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Items for discussion and decision: demographic statistics

A recommendation on the method to delineate cities, urban and rural areas for international statistical comparisons

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Executive summary

Several new global agendas call for the collection of harmonised indicators for cities, urban and rural areas. Because no harmonised method to delineate these areas is available, indicators rely on national definitions, which vary considerably and thus limit international comparability. This document addresses this lack by proposing a simple, new method that can be applied globally.

This new method, called the Degree of Urbanisation, classifies the entire territory of a country into three classes: 1) cities, 2) towns and semi-dense areas and 3) rural areas. It has two extensions. The first extensions identifies: cities, towns, suburban or peri-urban areas, villages, dispersed rural areas and mostly uninhabited areas. The second extension adds a commuting zone around each city to create a functional urban area or metropolitan area.

This new method has several benefits. It can be applied in a very cost effective manner. Existing data collections, such as household surveys, can often be aggregated by Degree of Urbanisation. By proposing three classes, it captures the urban-rural continuum. Because this method is based on a population grid, it reduces the distortions created by the variable size of statistical and administrative units. It improves global comparability by capturing the spatial concentration of people directly, instead of relying of proxies such as built-up areas or night lights. Last but not least, the method was explicitly designed to monitor access to services and infrastructure in areas with different population sizes and densities.

This method is proposed for endorsement to the 51st meeting of the UN Statistical Commission.

Contents

Table of Figures

A recommendation on the method to delineate cities, urban and rural areas for international statistical comparisons

1. INTRODUCTION

The Global Monitoring Framework of the 2030 Agenda for Sustainable Development (UN 2015) includes several indicators that should be collected for cities or for rural and urban areas. So far, however, no method or international standard has been proposed at the global level to delineate these areas. The broad array of different criteria applied in national definitions of rural and urban areas poses serious challenges to cross-country comparisons (ILO 2018). The Action Framework of the Implementation of the New Urban Agenda (UN-Habitat 2017) and the Global Strategy to improve Agricultural and Rural Statistics (IBRD-WB 2011) both highlight the need for a harmonised method to facilitate international comparisons and to improve the quality of rural and urban statistics in support of national policies and investment decisions.

That is why six international organisations, the European Union, The Food and Agriculture Organization of the United Nations (FAO), the International Labour Office (ILO), the Organization for Economic Co-operation and Development (OECD), United Nations Human Settlements Programme (UN-Habitat) and the World Bank, have been working closely together to develop a harmonised method to facilitate international statistical comparisons. This work was launched at the Habitat III conference in 2016 with the explicit aim to organise global consultations and present the new method to the UN Statistical Commission for endorsement.

The goal is to facilitate international statistical comparisons of cities, urban and rural areas across a selection of indicators. This method is meant to complement and not replace the definitions used by national statistical institutes and ministries. These national definitions typically rely on a much wider set of indicators and can be adjusted to take into account specific national characteristics and objectives. The proposed method is also not meant to limit the scope of certain policies to particular areas, for example rural policies should not be constrained to rural areas.

The Report of Secretary-General on Demographic Statistics presented during the 50th session stated that "The full report and recommendations with respect to endorsing the methodology for the purpose of ensuring international statistical comparability only – while not affecting or having an impact on national definitions of cities, townships and urban and rural areas – will be submitted to the Statistical Commission at its fifty-first session." (see United Nations, ESC 2018, section V).

This document was produced at the request of the 50th session of the UN Statistical Commission (see United Nations, ESC 2019, Decision 50/118, paragraph (d)), which "welcomed the work on developing the methodology for the delineation of urban and rural areas and the definition of the city based on the degree of urbanization, and requested the submission of the final assessment, to be prepared in consultation with Member States, on the applicability of this methodology for international and regional comparison purposes to the Commission at its fifty-first session".

2. THE PROPOSED METHOD, CALLED THE DEGREE OF URBANISATION, AND ITS TWO EXTENSIONS

The Degree of Urbanisation classifies the entire territory of a country along the urban-rural continuum. It combines population size and population density thresholds to capture the full settlement hierarchy. It is applied in a two-step process: First, 1 km^2 grid cells are classified based on population density, contiguity and population size. Subsequently, local units are classified based on the type of grid cells their population resides in. This method works best with small administrative or statistical units, such as municipalities or census enumeration areas.

The Degree of Urbanisation has two hierarchical levels. The Degree of Urbanisation level 1 uses three classes ("cities", "towns & semi-dense areas", and "rural areas") instead of using only two classes (urban and rural areas). Having three classes adds nuance by showing the situation of people living in this middle category. Data from a variety of sources show that indicators for this middle category have a value in between the values for the other two areas.

This document presents two extensions of the Degree of Urbanisation level 1. The Degree of Urbanisation level 2 identifies medium and small settlements, i.e. "towns" and "villages." The Functional Urban Area adds a commuting zone around each city to create a "metropolitan area."

2.1. The Degree of Urbanisation level 1

The Degree of Urbanisation classifies local units as 1) "cities" or "densely populated areas", 2) "towns & semi-dense areas" or "intermediate density areas" and 3) "rural areas" or "thinly populated areas" based on population density, population size and contiguity using 1 km² grid cells. Each local unit belongs exclusively to one of these three classes. Local units can be administrative units - such as municipalities - or statistical units - such as census enumeration areas.

The basis for the Degree of Urbanisation is a 1 km² population grid. Each grid cell has the same shape and size, thereby avoiding distortions caused by using units varying in shape and size. This is a considerable advantage when compared to methods based on the population size and density of local administrative or other statistical units (see section 3.2).

