→ EARTH OBSERVATION FOR SUSTAINABLE DEVELOPMENT

Urban Development

City Academy: Geospatial Data Applications for Urban Development, Sao Paulo 16.-17.09.2019

Earth Observation for the Assessment of Indicators for the SDG 11

Amelie Broszeit, GAF AG

urban development
eo4sd

GAF AG SIRS gisat DLR egis JOANNEUM RESEARCH NEO GISBOX

Agenda

1) Introduction and Objectives
2) Defining Urban, City and Human Settlement
3) SDG 11 Indicators supported by EO Data
   - **11.1.1:** Proportion of urban population living in slums, informal settlements or inadequate housing
   - **11.2.1:** Proportion of the population that has convenient access to public transport by sex, age and persons with disabilities
   - **11.3.1:** Ratio of land consumption rate to population growth rate
   - **11.7.1:** Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities
4) Conclusion

Introduction & Objectives

The Need of a Robust Monitoring Framework

Objective of the SDGs:

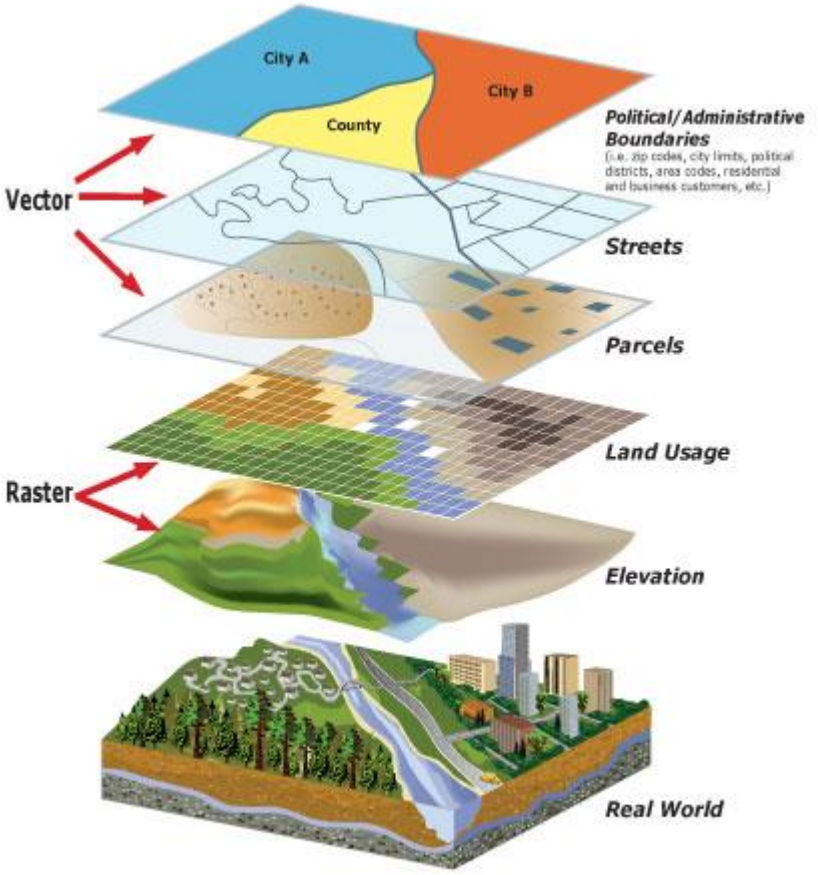
→ Monitor indicators in a harmonised way.

Problem:

- Too often, existing city data is not adequately detailed, documented, accessible and timely or harmonized.
- Very often no data at all is available

→ Good reliable data is a key element in impeding process in monitoring and reporting

Solution

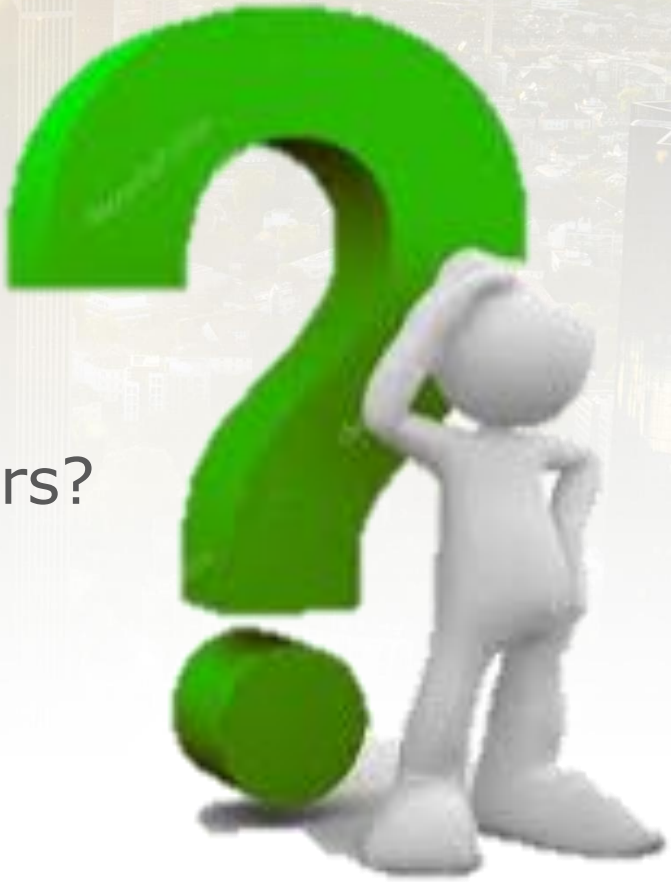


- Earth Observation
- Geospatial information

~80 to 90 percent of government information has a geographic component.

→ Geospatial data can support urban planning activities.

How to implement SDG 11 Indicators?



