UN-GGIM: Europe | Work Group on Data Integration | subgroup 2

The territorial dimension in SDG indicators: the contribution of geospatial data and analysis sand its combination with statistical data

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INDICATOR 11.3.1 | Ratio of land consumption rate to population growth rate

[Tier II indicator]

A | *Global metadata*

B | *National practices: Finland (NMCA), Ireland (NSI), Italy (e-GEOS) and Portugal (NSI and NMCA)*

C | *EU SDG indicators: 15.21 Artificial land cover per capita; 15.24 Change in artificial land cover per year (Eurostat)*

A. GLOBAL METADATA | UN SDG Metadata

1. Current reporting situation

Responsibility: (Identify the agency responsible for the indicator and the situation regarding the ESS and NSS projects (including dissemination) and /or INSPIRE conformance)

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.

Indicator disaggregation: (List the indicator disaggregation by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts to support the monitoring of the implementation of the SDGs)

Disaggregation proposed by UN-Habitat:

- Disaggregation by location (intra-urban)
- Disaggregation by income level
- Disaggregation by urban typology

Frequency of dissemination: (Describe the time interval at which information is disseminated over a given time period)

The monitoring of the indicator can be repeated at regular intervals of 5 years, allowing for three reporting points until the year 2030. Initial reporting is targeted for 2017 for all cities in the global sample of cities. Updates will be undertaken every year, which would allow for annual updates in reporting at the global level post 2017.

Timeliness: (Length of time between data availability and the event or phenomenon they describe. Describe the average production time for each release of data)

Data sources: (List the data sources and themes or variables in use, including conditions of access situation, resolution, positional accuracy, frequency and timeliness regarding the ESS and NSS projects and /or INSPIRE conformance).

The indicator requires defining the two components of population growth and land consumption rate:

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.

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.

Data for this indicator is available for all cities and countries (UN DESA - United Nations Department of Economic and Social Affairs 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 km squared of the built up areas or the land that is fully developed in km squared, annual urban population data for the reference years of analysis.

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.

The Global Human Settlement Layer (GHSL) technology open framework is proposed for global open spatial baseline data production (built-up and population grids) – global open data is available and will be updated by EU support plus 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 UN Habitat. Every country will soon be able to build their own set of built-up and population grids, or to use the globally-available ones.

Geospatial data analysis and integration: (Describe spatial analysis methods, procedures and computations, including regarding data integration)

Indicator computation should consider the following stages. The periods for both- urban expansion and population growth rates should be at comparable scale.

Stage 1: Estimate the land consumption rate (LCR):

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

Stage 2: Estimate the population growth rate (PGR):

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

Stage 3: Estimate the ratio of land consumption rate to population growth rate (LCRPGR).

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

Where:

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;

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.

The indicator may experience difficulties in capturing 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.

Data quality requirements: (List in general terms the requirements for the sources and themes in use with relevant parameters: Resolution, completeness, logical consistency, positional accuracy, temporal accuracy etc. List if certain international standards are being followed, including classifications/nomenclatures. Data quality should allow computing results to the needed level of resolution and disaggregation). Please take into account the EURO-SDMX Metadata Structure (ESMS) 2.0.

In order to calculate the indicator a clear definition of built-up area and urban area (cities) is needed. Unclear spatial definitions and an occasional use of administrative boundaries arbitrarily set for population and surface accounting creates more spatially-generated noise. 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.

At the global level, the following data sources are proposed to 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.

Current use of geospatial data for the indicator: (Describe the current use of geospatial data, as suggested by the existing metadata – the "as-is" situation)

See previous section.

2. Suggested Methodology

GAP analysis: (Describe what changes in use of **applied methods** are needed to go from the suggested/current procedure for monitoring the indicator, to a future procedure which better fulfils the reporting requirements - going from the "as-is" situation in the present metadata proposal to a "to-be" situation)

See section below.

3. Suggested geospatial data integration

GAP analysis: (Describe what changes in use of **data** needed to go from the suggested/current procedure for monitoring the indicator, to a future procedure which better fulfils the reporting requirements - going from the "as-is" situation in the present metadata proposal to a "to-be" situation)

This indicator is categorized under Tier II, meaning the indicator is conceptually clear and an established methodology exists but data on many countries is not yet available.

1. Conceptual definition

A clear definition regarding the underlying concepts for the operationalization of this indicator is needed, namely:

- Definition of built-up area:
  It is not clear what categories of land cover products should be used to measure land consumption over time (e.g., if road and traffic network, including airports and harbours should be taken into account within the scope of the built-up area concept).
- Definition of urban areas / cities:
  The territorial classifications and / or methodology to identify for cities delimitation are also not clearly stated. At the European level there are territorial typologies: Cities (Urban Audit) – cities or functional urban areas (cities + commuting zones) based on LAU level; Urban areas (DEGURBA – Degree of urbanization) – cities or cities + towns and suburbs based on LAU level; Grid typology – urban centres or urban centres + urban clusters based on a 1 km^2 grid. Additionally, countries may also have national classifications.

2. Data sources

Computation of built-up areas can rely on existing geospatial datasets or on procedures based on open source satellite data processing that can be made available for countries to use. Satellite imagery can be used to identify the areas to be considered as built-up areas. Additionally, at the European level, the CORINE Land Cover (CLC) Map could be a possible data source for built-up areas identification, but spatial resolution is relatively coarse (25 ha).

Derived thematic layers from satellite imagery:

- Global Human Settlement Layer (GHSL) - 250 m
- EU Copernicus Imperviousness HRL – 20 m
- EU CORINE Land Cover Map – 25 ha
- Other national thematic layers (e.g., in the case of Portugal, the Land Use and Land Cover Map (COS) has a spatial resolution of 1 ha)

Built-up areas can also be captured based on cadastre data on data parcels or survey in-situ data (e.g., LUCAS, other national projects).

3. Geospatial processing

The spatial resolution for input and output geospatial data processing needs to be better identified.

4. Indicator computation

The metadata should make clear the time intervals for the measurement of population growth and land consumption rates, as these can vary depending on information availability.

Land Use Efficiency with the Global Human Settlement Layer (JRC tool)

JRC has developed a tool to calculate the indicator 11.3.1 based on a proxy of Land Use Efficiency with the Global Human Settlement Layer.

The GHSL is a set of georeferenced layers that provides information on human settlements and population with global coverage. It is based on historical satellite images and data from open sources. The main datasets consist in gridded layers of built-up areas and number of inhabitants at a high resolution (38m and 250m, respectively) for four dates: 1975, 1990, 2000, and 2015. A global layer on built-up surfaces (GHS-BU) was produced from Landsat image collections for four different periods (1975-1990-2000-2015) and the information generated with the GHS-BU was used to downscale population and estimate population (GHS-POP) for the same years as the GHS-BU.

