UN HABITAT
FOR A BETTER URBAN FUTURE

Regional Workshop on the Integration of Big Data and Geospatial Information for the Compilation of SDG Indicators in Arab Countries

13-15 October 2020

Overview of methods and measurements for indicator 11.3.1

Data and Analytics Unit

Knowledge and Innovations Branch, UN-Habitat

Target 11.3

By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries

Indicator 11.3.1 (Tier II)

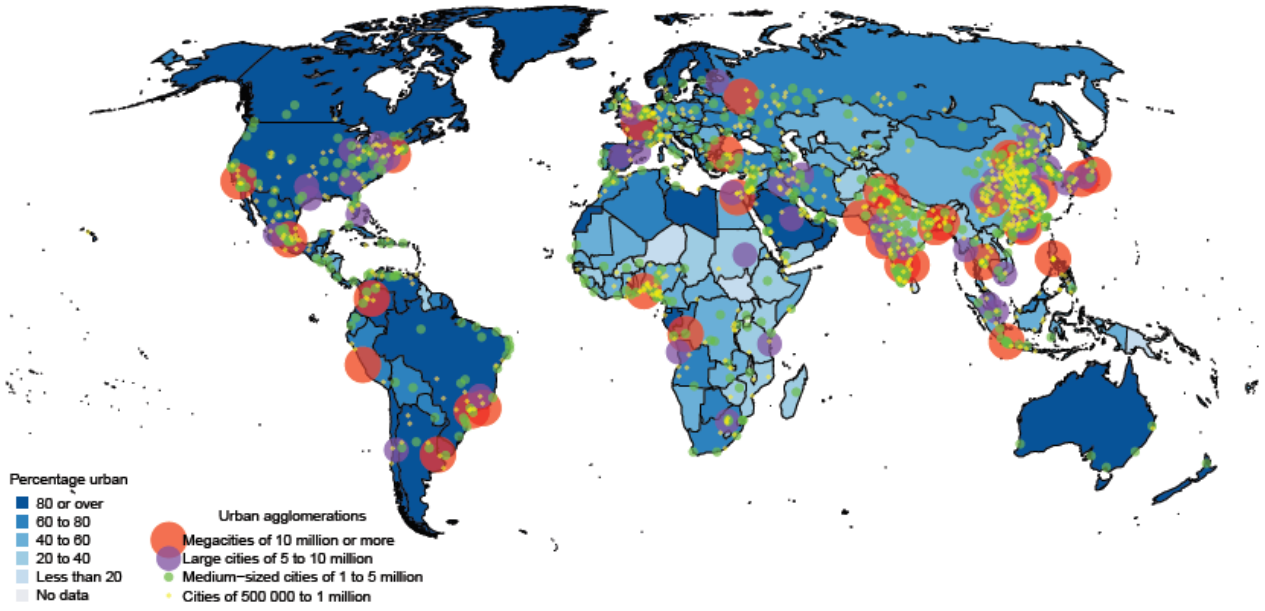
Indicator 11.3.1: Ratio of land consumption rate to population growth rate

Custodian Agency: UN-HABITAT FOR A BETTER URBAN FUTURE

A population-based monitoring of urbanization

Traditionally, we have measured urbanization by rate at which “urban” population changes over time – against diverse national definitions

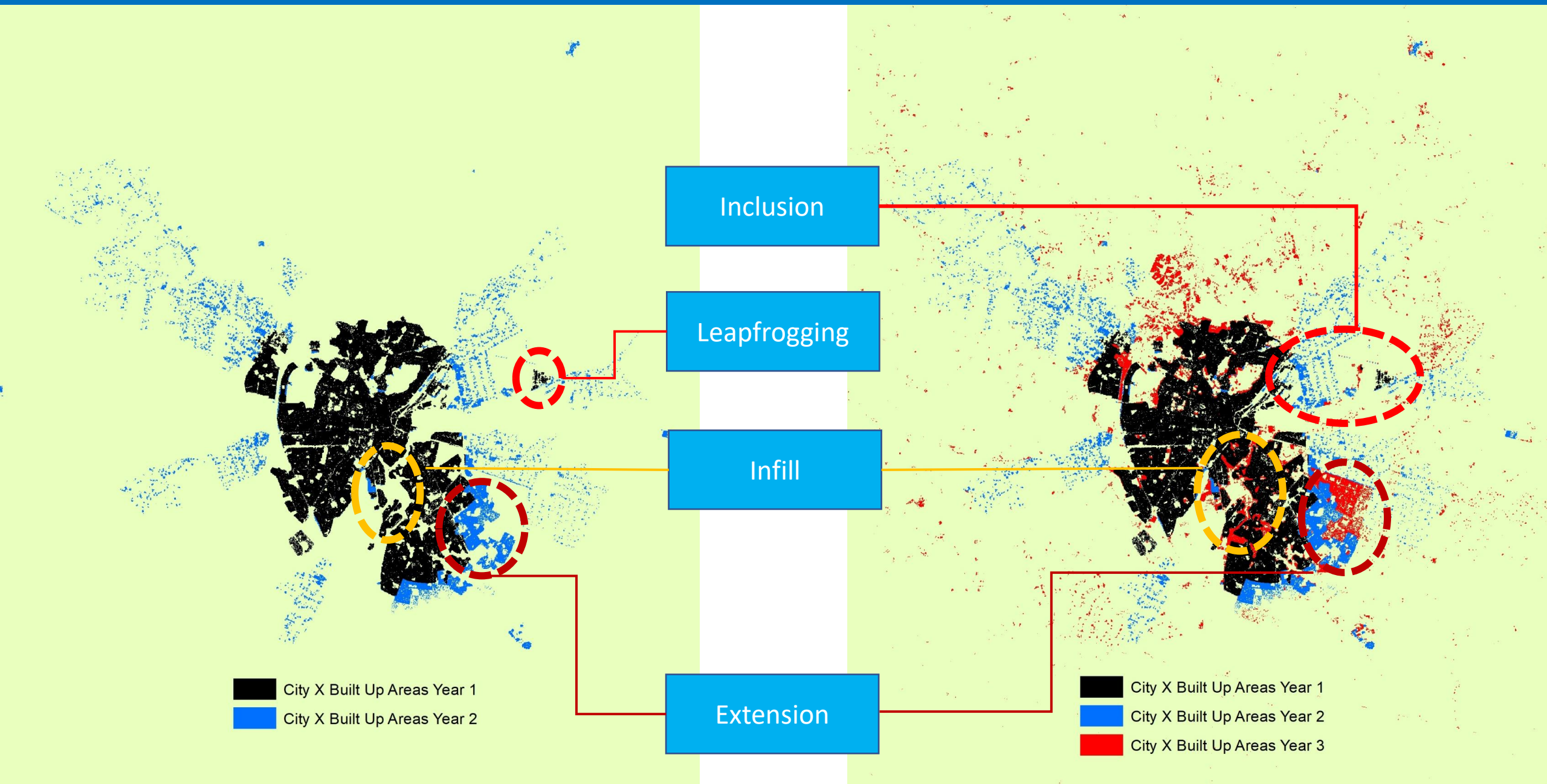
Percentage urban and urban agglomerations with 500,000 inhabitants or more, 2018