Step 1: grid classification

The Degree of Urbanisation identifies three types of grid cells (Figure 1):

- **An urban centre** (or a high density cluster) consists of contiguous grid cells with a density of at least 1,500 inhabitants per km^2. An urban centre has population of at least 50,000. Gaps in this cluster are filled and edges are smoothed. If needed, cells that are 50% built-up can be added[1].
- **An urban cluster** (or moderate density clusters) consists of contiguous grid cells with a density of at least 300 inhabitants per km^2 and has a population of at least 5,000 in the cluster. (The urban centres are subsets of the corresponding urban clusters.)
- **Rural grid cells** (mostly low density cells) are cells that do not belong to an urban cluster. Most of these will have a density below 300 inhabitants per km^2. Some rural cells will have a higher

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[1] In a few countries with relatively low-density urban development and a strong separation of land use functions, the Degree of Urbanisation generates multiple urban centres for a single city. Creating urban centres using both cells with a density of at least 1,500 inhabitants and cells that are at least 50% built-up resolves this issue. Such highly built-up cells typically contain office parks, shopping malls, factories and transport infrastructure.

density, but they are not part of cluster with a large enough population size to be classified as an urban cluster.

Step 2: classifying local units

Once all grid cells have been classified as urban centres, urban clusters and rural grid cells, the next step concerns overlaying these results onto local units, as follows (Figure 2):

1. **Cities (or densely populated areas):** local units that have at least 50% of their population in urban centres
2. **Towns and semi-dense areas (or intermediate density areas):** local units that have less than 50% of their population in urban centres and less than 50% of their population in rural grid cells
3. **Rural areas (or thinly populated areas):** local units that have at least 50% of their population in rural grid cells

Urban areas consist of cities plus towns and semi-dense areas. As this method was developed to capture the urban rural continuum, however, it recommends reporting indicators for all three classes instead of only for the urban-rural dichotomy. This is important because towns and semi-dense areas may differ significantly from both cities and rural areas. Policies that are uniformly applied to these three classes may not be suitable and could benefit from being tailored for each of these types of areas. An important consequence of this new method is a call for more research on policies for those intermediate density areas, which could take into account the complementarities and interdependencies among the three types of territories.

Comparisons with a selection of national definitions have shown a high level of agreement for the two extreme classes: cities are typically classified as urban and rural areas as rural (see section 3.1). The towns and semi-dense areas, however, are sometimes classified as urban and sometimes as rural by national definitions. By placing these areas in an intermediate category, this method tries to accommodate these different points of view and emphasises that these intermediate density areas are halfway between a city and a rural area.

Semi-dense areas in low- and middle-income countries are often described as peri-urban areas. In high-income countries, they are usually described as suburbs (see section 2.3). In both cases, these areas have a moderate density and are at the transition between a rural area and a city or town.

Note that the quality of the population grid can have a significant impact on the population shares in the three classes of the degree of urbanisation. This is particularly the case for the difference between rural areas and towns & semi-dense areas as this often requires a fine distinction within administrative units. A grid that concentrates population too much will overestimate the population in towns and semi-dense areas. A grid that disperses population too much will overestimate the population in rural areas.

Figure 1 Urban centre, urban cluster and rural grid cells around Durban, South Africa
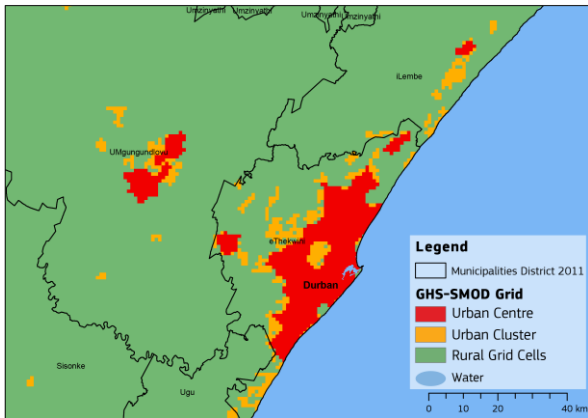
Figure 2 City, towns & semi-dense areas, and rural areas around Durban, South Africa
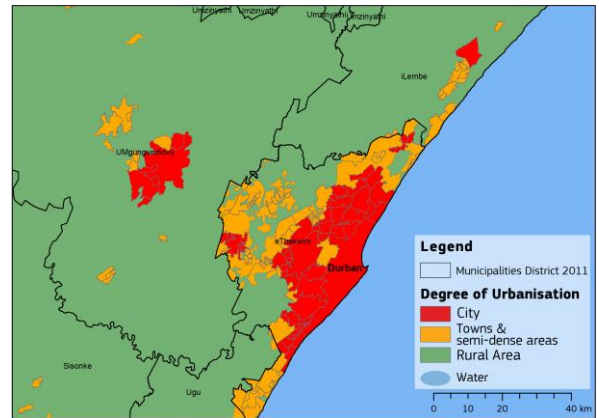
Source: (Florczyk et al 2019)

2.2.   Examples of data by Degree of Urbanisation

The Degree of Urbanisation has been implemented by all the 32 national statistical institutes in the European Statistical System in 2012. Eurostat, the Statistical Office of the European Union, now publishes over 100 indicators by Degree of Urbanisation, including multiple SDG indicators. It has been included in an EU Regulation (2017/2391) giving this classification an official recognition. A more detailed description can be found in the Methodological Manual on Territorial Typologies (European Commission 2019)

Figure 3 and Figure 4 show two examples of how the Degree of Urbanisation can be used to highlight significant disparities in the performance of UN SDG indicators along the urban-rural continuum. In most European countries, the poverty rate and the share of young people Neither in Employment, nor Education or Training (NEET) are considerably higher in rural areas than in cities. In a few countries, however, poverty and NEET are higher in cities than in towns & semi-dense areas or rural areas.