JRC tool proposes to adapt the formulation of the Land Use Efficiency (LUE) indicator in order to measure the change rate of the built-up are per capita (Corbane *et al.,* 2016):

$$Idx_t = \frac{Y_t - Y_{t+n}}{Y_t}$$

Where:

$Y_t = BU_t / POP_t$;

BU_t = built-up surface at t and POP_t = population at t.

The indicator can be estimated at different time intervals upon the availability of observations. In order to ensure the comparability of the results at different times, it is

recommended to normalise the values to obtain the variation a 10-year average change which divides the indicator by n (the number of years that separate the observations) and then multiply by 10. The formula of the normalised indicator is:

$$Idx_t = \frac{Y_t - Y_{t+n}}{Y_t} * \frac{10}{n}$$

A script that can be installed in the toolbox of Quantum GIS (QGIS) is available.

List required geospatial data: (Develop a list from the GAP analysis, which lists the geospatial data sources and themes which are required to support the to-be situation, including INSPIRE conformance)

Data quality requirements: (List in general terms the requirements for the suggested sources and themes with relevant parameters: Resolution, completeness, logical consistency, positional accuracy, temporal accuracy etc. List if certain international standards should be followed including classifications/nomenclatures. Data quality should allow computing results to the needed level of resolution and disaggregation). Please take into account the EURO-SDMX Metadata Structure (ESMS) 2.0.

Data availability: (List the data availability for the suggested sources and themes or variables: 1) Geographically: national/regional/global (as well as comparability across countries), 2) Source: Accessible through services or download, 3) Commercial/legally: license conditions - are data free or are there restriction on use; 4) Timeliness; 5) Frequency of dissemination)

Data collection: (Describe how the geospatial data for the indicator can be collected/made available, and issues to overcome – are there many sources to collect from, do they need to be integrated and normalized etc.)

Geospatial data analysis and integration: (Describe which analysis, procedures and computations are needed to provide the results needed to support the reporting requirements - “to-be” situation)

B. NATIONAL PRACTICE | Finland (NMCA)

1. Current reporting situation

Responsibility: (Identify the agency responsible for the indicator and the situation regarding the ESS and NSS projects (including dissemination) and /or INSPIRE conformance)

Statistics Finland

Indicator disaggregation: (List the indicator disaggregation by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts to support the monitoring of the implementation of the SDGs)

Free of charge: Number of persons and by gender and age. Data is available both on 7 level urban-rural classification and by municipalities (Chargeable data possible by time of birth, marital status, language, nationality and country of birth, possible spouse and all biological or adopted children, and a person's parents, person's possible date of marriage or divorce, when a person has become widowed, and on the ordinal number of his or her current marriage or registered partnership).

Frequency of dissemination: (Describe the time interval at which information is disseminated over a given time period)

Yearly.

Timeliness: (Length of time between data availability and the event or phenomenon they describe. Describe the average production time for each release of data)

265 days.

Data sources: (List the data sources and themes or variables in use, including conditions of access situation, resolution, positional accuracy, frequency and timeliness regarding the ESS and NSS projects and /or INSPIRE conformance).

Theme data:

- Population structure: Population Register Centre, description:

http://tilastokeskus.fi/til/vaerak/index_en.html

- Urban-rural classification:

http://pxnet2.stat.fi/PXWeb/pxweb/en/StatFin/StatFin__vrm__vaerak/049_vaerak_tau_204.px/?rxid=6dc5f002-30b0-4dff-8f26-33746f92300b

- Online open access. 1. Inner urban area 2. Outer urban area; urban-rural classification applied specifies inner and outer urban areas, the outer urban area extending to the outer edge of the continuous built area. Yearly updated.

Source data: Population, labour, commute and building data, as well as road network data and CORINE Land Cover data.

Geospatial data analysis and integration: (Describe spatial analysis methods, procedures and computations, including regarding data integration)

The geographical information-based area classification is independent of administrative borders. The population centres of urban areas are agglomerations with more than 15 000 residents. Each of these agglomerations consists of a core urban area, which is then divided into an inner and outer urban area. Surrounding the core urban area is a peri-urban and rural areas, and local centres. Classification system is based on Focal analysis of grid cells. The class borders of the area categories are generalised with different buffers in urban and rural areas.

http://pxnet2.stat.fi/PXWeb/pxweb/en/StatFin/StatFin__vrm__vaerak/049_vaerak_tau_204.px/?rxid=6dc5f002-30b0-4dff-8f26-33746f92300b.

Data quality requirements: (List in general terms the requirements for the sources and themes in use with relevant parameters: Resolution, completeness, logical consistency, positional accuracy, temporal accuracy etc. List if certain international standards are being followed, including classifications/nomenclatures. Data quality should allow computing results to the needed level of resolution and disaggregation). Please take into account the EURO-SDMX Metadata Structure (ESMS) 2.0.

The register data-based classification uses geographical information calculated using 250 x 250 metre grid cells. Based on the data, variables describing the amount, density, efficiency, accessibility, intensity, versatility and orientation each cell is categorized into one of seven urban-rural classes. Classification system is based on Focal analysis of grid cells. The class borders of the area categories are generalised with different buffers in urban and rural areas. Data updated on an annual basis.

Current use of geospatial data for the indicator: (Describe the current use of geospatial data, as suggested by the existing metadata – the "as-is" situation)

2. Suggested Methodology

GAP analysis: (Describe what changes in use of **applied methods** are needed to go from the suggested/current procedure for monitoring the indicator, to a future procedure which better fulfils the reporting requirements - going from the "as-is" situation in the present metadata proposal to a "to-be" situation)

The applied geospatial methodology depicts core urban area as continuous built area with versatile variables indicating expansion of urban activities, as well as an intermediate zone between urban and rural that can be examined as its own whole. It abundantly fulfils the indicator criteria. For a more simple method using only CORINE Land Cover (CLC) data has proved to be suitable for monitoring changes in the built area at a relative coarse scale but contains many unbuilt areas that are invisible due to its resolution thus missing continuous built area as urban measure.

3. Suggested geospatial data integration

GAP analysis: (Describe what changes in use of **data** needed to go from the suggested/current procedure for monitoring the indicator, to a future procedure which better fulfils the reporting requirements - going from the "as-is" situation in the present metadata proposal to a "to-be" situation)

For disaggregation by income level at least estimates can be added through a coarse statistical urban-rural grouping of municipalities and by major national regions.

