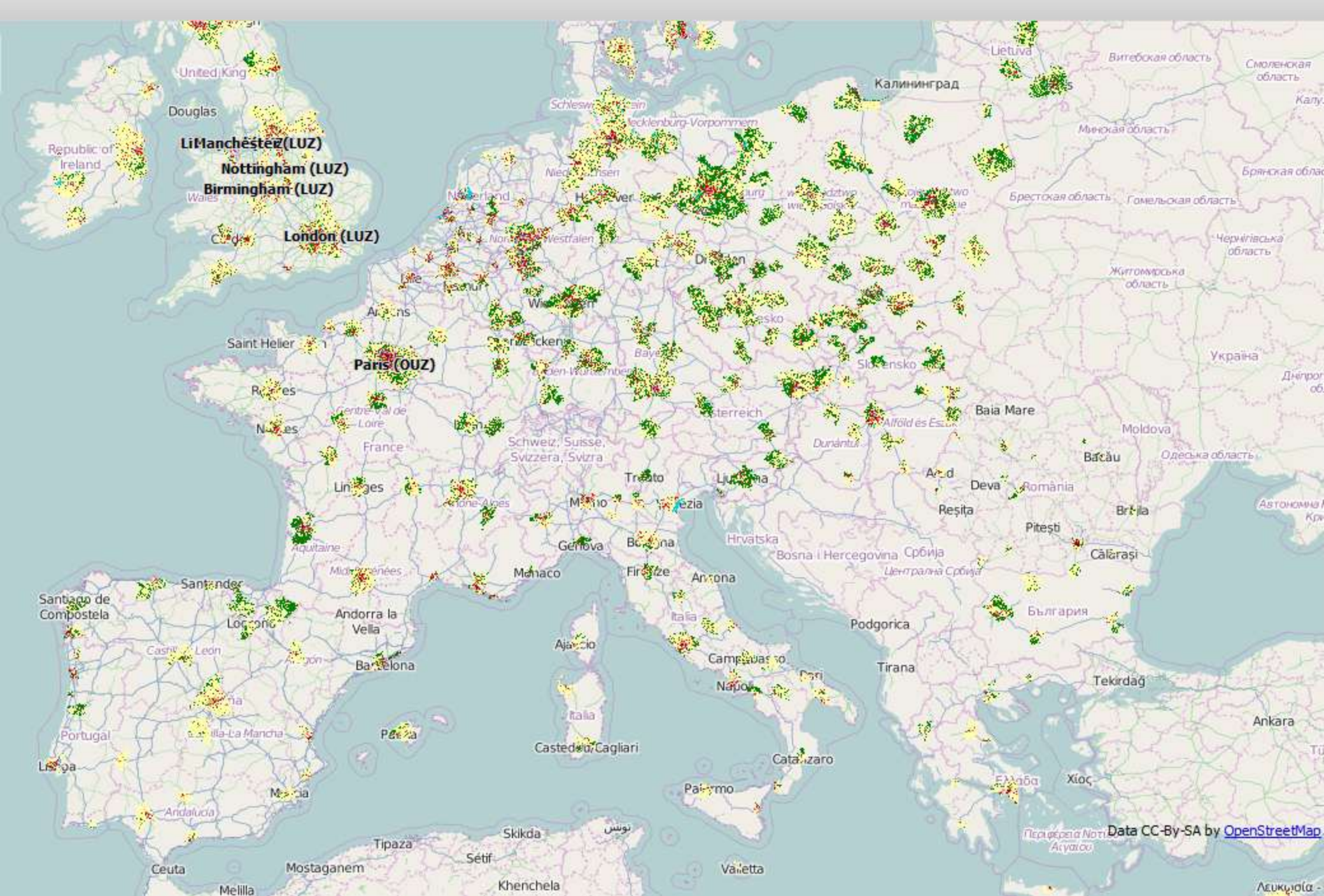


- Urban Landuse**
- European Cities Landuse (Beyond 1M)**
- Continuous Urban fabric (S.L. > 80%)
 - Discontinuous Dense Urban Fabric (S.L.: 50% - 80%)
 - Discontinuous Medium Density Urban Fabric (S.L.: 30% - 50%)
 - Discontinuous Low Density Urban Fabric (S.L.: 10% - 30%)
 - Discontinuous very low density urban fabric (S.L. < 10%)
 - Isolated Structures
 - Industrial, commercial, public, military and private units
 - Fast transit roads and associated land
 - Other roads and associated land
 - Railways and associated land
 - Port areas
 - Airports
 - Mineral extraction and dump sites
 - Construction sites
 - Land without current use
 - Green urban areas
 - Sports and leisure facilities
 - Agricultural Areas
 - Forests and semi-natural areas
 - Wetlands
 - Water