Figure 3 At risk of poverty rate by Degree of Urbanisation in European countries, 2017
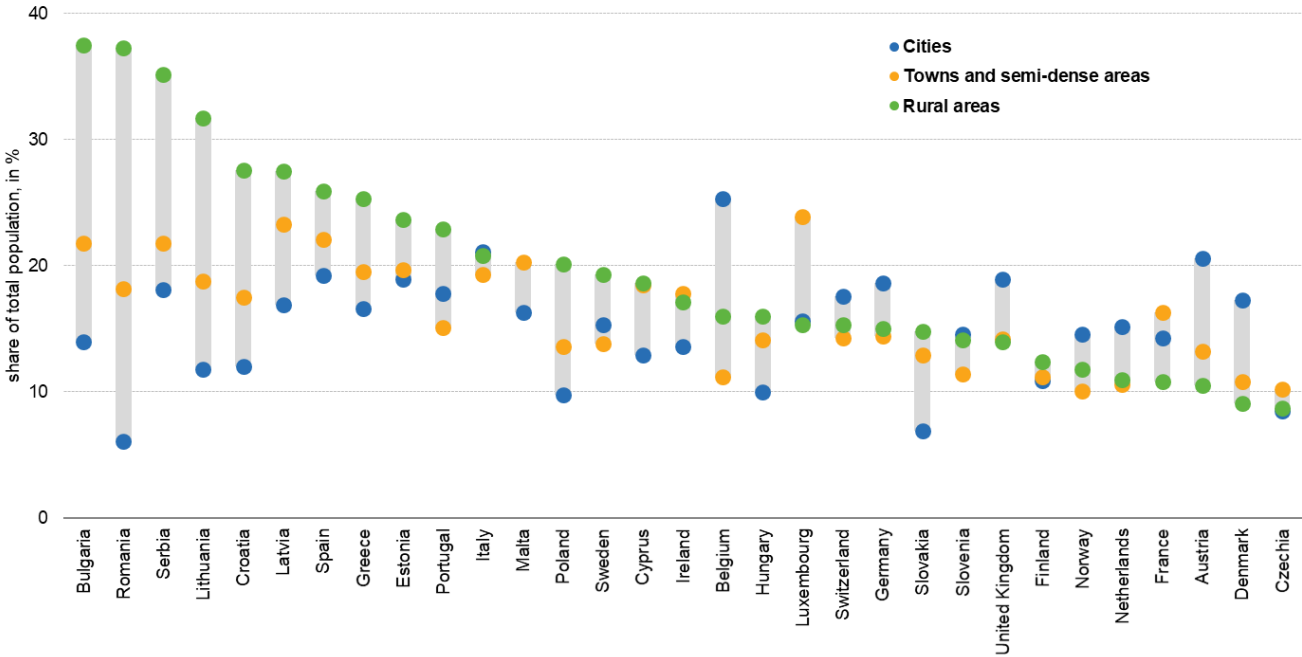
Source: Eurostat, table ilc_li43

Figure 4 Young people neither in employment, nor education or training in European countries, 2018
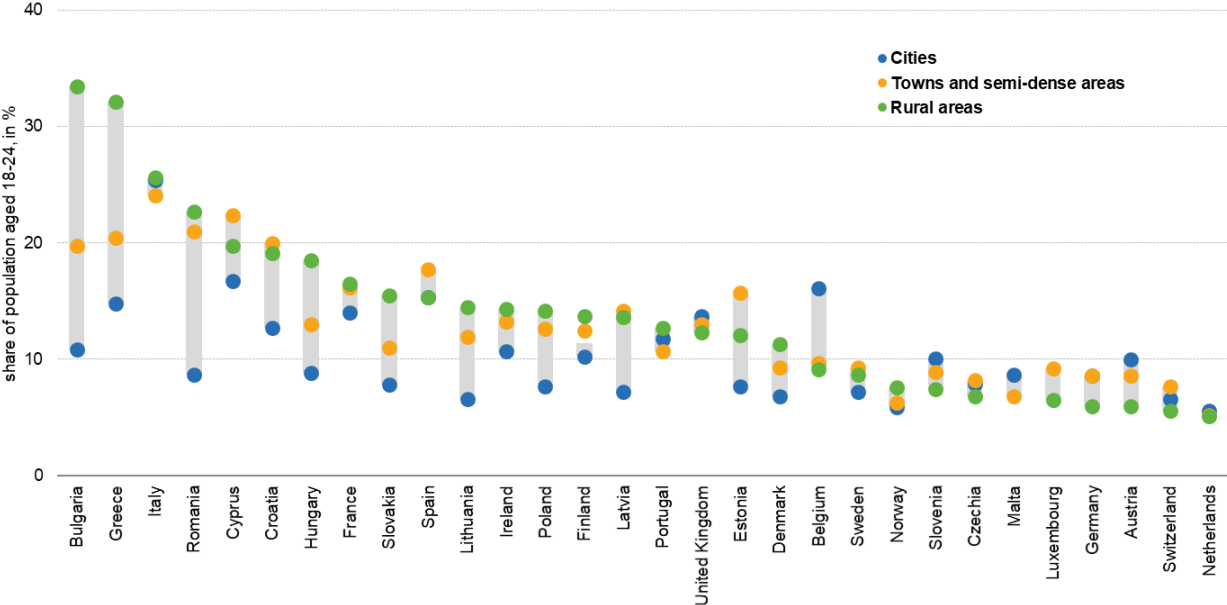
Source: Eurostat, table edat_lfse_29

Note that the value for the cities in Germany and Luxembourg is hidden by the value for towns and semi-dense areas.

Figure 5 shows that in most countries included in the Demography and Health Survey a larger share of the population living in cities has access to safely managed drinking water than in towns & semi-dense areas, which in turn have a large share of their population with access than in rural areas.

