Showcase on SDG 11.3.1 Land Consumption

Policy context

With the unanimous adoption of the United Nations (UN) General Assembly resolution 70/1 "Transforming our World: the 2030 Agenda for Sustainable Development" Member States agreed upon a framework of 17 Sustainable Development Goals (SDG) to guide societal development. These goals include goal 11: "Sustainable Cities and Communities" which have 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". This target progress can be indicated by usage of indicator 11.3.1: "Ratio of land consumption rate to population growth rate".

Many SDG 11 indicators require fine scale local data that are to be sourced locally, making it more difficult to reach adequate data availability –especially in countries in transitions and data-poor territories. Against this condition, remote sensing and EO are capable to collect information, at a large scale, at high degree of spatial resolution, repeatedly over time, and over wide geographical areas serving multiple applications, especially in the SDG framework, or for generic urban development indicators.

The indicator 11.3.1 requires defining the two components of population growth and land consumption rate. Computing the population growth rate is more straightforward and more readily available, while land consumption rate is slightly challenging, and requires the use of new techniques. In estimating the land consumption rate, one needs to define what constitutes "consumption" of land since this may cover aspects of "consumed" or "preserved" or available for "development" for cases such as land occupied by wetlands. Secondly, there is not one unequivocal measure of whether land that is being developed is truly "newly-developed" (or vacant) land, or if it is at least partially "redeveloped". As a result, the percentage of current total urban land that was newly developed (consumed) will be used as a measure of the land consumption rate. The fully developed area is also sometimes referred to as built up area.

Cities require an orderly urban expansion that makes the land use more efficient. They need to plan for future internal population growth and city growth resulting from migrations. They also need to accommodate new and thriving urban functions such as transportation routes, etc., as they expand. However, frequently the physical growth of urban areas is disproportionate in relation to population growth, and these results in land use that is less efficient in many forms. This type of growth turns out to violate every premise of sustainability that an urban area could be judged by including impacting on the environment and causing other negative social and economic consequences such as increasing spatial inequalities and lessening of economies of agglomeration.

This indicator is connected to many other indicators of the SDGs. It ensures that the SDGs integrate the wider dimensions of space, population and land adequately, providing the

framework for the implementation of other goals such as poverty, health, education, energy, inequalities and climate change. The indicator has a multipurpose measurement, as it is not only related to the type/form of the urbanization pattern. It is also used to capture various dimensions of land use efficiency: economic (proximity of factors of production); environmental (lower per capita rates of resource use and GHG emissions); social (reduced travel distance and cost expended). Finally, this indicator integrates an important spatial component and is fully in line with the recommendations made by the Data Revolution initiative

Population growth rate (PGR) is the increase of a population in a country during a period, usually one year, expressed as a percentage of the population at the start of that period. It reflects the number of births and deaths during a period and the number of people migrating to and from a country. Land consumption includes: (a) The expansion of built-up area which can be directly measured; (b) the absolute extent of land that is subject to exploitation by agriculture, forestry or other economic activities; and (c) the over-intensive exploitation of land that is used for agriculture and forestry. To make this indicator more measurable Land Consumption can be simplified to artificial land cover type as built-up-area. In this way land consumption can be easily measured by remote sensing data. This simplification is already proposed and tested by JRC EU Commission specialist and published in paper Michael Melchiorri et. al. "Principles and Applications of the Global Human Settlement Layer as Baseline for the Land Use Efficiency Indicator –SDG 11.3.1" and Human Settlement Layer is already proposed for usage in UNstats 11.3.1 indicator metadata (https://unstats.un.org/sdgs/metadata/files/Metadata-11-03-01.pdf).

So methodology for this indicator calculation can be described in this way:

1. Using statistic provided by governments or other geospatial products available for cities in country of interest such as UN DESA population data or Global Human Settlement Layer Population Grid calculate Population Growth rate by the formula $PGR = \ln\left(\frac{P_{t+n}}{P_t}\right)/n$, where P_t - population in t year, n - number of observed years
2. Using land cover maps for country of interest get built-up area for city and calculate Land Consumption Rate by formula $LCR = \ln\left(\frac{BA_{t+n}}{BA_t}\right)/n$, where BA_t - built-up area in t year, n - number of observed years
3. Calculate the ratio of land consumption rate to population growth rate (LCRPGR) as:

$$LCRPGR = LCR/PGR$$

To estimate land consumption rate we propose methodology of land cover classification for urban area, on the base of which it is possible to estimate built-up area for large territory of interest and even for the whole country. Our methodology (Fig. 1) provides high accuracy due to satellite data Sentinel-1 and Sentinel-2 usage. Classification maps can be produced with the 10 m spatial resolution annually.