Example of regional / local dataset

European Urban Atlas

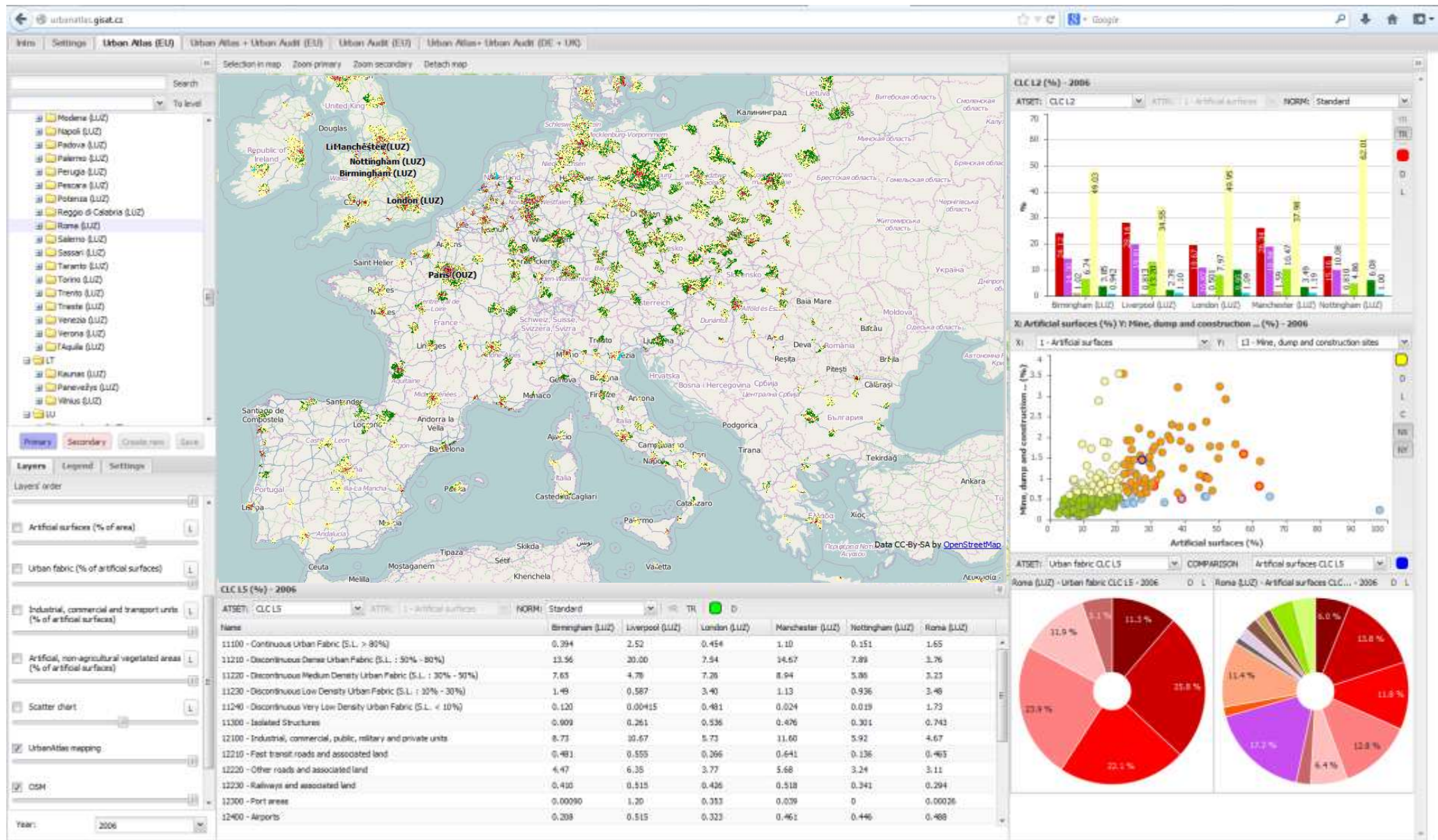




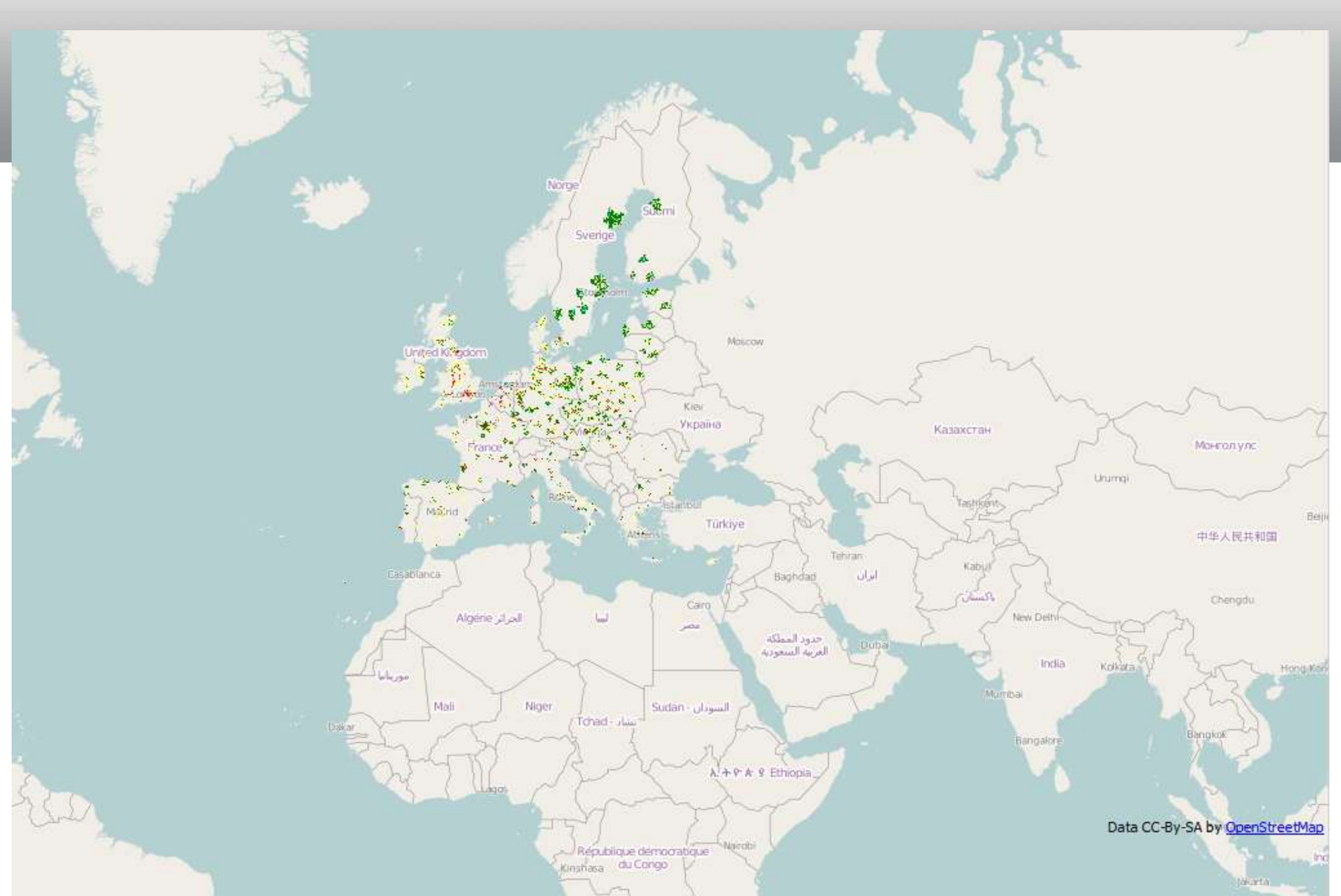
Li Manchester (LUZ)
Nottingham (LUZ)
Birmingham (LUZ)

London (LUZ)

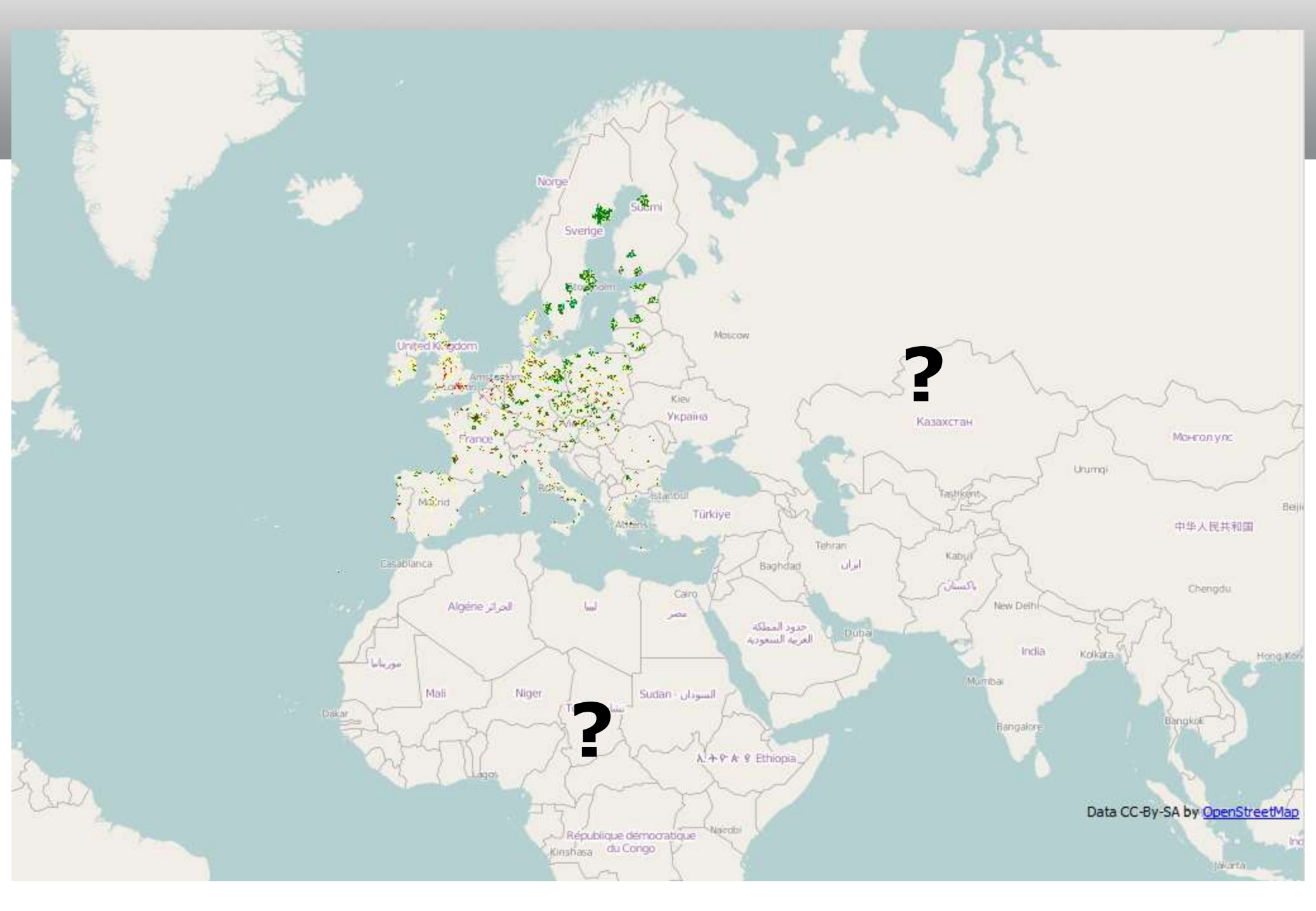
Paris (OUZ)



Credit: GISAT, Urban Atlas Plus project



Data CC-BY-SA by [OpenStreetMap](https://openstreetmap.org/)



Delhi, Dhaka, Mumbai - Case studies using European Atlas Methods

The screenshot displays the eoworld GISAT web application interface. At the top, the title "Delhi, Dhaka, Mumbai - Case studies using European Atlas Methods" is visible. The main interface includes a map of India with Delhi highlighted, a search bar, and a sidebar with navigation options. The central part of the interface features the "eoworld" logo and the tagline "Earth Observation for Development".