UNDESA(2018). World Urbanization Prospects: The 2018 Revision

	Admin function	Econ. function	Pop. size	Pop. density	Urban characteristics	Other criteria	No definition
Bahrain	x	x	x	x	x		
Jordan			x				
Morocco	X		x		x		
Palestine						x	
Saudi Arabia	x	x	x			x	
Sudan	x		x		x		
Syria			x				
Tunisia							x
Yemen	x		x				
Iraq	X	X	X	X	X		
Lebanon							x
Egypt					x	X	
UAE			x			X	

An urbanizing world - but where and how is the growth happening?



Indicator 11.3.1 measures rate at which cities are changing spatially versus the rate at which their population is changing

Compute the ratio of land consumption rate to population growth rate (LCRPGR) = ratio of ratios

$$LCRPGR = \left(\frac{\text{Annual } Land\ Consumption\ rate}{\text{Annual } Population\ growth\ rate}\right)$$

Thus $LCRPGR = \left(\frac{\text{LN}\left(\frac{Urb_{t+n}}{Urb_t}\right)}{y}\right) \Big/ \left(\frac{LN\left(\frac{Pop_{t+n}}{Pop_t}\right)}{y}\right)$

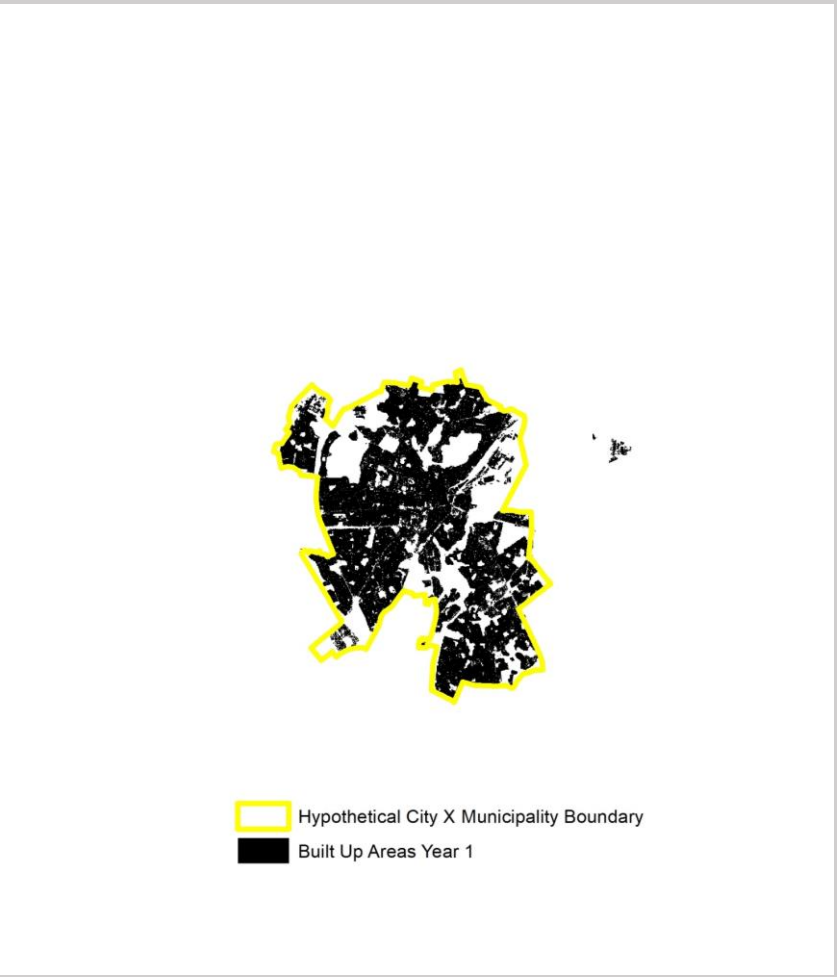
- **Land consumption rate** – the annual rate at which cities uptake land for **urbanized uses** (both built-up and open space demands)

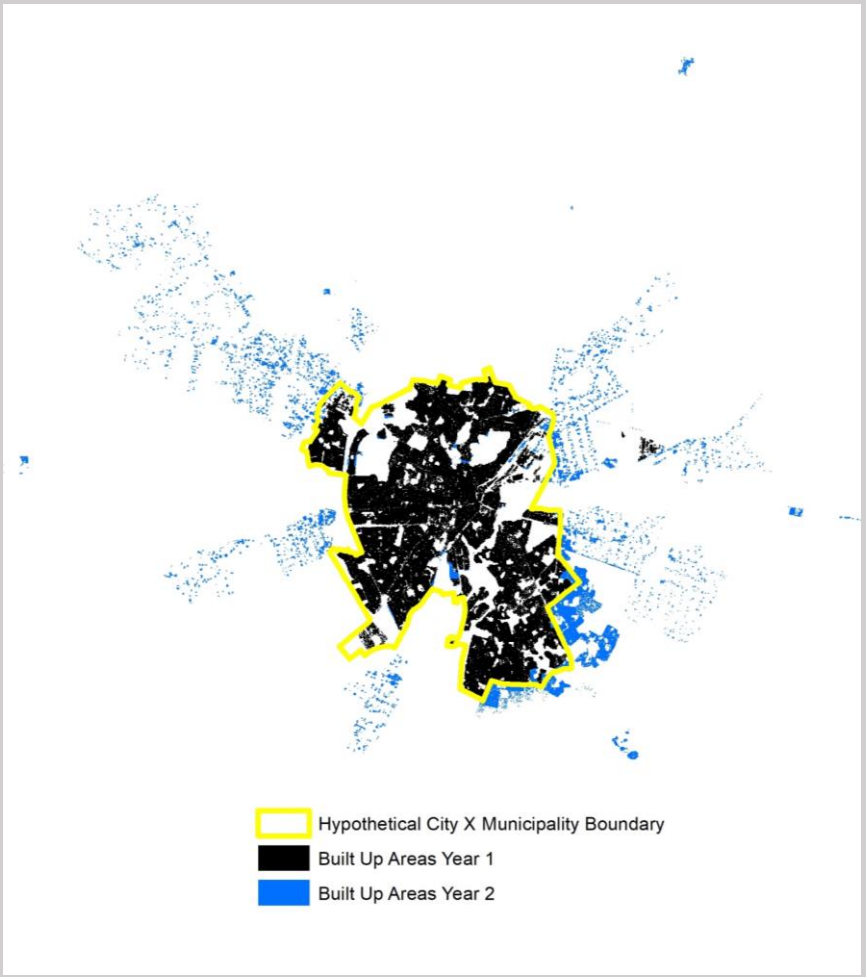
- **Population growth rate** - the change in population in a given area over a unit period of time; expressed as a percentage of the number of individuals in the population at the beginning of that period