List required geospatial data: (Develop a list from the GAP analysis, which lists the geospatial data sources and themes which are required to support the to-be situation, including INSPIRE conformance)

Statistical urban-rural grouping of municipalities and by major national regions (http://pxnet2.stat.fi/PXWeb/pxweb/en/StatFin/StatFin__tul__tvt__2015/090_tvt_tau_109.px/?rxid=ee9dd497-85c8-42b4-ace0-9fa3b37cd475) or more precisely income level grouping by urban-rural class areas.

Data quality requirements: (List in general terms the requirements for the suggested sources and themes with relevant parameters: Resolution, completeness, logical consistency, positional accuracy, temporal accuracy etc. List if certain international standards should be followed including classifications/nomenclatures. Data quality should allow computing results to the needed level of resolution and disaggregation). Please take into account the EURO-SDMX Metadata Structure (ESMS) 2.0.

The adopted urban-rural classification is based on multiple administrative data sources with appropriate quality management and standard geospatial analysis methodology. The urban-rural classification system primarily depicts differences between areas at the level of the regional structure and does not describe in great detail the characteristics of a particular location in a single class as it characterises the areas based on focal analysis.

Data availability: (List the data availability for the suggested sources and themes or variables: 1) Geographically: national/regional/global (as well as comparability across countries), 2) Source: Accessible through services or download, 3) Commercial/legally: license conditions - are data free or are there restriction on use; 4) Timeliness; 5) Frequency of dissemination)

Thematic national data available on-line, yearly and free with copyright: http://pxnet2.stat.fi/PXWeb/pxweb/en/StatFin/StatFin__vrm__vaerak/?tablelist=true&rxid=000dc38d-6985-49b3-8148-00c6c2cb12d0

- table 10: Population according to urban-rural classification

- table 11: Population according to urban-rural classification by age and sex.

The urban-rural classification system is freely available on a website in the form of a GIS dataset.

Data sources: National data: Population, labour and commute data (eServices and licences by Statistic Finland) - yearly at least; National data - INSPIRE: Road network data (Annex I), CORINE Land Cover (Annex II) and Building data (Annex III) accessible to public authorities through download services; CORINE Land Cover: EU39 coverage, methodology exportable worldwide, accessible through download, no limitations, six years refresh.

Data collection: (Describe how the geospatial data for the indicator can be collected/made available, and issues to overcome – are there many sources to collect from, do they need to be integrated and normalized etc.)

Based on the data from many different sources, variables describing the amount, density, efficiency, accessibility, intensity, versatility and orientation of the areas the urban-rural classes have been calculated in a series of geospatial analysis and classification rules. The urban-rural classification system is based on Focal analysis of grid cells. The borders of the area categories have been generalised in such a way that the classification system is best for examining broader areas enabling to identify different developments at the regional and national level.

Geospatial data analysis and integration: (Describe which analysis, procedures and computations are needed to provide the results needed to support the reporting requirements - “to-be” situation)

B. NATIONAL PRACTICE | Ireland (NSI)

1. Current reporting situation

Responsibility: (Identify the agency responsible for the indicator and the situation regarding the ESS and NSS projects (including dissemination) and /or INSPIRE conformance)

Population growth rates from the most recent census and the definition of urban areas are available from Central Statistics Office Ireland (CSO), while data relating to changes in built-up areas can be obtained from the PRIME2 database maintained by Ordnance Survey Ireland (OSi), which corresponds to the central database of spatial information.

Indicator disaggregation: (List the indicator disaggregation by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts to support the monitoring of the implementation of the SDGs)

In relation to geographical breakdown it is planned to calculate this indicator for urban areas only although the data could be produced for other geographical levels.

Frequency of dissemination: (Describe the time interval at which information is disseminated over a given time period)

Given that the census is the source of the demographic data for this indicator, the data can be disseminated at five year intervals.

Timeliness: (Length of time between data availability and the event or phenomenon they describe. Describe the average production time for each release of data)

As described the demographic data are available every five years. New versions of PRIME2 are available on a quarterly basis with the entire country being surveyed by OSi over a three year period.

Data sources: (List the data sources and themes or variables in use, including conditions of access situation, resolution, positional accuracy, frequency and timeliness regarding the ESS and NSS projects and /or INSPIRE conformance).

Data Source for Population

Resident population and population characteristics can be sourced from the most recent census which has been geocoded to address point level. During the fieldwork around 1.5% of dwellings enumerated were not listed in the national address database, and these were retrospectively geocoded according to the location stated on the enumerator maps. The two most recent censuses in 2011 and 2016 have been geocoded.

Data Source for Urban Areas

For the calculation of an urban area, the definition applied by the census is used. Since the 2011 census a settlement is defined as being a cluster of 50 or more occupied dwellings, with a maximum distance between any dwelling and the building closest to it of 100 metres, and where there is evidence of an urban centre (shop, school etc.). The criteria for extending an existing settlement depends on whether there are newly created estates or dwellings within 100 metres of the original settlement boundary.

The settlement boundaries were delineated according to the location of dwellings enumerated in the census. Other information based on OSi mapping and orthogonal photography was also taken into account when extending boundaries. Boundary extensions were generally made to include the land parcel on which dwellings were built or using other physical features such as roads, paths etc.

At national level an urban area is a settlement in excess of 1 500 persons. Five of the urban settlements are considered to be cities, i.e. populations exceeding 50 000 (Dublin, Cork, Galway, Limerick and Waterford).

Data Source for Land consumption

PRIME2 contains over 50 million attributed objects in point (building), line (road) and polygon (parcel) format, and includes form and function object classification which describes the physical form (e.g., building) and its use (e.g., residential, hospital, church etc.). There are over 1 000 different function types recorded in PRIME2.

The central premise behind PRIME2 is the 'skin of the earth' concept where topologically consistent polygons cover the surface of Ireland. These polygons are grouped into five broad categories: way, water, vegetation, artificial and exposed (non-vegetative ground such as sand and mud).

For the built-up areas described in the indicator, Artificial and Way objects are considered to be in scope. Artificial objects represent man-made ground cover such as concrete, tarmacadam, gravel, sloping masonry, rail bed etc. Note that gardens are regarded as an artificial object. Way objects represent all drivable and walkable roads and paths from motorways down to sidewalks.

For this indicator the consumption of land will be calculated from the change in the total surface area of Artificial and Way objects that have occurred over the intercensal period within the urban settlement, in addition to the settlement boundary extensions recorded in the census due to urban sprawl.