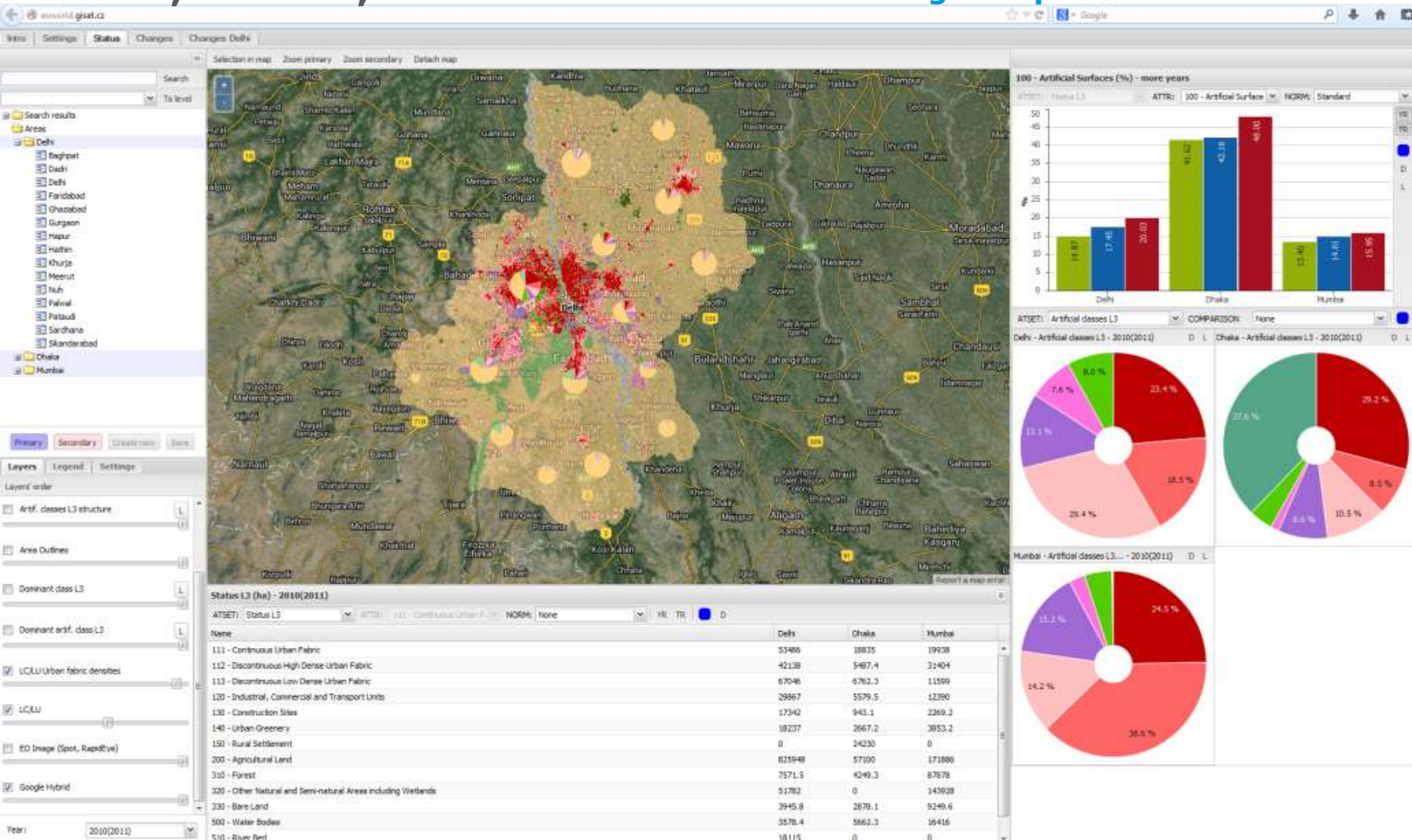
On the right side, there are two data visualizations: a bar chart titled "100 - Artificial Surfaces (%) - more years" and a pie chart titled "Dhaka - Artificial classes L3 - 2010(2011)". The bar chart shows data for three cities: Delhi (41.00%), Dhaka (42.00%), and Mumbai (15.95%). The pie chart shows the distribution of artificial classes in Dhaka for 2010/2011, with the largest category being 38.8%.

At the bottom, a table titled "Status L3 (ha) - 2010(2011)" provides a detailed breakdown of land use classes for Delhi, Dhaka, and Mumbai. The table includes columns for the class name and the area in hectares for each city.

None	Delhi	Dhaka	Mumbai
111 - Continuous Urban Fabric	53486	18835	19938
112 - Discontinuous High Dense Urban Fabric	42138	5487.4	31494
113 - Discontinuous Low Dense Urban Fabric	67046	6762.3	11599
120 - Industrial, Commercial and Transport Units	29867	5575.5	12390
130 - Construction Sites	17342	943.1	2269.2
140 - Urban Greenery	18237	2667.2	3653.2
150 - Rural Settlement	0	24230	0
200 - Agricultural Land	825948	57300	178886
320 - Forest	7571.5	4246.3	87676
320 - Other Natural and Semi-natural Areas including Wetlands	51782	0	143928
330 - Bare Land	3945.6	2876.1	9249.6
500 - Water Bodies	3578.4	5662.3	16436
510 - River Bed	18115	0	0