Defining Urban, City and Human Settlement

"Cities"

"Human Settlements"

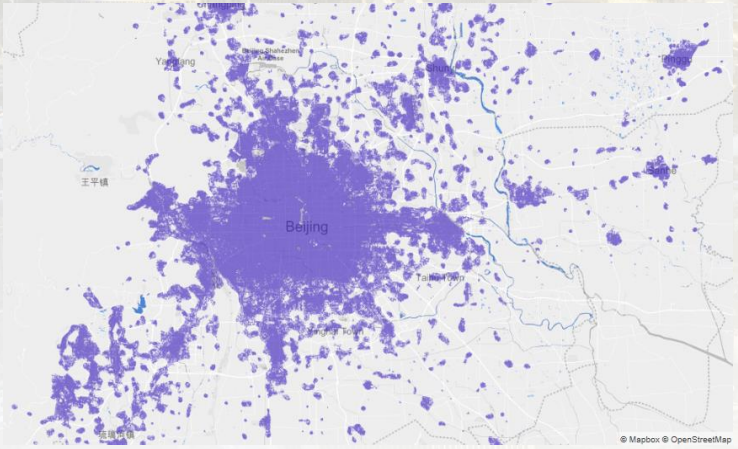
"Urban"

"Built-up Area of the Urban Agglomeration"

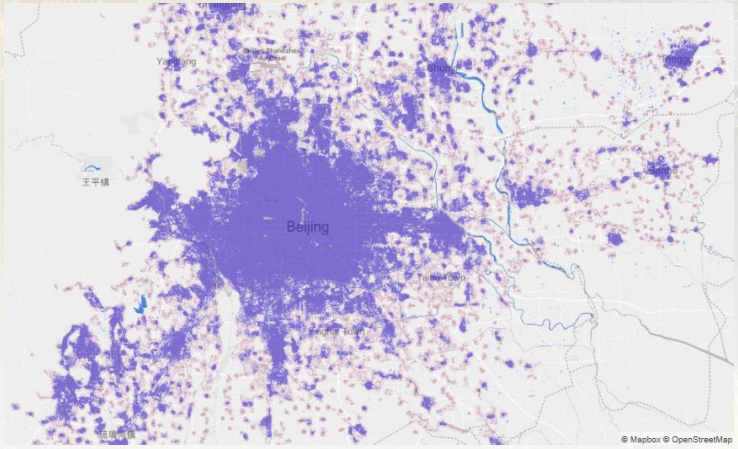
Defining Urban, City and Human Settlement

"Built-up Area of the Urban Agglomeration"

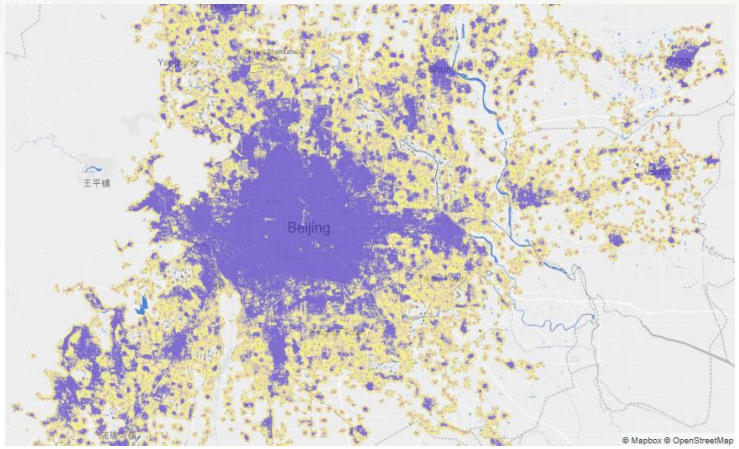
Build-Up Area



Build-Up Area
Suburban Built-Up
Rural Built-Up



Build-Up Area
Suburban Built-Up
Rural Built-Up
Urbanized Open Space



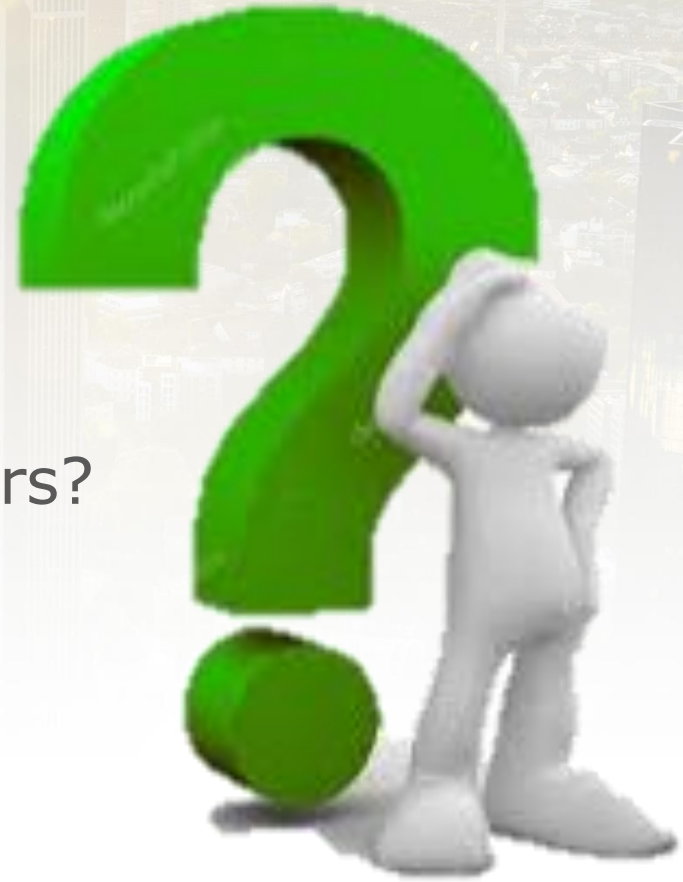
City of Beijing, 2013, Atlas of Urban expansion (http://www.atlasofurbanexpansion.org/cities/view/Beijing_Beijing)

Different Possibilities to extract the Built-up Area

- **Population data** (e.g. UN DESA, Global Human Settlement Population Layer, WorldPop, …)

- **Built-up area / Land that is fully developed** (e.g. World Settlement Footprint, EO4SD-Urban Land Use/Land Cover product, Global Human Settlement Layer, Eurostat, World Bank and Lincoln Institute collected data for 120 cities and published it in the Atlas of Urban Expansion, UN-Habitat, Lincoln Institute and New York University prepared a similar study for another 200 cities, UN-Habitat City Prosperity Initiative is collecting data on this indicator for nearly 300 cities, …)

How to implement SDG 11 Indicators?