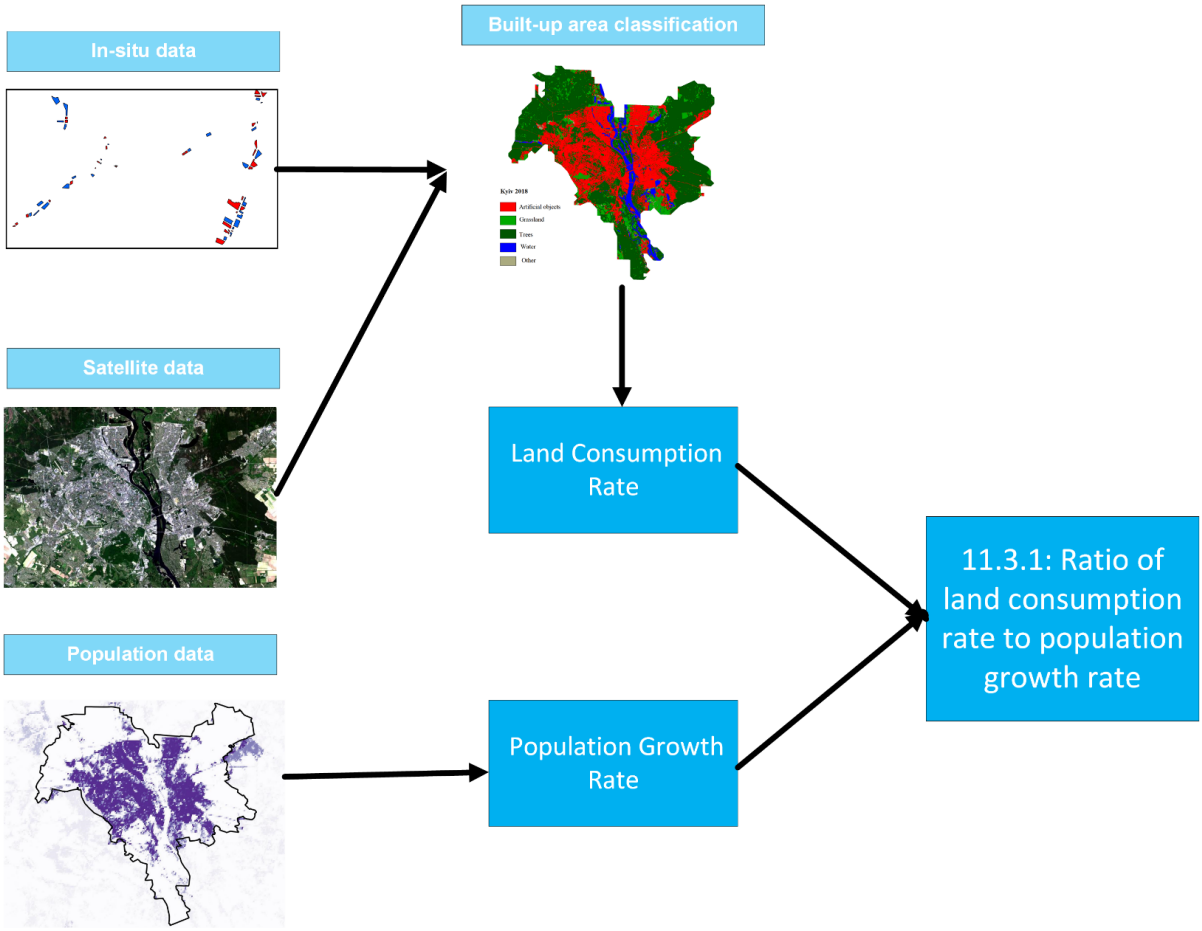
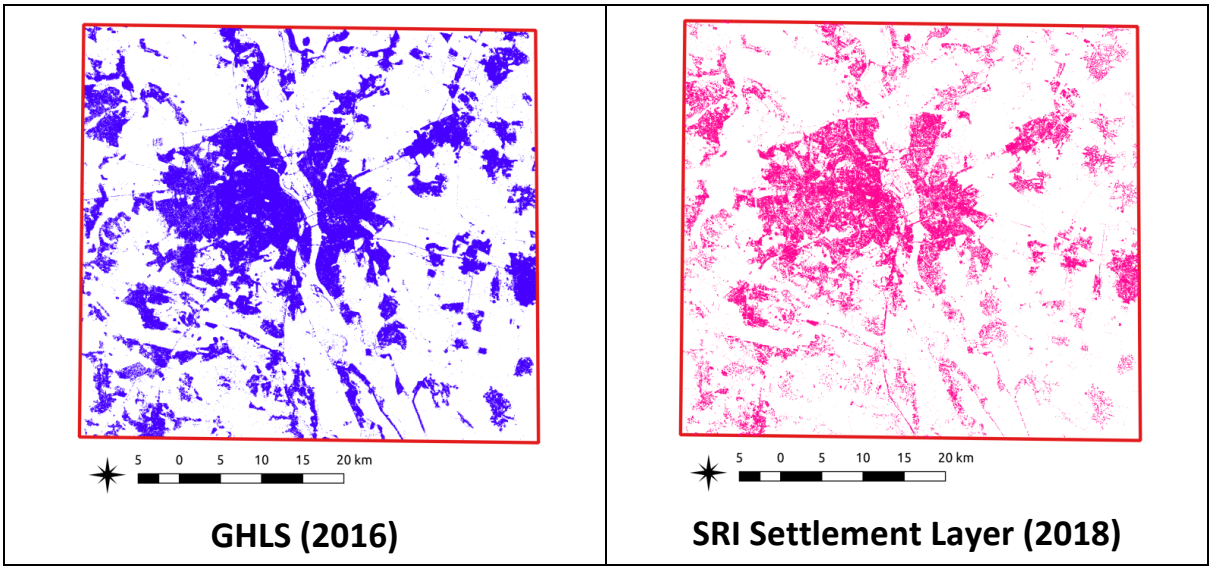