Figure 5 Access to safely managed drinking water in selected countries, 2010-2016

Source: Henderson et al. 2019
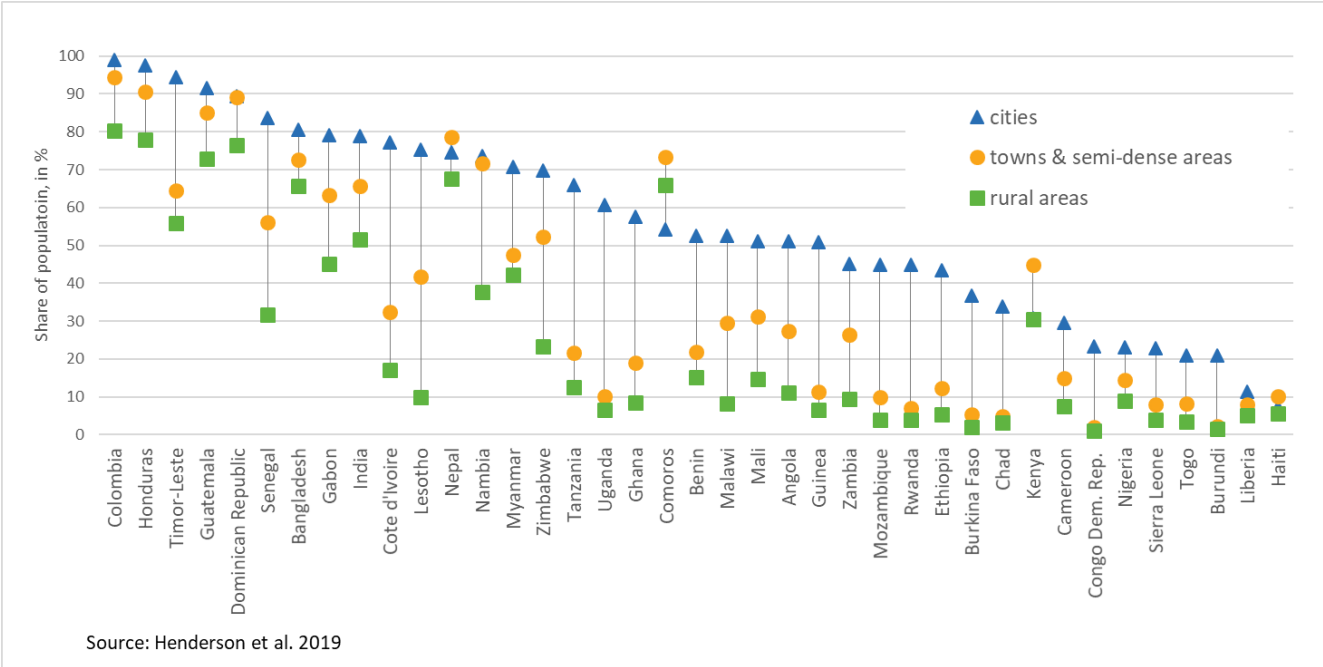
Note: Safely managed drinking water is defined by the DHS-WHO Joint Monitoring Program as all improved water sources that take zero minutes to collect or are on the premises. Improved water sources encompass all piped water and packaged water, as well as protected wells or springs, boreholes, and rainwater.

2.3.   The Degree of Urbanisation level 2

The Degree of Urbanisation level 2 is implemented with the same two step approach. First grid cells are classified based on population density, population size and contiguity (Figure 6). Subsequently, local units are classified according to the type of grid cells their inhabitants live in (Figure 7).The Degree of Urbanisation level 2 is a sub-classification level 1. It was created to identify medium and small settlements, i.e. towns and villages.

Step 1 Grid classification

An urban centre is identified in the identical manner as in the Degree of Urbanisation level 1:

- **An urban centre** consists of contiguous grid cells with a density of at least 1,500 inhabitants per km^2. An urban centre has population of at least 50,000. Gaps in this cluster are filled and edges are smoothed. If needed, cells that are 50% built-up can be added.

The urban cluster cells that are not part of an urban centre can be subdivided into three types.

- **A dense urban cluster** consists of contiguous cells with a density of at least 1,500 inhabitants per km^2, with a population of at least 5,000 and less than 50,000 in the cluster

- **A semi-dense urban cluster** consist of contiguous grid cells with a density of at least 300 inhabitants per km^2 and has a population of at least 5,000 (i.e. an urban cluster) and this cluster is neither contiguous with nor within 2 km of a dense urban cluster or an urban centre[2].

- **Suburban or peri-urban cells** are the remaining urban cluster cells i.e. those not part of dense or semi-dense cluster. These cells are part of an urban cluster that is contiguous or within 2 km of a dense urban cluster or an urban centre.

Rural grid cells can be categorised into three types.

- **A rural cluster** consists of contiguous cells with a density of at least 300 inhabitants per km^2 and a population between 500 and 5,000 in the cluster

- **Low density rural grid cells** are rural grid cells with a density of at least 50 and are not part of a rural cluster

- **Very low density rural grid cells** are cells with a density of less than 50 inhabitants per km^2.

Step 2 Local Unit classification

Local units are classified as cities in the identical manner as in Degree of Urbanisation level 1:

- **A city consists** of one or more local units that have at least 50% of their population in an urban centre.

Local units classified as "towns and semi-dense areas" can be divided into three classes:

- **Dense Towns** have a larger share of their population in dense urban clusters than in semi-dense urban clusters (i.e. it is dense) and a larger share in dense plus semi-dense urban clusters than in suburban or peri-urban cells (i.e. it is a town).

- **Semi-dense Towns** have a larger population share in semi-dense urban clusters than in dense urban clusters (i.e. it is semi-dense) and a larger share in dense plus semi-dense urban clusters than in suburban or peri-urban cells (i.e. it is a town)

- **Suburban or peri-urban areas** have a larger population share in suburban or peri-urban cells than in dense plus semi-dense urban clusters

Dense and semi-dense towns can be combined into towns. This reduces the number of classes and may be useful especially if the population share in semi-dense towns is low.

Local units classified as "rural areas" can be divided into three classes:

- **Villages** have the largest share of their rural grid cell population living in a rural cluster

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[2] Measured as outside a buffer of three grid cells of 1 km^2 around dense urban clusters and urban centres.

- **Dispersed rural areas** have the largest share of their rural grid cell population living in low density rural grid cells.

- **Mostly uninhabited areas** have the largest share of their rural grid cell population living in very low density rural grid cells.