SDG 11 Indicators supported by EO Data

SUSTAINABLE DEVELOPMENT GOAL 11:

Make cities and human settlements inclusive, safe, resilient and sustainable

Target 11.1: Housing and Slums	**11.1.1:** Proportion of urban population living in slums, informal settlements or inadequate housing
Target 11.2: Public Transport	**11.2.1:** Proportion of the population that has convenient access to public transport by sex, age and persons with disabilities
Target 11.3: Land Consumption	**11.3.1:** Ratio of land consumption rate to population growth rate
Target 11.7: Public Space	**11.7.1:** Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities

Target 11.1: By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums.

11.1.1: Proportion of urban population living in slums, informal settlements or inadequate housing.

Indicator Definition:

This indicator combines the components of slums, of informal settlements and of inadequate housing to have a universal indicator that can be used to monitor these areas in both developing and developed regions.

The indicator considers three components which are computed as follows:

a) Slum Households (SH) = $$\frac{100x\ (\text{No.of people living in slums})}{\text{City Population}}$$

b) Informal Settlement Households (ISH) = $$\frac{100x\ (\text{No.of people living in informal settlements households})}{\text{City Population}}$$

c) Inadequate Housing Households (IHH) = $$\frac{100x\ (\text{No.of people living in inadequate housing})}{\text{City Population}}$$

Target 11.1: By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums.

11.1.1: Proportion of urban population living in slums, informal settlements or inadequate housing.

Concept:

SLUM

- No improved drinking water
- No improved sanitation facilities
- No sufficient living area
- No housing durability
- No security of tenure

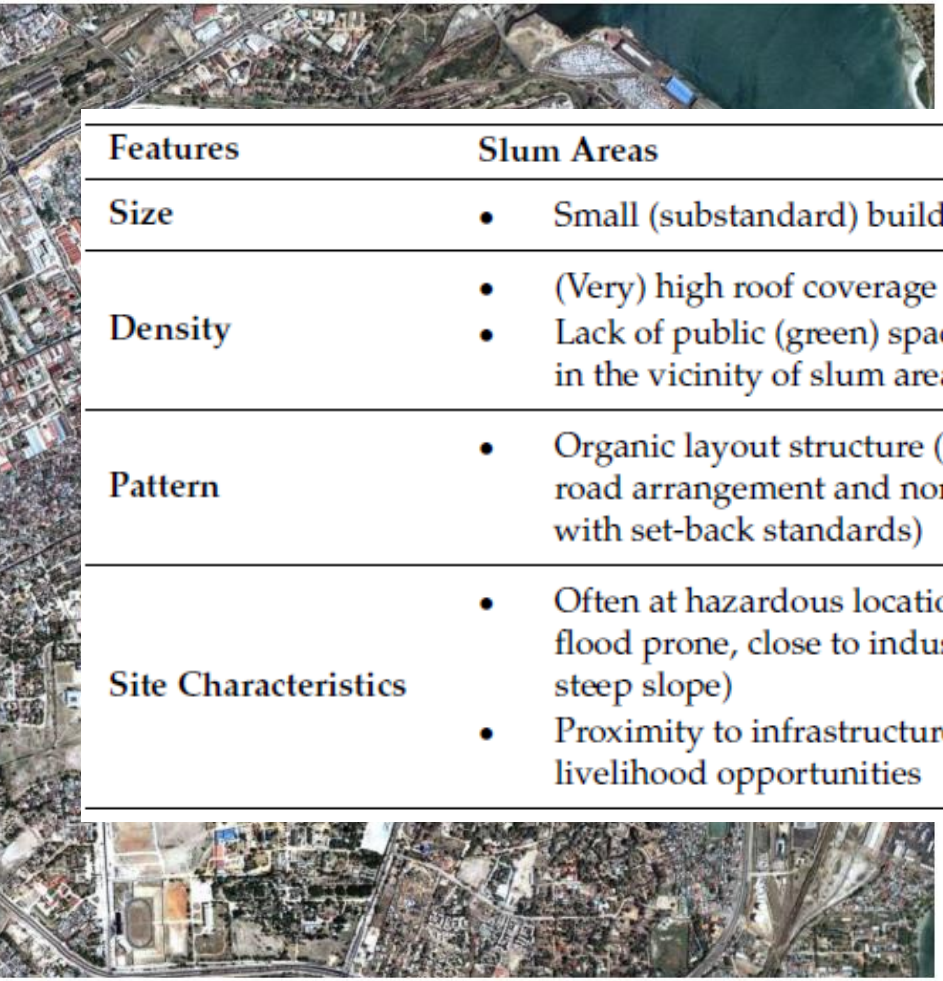
INFORMAL SETTLEMENTS

- Lack, or cut off from, formal basic services
- Inhabitants have no security of tenure
- Housing may not comply with current planning and building regulations