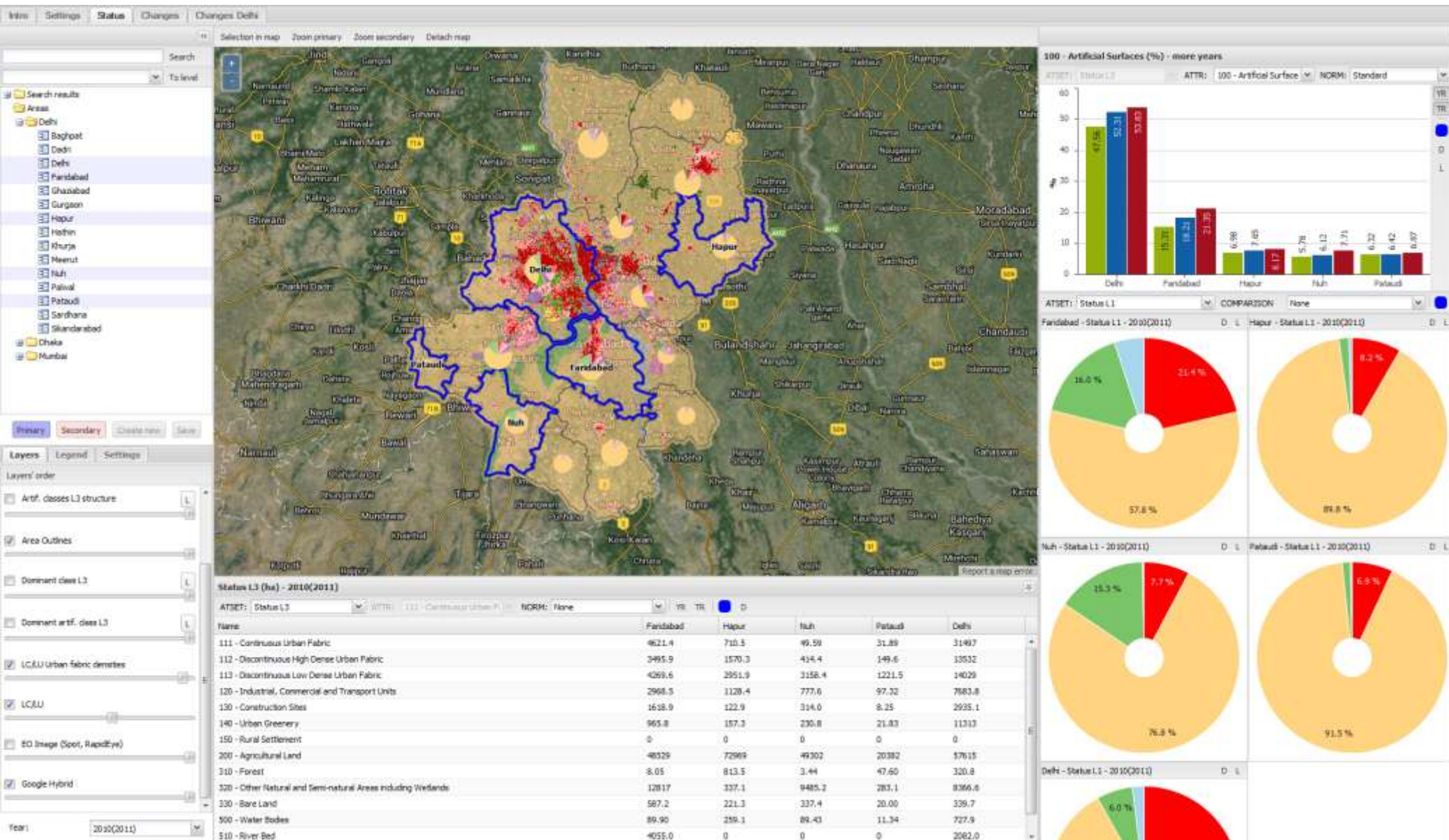
Credit: GISAT, eoworld project

Delhi, Dhaka, Mumbai - Case studies using European Atlas Methods



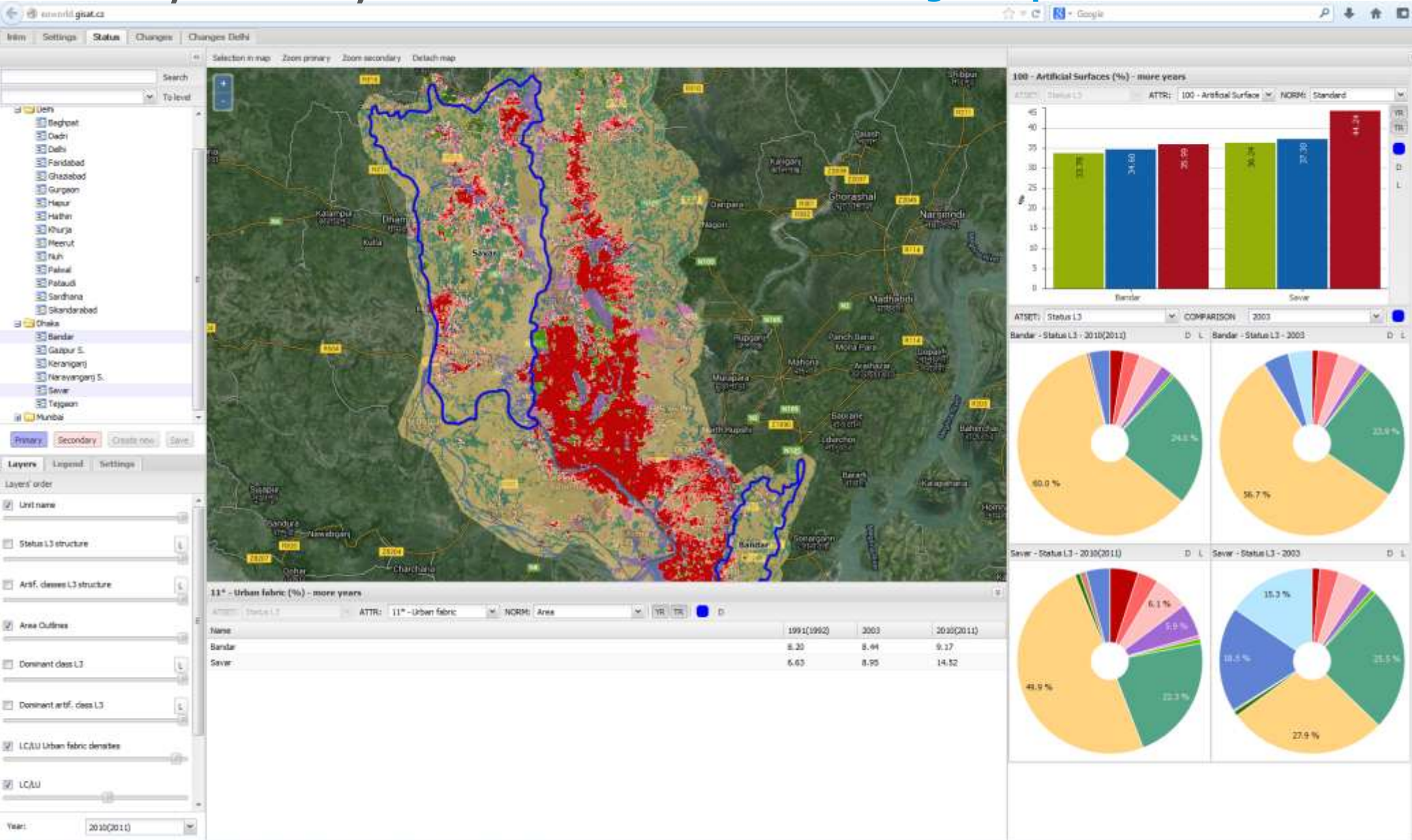
Credit: GISAT, eoworld project

Delhi, Dhaka, Mumbai - Case studies using European Atlas Methods



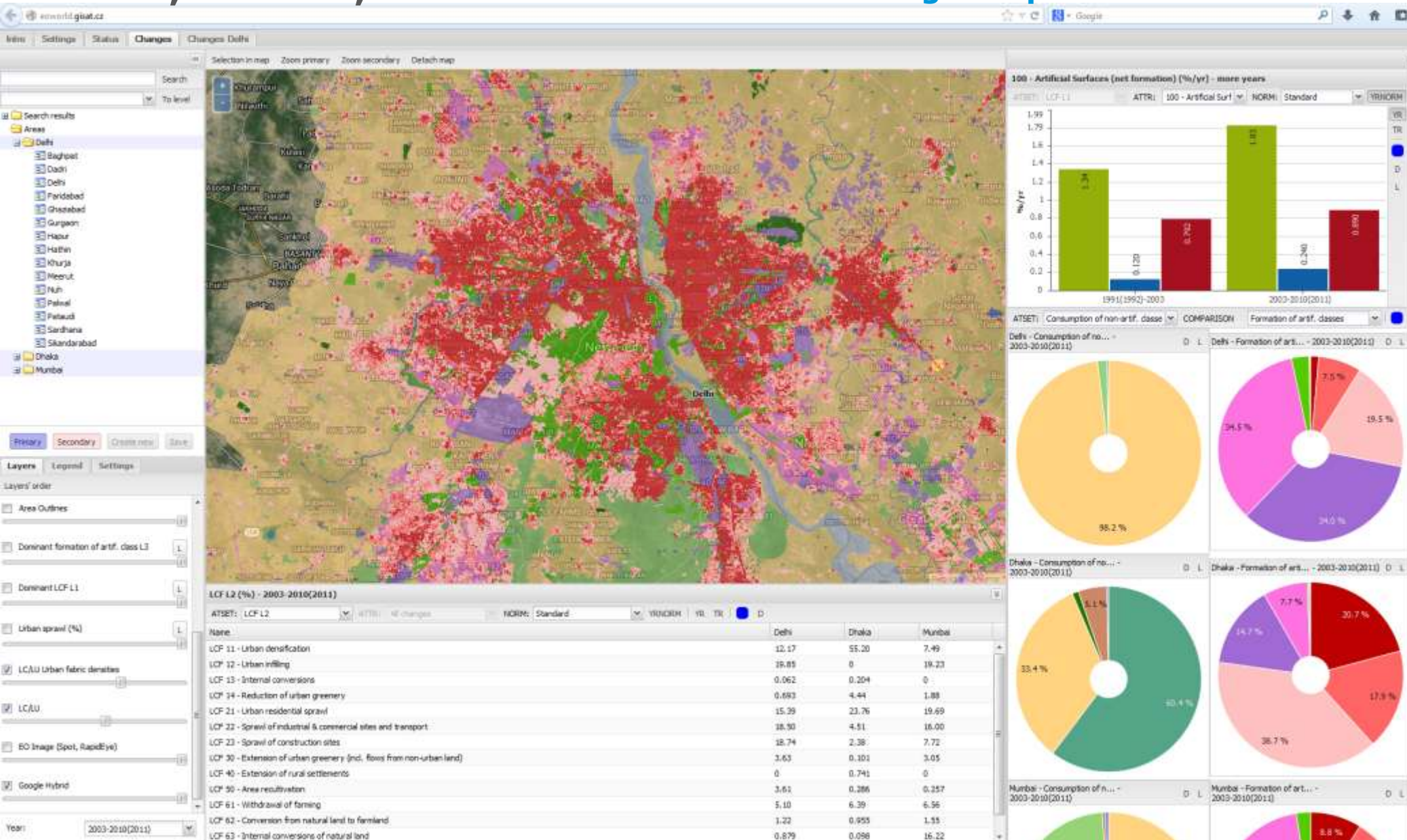
Credit: GISAT, eoworld project

Delhi, Dhaka, Mumbai - Case studies using European Atlas Methods



Credit: GISAT, eoworld project

Delhi, Dhaka, Mumbai - Case studies using European Atlas Methods



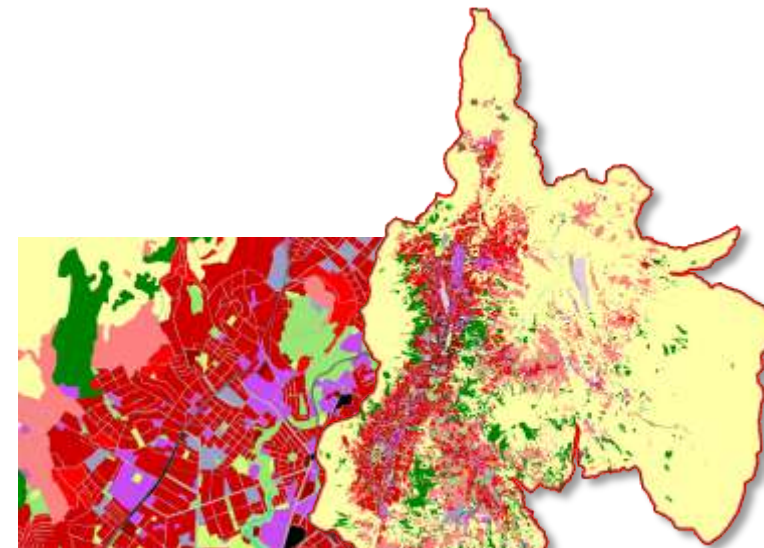
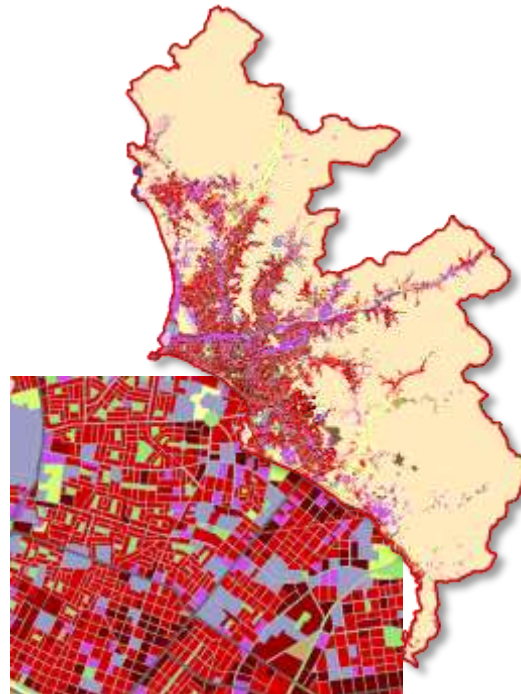
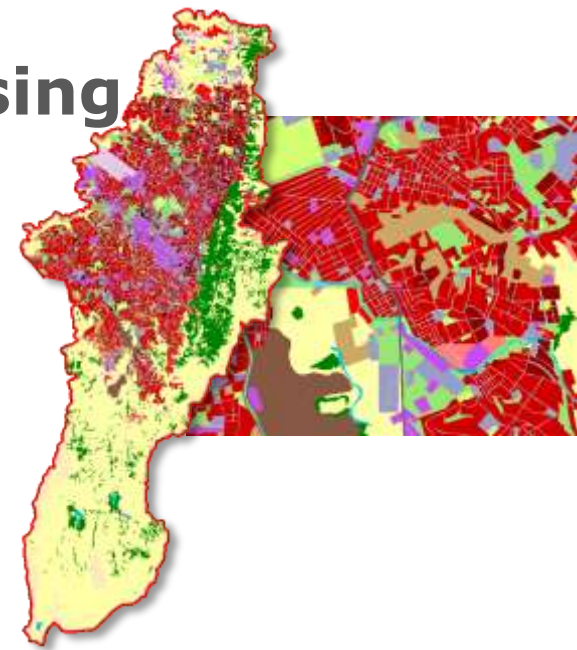
Credit: GISAT, eoworld project

List of cities outside Europe mapped using Urban Atlas methodology

- **Dheli**
- **Dhaka**
- **Mumbai**
- **Lima**
- **Bogota**
- **Quito**
- **Jalalbad**
- **Karach**
- **Chittagong**
- **Colombo**
- **Ho Chi Min City**
- **Yogyakarta**
- **Georgetown (Guyana)**
- **Rio de Janeiro**
- **Manila**
- **Cebu City**
- **Hai Phong**
- **Surabaya**
- **Ulanbaatar**

Mapping/monitoring principles:

- Two to three decades of urban growth 1990, 2000, 2010
- At least 13 urban classes
- Showing land conversions across classes
- Using the same definitions for comparable results



From maps to indicators

Indicator 1: Urban growth

Indicator 2: Growth of residential areas

Indicator 3: Growth of industrial areas

Indicator 4: Urban growth and population development

Indicator 5: Productivity of land consumption

Indicator 6: Urban sprawl intensity

Indicator 7: Land cover replaced by built-up area

Indicator 8: Land use

Indicator 9: Loss of natural areas

Indicator 10: Structural indicators

Indicator 11: Informal Settlements

Platform for Urban Management and Analysis