Figure 6 and Figure 7 show the application of this method to Toulouse and its surroundings.

Figure 6 Degree of urbanisation level 2 grid classification around Toulouse, France

Figure 7 Degree of urbanisation level 2 local unit classification around Toulouse, France
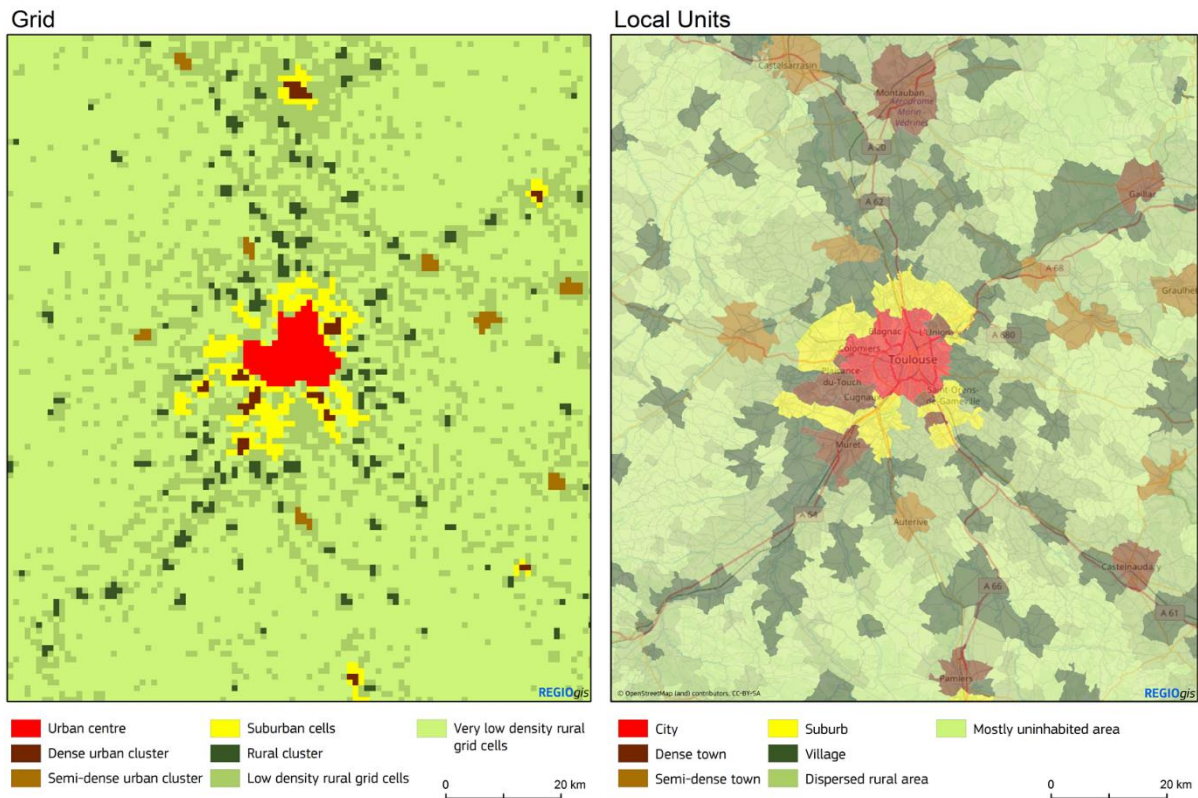
Figure 8 provides a simplified and schematic overview of the Degree of Urbanisation level 2.

Figure 8 Schema for the Degree of Urbanisation level 2 grid classification

		Population size thresholds of the cluster of cells (settlement size)			No population size criterion (not a settlement)
		>= 50,000	5,000 - 49,999	500 - 4,999	
Population density of cells, inhabitants per km²	>= 1500	Urban centre	Dense urban cluster		
	>= 300		Semi-dense urban cluster*	Rural cluster	Suburban or peri-urban grid cells
	>= 50				Low density rural grid cells
	<50				Very low density rural grid cells

* Semi-dense urban clusters can have a population of more than 49,999

2.4. A consistent nomenclature for the Degree of Urbanisation

Two sets of terms have been developed to describe each of the classes of the Degree of Urbanisation. The first set uses simple and short terms such as city, town, suburb and village. The second set uses a more neutral and technical language. The second set can be helpful to avoid overlap with the terms used in the national definition.

Figure 9 Short and technical terms for Degree of Urbanisation level 1 and 2 for the local unit classification

	Local Unit Classification	
Level	Short terms	Technical terms
1	**City**	**Densely populated area**
2	City	Large settlement
1	**Town & semi-dense area**	**Intermediate density area**
2	Dense town	Dense, medium settlement
2	Semi-dense town	Semi-dense, medium settlement
2	Suburban or peri-urban area	Semi-dense area
1	**Rural area**	**Thinly populated area**
2	Village	Small settlement
2	Dispersed rural area	Low density area
2	Mostly uninhabited area	Very low density area

Figure 10 Short and technical terms for Degree of Urbanisation level 1 and 2 for grid cell classification

	Grid classification	
Level	Short terms	Technical terms
1	**Urban centre**	**High density cluster**
2	Urban centre	Dense, large cluster
1	**Urban cluster**	**Moderate density cluster**
2	Dense urban cluster	Dense, medium cluster
2	Semi-dense urban cluster	Semi-dense, medium cluster
2	Suburban or peri-urban grid cells	Semi-dense grid cells
1	**Rural grid cells**	**Mostly low density cells**
2	Rural cluster	Semi-dense, small cluster
2	Low density rural grid cells	Low density grid cells
2	Very low density rural grid cells	Very low density grid cells

2.5. The Functional Urban Area

Several National Statistical Offices, including those of Brazil, Italy, Japan and the USA, complement their urban and rural area definition with a metropolitan area definition. A metropolitan area consists of a city and its commuting zone. This commuting zone generates a daily flow of people into the city and back. Such a definition is often referred to as "functional" because it captures the full economic function of a city. A metropolitan area definition is particularly useful to inform policy making in a number of domains, including transport, economic development and planning.