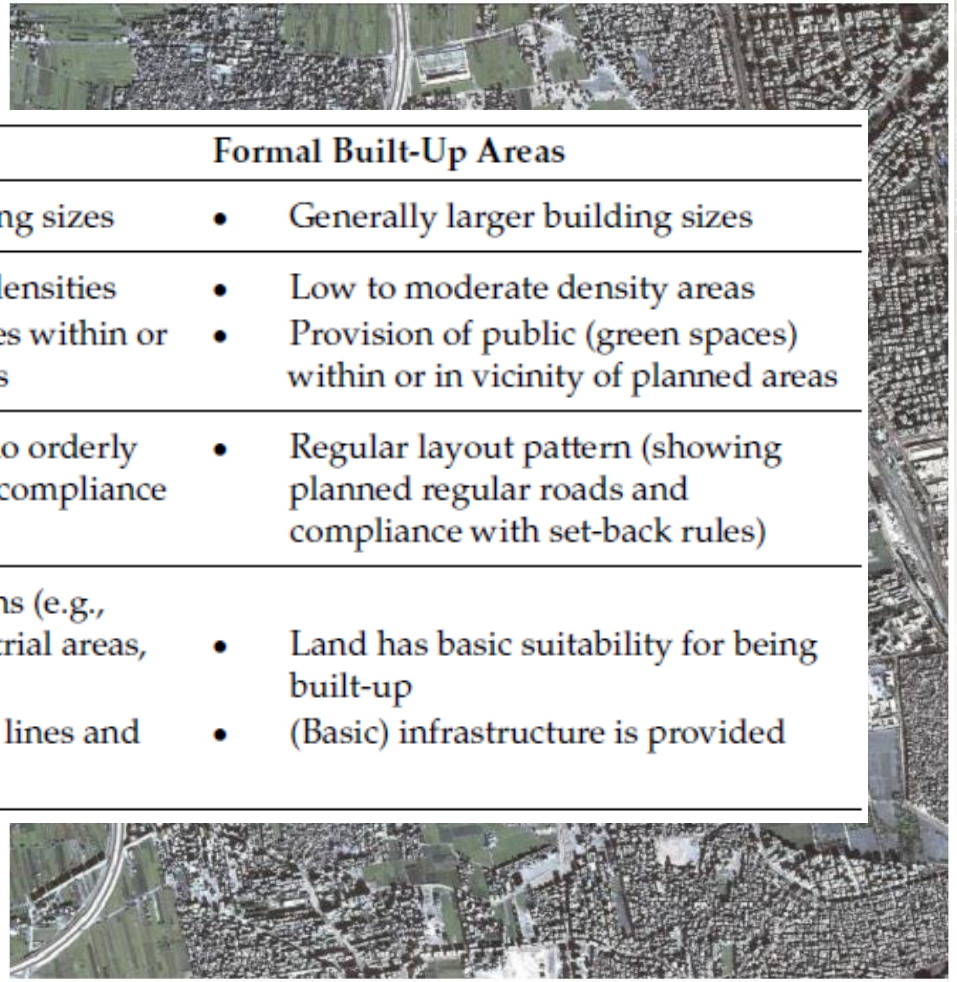
INADEQUATE HOUSING

- Legal security of tenure
- Availability of services, materials,
- Facilities and infrastructure
- Affordability
- Habitability
- Accessibility
- Location
- Cultural adequacy

Target 11.1: By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums.



Features	Slum Areas	Formal Built-Up Areas
Size	• Small (substandard) building sizes	• Generally larger building sizes
Density	• (Very) high roof coverage densities • Lack of public (green) spaces within or in the vicinity of slum areas	• Low to moderate density areas • Provision of public (green spaces) within or in vicinity of planned areas
Pattern	• Organic layout structure (no orderly road arrangement and noncompliance with set-back standards)	• Regular layout pattern (showing planned regular roads and compliance with set-back rules)
Site Characteristics	• Often at hazardous locations (e.g., flood prone, close to industrial areas, steep slope) • Proximity to infrastructure lines and livelihood opportunities	• Land has basic suitability for being built-up • (Basic) infrastructure is provided



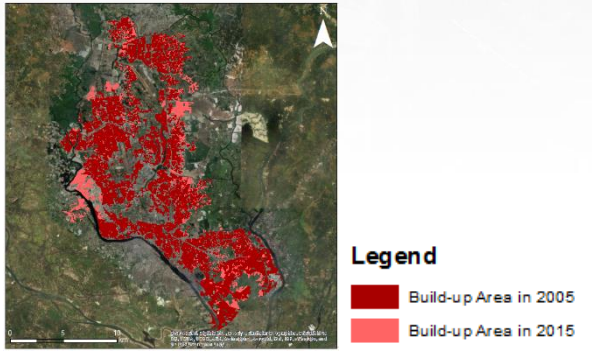
Left: Colour orthophoto (60cm resolution) of Dar es Salaam, Tanzania. Right: Ikonos image (1m) of Cairo, Egypt (Sliuzas et al. 2008). Morphological features typical for slum areas (adopted from Kuffer et al. (2014) and Baud et al. (2010))

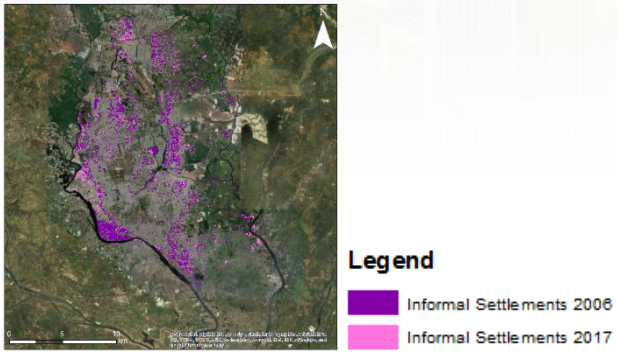
Target 11.1: By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums.

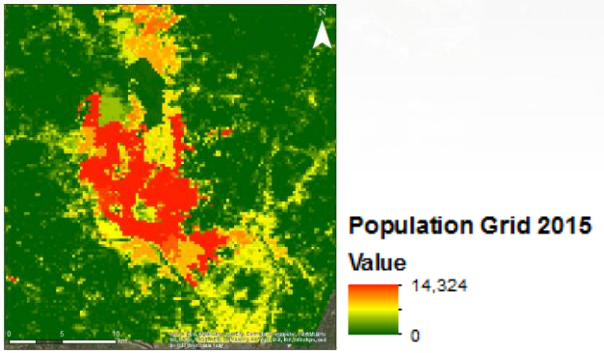
11.1.1: Proportion of urban population living in slums, informal settlements or inadequate housing.

Required Input Data:

- Built-up area of the urban agglomeration
- Extent of informal settlements (Information on the typical pattern of informal settlement in this region is helpful)
- Population raster data (or Census data)