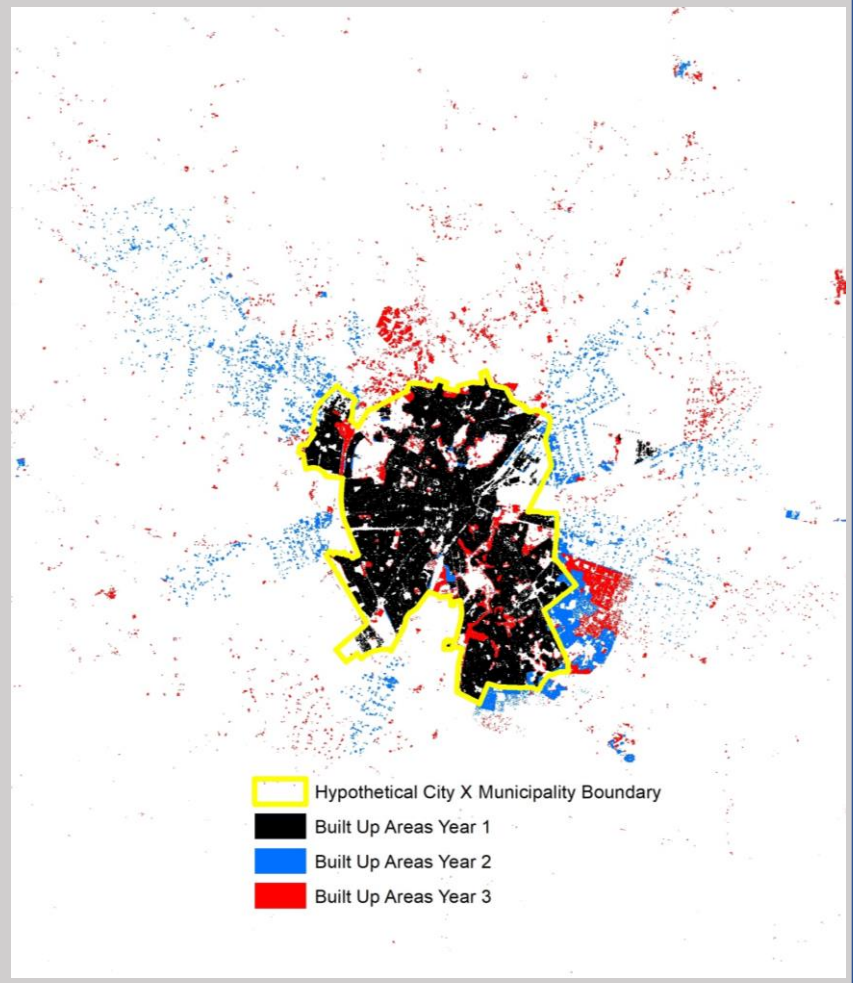
But what is an urban area?

Some urban growth scenarios

Measuring land consumption scenario 1: Hypothetical fixed "urban area" boundaries

