Metadata on SDGs Indicator 11.3.1
Indicator category: Tier II

Goal 11: *Make cities and human settlements inclusive, safe, resilient and sustainable.*

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: *Ratio of land consumption rate to population growth rate*

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1. Definition and method of computation

Ratio of land consumption rate to population growth rate is a good indicator for measuring land use efficiency and is intended to answer the question of whether the remaining undeveloped urban land is being developed at a rate that is less than, or greater than, the prevailing rate of population growth. With a primary aim of achieving optimal urban land use, a rate of land consumption lower than the rate of population growth would be desirable. This indicator 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. Tracking and understanding land consumption is critical in maintaining a sufficient supply of developable land.

Population growth rate (PGR) is the rate at which population size changes 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 is defined as the uptake of land by urban developments including the urbanized open spaces

City proper: The Built-Up Area is the total area of the impervious surfaces in the city proper—roofs, streets, and parking lots—but excluding urbanized open space, both public and private, as well as vacant lands, measured in hectares.

Urban extent (Urban area) is the total built-up area of the city proper and the Urbanized Open Space in and around it.

The **Population** of the city is the total population in the set of administrative districts encompassing the urban area of the city.

Amsterdam, Netherlands © Flickr / European Space Agency.

1.1 Method of Computation

The formula to estimate the land will be provided with two stages.

Stage 1: Estimate the population growth rate.

Population Growth rate i.e.

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

Where

Pop_t = Total population within the urban extent in the past/initial year

$Pop_{(t+n)}$= Total population within the urban extent in the current/final year

y = the number of years between the two measurement periods

Stage 2: Estimating the land consumption rate

This rate gives us a measure of compactness, which indicates a progressive spatial expansion of a city.

Land consumption rate i.e. (LCR)

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

Where,

Urb_t= Total area of the urban extent of the in km2 for past/initial year

$Urb_{(t+n)}$ = Total area of the urban extent of the in km2 for current year

y = The number of years between the two measurement periods

The formula to estimate the ratio of land consumption rate to population growth rate (LCRPGR) is provided as follows:

And the overall formula can be summarized as:

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

The periods for both urban expansion and population growth rates should be at comparable scale.

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

2. Rationale and interpretation

Globally, land cover today is altered principally by direct human use: Through agriculture and livestock raising, forest harvesting and management and urban and suburban construction and development. A defining feature of many of the world's cities is an outward expansion far beyond formal administrative boundaries, largely propelled by the use of the automobile, poor urban and regional planning and land speculation. A large proportion of cities both from developed and developing countries have high consuming suburban expansion patterns, which often extend to even further peripheries.

A global study on 120 cities shows that urban land cover has, on average, grown more than three times as much as the urban population [1]; in some cases similar studies at national level showed a difference that was three to five times fold. [3]. In order to effectively monitor land consumption growth, it is not only necessary to have the information on existing land use cover but also the capability to monitor the dynamics of land use resulting from both changing demands of increasing population and forces of nature acting to shape the landscape.

Cities require an orderly urban expansion that makes the land use more efficient. They need 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, resulting 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.

The indicator measures how compact cities are at any given time, to assess whether they are becoming more or less compact over time. With this indicator in mind, meeting Target 11.3 by 2030 requires, at the minimum, slowing down the decline in compactness and, if possible, ensuring that the compactness of cities is maintained or increased over time. Ideally, an accepted ratio of land consumption to population growth rate should equal one. In the cities where this ratio is higher, progress on this indicator should be measured by reduction of the baselines moving towards one. However, numerous exceptions can be identified in the measurement of this indicator (i.e. overcrowding/saturation/high-plot coverage or on the contrary low growth rates and densities/large urban areas), specific policies towards more efficient land consumption patterns should be designed and implemented.

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); and 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.