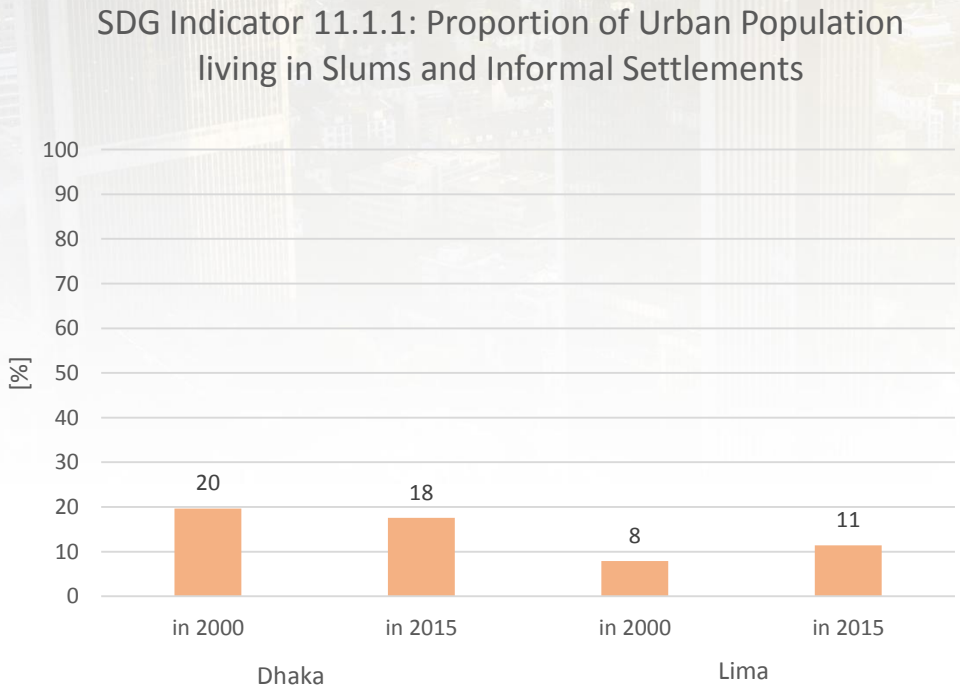




Target 11.1: By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums.

11.1.1: Proportion of urban population living in slums, informal settlements or inadequate housing.

Results for Dhaka, Bangladesh and Lima, Peru:



11.2.1: Proportion of the population that has convenient access to public transport by sex, age and persons with disabilities.

Indicator Definition:

The indicator aims to monitor the use and access of public transportation system and move towards reaching a convenient access for all.

→ Access to public transport is considered convenient when an officially recognised stop is accessible within a distance of 0.5 km from a reference point such as home, school, workplace, market, etc. (UN-Habitat, 2017).

$$\% \text{ with access to public transport} = \frac{100x\ (population\ with\ convenient\ access\ to\ public\ transport\ )}{city\ population}$$

11.2.1: Proportion of the population that has convenient access to public transport by sex, age and persons with disabilities

Limitations:

- Convenience measured as distance does not illustrate quality of Public Transport station

You might be 0.5 km away from the nearest bus stop, but …

Target 11.2: By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, and children, persons with disabilities and older persons.

11.2.1: Proportion of the population that has convenient access to public transport by sex, age and persons with disabilities

Limitations:

Convenient access??

Accessibility

Frequency

Affordability

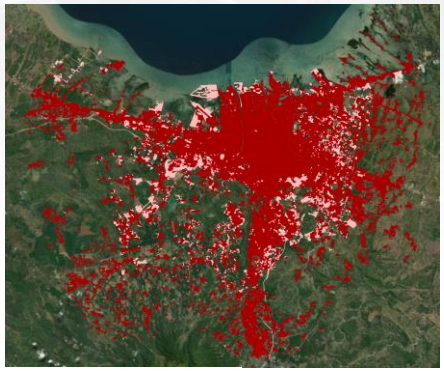
Safety

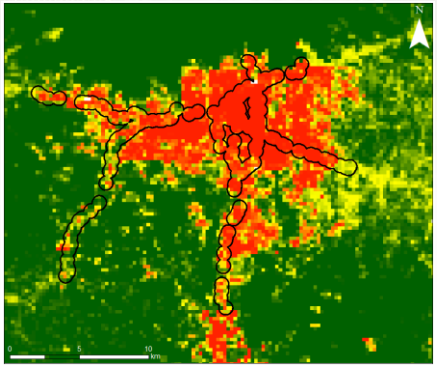
Target 11.2: By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, and children, persons with disabilities and older persons.

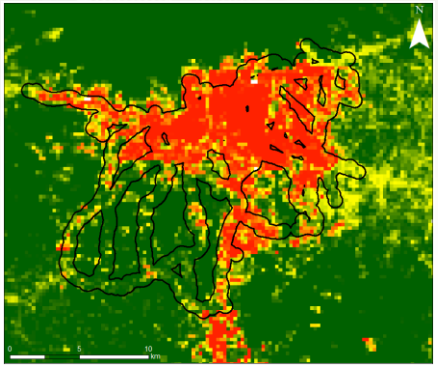
11.2.1: Proportion of the population that has convenient access to public transport by sex, age and persons with disabilities

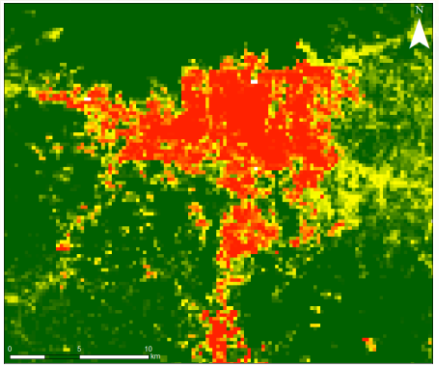
Required Input Data:

- Built up area of the urban agglomeration
- Data on public transport stations
- Population raster









