Indicator 11.3.1

Indicator Name, Target and Goal

Indicator 11.3.1 Ratio of land consumption rate to population growth rate

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

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

Definition and Rationale

○ Definition

LCRPGR is defined as the ratio of Land Consumption Rate (LCR) to Population Growth Rate (PGR).

Land consumption used to calculate Land Consumption Rate is the area newly developed as city or an urban area.

○ Concepts

Population Growth Rate is the change of population in a defined region (country, city, etc.) per year over a given period, and calculated as the natural logarithm of the ratio of population at the end of the period to population at the beginning of the period divided by the number of years in the period. It reflects the number of births, deaths and emigrants during the period.

While Land Consumption Rate is the change of land occupied by a city/urban area in a defined region per year over a given period, and calculated as the ratio of the change of the land occupied by a city/urban over the period to the land occupied by a city/urban at the beginning of the period divided by the number of years in the period. The city/urban area within the context of indicator 11.3.1 is defined as built-up area.

For the area of the city that is the scope of the calculation of indicator 11.3.1, although UN-Habitat encourages to adopt the degree of urbanization using population size and population density thresholds, the scope of calculation in Japan applies to government ordinance-designated cities to have the government use the

indicator and to compare them across cities.

○ Rationale and Interpretation
Land cover is altered by direct human use such as agriculture, forestry and urban development, and many cities are expanding development into the suburbs. In order to effectively monitor land consumption growth, it is necessary to have the information on not only existing land use cover but also changing demands due to increasing population.

In addition, for an orderly urban development that makes the land use more efficient, urban planning should be based on future population changes. Urban expansion disproportionate to population growth leads to inefficient land use. 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 11.3.1 is not only related to the form of the urbanization pattern, 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).

Data Sources and Collection Method
1） Population data
- Ministry of Internal Affairs and Communications, Population Census / 2010 Population Census / Basic Complete Tabulation on Population and Households Japan
- Ministry of Internal Affairs and Communications, Population Census / 2015 Population Census / Basic Complete Tabulation on Population and Households Japan
- Ministry of Internal Affairs and Communications, Population Census / 2020 Population Census / Basic Complete Tabulation on Population and Households Japan

2）Land cover data
- JAXA High-Resolution Land Use and Land Cover Map of Japan [2006-2011] (Released in September 2016 / Version 16.09, 10 m resolution)
  ※The representative value in 2006-2011 is used as the value in 2010
- JAXA High-Resolution Land Use and Land Cover Map of Japan [2014-2016] (Released in March 2016 / Version 18.03, 30 m resolution)
  ※The representative value in 2014-2016 is used as the value in 2015
- JAXA High-Resolution Land Use and Land Cover Map of Japan [2018-2020] (Released in November 2021 / Version 21.11, 10 m resolution)
  ※The representative value in 2018-2020 is used as the value in 2020

3）Administrative district boundary data
"Geospatial Information Authority of Japan, Digital Maps (Basic Geospatial Information) (2021) Administrative District Boundary Data"

Method of Computation and Other Methodological Considerations
○ Computation Method
1）Definition of LCRPGR:
The following equations are used to compute Population Growth Rate (LCR), Land Consumption Rate (PGR) and the ratio of Population Growth Rate to Land Consumption Rate (LCRPGR).

$$PGR = \frac{\ln(Pop_{t+n}) - \ln(Pop_t)}{y},$$

$$LCR = \frac{Urb_{t+n} - Urb_t}{Urb_{t+n}} \times \frac{1}{y},$$

$$LCRPGR = \frac{LCR}{PGR},$$

where Pop_t is the total population of the target region in the first or the past year, Pop_{t+n} is the total population of the target region

in the last or the present year, Urb_t is the total area of city/urban area in the first or the past year, Urb_{t+n} is the total area of city/urban area in the last or the present year and y is the number of years in the measurement period for population and the area of the region. The total area of city/urban area, Urb_t is calculated as $Urb_t=Ap_t$, using total area of the target region, A and the ratio of land occupied by city/urban area in the target region, p_t.