World Bank EAP Regional Urbanization Flagship // support tool

<http://puma.worldbank.org>

The screenshot displays the 'Data Exploration' web application. At the top, the browser address bar shows the URL 'geonode.gisat.cz/app/public/data-exploration.html'. The page header includes 'THE WORLD BANK' logo and navigation links for 'DATA EXPLORATION', 'DOWNLOADS', and 'HELP'. A dark navigation bar contains a search icon, 'LOG IN', and 'SIGN UP' buttons. The main content area features a map of East Java, Indonesia, with various cities labeled. A dark overlay on the left contains the 'DATA EXPLORATION' logo and a search form with fields for 'Scope', 'Theme', and 'Place', along with an 'Explore' button. A 'Selection guide' box on the right provides instructions for using the search filters. The footer includes the 'WORLD BANK GROUP' logo, navigation links for 'IBRD', 'IDA', 'IFC', 'MIGA', and 'ICSID', and a 'Fraud & Corruption Hotline' number.

THE WORLD BANK | Working for a World Free of Poverty

DATA EXPLORATION | DOWNLOADS | HELP | LOG IN | SIGN UP

Sumenep

DATA EXPLORATION

Scope: Select scope... Theme: Place: Explore

Selection guide

Scope
Different data address different scope level of analysis. Please choose your scope of interest.

Place
Data for different analysis scopes can be available for different places. Please select place covered / prepared for exploration and analysis according to region, country or city of your interest.

Theme
Standard views on data are focused on different thematic information. Please select theme according your thematic interests.

Map data ©2014 Google

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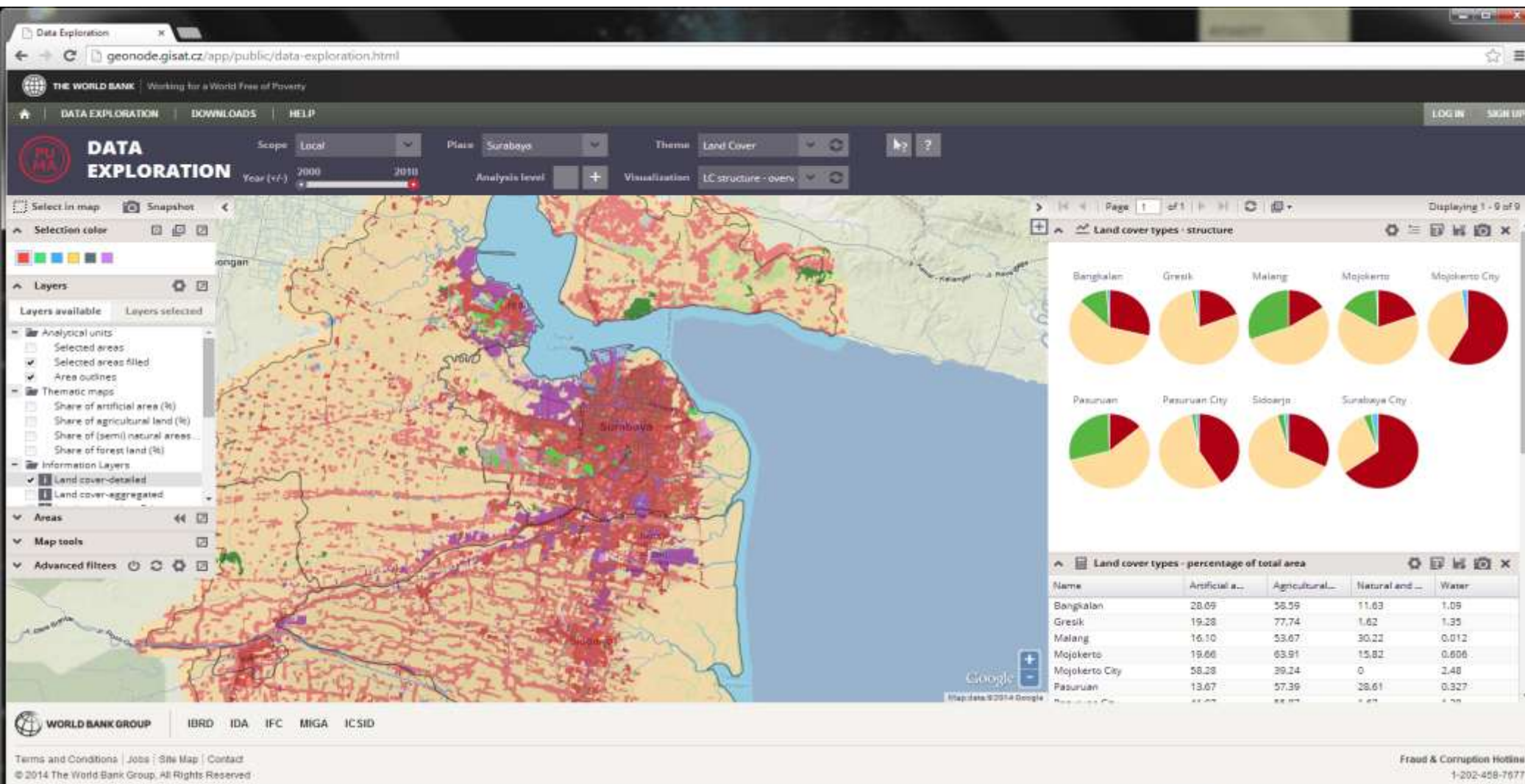
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Fraud & Corruption Hotline
1-202-458-7677