The Degree of Urbanisation can be extended with a delineation of Functional Urban Areas. The Functional Urban Area (FUA) is composed of a 'city' plus its surrounding, less densely populated local units that are part of the city's labour market ('commuting zone'). The two methods are linked because they use the identical concept of 'city'.

While the Degree of Urbanisation classifies all local units in a country, the Functional Urban Area method classifies only the local units that are either cities or part of their surrounding commuting zones. A Functional Urban Area can contain rural areas if these belong to the commuting zone of a city.

The Functional Urban Area method has been implemented by all European national statistical institutes in 2012 and has been included in EU regulation 2017/2391. The method has also been applied by the OECD to most of its member countries for the purpose of international comparisons in coordination with national statistical agencies of those countries. For a more detailed description see The EU-OECD definition of a Functional Urban Area (Dijkstra et al. 2019).

The delineation of the Functional Urban Area requires the availability of a population grid at 1 km^2 geographical detail, the digital boundaries of local units, and commuting data between local units.

The Functional Urban Area can be created in four steps, as follows:

1. Identify an **urban centre:** a set of contiguous grid cells with a density of at least 1,500 residents per km^2. An urban centre has population of at least 50,000 inhabitants. Gaps in the cluster are

filled and the edges are smoothed. If needed, cells that are 50% built-up can be added. This step is identical to the one used in the Degree of Urbanisation to define an urban centre.

2. Identify a **city**: one or more local units that have at least 50% of their residents inside an urban centre. This step is identical to the one used in the Degree of Urbanisation to define a city.

3. Identify a **commuting zone**: a set of contiguous local units that have at least 15% of their employed residents working in the city. If 15% of employed persons living in one city work in another city, these cities are treated as a single destination. Enclaves, i.e. local units entirely surrounded by other local units that belong to a commuting zone or a city are included and exclaves or non-contiguous local units are dropped.

4. **A Functional Urban Area** is the combination of the city with its commuting zone.

It can happen that, due to a low intensity of commuting flows, there is no commuting zone. In this case, there is a perfect correspondence between the Functional Urban Area and the city.

Figure 11 provides an example of the four steps above for San Luis Potosí, Mexico. The whole method to delineate FUAs is also visually summarised in Figure 12.

Figure 11 Urban centre, city, commuting zone and Functional Urban Area of San Luis Potosí, Mexico
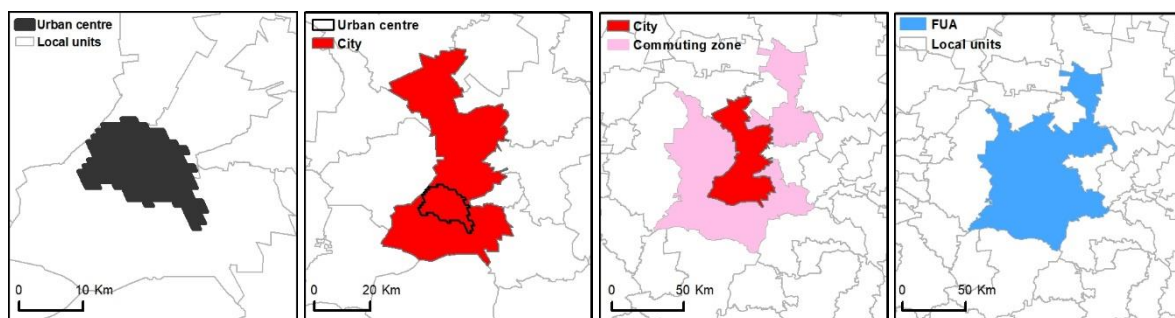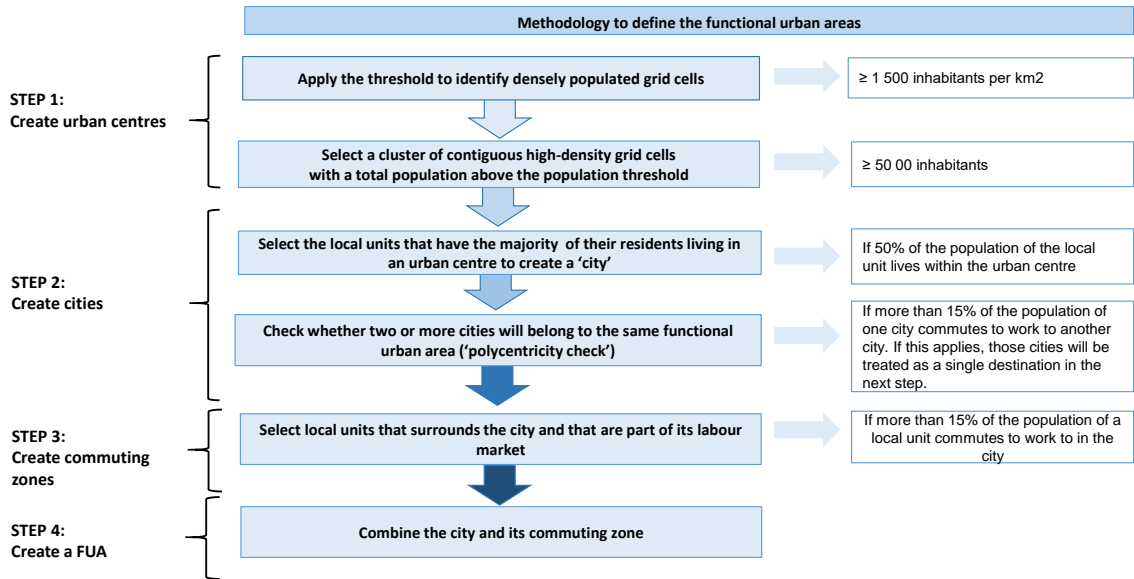
Figure 12 The method to identify a Functional Urban Area