2） Computation method for government ordinance-designated cities
   1. The boundary data of each government ordinance-designated city is generated using "Geospatial Information Authority of Japan, Digital Maps (Basic Geospatial Information) (2021) Administrative District Boundary Data."
   2. PGR is computed using the total population of each government ordinance-designed city of Ministry of Internal Affairs and Communications, Population Census (2010 Population Census, 2015 Population Census and 2020 Population Census).
   3. The built-up (for 2020, classification of solar panel is included) ratio (city population proportion) is computed in the land cover map within each government ordinance-designated city, which are generated using JAXA High-Resolution Land Use and Land Cover Map of Japan (2006-2011, 2014-2016, 2018-2020) and the boundary data generated by 3.

Here, a confusion matrix which indicates the accuracy of land cover classification is produced in addition to the above computation method (refer to 4), and sampling errors and classification errors of city population proportion are corrected using a statistical method.

   4. The confusion matrix of city (built-up) and non-city for each year of coverage （2010, 2015, and 2020） is created by

verification data of JAXA High-Resolution Land Use and Land Cover Map of Japan and data collation between JAXA High-Resolution Land Use and Land Cover Map of Japan and "Ministry of Land, Infrastructure, Transport and Tourism, National Spatial Planning and Regional Policy Bureau, National Land Information Division, Land Market Value Publication Data."

Confusion matrix of two-category classification of city/non-city in year t

		validated b	
	a/b	city ($b=1$)	non-city ($b=0$)
classified	city ($a=1$)	TP_t	FP_t
a	non-city ($a=0$)	FN_t	TN_t

Here, TP_t, FP_t, TN_t, FN_t are the number of observations in each category.

5. When the city population proportion in year t is $\widetilde{p}_t$, its corrected value p_t can be given as follows:

$$p_t = \frac{\widetilde{p}_t - R_t(1|0)}{R_t(1|1) - R_t(1|0)}$$

Where,

$$R_t(0|0) = \frac{TN_t}{FP_t + TN_t}, \quad R_t(1|0) = \frac{FP_t}{FP_t + TN_t}$$

$$R_t(0|1) = \frac{FN_t}{TP_t + FN_t}, \quad R_t(1|1) = \frac{TP_t}{TP_t + FN_t}$$

6. LCR is computed by using the corrected city area derived from the corrected value of the city population proportion in 5, and LCRPGR is computed using PGR in 2.

○ Comments and limitations

Since LCRPGR is the ratio of LCR to PGR, LCRPGR is positive both when PGR and LCR are positive values and when PGR and LCR are negative values. Therefore, the assessment of each value of PGR and LCR is also necessary to compare and evaluate LCRPGR among multiple cities and over multiple periods.

A comparison with the equations before the revision of metadata in March 2021 confirmed that the corrected LCR values were nearly identical between before and after of the metadata revision.

Data Disaggregation

PGR and LCR of each government ordinance-designed city (JIS X0402), each prefecture (JIS X0401), and fundamental grids (JIS X0410).

Reference

- Ministry of Internal Affairs and Communications, Population Census / 2010 Population Census / Basic Complete Tabulation on Population and Households Japan, https://www.e-stat.go.jp/en/stat-search/files?page=1&layout=datalist&toukei=00200521&tstat=000001039448&cycle=0&tclass1=000001045009&tclass2=000001046265&stat_infid=000012460662&tclass3val=0

- Ministry of Internal Affairs and Communications, Population Census / 2015 Population Census / Basic Complete Tabulation on Population and Households Japan, https://www.e-stat.go.jp/en/stat-search/files?page=1&layout=datalist&toukei=00200521&tstat=000001080615&cycle=0&tclass1=000001089055&tclass2=000001089056&stat_infid=000031473210&tclass3val=0

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- United Nations Statistics Division (UNSD), Department of Economic and Social Affairs (DESA), SDG Indicators Metadata repository, Indicator 1.3.1, https://unstats.un.org/sdgs/metadata/files/Metadata-11-03-01.pdf
- United Nations Human Settlements Programme (UN-Habitat), Metadata on SDGs Indicator 11.3.1 Indicator category: Tier II, https://data.unhabitat.org/documents/GUO-UN-Habitat::metadata-on-sdg-indicator-11-3-1/explore

Custodian Ministries of Data
Ministry of Internal Affairs and Communications
Japan Space Exploration Agency (JAXA),
Ministry of Land, Infrastructure, Transport and Tourism/Geospatial Authority of Japan

Custodian Ministries of Related Policies
Ministry of Education、Culture, Sports, Science and Technology
Ministry of Land, Infrastructure, Transport and Tourism

International Organization(s)
United Nations Human Settlements Programme (UN-Habitat)