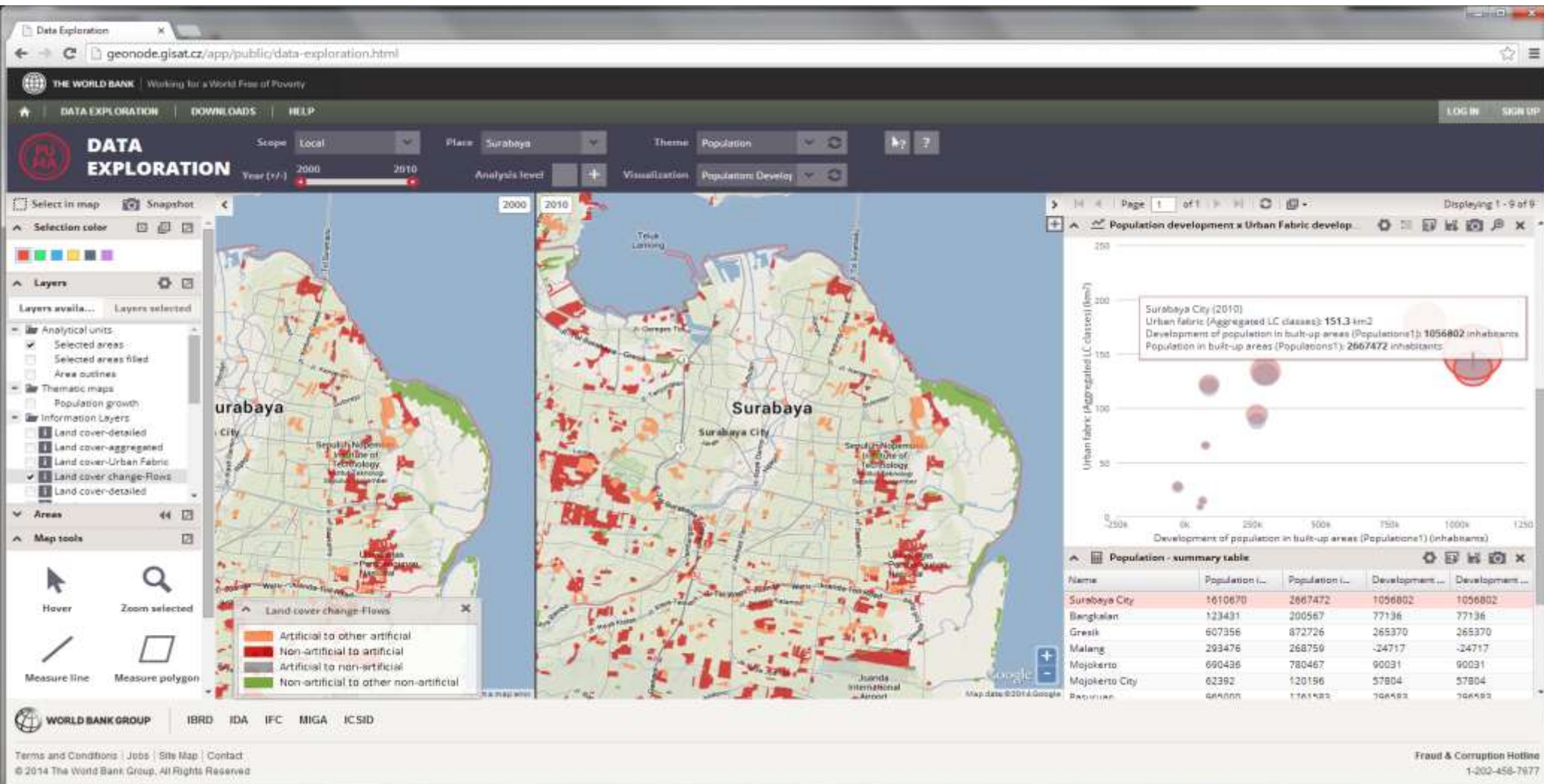
Platform for Urban Management and Analysis

World Bank EAP Regional Urbanization Flagship // support tool



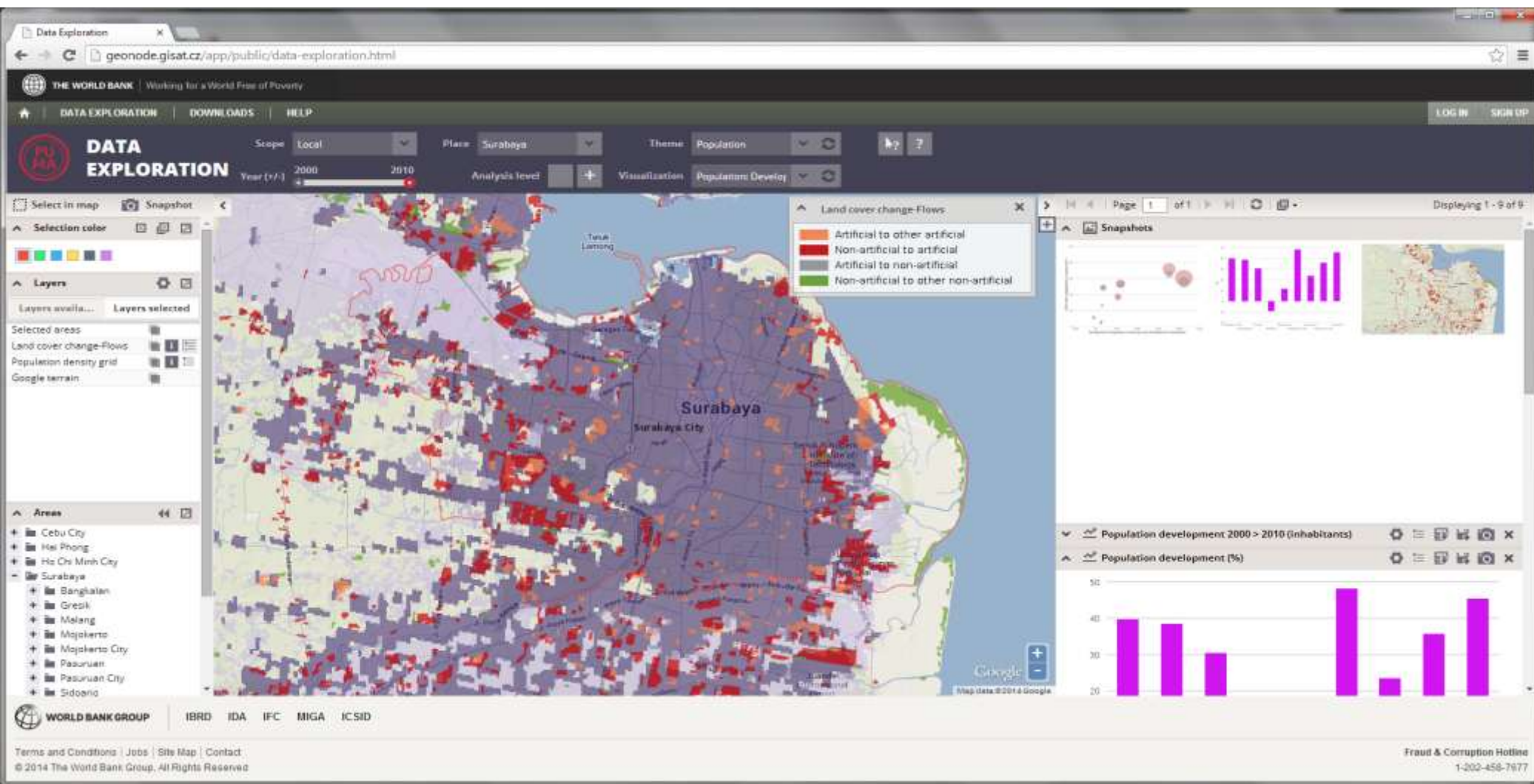
Platform for Urban Management and Analysis