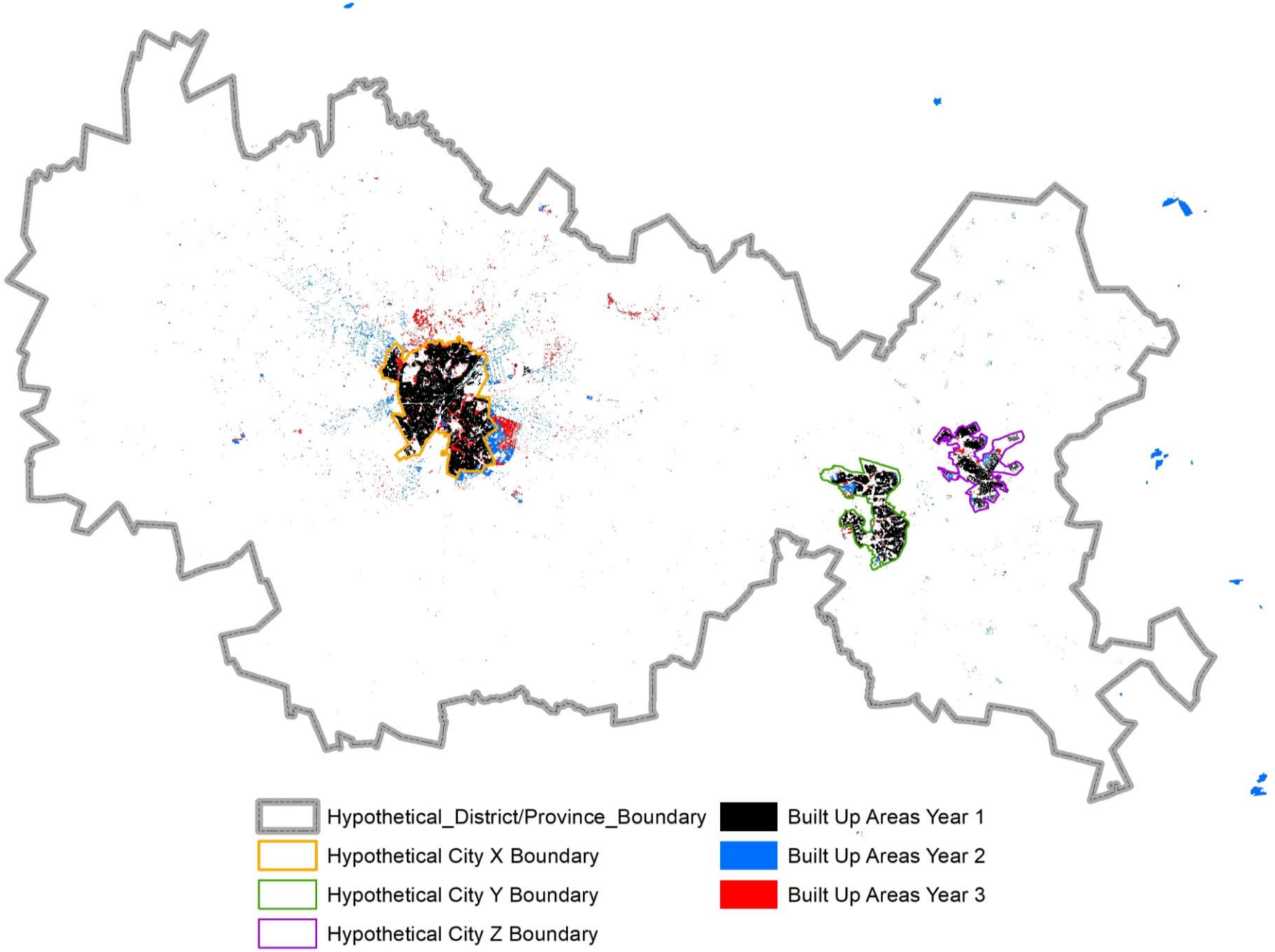




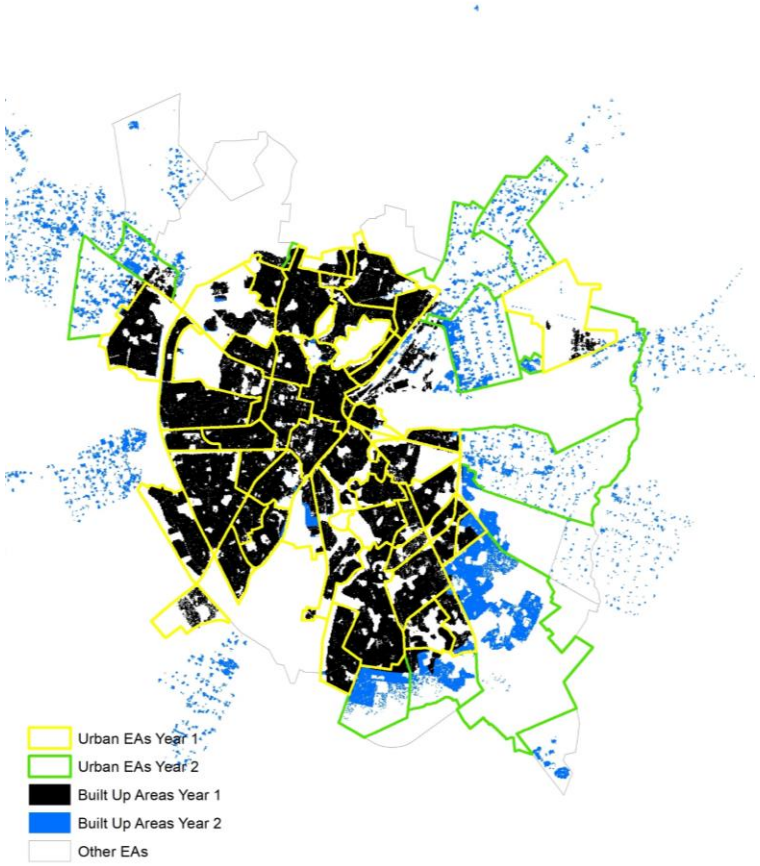


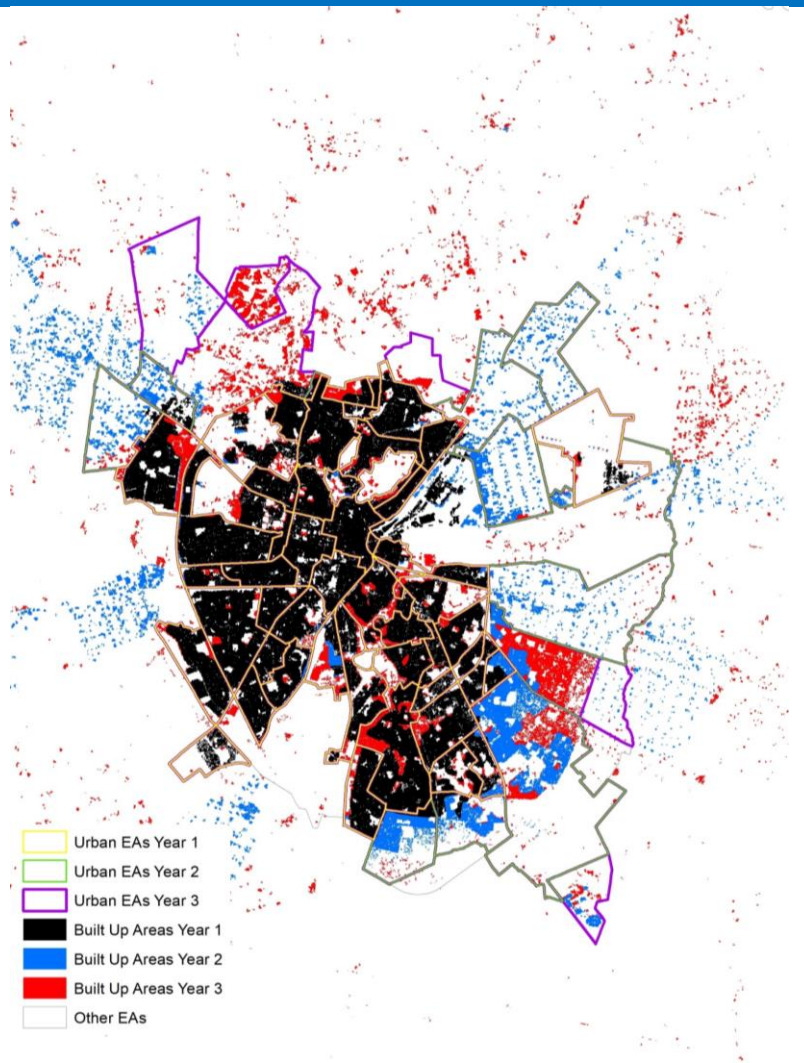
- For demonstration purposes only, map is not authority to boundaries, not a depiction of boundary designations by the United Nations nor a representation of any actual / official designation in any country

Measuring land consumption scenario 2: Fixed admin level boundaries, Situation 2



Measuring land consumption scenario 3: HYPOTHETICAL case using dynamic urban boundaries at admin/census level