Geospatial data analysis and integration: (Describe spatial analysis methods, procedures and computations, including regarding data integration)

The first step involves calculating the population growth rate for the urban area between the two most recent Censuses (2011 and 2016). To get population data at any point between 2011 and 2016 interpolation techniques will be applied.

For the next step, data from PRIME 2 at two different time intervals over the inter-censal period will be examined to identify the difference in area arising from the sum of all Artificial and Way objects in

both versions of the database within the urban settlement. In addition, any extensions to the boundaries of the urban area between the 2011 and 2016 Census will be examined. The land consumption rate is calculated from the consumption of land due to urban sprawl as well as any land that might have been consumed within the urban settlement due to growth in built-up areas.

Finally, the indicator value is produced from the ratio of the land consumption rate to the population growth rate.

Data quality requirements: (List in general terms the requirements for the sources and themes in use with relevant parameters: Resolution, completeness, logical consistency, positional accuracy, temporal accuracy etc. List if certain international standards are being followed, including classifications/nomenclatures. Data quality should allow computing results to the needed level of resolution and disaggregation). Please take into account the EURO-SDMX Metadata Structure (ESMS) 2.0.

Population (census dataset)
Completeness: 100%
Temporal accuracy: five-yearly
Positional accuracy: 1 metre for 98% of dataset, 10 metres for remaining 2%

PRIME2
Resolution: 0.25 to 1 metre
Temporal accuracy: three-yearly
Positional accuracy: 0.7 to 5 metres

Current use of geospatial data for the indicator: (Describe the current use of geospatial data, as suggested by the existing metadata – the "as-is" situation)

Currently this indicator value has not been produced, although plans are being made to do so.

2. Suggested Methodology

GAP analysis: (Describe what changes in use of **applied methods** are needed to go from the suggested/current procedure for monitoring the indicator, to a future procedure which better fulfils the reporting requirements - going from the "as-is" situation in the present metadata proposal to a "to-be" situation)

It is currently not possible to provide disaggregation by income as proposed by UN-Habitat. A person income register has already been created within CSO through the matching of Revenue and Social Protection files. However it has not been geocoded, so a data matching exercise is required.

3. Suggested geospatial data integration

GAP analysis: (Describe what changes in use of **data** needed to go from the suggested/current procedure for monitoring the indicator, to a future procedure which better fulfils the reporting requirements - going from the "as-is" situation in the present metadata proposal to a "to-be" situation)

Work is ongoing in preparing a methodology for providing estimates on the spread of income across the State using this dataset. This methodology will involve matching to an existing geocoded file such as the census to provide this breakdown.

List required geospatial data: (Develop a list from the GAP analysis, which lists the geospatial data sources and themes which are required to support the to-be situation, including INSPIRE conformance)

Income data by geographical breakdown.

Data quality requirements: (List in general terms the requirements for the suggested sources and themes with relevant parameters: Resolution, completeness, logical consistency, positional accuracy, temporal accuracy etc. List if certain international standards should be followed including classifications/nomenclatures. Data quality should allow computing results to the needed level of resolution and disaggregation). Please take into account the EURO-SDMX Metadata Structure (ESMS) 2.0.

If the income register was geocoded to the census then the same data quality considerations apply.

Data availability: (List the data availability for the suggested sources and themes or variables: 1) Geographically: national/regional/global (as well as comparability across countries), 2) Source: Accessible through services or download, 3) Commercial/legally: license conditions - are data free or are there restriction on use; 4) Timeliness; 5) Frequency of dissemination)

Data are not available at this moment.

Data collection: (Describe how the geospatial data for the indicator can be collected/made available, and issues to overcome – are there many sources to collect from, do they need to be integrated and normalized etc.)

Given that the census would be used in any data matching project, the data can be disseminated at five year intervals.

Geospatial data analysis and integration: (Describe which analysis, procedures and computations are needed to provide the results needed to support the reporting requirements - "to-be" situation)

Aggregation of income by the relevant geographical area.

B. NATIONAL PRACTICE | Italy (e-GEOS)

1. Current reporting situation

Responsibility: (Identify the agency responsible for the indicator and the situation regarding the ESS and NSS projects (including dissemination) and /or INSPIRE conformance)

ISTAT - the Italian National Institute of Statistics

Indicator disaggregation: (List the indicator disaggregation by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts to support the monitoring of the implementation of the SDGs)

ISTAT releases statistics about population growth rate and about the ratio of high density built-up areas to population.

Data released on population can be disaggregated according to several parameters related to population (sex, age, married/divorced) on a Commune basis. Additional parameters related to migratory status released on a Province basis.

No info collected on the ratio of high density built-up areas to population disaggregation level.

Frequency of dissemination: (Describe the time interval at which information is disseminated over a given time period)

ISTAT publishes population statistics on a yearly basis. The ratio of high density built-up areas to population (square meters per inhabitant) is published on a 10-years basis.

The indicator itself is not released.

Timeliness: (Length of time between data availability and the event or phenomenon they describe. Describe the average production time for each release of data)

Data sources: (List the data sources and themes or variables in use, including conditions of access situation, resolution, positional accuracy, frequency and timeliness regarding the ESS and NSS projects and /or INSPIRE conformance).

Geospatial data analysis and integration: (Describe spatial analysis methods, procedures and computations, including regarding data integration)

Commune units are used for population disaggregation. Not known how the square meters per inhabitant are computed.

Data quality requirements: (List in general terms the requirements for the sources and themes in use with relevant parameters: Resolution, completeness, logical consistency, positional accuracy, temporal accuracy etc. List if certain international standards are being followed, including classifications/nomenclatures. Data quality should allow computing results to the needed level of resolution and disaggregation). Please take into account the EURO-SDMX Metadata Structure (ESMS) 2.0.

Population statistics disaggregated on a Commune basis on a yearly basis all over the country.

Current use of geospatial data for the indicator: (Describe the current use of geospatial data, as suggested by the existing metadata – the "as-is" situation)

2. Suggested Methodology

GAP analysis: (Describe what changes in use of **applied methods** are needed to go from the suggested/current procedure for monitoring the indicator, to a future procedure which better fulfils the reporting requirements - going from the "as-is" situation in the present metadata proposal to a "to-be" situation)

Existing datasets are mainly related to population growth rate, without a direct connection with land consumption, which should be also defined in detail. Therefore, procedures for the definition and computation of land consumption area should be set up, as well as their relation with population growth rate, mainly based on the proper usage of geospatial information.