	Methodology to define the functional urban areas	
STEP 1: Create urban centres	Apply the threshold to identify densely populated grid cells	≥ 1 500 inhabitants per km2
	Select a cluster of contiguous high-density grid cells with a total population above the population threshold	≥ 50 00 inhabitants
STEP 2: Create cities	Select the local units that have the majority of their residents living in an urban centre to create a 'city'	If 50% of the population of the local unit lives within the urban centre
	Check whether two or more cities will belong to the same functional urban area ('polycentricity check')	If more than 15% of the population of one city commutes to work to another city. If this applies, those cities will be treated as a single destination in the next step.
STEP 3: Create commuting zones	Select local units that surrounds the city and that are part of its labour market	If more than 15% of the population of a local unit commutes to work to in the city
STEP 4: Create a FUA	Combine the city and its commuting zone	

3. THE ADVANTAGES OF THE NEW METHOD

3.1. Capturing the urban-rural continuum

The UN World Urbanization Prospects (UNPD 2018) reports data for urban areas and rural areas. Many countries, however, use an approach with multiple classes to better capture the urban-rural continuum. For example, the 2011 census in India defined three types of urban areas: Statutory Towns, Census Towns and Outgrowths. The USA census uses Urbanized Areas, Urban Places Outside of Urbanized Areas, and Rural Places and Territory. Portugal uses Predominantly Urban Areas, Medium Urban Areas, and Predominantly Rural Areas. South Africa uses three geography types: Urban Areas, Rural Areas and Traditional Areas. The Degree of Urbanisation is also designed to capture the urban-rural continuum by proposing three classes at level 1 and seven classes at level 2.

Comparing the Degree of Urbanisation to the traditional urban-rural dichotomy shows that depending on the country, national definitions include these towns and semi-dense areas in the urban class or the rural class (Figure 13). For example, the population in towns & semi-dense areas are almost entirely classified as urban by the national definitions of Portugal, Brazil, France and the USA, while in Uganda and India the population in towns & semi-dense areas is mostly classified as rural.

By creating a separate class for areas where national definitions disagree on their classification, the Degree of Urbanisation proposes a compromise which acknowledges both approaches.

Figure 13 Comparing the Degree of Urbanisation and national urban-rural definitions in selected countries
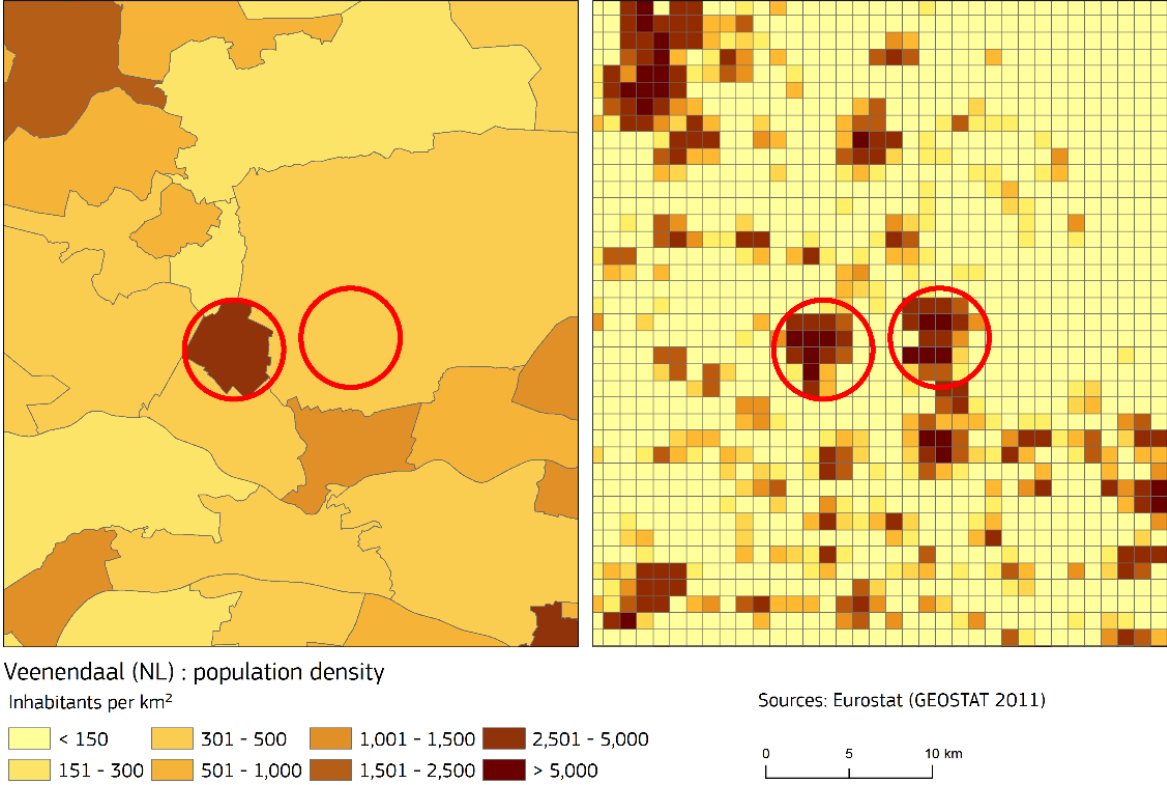

Note: This graph shows for each Degree of Urbanisation what share of its population is classified as urban and what share as rural by the national definition. Countries are ranked by the share of population in town and semi-dense areas classified as urban. Reference years vary from 2010 to 2018 depending on the country.

3.2. Reducing the bias generated by the different shapes and sizes of local units

More than half of the countries in the world have a national definition with a minimum population size threshold to classify an urban area. Applying such a threshold, however, can lead to classifying rural areas as urban only because they are part of a large local unit. For example, Plockton in Scotland has 387 inhabitants, but it is part of Highland Council which has more than 230,000 inhabitants.