3. Disaggregation

Potential Disaggregation:

- Disaggregation by location (intra-urban)
- Disaggregation by urban typology
- Disaggregation by city level (high and low density)
- Disaggregation by type of land use

Quantifiable Derivatives

- Land consumption per capita
- Compactness of a city (measures of density)

4. Sources and data collection processes

Data for this indicator is available for all cities and countries (UNDESA population data) and satellite images from open sources. Several sources of information are required for this computation: Satellite imagery from open sources or the exact measurements in squared kilometers of the built up areas or the land that is fully developed in squared kilometers, annual urban population data for the reference years of analysis (geo-coded).

Data for the size of the city land that is currently considered as developed is usually available from the urban planning units of the cities. New options using remote sensing techniques have also been developed to estimate the land that is currently developed or considered as built up areas out of the total city land. This option also accurately extracts land that is considered as wetlands and hence unlikely to be occupied now or in the future.

Land use in Barcelona,Spain © Thegurdian.

When the spatial measurement option is used, the use of the urban agglomeration (built-up area) is a precondition for the measurement and comparability of this indicator. Data for this indicator can be easily availed using global and local sources. The indicator has been collected and analyzed since 2000 by several municipalities and countries. Various governments (Mexico, Colombia Brazil, India, Ethiopia, etc., and most European countries) have collected data on this indicator recently.

Eurostat collects data on this indicator using other comparable techniques. World Bank and Lincoln Institute collected data for 120 cities and published it in the Atlas of Urban Expansion. [02]. In addition 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 as part of the Agency's efforts to integrate spatial analysis in the SDGs.

5. Comments and limitations

The values of the indicator is interpreted based on the value. If the value is below one it implies efficient land use, a value above one implies inefficient land use. However, this interpretation has various issues.

1. Land use as currently formulated is only a measure of change and not absolute
2. The negatives values that could arise from the computation could be from population loss or shrinking built-up footprint whereas the positive values could come from population loss and shrinking built-up footprint together (ratio of two negative values).
3. Aggregating the measure for more than one city makes the interpretation ambiguous. For example, an average land use efficiency for a country with two cities might be between 0 and 1 ("efficient") if both cities are "efficient", or if one is inefficient (above 1) and another is shrinking (below 0).
4. Increasing density is not necessarily more efficient, e.g. in cities with overcrowding and no services. In order to overcome these challenges, it is proposed to consider the possibility of using high and low dense type of disaggregates at city level.

Another approach would be to look at the difference between the city and the global norm in initial year ***(Urbt)*** and current year ***(Urbt+n)***, then see if it is moving toward the norm or moving away from it, or staying the same. The indicator itself would be some expression of that change between initial year ***(Urbt)*** and current year ***(Urbt+n)***. If it is positive, that means that the city is above the global norm by that proportion. If it is negative, it means it is below the global norm by that proportion. If the indicator is positive, it means the city is converging on the norm by those percentage points. If the indicator is negative, it means the city is moving away from the norm by those percentage points.

In some cases, it is difficult to measure the urban expansion by conurbations of two or more urban areas that are in close proximity, to whom to attribute the urban growth and how to include it as one metric usually becomes a challenge. At the same time, data would not always coincide to administrative levels, boundaries and built-up areas. However, the European Commission highlights some possible drawbacks of this indicator that can be technically addressed. Efforts to use the area of reference at the level of the built-up area of the urban agglomeration should be taken into consideration. The delimitation of city boundaries may be another methodological problem that a clear agreed definition can solve.

Human Population Growth © Biologicaldiversity.org.

It may be difficult for the indicator to capture appropriately the cases of cities with negative or zero population growth; or cities that due to severe disaster have lost part of their territories. To face this challenge, the baseline/benchmark of population density and its change over time must be taken into consideration. Reducing densities below sustainable levels have impacts on the cities' sustainability. The indicator presents the opportunity for data and methodology convergence and can be calculated for available datasets with a guideline for interpretation.