Legend

Build-up Area in 2005

Build-up Area in 2015

BRT stations with a buffer of 500m

Angkot stations with a buffer of 500m

GHSL Population Data

Number of persons per pixel

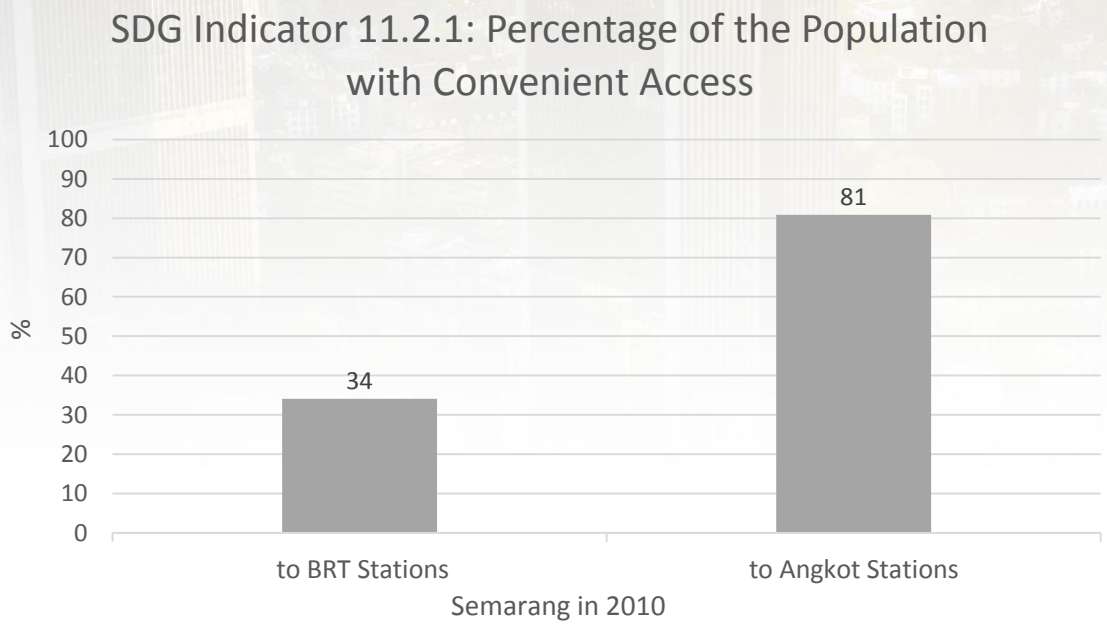
High : 1203

Low : 0

Target 11.2: By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, and children, persons with disabilities and older persons.

11.2.1: Proportion of the population that has convenient access to public transport by sex, age and persons with disabilities

Results for Semarang, Indonesia:



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.

11.3.1: Ratio of land consumption rate to population growth rate

Indicator Definition:

Land Consumption rate = the annual rate at which cities uptake land for urbanised uses (both built-up and open space demand)

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

Urb_t	Total areal extent of the urban agglomeration in km^2 for past/ initial year
Urb_{t+n}	Total areal extent of the urban agglomeration in km^2 for current year
y	The number of years between the two measurement periods

Population Growth rate = the change in population in a given area over a unit period of time; expressed as percentage of the number of individuals in the population at the beginning of that period.

$$PGR = \frac{LN(Pop(_{t+n})/Popt)}{(y)}$$

Pop_t	Total population within the city in the past/initial year
Pop_{t+n}	Total population within the city in the current/final year
y	The number of years between the two measurement periods

11.3.1: Ratio of land consumption rate to population growth rate

Indicator Definition:

The indicator is calculated by using following formula:

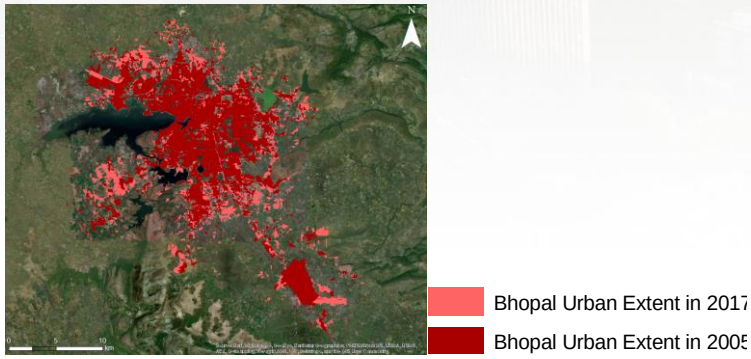
Ratio of land consumption rate to population growth rate (LCRPGR) =

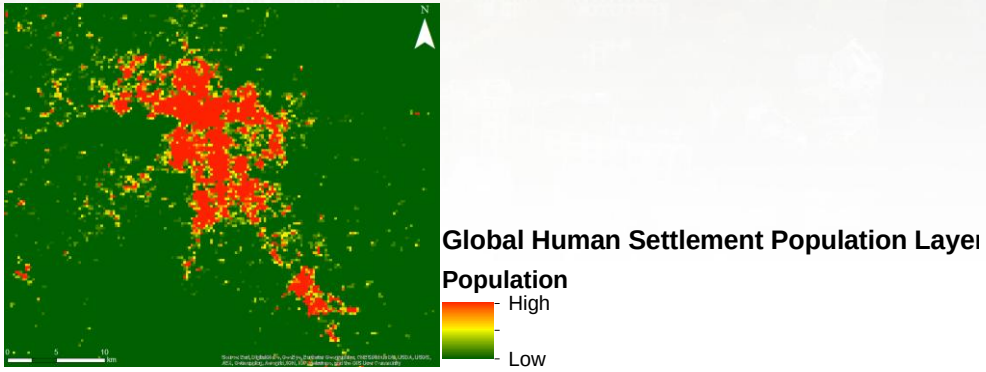
$$\frac{\text{Land consumption rate}}{\text{Annual population growth rate}}$$

11.3.1: Ratio of land consumption rate to population growth rate

Required Input Data:

- Built-up area of the urban agglomeration
- Population raster data (or Census data)