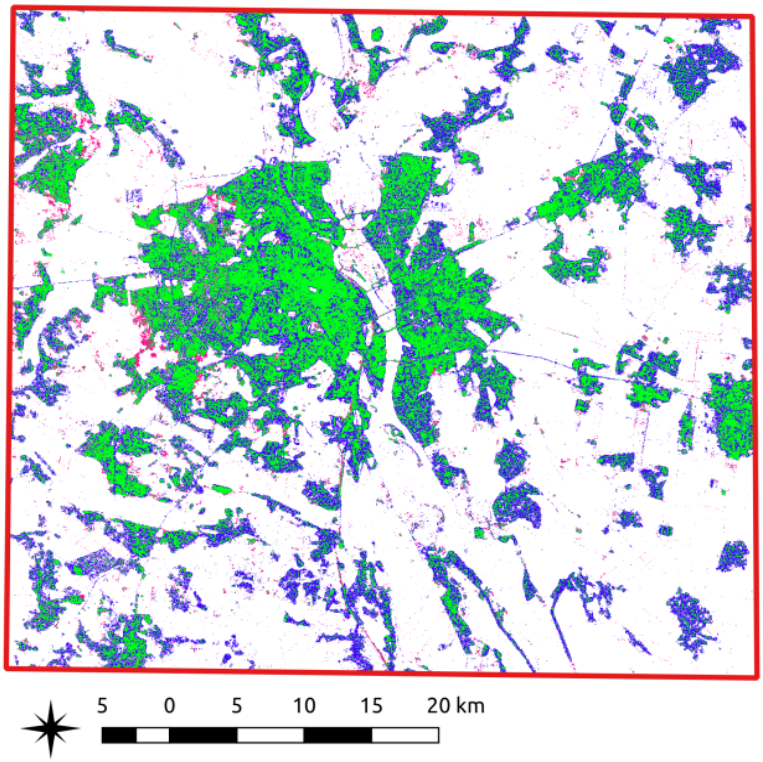