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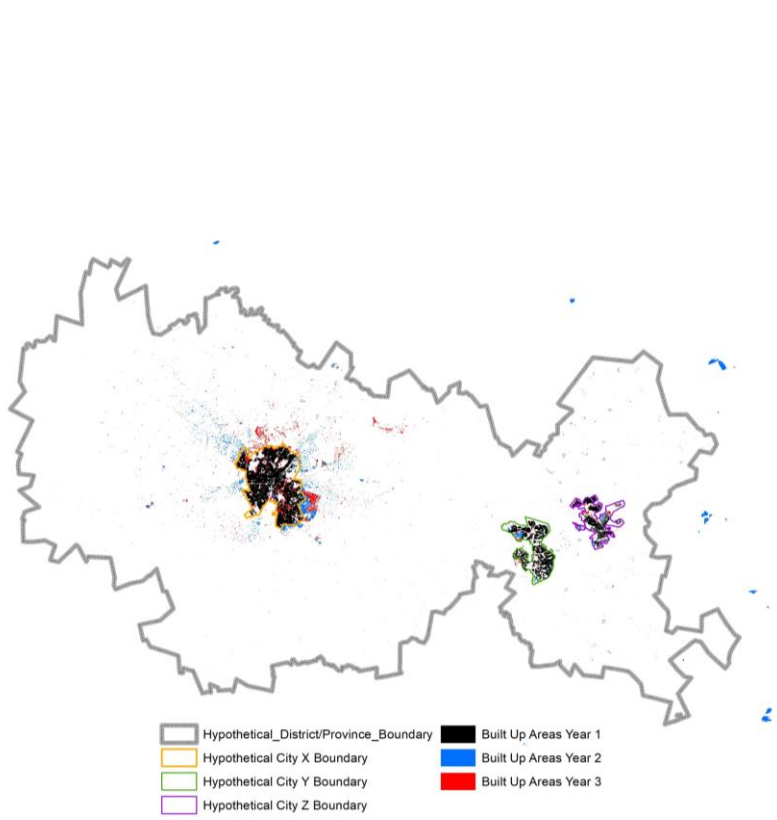
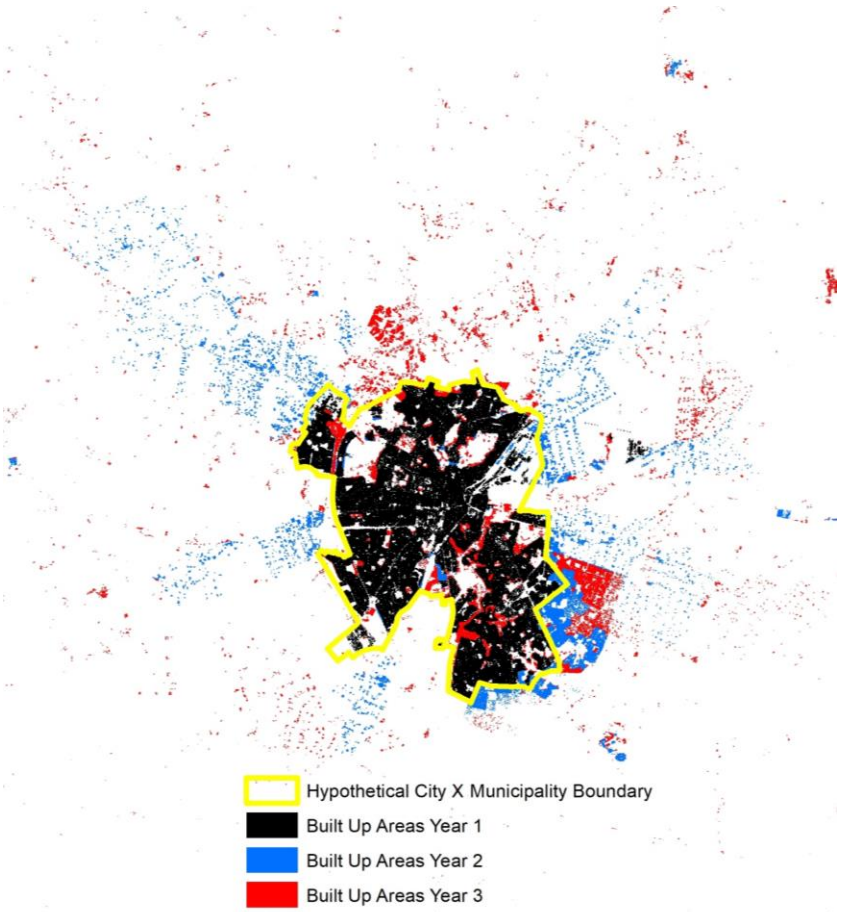
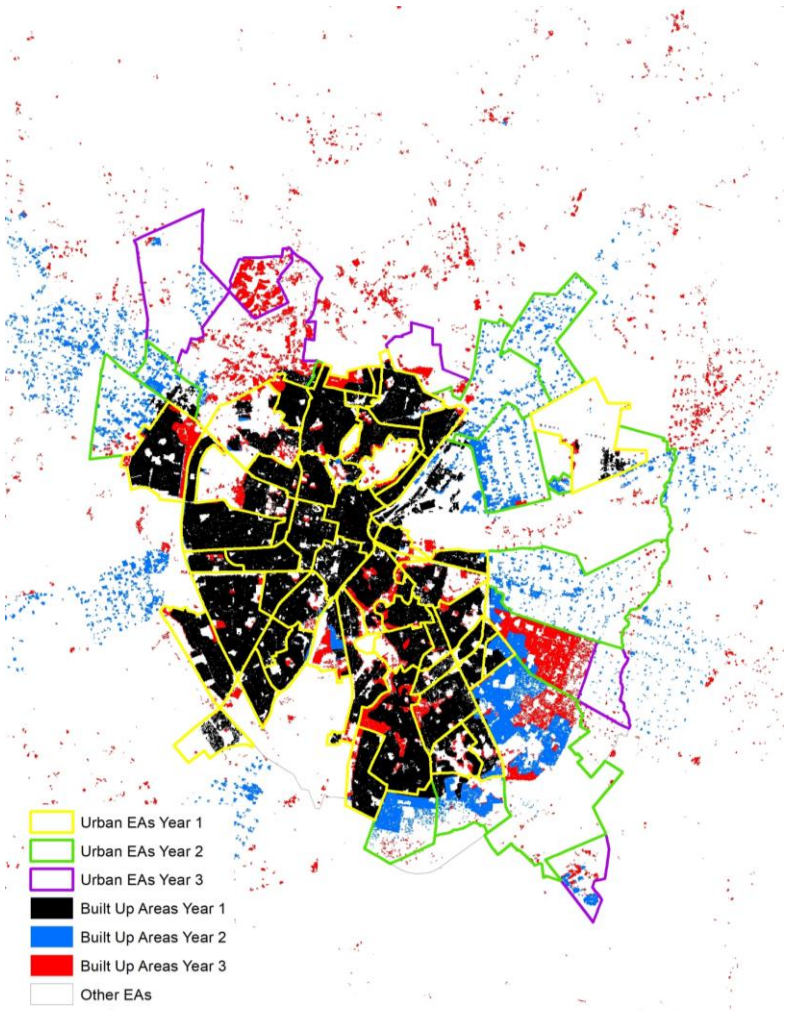
The planner's and decision maker's dilemma in different growth scenarios