3. Suggested geospatial data integration

GAP analysis: (Describe what changes in use of **data** needed to go from the suggested/current procedure for monitoring the indicator, to a future procedure which better fulfils the reporting requirements - going from the "as-is" situation in the present metadata proposal to a "to-be" situation)

The need for data is for the computation of land consumption rate, that requires a detailed description of the amount of land that has been subject to consumption in a given time interval (for example one year). Geospatial data and/or geospatial datasets are required.

List required geospatial data: (Develop a list from the GAP analysis, which lists the geospatial data sources and themes which are required to support the to-be situation, including INSPIRE conformance)

The identification of urban perimeters can be done with high detail by using Urban Cadastre Maps or fresh satellite data, such as Sentinel-2 data. Other existing layers that could support the identification are the Copernicus HRL imperviousness (values from 0 to 100, describe the sealing percentage of urban areas) of the CORINE Land Cover (urban areas). Other official data on building, such as those derived by Regional Maps, are updated on a very coarse and irregular temporal basis for a proper usage for indicator computation support.

Data quality requirements: (List in general terms the requirements for the suggested sources and themes with relevant parameters: Resolution, completeness, logical consistency, positional accuracy, temporal accuracy etc. List if certain international standards should be followed including classifications/nomenclatures. Data quality should allow computing results to the needed level of resolution and disaggregation). Please take into account the EURO-SDMX Metadata Structure (ESMS) 2.0.

Geospatial data and thematic layers that can support the indicator are or could be produced and validated on a regular temporal basis, with high level of positional accuracy, thematic quality, logical consistency. Resolution is depending on data sources.

Data availability: (List the data availability for the suggested sources and themes or variables: 1) Geographically: national/regional/global (as well as comparability across countries), 2) Source: Accessible through services or download, 3) Commercial/legally: license conditions - are data free or are there restriction on use; 4) Timeliness; 5) Frequency of dissemination)

- Geospatial data (Sentinel-2 satellite images): available worldwide accessible through download no usage restrictions available few days after collection, collection and dissemination frequency more times per month worldwide times

- Thematic layer Urban Cadastre: available over Italy only accessible through service high usage restrictions variable timeliness (also 1-2 years) continuous collection and dissemination frequency

- Thematic layers (Copernicus HRL imperviousness, CORINE Land cover): available over Europe accessible through download no usage restrictions available 1-2 years in average after collection, collection and dissemination frequency depending on data but in general 3-6 years

Data collection: (Describe how the geospatial data for the indicator can be collected/made available, and issues to overcome – are there many sources to collect from, do they need to be integrated and normalized etc.)

Geospatial data can be collected on a regular and highly frequent time basis (more times during the year). The processing of geospatial data for the extraction of requested information can be performed with standard workflows that can be applied worldwide. When adopting thematic layers, the procedures followed in Europe should be exported worldwide.

Geospatial data analysis and integration: (Describe which analysis, procedures and computations are needed to provide the results needed to support the reporting requirements - "to-be" situation)

The indicator could be obtained with the integration of already collected data on population growth with detailed procedures based on geospatial data/thematic layers processing, that could lead to a yearly release of the indicator with a good level of disaggregation.

B. NATIONAL PRACTICE | Portugal (NSI and NMCA)

1. Current reporting situation

Responsibility: (Identify the agency responsible for the indicator and the situation regarding the ESS and NSS projects (including dissemination) and /or INSPIRE conformance)

Currently this indicator is not being produced and our comments to point 1 will address the current available information to produce this indicator and comments to points 2 and 3 will discuss how this indicator can be produced based on existent data sources and how these data sources could be improved.

This indicator requires specific articulation between Statistics Portugal and the Directorate-General for Territory - DGT (NMCA Portugal).

Indicator disaggregation: (List the indicator disaggregation by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts to support the monitoring of the implementation of the SDGs)

Data on resident population from Statistics Portugal and data on Land Use Land Cover Map (COS) from DGT is free of charge.

Annual data on resident population:

Population estimates by municipality is available by gender and age groups (five-year age groups)

Population estimates by NUTS 3 and Classification of urban area is available by gender and large age groups (life cycles)

10-year data on population:

Census population data is disseminated every ten-years, by gender and age (other segmentation are possible, e.g., level of education). A population grid based on 2011 Census data is available by large age groups (life cycles).

The indicator can be disaggregated namely by urban-rural, cities or administrative units (LAU 1).

Frequency of dissemination: (Describe the time interval at which information is disseminated over a given time period)

Data on population estimates are disseminated yearly.

Census population data is available every ten-years.

The Land Use and Land Cover Map (COS) does not have a defined periodicity, but taking into consideration the last editions of COS, the availability of this product has varied between three and five years.

Timeliness: (Length of time between data availability and the event or phenomenon they describe. Describe the average production time for each release of data)

Population estimates are disseminated within six months (mid-June) of the end of the reference year.

Based on last COS 2015 dissemination of consolidated final results: +3y (June 2018).

Data sources: (List the data sources and themes or variables in use, including conditions of access situation, resolution, positional accuracy, frequency and timeliness regarding the ESS and NSS projects and /or INSPIRE conformance).

Data sources on population:

Resident population data (Census and estimates) are based on the following statistical concept "Set of persons who, regardless of being present or absent in a given housing unit at the moment of observation, have lived in the place of their usual residence for a continuous period of 12 months prior to the moment of observation, or have arrived to the place of their usual residence during the period of 12 months prior to the moment of observation, with the purpose of living there for a year, at least. The reference date for population data is the end of the reference period (midnight of 31 December)."Population estimates are disseminated at municipality level by gender and age groups (five-year) yearly. Input data for population estimates correspond to 2011 Population Census (base-population), Vital Statistics (Civil Registration Offices/Ministry of Justice) and Household Surveys (LFS and an LFS module of Emigration Survey). Based on the national microdata on vital events transmitted, Statistics Portugal calculates aggregated data on births by sex and deaths by sex and year of birth (cohort). Emigrants and immigrants are estimates based on household surveys data. Population estimates are obtained by applying the cohort-component method.

Population estimates are also disseminated by territorial typologies, namely the Classification of Urban Areas 2014 (TIPAU) at NUTS 2 and NUTS 3 levels.

Census data on population is available at grid level (harmonised EU grid layer - http://inspire.ec.europa.eu/theme/gg) by age groups (three major age groups - life cycles), but only for the 2011 Census round. A preliminary study has been conducted in order to have population grid for 2001, but further development is needed.