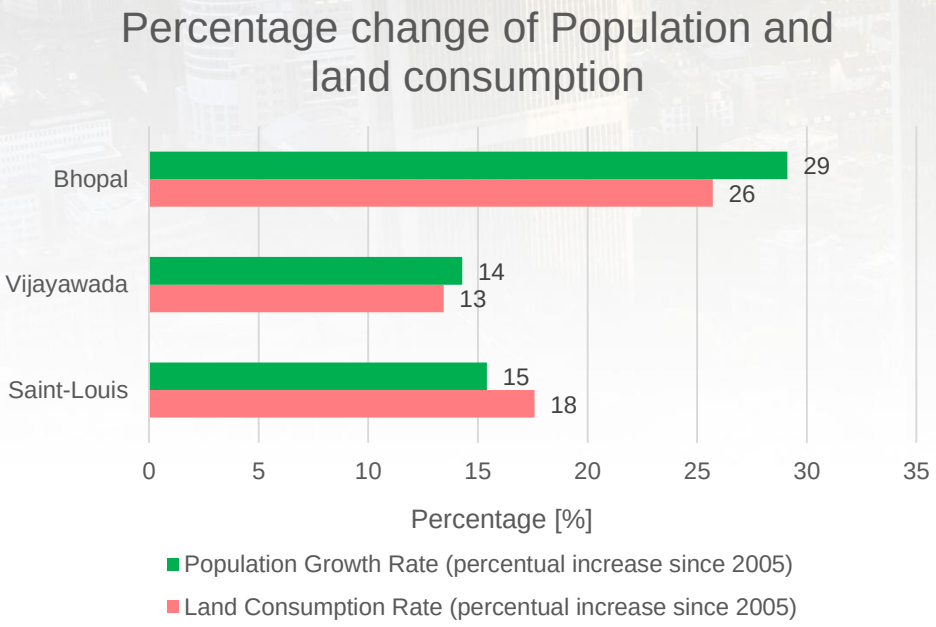


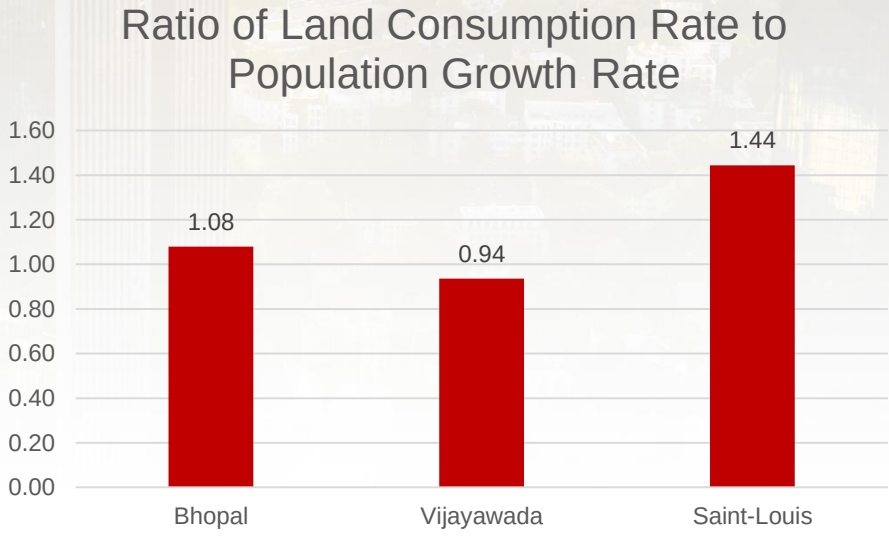


Target 11.3: By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries.

11.3.1: Ratio of land consumption rate to population growth rate

Results:





Target 11.7: By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities.

11.7.1: Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities.

Indicator Definition:

This indicator aims to monitor the amount of land that is dedicated by cities for public space. According to the UN-Habitat Methodological Guidance document (UN-Habitat, 2017) public space includes open spaces and streets and should be accessible by all.

% of land that is dedicated by cities for public space (open spaces and streets) =

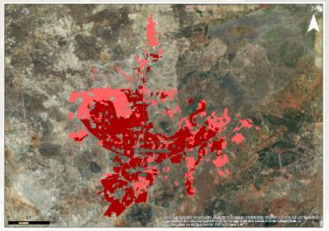
$$100\ \frac{(\text{Total surface of open public space} + \text{Total surface of land allocated to streets})}{\text{Total surface of built up area of the urban agglomeration}}$$

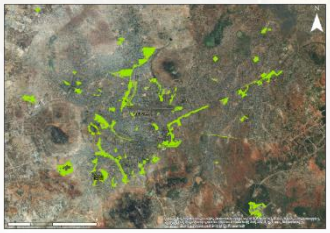
Target 11.7: By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities.

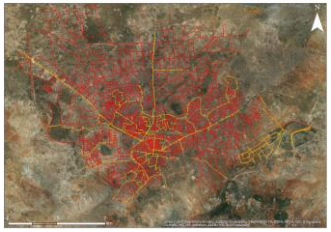
11.7.1: Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities.

Required Input Data:

- Built-up area of the urban agglomeration
- Public spaces
- Road network
- Information on the public accessibility of open spaces (in-situ)



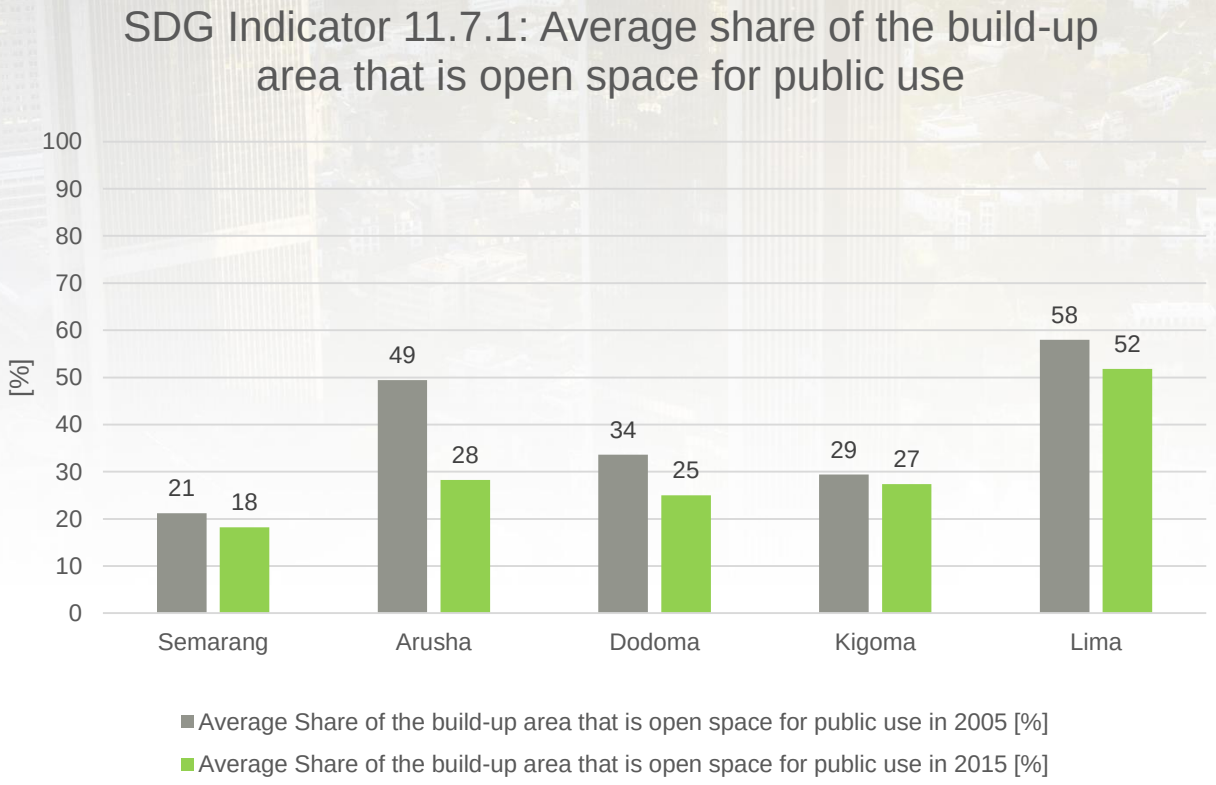




Target 11.7: By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities.