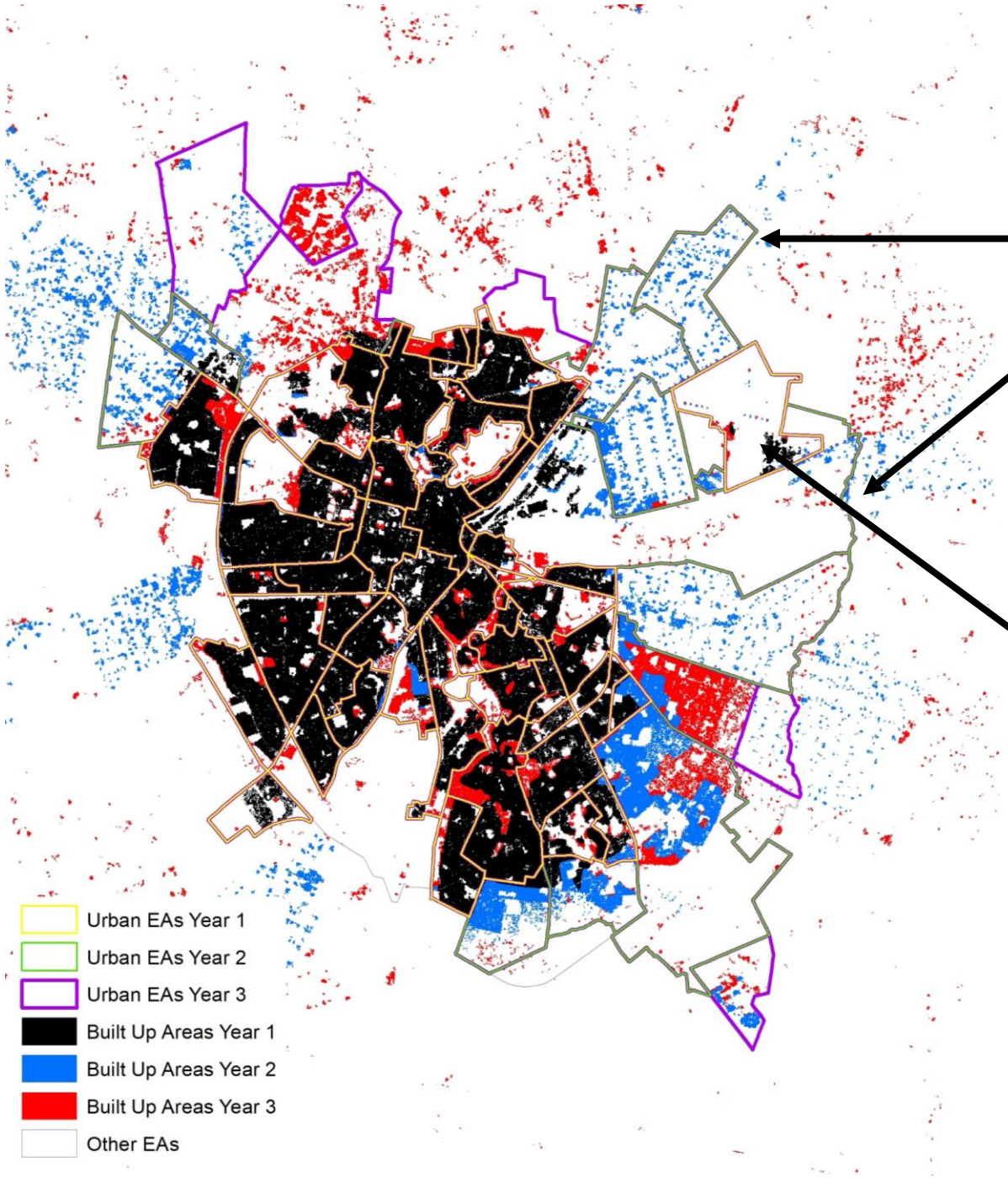






The main aim of Indicator 11.3.1 is to capture real urban change, which quite often happens outside formal boundaries

A today to history measurement ….



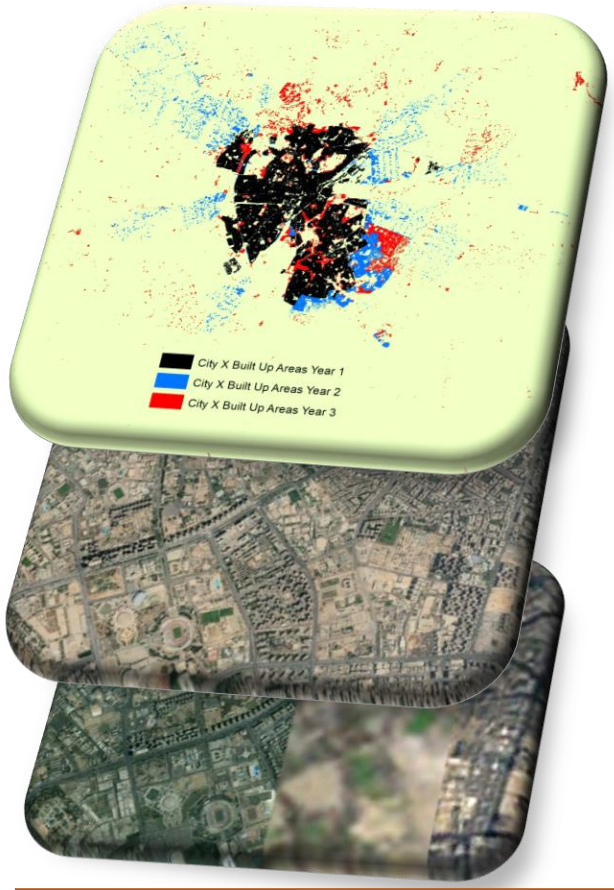
Urban area boundary Year 3 (2015)