Data sources on land consumption (built-up area):

Land Use and Land Cover Map (COS) is a national product under the responsibility of the Directorate-General for Territory (NMCA Portugal). Data series is available for four reference years - COS 1995, COS 2007, COS 2010 and COS 2015 - and corresponds to polygonal maps that represent homogenous land use/cover units. COS is based on a vector data model and the reference mapping unit corresponds to 1 hectare, with a defined distance between lines equal or higher than 20 meters and a percentage equal or higher than 75% of a given land use/ cover thematic class. COS thematic classification is based on a hierarchical system of 5-level classes- COS 2007 and COS 2010 have 225

classes (at the more detailed level) and COS 1995 has 89 classes. COS 2015 has a simplified nomenclature with 48 classes. A matching table between the different nomenclatures has been produced, thus allowing comparability between megaclasses. The built-up area concept corresponds to megaclass 1 of COS nomenclature - "artificial land", excluding the class 133 corresponding to “areas under construction”.

Territorial classifications for urban delimitation:

If one wants to report the indicator disaggregated by urban typologies, these need to be defined first. At national level: the Classification of urban areas (TIPAU 2014) classifies each parish (LAU 2) in one of three categories - Predominantly urban areas, Medium urban areas and Rural urban areas. The classification of Statistical Cities is based on 2011 Census tracks geography.

At the European level: territorial typologies at LAU level include the degree of urbanisation (DEGURBA) which identifies Densely populated areas (Cities), Intermediate density areas (Towns and suburbs) and Thinly populated areas (rural areas); and functional urban areas (FUA), which define Cities plus their Commuting zones (Urban Audit). These are part of the NUTS Regulation (Regulation (EU) 2017/2391 of the European Parliament and of the Council of 12 December 2017, amending Regulation (EC) No 1059/2003) together with other territorial typologies.

Geospatial data analysis and integration: (Describe spatial analysis methods, procedures and computations, including regarding data integration)

1- Urban delimitation

It is not clear the concepts and classification to be used for urban delimitations. In Portugal, we have the definition of statistical cities (Census 2011) with data provided mostly by Census data. Territorial classification on urban areas based on parish level are available at national level (Classification of urban areas - TIPAU) and at the European level (Degree of urbanisation – DEGURBA, Cities and functional urban areas – Urban Audit).

2- Areas extraction

COS is based on a vector data model, thus allowing for the extraction of areas by combining the relevant polygons for the operationalization of built-up areas (e.g., megaclass 1 “ artificial land"), that need to be evaluated, with the relevant geographies for dissemination. DGT (NMCA Portugal) has already tested areas for 1km^2 grid.

3- Population data

2011 Census data is available at building point-based level (geo coordinates) allowing to extract data for the different geographies. Population data for 2001 Census would have to be estimated based on downscaling techniques explored in GEOSTAT 1 to be applied to the different geographies. Population annual estimates are based on non-spatial algorithms and on data for LAU 1 and for territorial typologies based on LAU2.

4- Administrative territorial delimitation of units

Administrative territorial delimitation of units is based on the Official Administrative Map of Portugal - CAOP, also produce annually by DGT (NMCA Portugal).

Data quality requirements: (List in general terms the requirements for the sources and themes in use with relevant parameters: Resolution, completeness, logical consistency, positional accuracy, temporal accuracy etc. List if certain international standards are being followed, including classifications/nomenclatures. Data quality should allow computing results to the needed level of resolution and disaggregation). Please take into account the EURO-SDMX Metadata Structure (ESMS) 2.0.

Data on population:

The accuracy of population estimates is generally considered to be high. Population Censuses have been developed according to international standards. Data collection on births and deaths is exhaustive and based on administrative records (Civil Registration Offices/Ministry of Justice) and information provided by individuals. Migratory data are based on census, LFS (Labour Force Survey) and an LFS module of Emigration Survey data. Data validation procedures are performed in the process of calculating annual population estimates at municipality level (file structure, checking rules, missing values, logical conditions checking, and time series checks). Delimitation of territorial units is based on the Official Administrative Map of Portugal.

Data on land consumption:

COS map is produced based on visual interpretation of orthorectified aerial images. For COS 2007 and 2010 orthophotomaps (aerial photographs) with four spectral bands (red, green, blue and near infrared) were used and a spatial resolution of 50 cm. For COS 1995 "false colour" ortophotomaps (near infrared, red and green) were used and a spatial resolution of 1m. The projection system is ETRS89/PT-TM06. Thematic accuracy equal or higher than 85% and geometric accuracy equal or higher than 5,5m. Delimitation of territorial units is based on the Official Administrative Map of Portugal - CAOP (CAOP 2007 for COS 1995 and COS 2007 and CAOP 2010 for COS 2010). Auxiliary data has been used to produce COS, including intra-annual multi-temporal satellite images.

COS nomenclature is compatible with CORINE Land Cover Map - a reference European land use/land cover map with a minimum unit of 25 ha and comprising 44 classes (available series 1990, 2000, 2006 e 2012) - and an harmonization effort with other reference international nomenclatures has been made in terms of class definition, namely with the Temperate and Boreal Forest Resources Assessment 2000 and the Land Cover Classification Systems (LCCS) from the United Nations.

Current use of geospatial data for the indicator: (Describe the current use of geospatial data, as suggested by the existing metadata – the "as-is" situation)

Our comments to points 2 and 3 will discuss how this indicator can be produced based on existent data sources and how these data sources can be improved.

2. Suggested Methodology

GAP analysis: (Describe what changes in use of **applied methods** are needed to go from the suggested/current procedure for monitoring the indicator, to a future procedure which better fulfils the reporting requirements - going from the "as-is" situation in the present metadata proposal to a "to-be" situation)

Input data on population growth and on land consumption growth (built-up area) is available, but requires a specific process of articulation between Portugal's NSI and NMCA to calculate this indicator. Data needs to be integrated at a comparable territorial level, guaranteeing conceptual and geographical consistence.

Clear definition and computation of land consumption rate at a comparable geographical level with population growth rate for specific time intervals in order to monitor changes is needed. Geospatial datasets and integration of information is needed.

Data for this indicator should account for the entire national territory and not be limited to the urban perimeter. The definition of urban should be in line with the European Commission orientation regarding the use of territorial typologies.

3. Suggested geospatial data integration

GAP analysis: (Describe what changes in use of **data** needed to go from the suggested/current procedure for monitoring the indicator, to a future procedure which better fulfils the reporting requirements - going from the "as-is" situation in the present metadata proposal to a "to-be" situation)

Census population data for 2011 is available at grid level (by large age groups) and efforts would have to be implemented to have a 2001 population grid. This would allow having robust information for at least one point in time for population growth rate, thus allowing the minimum frequency of dissemination suggested by UN SDG Metadata.