World Bank EAP Regional Urbanization Flagship // support tool



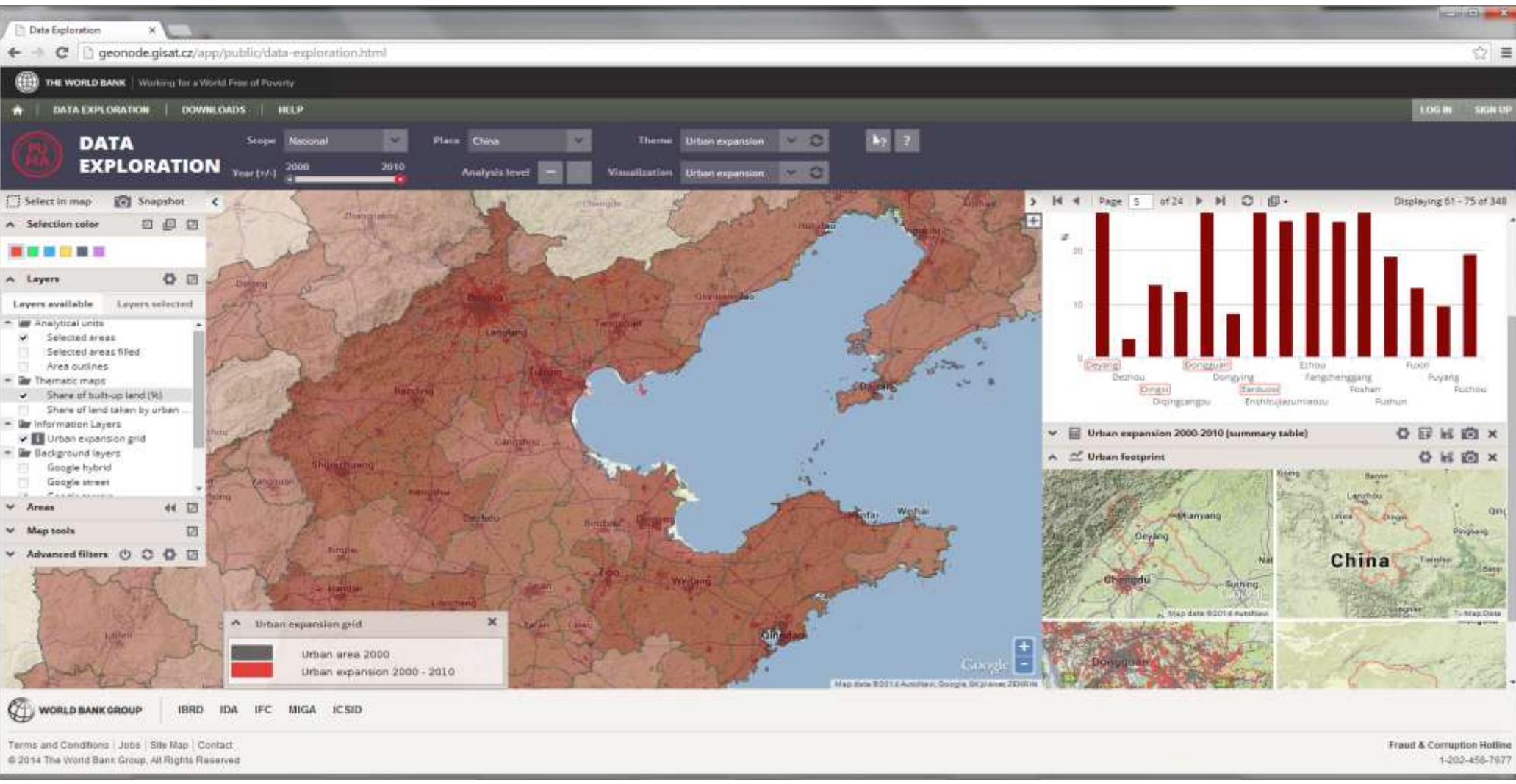
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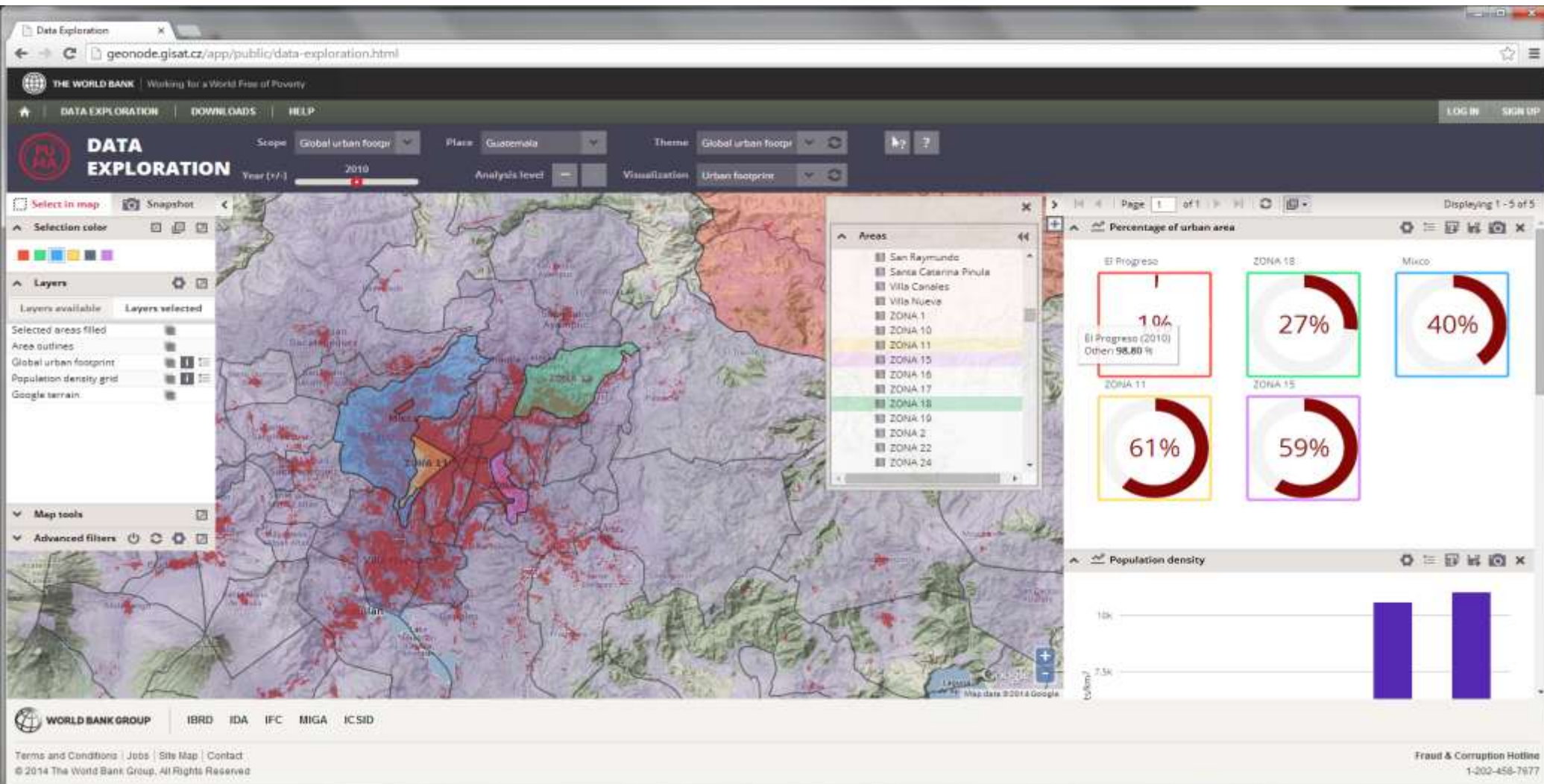
Platform for Urban Management and Analysis