Urban Year 1 (1990) within Y3 boundary

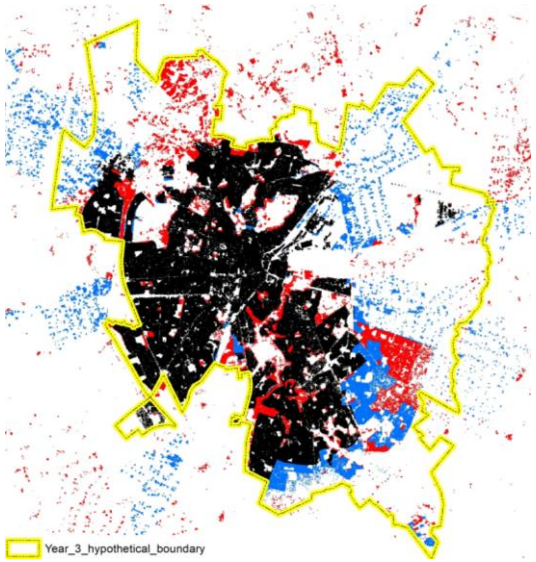
SDG 11.3.1 workflow and data needs

1 Decide the two years for which the indicator should be computed – usually, 5 to 10 year intervals

2 Extract built up areas for each measurement year



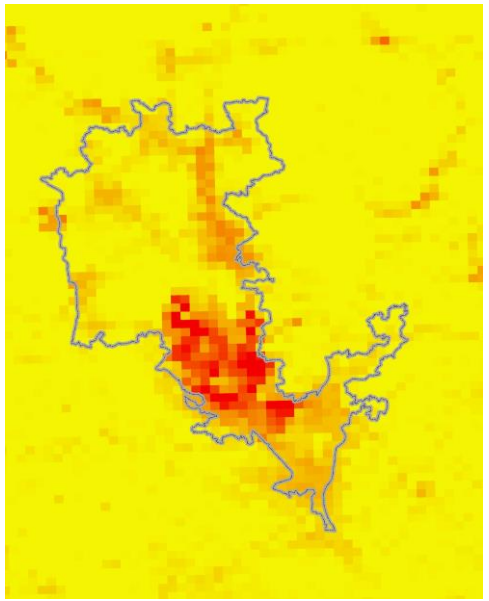
3 Delimit city boundaries



4 Compute land consumption rate

$$\mathbf{LCR}\ (\%) = \frac{\mathbf{LN(Urb_{t+n}/Urb_t)}}{\mathbf{(y)}}$$

5 Integrate population for each analysis year



6 Compute population growth rate

$$\mathbf{PGR}\ (\%) = \frac{\mathbf{LN(Pop_{t+n}/Pop_t)}}{\mathbf{(y)}}$$

7 Compute core indicator: land consumption to population growth rate

$$\mathbf{LCRPGR} = \left(\frac{\mathbf{LCR}}{\mathbf{PGR}}\right)$$

LN - natural logarithm value
Urb_t total built-up areas within the urban area in the initial year
Urb_{t+n} - total built-up areas within the urban area in the current year
Pop_t - population within the urban area in the initial year
Pop_{t+n} population within the urban area in the current year
y is the number of years between the two measurement periods

Historical satellite imagery + geospatial Analysis

EO extracted products, geospatial analysis

Statistical data integration, geospatial analysis

Suggested secondary indicators

a) Land consumption per capita

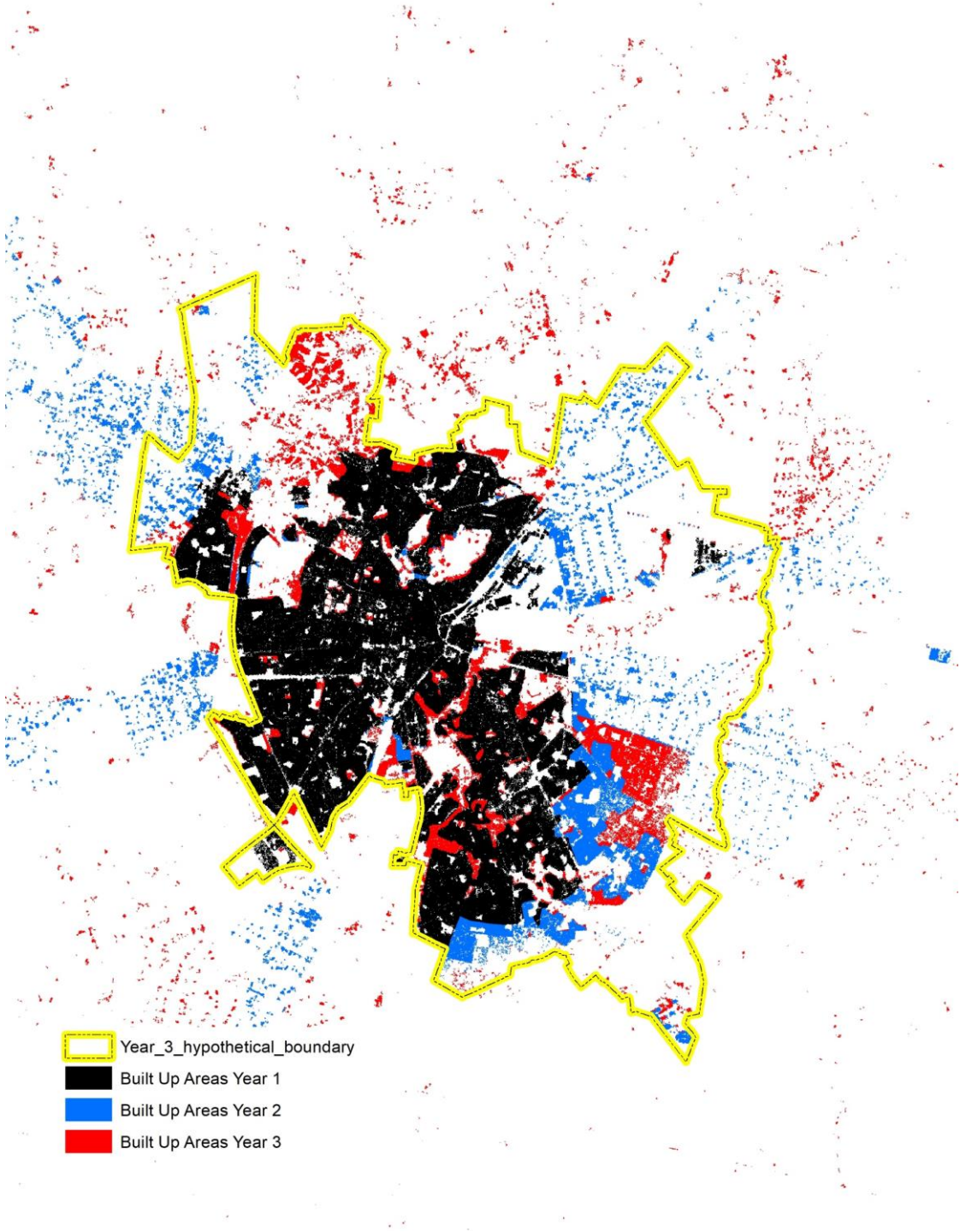
$$\textbf{Built} - \textbf{up area per capita } (\mathrm{m}\,2/\textbf{p erson}) = \left(\frac{\mathbf{UrBU_t}}{\mathbf{Pop_t}}\right)$$

Where
$UrBU_t$ is the total built-up area/city in the urban area in time t (in square meters)
Pop_t is the population in the urban area in time t

b) Total change in built up area

$$\textbf{Total change in built up area } (\%) = \frac{(\mathbf{UrBU_{t+n}} - \mathbf{UrBU_t})}{\mathbf{UrBU_t}}$$