Up to this point, COS does not have a defined periodicity and a viability study is being carried out in order to assess the possibility of producing information according to the LUCAS project specifications every three years. Namely, under the scope of LUCAS Grant 2015, COS2010 nomenclature has a correspondence of 224 out of the 225 land cover classes with LUCAS. The full compatibility in the level 1 class of artificial land (artificial and waterproof cover that is either constructed or paved), incorporates level 2 classes:

a) roofed built-up areas (all buildings, regardless height and greenhouses);
b) artificial non-built-up areas (all paved or waterproof surfaces, overhead or linear, as parking garages, roads, railways, surfaces dressed with gravel or other inert material) and;
c) other built-up areas (bridges and viaducts, mobile homes, power plants, electrical substations, pipelines, water sewage plants and open dump sites).

Within the project LUCAS Grant 2015, in the case of Portugal it was possible to develop a methodology that can be applied in other European countries, because it is based on multi-temporal

satellite imagery to access the land cover changes with a consolidated nomenclature grounded on the national Land Cover Map and with LUCAS Survey results (2015 and 2018).

Reference available periods for Census population data and for COS versions are different.

List required geospatial data: (Develop a list from the GAP analysis, which lists the geospatial data sources and themes which are required to support the to-be situation, including INSPIRE conformance)

To correspond to the 5 year monitoring report until 2030:

- Population grid data available every five-years
- COS data available every five-years

Data quality requirements: (List in general terms the requirements for the suggested sources and themes with relevant parameters: Resolution, completeness, logical consistency, positional accuracy, temporal accuracy etc. List if certain international standards should be followed including classifications/nomenclatures. Data quality should allow computing results to the needed level of resolution and disaggregation). Please take into account the EURO-SDMX Metadata Structure (ESMS) 2.0.

The data sources referred above provide information according to ESS data quality requirements and standards and COS is an official national product from DGT (NMCA Portugal), which is compatible with CORINE Land Cover Map, but providing information with more spatial (1ha) and thematic detail (thematic accuracy ≥ 85%).

Data availability: (List the data availability for the suggested sources and themes or variables: 1) Geographically: national/regional/global (as well as comparability across countries), 2) Source: Accessible through services or download, 3) Commercial/legally: license conditions - are data free or are there restriction on use; 4) Timeliness; 5) Frequency of dissemination)

Population Census data and COS data at grid level as defined by INSPIRE data specification theme on Geographical grid systems.

Information available through download services and free of charge.

Frequency of dissemination comprising every five years.

Data collection: (Describe how the geospatial data for the indicator can be collected/made available, and issues to overcome – are there many sources to collect from, do they need to be integrated and normalized etc.)

Two sources of information would have to be compiled:

1- Data on population (Census or populations estimates) produced by Statistics Portugal;

2- Data on built-up area based on COS (megaclass 1 " artificial land") produced by DGT (NMCA Portugal).

Data would comprise three themes and two variables that need to be integrated at a comparable scale.

Geospatial data analysis and integration: (Describe which analysis, procedures and computations are needed to provide the results needed to support the reporting requirements - "to-be" situation)

Spatial analysis techniques would be required including areas extraction, spatial intersection, data combination, as well as calculation of formulas for population growth rate and built-up areas growth rate.

The formula reflects the relation between land consumption, city growth and artificial land. Built-up areas, new developments and urban land cover are underlying this concept that aims to relate the tendency between population growth and urbanization, as an expression of land consumption.

Therefore, it would be useful to create a scale system to measure the degrees of land consumption ratio. This scale would improve interpretation of land consumption from its association with population growth based on aggregation and dispersion scale.

Tendency	*Scale*
>pop. >city	=stable growth
<pop. <city	=regression
>pop. <city	=compactness
<pop. >city	=dispersion/expansion

C. EU SDG 15.21- Artificial land cover per capita | Eurostat

1. Current reporting situation

Responsibility: (Identify the agency responsible for the indicator and the situation regarding the ESS and NSS projects (including dissemination) and /or INSPIRE conformance)

Eurostat, using LUCAS data.

Indicator disaggregation: (List the indicator disaggregation by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts to support the monitoring of the implementation of the SDGs)

By NUTS 2.

Frequency of dissemination: (Describe the time interval at which information is disseminated over a given time period)

Every three years in line with LUCAS, i.e. 2009, 2012, 2015, 2018.

Timeliness: (Length of time between data availability and the event or phenomenon they describe. Describe the average production time for each release of data)

X+2 since 2009.

Data sources: (List the data sources and themes or variables in use, including conditions of access situation, resolution, positional accuracy, frequency and timeliness regarding the ESS and NSS projects and /or INSPIRE conformance).

LUCAS.

Geospatial data analysis and integration: (Describe spatial analysis methods, procedures and computations, including regarding data integration)

LUCAS point data. No geospatial analysis in the strict sense.

Data quality requirements: (List in general terms the requirements for the sources and themes in use with relevant parameters: Resolution, completeness, logical consistency, positional accuracy, temporal accuracy etc. List if certain international standards are being followed, including classifications/nomenclatures. Data quality should allow computing results to the needed level of resolution and disaggregation). Please take into account the EURO-SDMX Metadata Structure (ESMS) 2.0.

The data sources should be consistent with other EU wide land cover land use data such as LUCAS and Copernicus. For the ESS national level and NUTS 2 level information are sufficient. Other departments of the Commission ask for more detailed data e.g. by NUTS 3, data by degree of urbanisation and other typologies.

General comments: (Please provide any additional information or comments)

There is a Commission / EEA wide task team comparing Copernicus VHRL with LUCAS data, in this case imperviousness. LUCAS data are available for NUTS 2 while other users ask for more detailed disaggregation e.g. for cities, degree of urbanisation, etc. Likewise the task will also look at Forest areas. The task will start in autumn 2017 and should be completed by end of 2018 in time for the next Copernicus data processing campaign.

There is a problem with the definition of what artificial should comprise, e.g. in the urban context are parks and gardens artificial land or not. Do we use built-up areas?

This will be clarified by the team working on SDG indicators for the EU.

At the global level Indicator 11.3.1 speaks about ratio of land consumption rate to population growth rate and employs a wider concept of land consumption than just artificial.

2. Suggested Methodology

GAP analysis: (Describe what changes in use of **applied methods** are needed to go from the suggested/current procedure for monitoring the indicator, to a future procedure which better fulfils the reporting requirements - going from the "as-is" situation in the present metadata proposal to a "to-be" situation)

Deriving artificial land cover from a point based sample or earth observation data has limitations in either case, mainly due to uncertainties of the concepts used to define artificial land and the accuracy of earth observation data.