11.7.1: Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities.

Results:



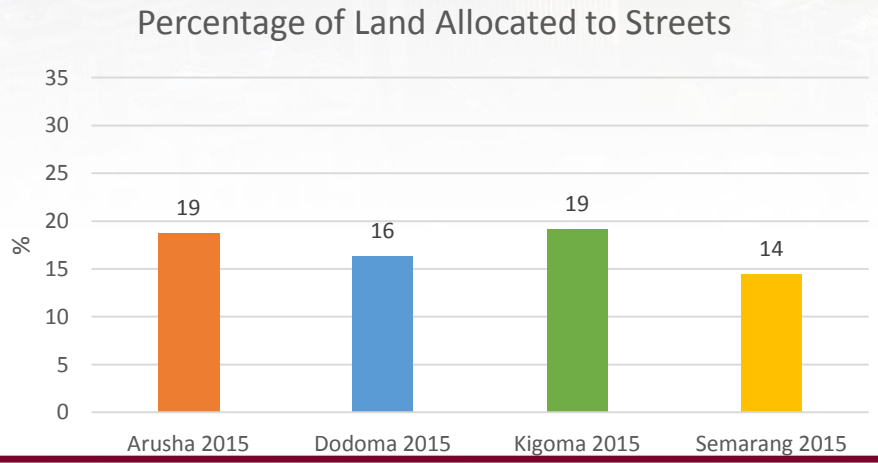
Target 11.7: By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities.

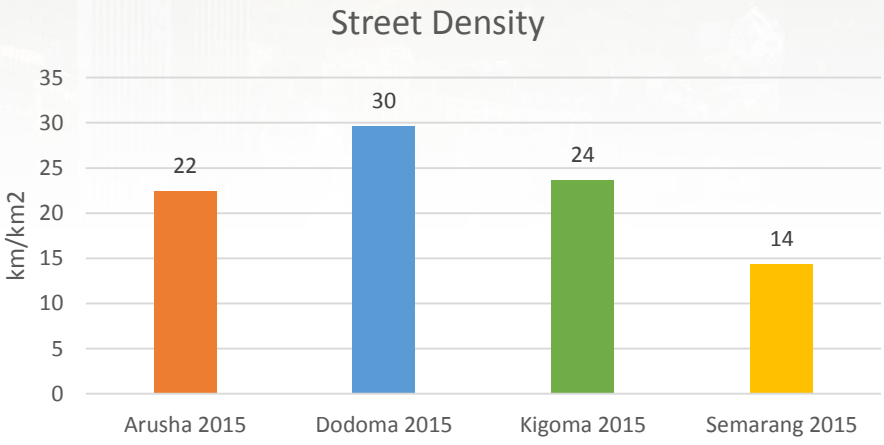
11.7.1: Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities.

Interpretation of the Indicator Metrics:

To achieve a sustainable neighbourhood planning and a productive urban system, UN-Habitat recommends to have

- At least 30% of land allocated to streets
- At least 18km/km2 of roads (Street Density)





Conclusion

Pros:

- SDG Indicator calculation can be supported with EO data in a harmonised way on national or international level
- EO data is more cost efficient than traditional in situ techniques

Cons:

- Calculation of these indicators with EO data is an estimation of the indicator.

Fazit:

- EO data can be used to support some SDG 11 indicators
- The indicators sometimes itself have limitations, e.g. the land consumption indicator.

References

- **Asia-Pacific Regional Training Workshop on Human Settlement Indicators**, 26.03.2018 - 29.03.2018, Bangkok (Thailand), https://www.unescap.org/events/asia-pacific-regional-training-workshop-human-settlement-indicators
  - Abilla, a. (2018): Presentation on Module 1: Slums, Informal settlements and inadequate housing, https://www.unescap.org/sites/default/files/Module%201_Slums%20and%20Informal%20Settlements%20for%20SDG%20indicator%2011.1.pdf
  - Nijru, E. (2018): Module 2: Public Transport, https://www.unescap.org/sites/default/files/Module%202_Public%20Transport%20for%20SDG%20indicators%2011.2.pdf
  - Mwaniki, D. et. al. (2018): Module 3 Indicator 11.3.1 Land Consumption Rate to Population Growth Rate, https://www.unescap.org/sites/default/files/Module%203_Land%20Consumption%20Rate%20to%20Population%20Growth%20Rate%20for%20indicator%2011.3.pdf
  - Mwaniki, D. et. al. (2018): Module 6 Indicator 11.7.1: Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities, https://www.unescap.org/sites/default/files/Module%206%20_Public%20Spaces.pdf.

- Nicolau, R. et. al. (2018): Ratio of Land Consumption Rate to Population Growth Rate—Analysis of Different Formulations Applied to Mainland Portugal, ISPRS Int. J. Geo-Inf. 2019, 8, 10.
- UN-Habitat (2017): A Guide to assist National and Local Governments to Monitor and Report on SDG Goal 11+ Indicators.
- Baud, I., Kuffer, M., Pfeffer, K., Sliuzas, R., Karuppannan, S. (2010): Understanding heterogeneity in metropolitan India: The added value of remote sensing data for analyzing sub-standard residential areas, *International Journal of Applied Earth Observation and Geoinformation*, vol. 12, no. 5, pp. 359–374.
- Kuffer, M., Barros, J., Sliuzas, R. (2014): The development of a morphological unplanned settlement index using very-high-resolution (VHR) imagery. *Computers, Environment and Urban Systems*, vol. 48, November 2014, pp. 138–152.

Thank you for your attention!

GAF AG
Dr. Thomas Häusler (EO4SD-Urban Coordinator)
Dr. Sharon Gomez
Amelie Broszeit
Arnulfstr.199, 80609 Munich - GERMANY

www.gaf.de
thomas.haeusler@gaf.de
sharon.gomez@gaf.de
amelie.broszeit@gaf.de