Where:
$UrBU_{t+n}$ is the total built-up area in the urban area/city in time the current/final year
$UrBU_t$ is the total built-up area in the urban area/city in time the past/initial year



Interpretation of indicators for policy making, actions

- A LCRPGR value less than 1 points towards less sprawling cities
- LCRPGR Values need to be analysed against land consumption per capita
- Indicator needs to be evaluated against other indicators – it has significant implications in other urban functions
  - Increasing compactness is good if accompanied by adequate access to other services, open spaces, etc

Why monitor land consumption to population growth rates

- To understand urban transition dynamics
  - Speed of growth for different settlements – how much land is converted from other uses? Which cities are growing faster, why?
  - Direction of growth – which areas require land banks?
  - Type of growth – are urban areas sprawling or densifying? what policies are needed?
- Understanding growth helps to estimate demand for services, direct their provision to the right places
- Development of policies for sustainable urbanization (locally, globally)
  - Intra-city policies and actions / priorities
  - Regional development policies / priorities
- Informs investment – compactness versus dispersal have different investment implications for city
- Can help assess vulnerability and appropriately prepare for disaster response – e.gs rapid settlement in environmentally sensitive areas.
- Understanding historical land consumption patterns/ cultures inform spatial planning
- Indicator provides cities, urban areas, governments with base layers for more advanced settlements/systems analysis

Some Data Sources for Indicator Computation

- **National Statistical Agencies**
  - **C**ustodians of statistical data in countries - Source of population data (incl. high resolution mapped data)
  - Reference authority for data disaggregation, interpolation/extrapolation
- **UNDESA -** Global Urbanization Prospects initiative
- **City/ country high resolution imagery**
  - Country based sensors ; High resolution commercial imagery through partnership with providers
  - The preferred option for indicator computation – where they exist
- **Open source Imagery Platforms**
  - **Landsat** – NASA; 16 days return period ; average 30m spatial resolution
  - **Sentinel 1 & 2**– Copernicus Programme - European Space Agency; 5 – 12 days return period, 10 - 20m spatial resolution
  - **Google Earth** –medium to high resolution free imagery
- **Analytical databases**
  - Urban Indicators database, UN-Habitat – data.unhabitat.org
  - Global Human Settlements Layer (GHSL) & related products, EC/JRC varied data from 1975 – 2015
  - World Settlements Footprint (German Aerospace Center / ESA) – 1985 – 2018 (on request till formal release)
  - Gridded Population of the World (GPW)
  - Worldpop
  - Trends.Earth analytical tool – Conservation International / NASA

Most open source platforms offer good starting point where data is inexistent. Qualities vary

Data Reporting Template send out to countries by UN-Habitat

City name	Analysis Years (Advisable to keep similar months between years)			Built up area within T3 urban area boundaries (Km2)			Total population within T3 urban area boundaries for each analysis year		
	T1	T2	T3	T1	T2	T3	T1	T2	T3
City/urban area 1_Name									
City/urban area 2_Name									
City/urban area 3_Name									
City/urban area 4_Name									
City/urban area 5_Name									
City/urban area 6_Name									
City/urban area 7_Name									
City/urban area 8_Name									
City									
City									
City									

t (Number of years between analysis cycles)		Land Consumption Rate		Population Growth Rate		Ratio of land consumption rate to population growth rate		Land consumption per capita		
t (T1-T2)	t (T2-T3)	T1 - T2	T2 - T3	T1 - T2	T2 - T3	T1 - T2	T2 - T3	T1	T2	T3
0	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
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Detailed guides on indicator computation available

MODULE 3

LAND USE EFFICIENCY

2.1 Computing land consumption rate

2.1.1 The concept of dynamic and functional city boundaries

In this example, we use a small section of the city X to demonstrate why adopting a functional city boundary is important to the indicator measurement. Hypothetical boundaries are created to explain the concept, which do not in any way represent any official boundaries in city X.

Figures 1 and 2 represent two hypothetical city boundary situations and the growth of city X in two time periods (t_1, t_2). In both scenarios, the adopted assumption is that the presence of buildings is a good indicator of urbanness of an area – i.e., an area that is densely built up is likely to be urban, while a sparsely built up area is likely to represent rural settlements.

Figure 1: Boundary scenario 1

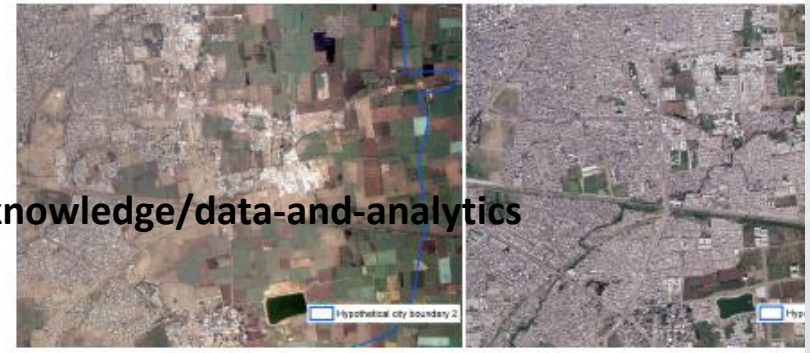

Figure 2: Boundary scenario 2

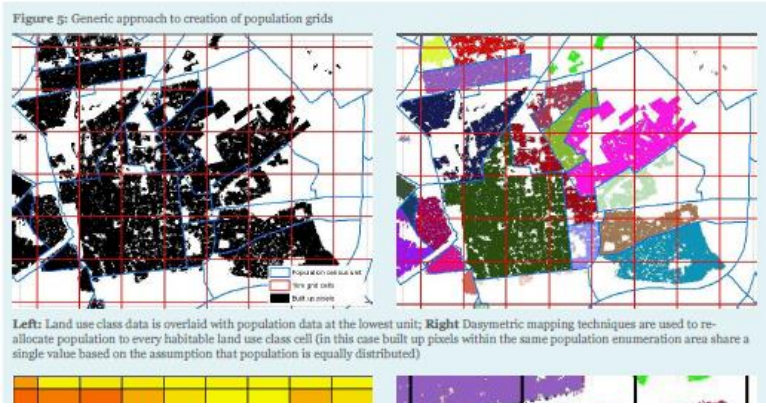

Figure 5: Generic approach to creation of population grids

Left: Land use class data is overlaid with population data at the lowest unit; **Right** Dasymetric mapping techniques are used to re-allocate population to every habitable land use class cell (in this case built up pixels within the same population enumeration area share a single value based on the assumption that population is equally distributed)

https://unhabitat.org/knowledge/data-and-analytics

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