Figure 1. SDG 11.3.1 calculation scheme

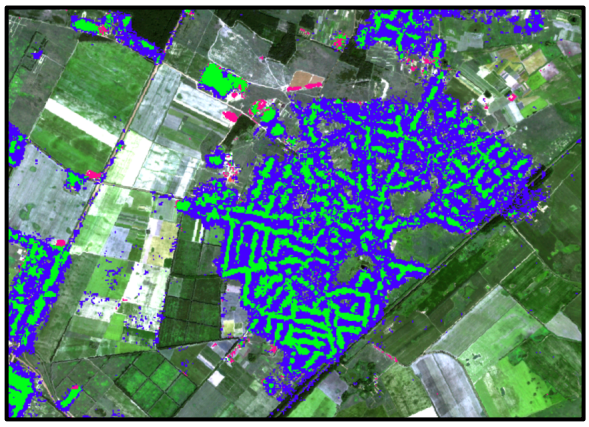
Besides that, global land covers and built-up area products can be additionally used for these purposes, but products at the local scale have higher accuracy. It is important to use products with higher accuracy and spatial resolution because it is significantly affect the indicator calculation result. On figure 2 and 3 is shown comparison between Global Human Settlement Layer and our classification results for the Kyiv city.



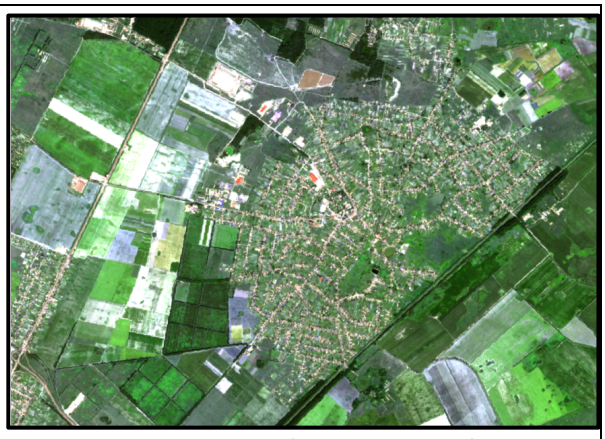


SRI Settlement Layer and GHSL

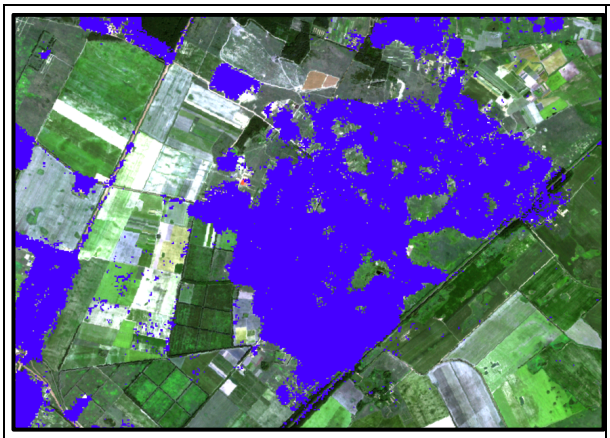
Figure 2: National vs global products over territory of Ukraine



SRI Settlement Layer and GHSL – common part



Sentinel-2 (11.08.2018)



GHLS (2016)

SRI Settlement Layer (2018)

Figure 3: National vs global products over territory of Ukraine in zoom

Showcase description

GEOEssential	Land Consumption
Spatial Extent	Ukraine, Europe
Dashboard link	NA
Temporal Extent	2000-2019
EVs used	Land cover, Population
Inputs	Landsat, Modis, Copernicus, ESA-CCI-LC, HWSD, Global Human Settlement Layer, Urban Atlas, UN DESA population data, Local Statistics
Outputs	Land Consumption, ratio of land consumption rate to population growth rate
Targeted Policy	SDG 11.3: By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries
Targeted indicators	11.3.1: Ratio of land consumption rate to population growth rate
Main Process	Trends.Earth model: http://trends.earth + own scripts + vlab
Level of development	70%
GitHub code	To be included when available
Outputs endpoint	To be included when available
Partner(s)	SRI
Contact person	shumilo.leonid@gmail.com (SRI)