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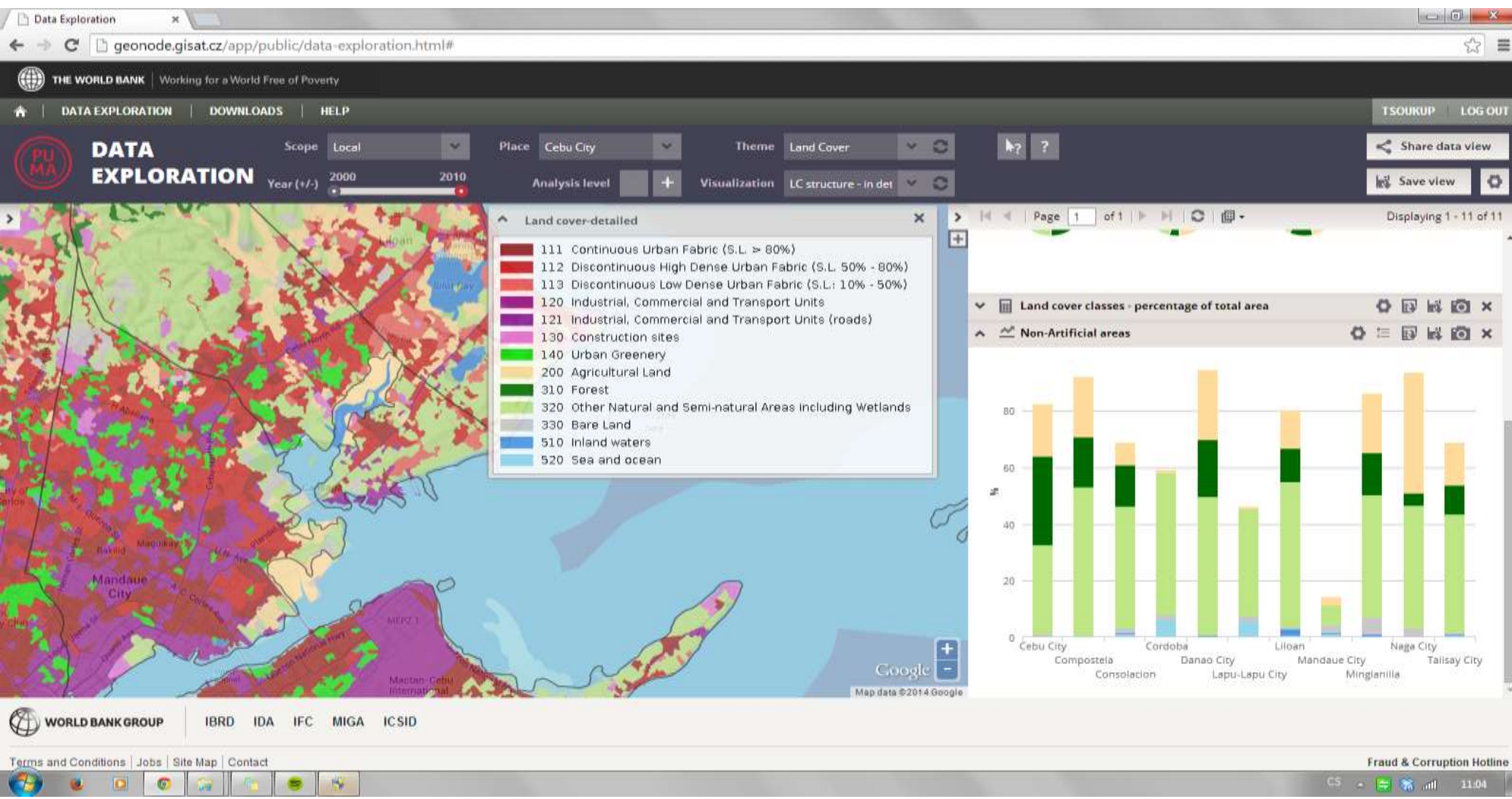
Platform for Urban Management and Analysis

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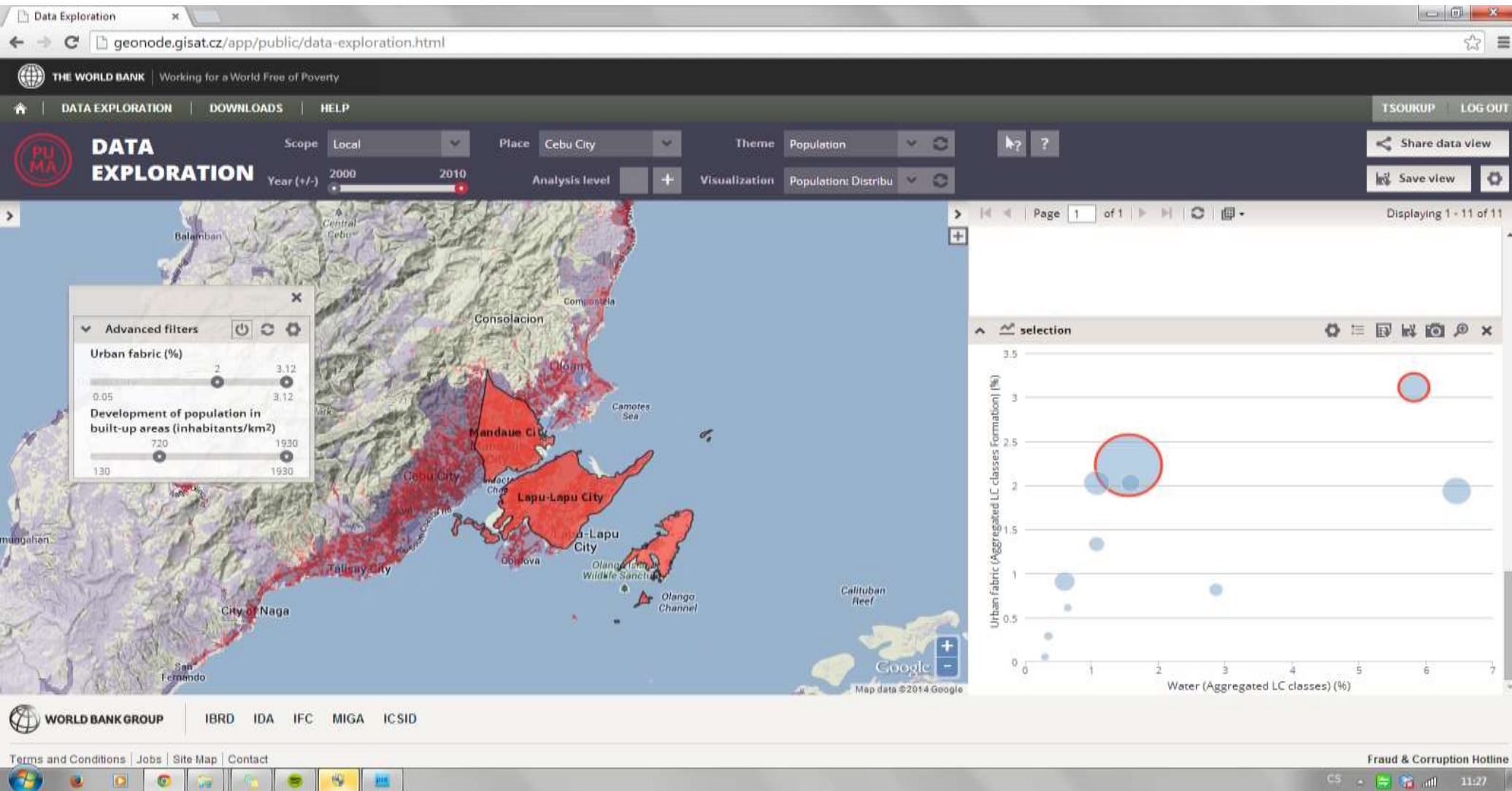


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PUMA Examples



Measuring Urban Growth

Global Urban Unit Data Initiative

- **Phase 1** Creating a Standard Baseline (c.2010) – (completed by end 2015)
 - Urban areas definition (based on adapted OECD Methodology)
 - Urban territorial extent (based on Global Urban Footprint)
 - Population distribution data (based on WorldPop)
 - Updated administrative boundaries dataset (as available)
 - Roll out of the **PUMA Platform** as a WBG urban data hub

- **Phase 2** (2016 -)
 - Long term monitoring / historical urban change
 - gathering comparable data from prior years, in order to apply track changes in urban extent from 1990-2000-2010 (combination of various sources of data Global Human Settlements Layer, GUF, nightlights, Modis250, etc.)
 - updates collected in 2015, which will coincide with the new post-2015 Sustainable Development Goals.
 - Looking beyond urban growth: green cities, natural hazards, climate resilience, urban planning and economic perspective, and so on.