An alternative could be the aggregation of this information from a very detailed cadastre that not only contains the boundaries of all land parcels but also their land use and the size and shape of buildings. It should also contain detailed spatial information on infrastructure used for transport.

3. Suggested geospatial data integration

GAP analysis: (Describe what changes in use of **data** needed to go from the suggested/current procedure for monitoring the indicator, to a future procedure which better fulfils the reporting requirements - going from the "as-is" situation in the present metadata proposal to a "to-be" situation)

Currently the indicator is directly derived from the LUCAS data. An aggregation from cadastre information would be straightforward provided that a mapping of the use of a land parcel in the cadastre to the concept of artificial land could be done.

List required geospatial data: (Develop a list from the GAP analysis, which lists the geospatial data sources and themes which are required to support the to-be situation, including INSPIRE conformance)

Large scale transport infrastructure information, cadastral parcels, buildings, land use and land cover information.

Data quality requirements: (List in general terms the requirements for the suggested sources and themes with relevant parameters: Resolution, completeness, logical consistency, positional accuracy, temporal accuracy etc. List if certain international standards should be followed including classifications/nomenclatures. Data quality should allow computing results to the needed level of resolution and disaggregation). Please take into account the EURO-SDMX Metadata Structure (ESMS) 2.0.

Scale 1:10 000 or better. Land use and land cover information used for cross-checking, and therefore less demanding.

Data availability: (List the data availability for the suggested sources and themes or variables: 1) Geographically: national/regional/global (as well as comparability across countries), 2) Source: Accessible through services or download, 3) Commercial/legally: license conditions - are data free or are there restriction on use; 4) Timeliness; 5) Frequency of dissemination)

Copernicus data and LUCAS data are available free of charge. Transport network, and cadastral parcels data should be available thanks to INSPIRE as data and services, though not necessarily free of charge, building data not yet available in all Member States as Annex III Theme.

Copernicus data has currency of every three years, currently with a lag of three years. It should improve in the future thanks to Sentinel data.

Cadastre information normally is always up to date.

Data collection: (Describe how the geospatial data for the indicator can be collected/made available, and issues to overcome – are there many sources to collect from, do they need to be integrated and normalized etc.)

LUCAS and Copernicus data are both available and open, Cadastral parcels, transport networks available via the INSPIRE Geoportal but not necessarily open data in all countries.

Geospatial data analysis and integration: (Describe which analysis, procedures and computations are needed to provide the results needed to support the reporting requirements - “to-be” situation)

Classification of land parcels based on a mapping of land use categories used in the cadastre to the concept of artificial land, aggregation of all relevant parcels.

C. EU SDG 15.24 - Change in artificial land cover per year | Eurostat

1. Current reporting situation

Responsibility: (Identify the agency responsible for the indicator and the situation regarding the ESS and NSS projects (including dissemination) and /or INSPIRE conformance)

Eurostat using LUCAS data.

Indicator disaggregation: (List the indicator disaggregation by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts to support the monitoring of the implementation of the SDGs)

With LUCAS data at NUTS 2 level.

Frequency of dissemination: (Describe the time interval at which information is disseminated over a given time period)

Every three years in line with LUCAS.

Timeliness: (Length of time between data availability and the event or phenomenon they describe. Describe the average production time for each release of data)

X+2.

Data sources: (List the data sources and themes or variables in use, including conditions of access situation, resolution, positional accuracy, frequency and timeliness regarding the ESS and NSS projects and /or INSPIRE conformance).

LUCAS data, potentially Copernicus imperviousness.

Geospatial data analysis and integration: (Describe spatial analysis methods, procedures and computations, including regarding data integration)

Based on total artificial land and built-up areas based on a point based survey. As a result no spatial calculations and data analysis at raster or vector level.

Data quality requirements: (List in general terms the requirements for the sources and themes in use with relevant parameters: Resolution, completeness, logical consistency, positional accuracy, temporal accuracy etc. List if certain international standards are being followed, including classifications/nomenclatures. Data quality should allow computing results to the needed level of resolution and disaggregation). Please take into account the EURO-SDMX Metadata Structure (ESMS) 2.0.

The data sources should be consistent with other EU wide land cover land use data such as LUCAS and Copernicus. For the ESS, national level and NUTS 2 lever information are sufficient. Other departments of the Commission ask for data by degree of urbanisation and other typologies.

More detailed data e.g. by NUTS 3 area are desirable.

General comments: (Please provide any additional information or comments)

In general EU SDG monitoring is skeptical of change indicators so it is not clear if this indictor will remain on the list.

2. Suggested Methodology

GAP analysis: (Describe what changes in use of **applied methods** are needed to go from the suggested/current procedure for monitoring the indicator, to a future procedure which better fulfils the reporting requirements - going from the "as-is" situation in the present metadata proposal to a "to-be" situation)

Currently Eurostat does not propose a change in methodology.

3. Suggested geospatial data integration

GAP analysis: (Describe what changes in use of **data** needed to go from the suggested/current procedure for monitoring the indicator, to a future procedure which better fulfils the reporting requirements - going from the "as-is" situation in the present metadata proposal to a "to-be" situation)

Currently, no change planned.

List required geospatial data: (Develop a list from the GAP analysis, which lists the geospatial data sources and themes which are required to support the to-be situation, including INSPIRE conformance)

Currently, no change planned.

Data quality requirements: (List in general terms the requirements for the suggested sources and themes with relevant parameters: Resolution, completeness, logical consistency, positional accuracy, temporal accuracy etc. List if certain international standards should be followed including classifications/nomenclatures. Data quality should allow computing results to the needed level of resolution and disaggregation). Please take into account the EURO-SDMX Metadata Structure (ESMS) 2.0.

Currently, no change planned.

Data availability: (List the data availability for the suggested sources and themes or variables: 1) Geographically: national/regional/global (as well as comparability across countries), 2) Source: Accessible through services or download, 3) Commercial/legally: license conditions - are data free or are there restriction on use; 4) Timeliness; 5) Frequency of dissemination)

Currently, no change planned.

Data collection: (Describe how the geospatial data for the indicator can be collected/made available, and issues to overcome – are there many sources to collect from, do they need to be integrated and normalized etc.)

Currently, no change planned.

Geospatial data analysis and integration: (Describe which analysis, procedures and computations are needed to provide the results needed to support the reporting requirements - “to-be” situation)

Currently, no change planned.