In the absence of the GIS layers, this indicator may not be computed as defined. As a result, more alternative measures for using know land that is developed or consumed per year can be adequately used. Alternatively, one can monitor the efficient use of urban land by measuring how well we are achieving the densities in residential zones that any city plans or international guidance call for. Comparing achieved to planned densities is very useful at the city level. However, planned densities vary greatly from country to country, and at times from city to city. At the sub-regional or city levels, it is more appropriate to compare average densities achieved currently to those achieved in the recent past. While building more densely does use land more efficiently, high-density neighborhoods, especially in and around urban centers, have a number of other advantages. They support frequent public transportation, and more local stores and shops; they encourage pedestrian activity to and from local establishments; and they create lively (and sometimes safer) street life.

6. Current data availability/ indicator tier

This indicator is categorized under Tier II, meaning that the indicator is conceptually clear and an established methodology exists but data on many countries is not yet available. The Global Human Settlement Layer (GHSL) technology open framework is proposed for global open spatial baseline data production (built-up and population grids). The global open data is available and will be updated through EU support and international partnership; the tools will be opened to national Authorities by a new platform and capacity building program that will be soon made available with the support of the EU and Habitat. Every country will soon be able to build their own set of built-up and population grids, or to use the globally available data.

7. Responsible entities

UN-Habitat and other partners such as the Global Human Settlement Layer (GHSL) team and ESRI will support various components for reporting on this indicator. The global responsibility of building the capacity of national governments and statistical agencies to report on this indicator will be led by UN-Habitat. National governments/ national statistical agencies will have the primary responsibility of reporting on this indicator at national level with the support of UN-Habitat to ensure uniform standards in analysis and reporting.

8. Data collection and data release calendar

The monitoring of the indicator can be repeated at regular intervals of 5 years, allowing for three reporting points until the year 2030.

9. Treatment of missing values

All countries are expected to fully report on this indicator more consistently after a 2-3 years with few challenges where missing values will be reported due to missing base map files. Either therefore any missing values will be representative of populations where population growth figures are unavailable or land consumption rates are inestimable. Because the values will be aggregated at the national levels from a national sample of cities, missing values will be less observed at national and global levels.

10. Sources of differences between global and national figures

Based on several consultations, we note that in order to calculate the land use efficiency ratio, we must stabilize the definition of population and spatial footprint of the city which is literally defined as "urban extension". Unclear spatial definitions and an occasional use of administrative boundaries arbitrarily set for population and surface accounting creates more spatially-generated noise than signal in the final accounting of the indicators. Already some spatial noise is particularly created by the use of ratios. The following data sources will be harmonized to ensure more consistent reporting on this indicator--Satellite data, built-up areas grids, time-standardized census population grids; globally complete classification grids can be aggregated to administrative units but may create inconsistencies if they are not available for all cities, allowing to classify them by dominance of the urban/rural surfaces or similar approaches.

11. Regional and global estimates and data collection for global monitoring

Data at the regional levels will be estimated from national figures derived from national sample of cities. Regional estimates will incorporate national representations using a weighting by population sizes. Global monitoring will be led by UN-Habitat with the support of other partners and regional commissions.

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Relation with other indicators

11.2.1 Public Transit Stop Coverage; 11.6.2 PM2.5 Concentration; 11.7.1 Accessibility to Open Public Area; 11.a.1 Regional Development Plans; 15.1.2 Forest area as a percentage of total land area; 3.9.1 Population Exposed to Outdoor Air Pollution; 6.1.1 Access to Improved Water; 6.2.1 Access to Improved Sanitation; 6.3.1 Waste water treatment; 7.1.1 Access to Electricity; 7.2.1 Share of renewable energy;

8.1.1 City Product per Capita; 8.2.1 Growth rate per employment; 8.5.2 Unemployment Rate; 11.6.1 Solid Waste Collection; 11.7.2 Public Space Safety for Women; 11.b.1 Disaster Risk Reduction Strategies.

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