To avoid classifying rural areas as urban, some national definitions add a population density requirement. A large city, however, can have a very low population density if it is part of a local unit with a very large area. For example, Ulaanbaatar in Mongolia has 1.4 million inhabitants, but it has a low population density of only 270 inhabitants per km^2. The bias created by the shape and size of local units is called the modifiable areal unit problem. This can be addressed by using spatial units of the same shape and size, such as the population grid. Figure 14 shows how the population grid reveals two settlements (circled in red), but when using the population density of the local units, only the settlement in the small local unit remains visible.

Figure 14 Population density of local units and grid cells in the Netherlands, 2011

Veenendaal (NL) : population density
Inhabitants per km²

< 150	301 - 500	1,001 - 1,500	2,501 - 5,000
151 - 300	501 - 1,000	1,501 - 2,500	> 5,000

Sources: Eurostat (GEOSTAT 2011)

0   5   10 km

The method proposed here starts with a classification of a 1 square kilometre population grid. This creates a classification which is independent from the administrative units of a country and is typically far more detailed. For example, the European Union has around 120,000 local administrative units, but more than 4 million grid cells of 1 square kilometre. Some national definitions are applied census enumeration areas, which are typically much smaller than local administrative units. As they are designed to capture roughly the same number of households, they tend to be (very) small in urban areas and (very) large in rural areas. As a result, the population density of enumeration areas will be higher in urban areas and lower in rural areas as compared to units of the same shape and size. For example, the Australian mesh block vary in size by a factor of 1 billion from 0.0001 km² to more than 100,000 km². Such large differences in size are bound to have a significant impact on population density figures and thus also on a definition that relies on population density. The benefit of using the grid is that all the cells have the same shape and size and their borders are stable over time. This produces a classification which is more comparable across space and more stable over time.

The second step of this method classify local units, which does reintroduce the problem of working with units of varying shapes and sizes. Therefore, it recommends using the small administrative or statistical units. This will ensure a good match with the grid classification. Applying this method to very large units, such as regions, may significantly alter the population shares as compared to the grid classification.

3.3.   Measuring population clusters directly

The UN Principles and Recommendations on Population and Housing Censuses Revision 3 defines a locality or settlement as a distinct population cluster (section 1.8 p. 187). In the past, however, it was

not possible to measure where people were clustered, but buildings were mapped at a much higher spatial resolution than population. For example, a cadastral map with the outline of each building has a very high spatial resolution and can be used to identify which buildings are within 200m of each other. Population data, however, was only available at a much coarser spatial resolution. Therefore, some national and academic definitions use buildings clusters to identify settlements.

Today, however, far more precise information is available on the location of the population. With the advent of geo-coded censuses, geo-referenced population registers and high resolution population grids, the spatial resolution of population data has increased dramatically and allows the direct identification of population clusters. As a result, it is no longer necessary to approximate a population cluster with a building cluster.

Measuring population concentrations directly makes them more comparable across levels of development. Cities in high income countries have far more built-up area per inhabitant than cities in low income countries. Using only built-up area to define cities would mean that a high income country would have more cities and each city would be bigger than a low income country even if they had exactly the same urban structure.

Measuring population concentrations directly also makes them more comparable over time. In many countries, the amount of built-up land grows faster than population does. This means over time, less and less people are needed to reach a certain amount of built-up area. As a result, built-up area based definitions would inflate the share of urban population over time, while a people-based definition is not affected by this problem.

The Degree of Urbanisation matches the locality size classes recommended by the UN Principles and Recommendations for Population and Housing Censuses (UNSD 2017). Cities capture the top three size classes (50,000-99,999; 100,000-499,999; and 500,000 or more inhabitants). Towns capture the following three size classes (5,000-9,999; 10,000-19,999; and 20,000-49,999 inhabitants). Villages capture the next three classes (500-999; 1,000-1,999; 2,000-4,999 inhabitants).

3.4. Areas to monitor access to services, not areas defined by access to services

The Sustainable Development Goals include multiple indicators that monitor access to services or infrastructure. Examples include indicators measuring access to electricity, safely managed drinking water, a mobile phone network and all-weather road. To properly monitor the access to these services in urban and rural areas, these services should not be part of the definition of these areas. If the definition of an urban area includes a criterion that everyone should have access to electricity, it means that the entire urban population will have access to electricity, by definition. This would make it impossible to monitor access to electricity in urban areas. Because there may be urban areas, i.e. large and dense settlements, that lack electricity but they would not be classified as urban.

To avoid this problem, the Degree of Urbanisation does not use access to services or infrastructure. This means that it can be used to identify cities, towns & semi-dense areas, and rural areas that lack or have successfully acquired such a service. This can facilitate international policy exchanges on how to provide electricity in different types of areas.

The Degree of Urbanisation does not use the share of agricultural employment for both conceptual and empirical reasons. The concept of the Degree of Urbanisation is people-based. It means that

settlements of the same size are consistently classified in the same way. Including a maximum of threshold of agricultural employment in the method to identify urban areas would mean that settlements with the same population size could be classified as urban or rural. This would undermine the central principle of this method.

Empirically, the share of employment in agriculture varies from more than 50% to less than 1% between different countries in the world. Using the same threshold, in all countries would mean that some countries would become entirely rural or entirely urban. This would undermine the goal of facilitating international comparisons and measuring the Sustainable Development Goals in a harmonised manner.

Because, agricultural employment is not part of the Degree of Urbanisation method, it will be present in all three classes. For example, in the EU-28 6% of the people working in agriculture live in cities, 24% in towns and semi-dense areas and 69% in rural areas. The presence of agricultural employment outside rural areas should not be seen as a problem, but rather as a benefit of this method. For example, farmers living in cities, towns and semi-dense areas will have better access to markets, allowing them to focus on more perishable and higher value added produce. They may also have more opportunities to combine farming with working in a different economic sector.

The UN Principles and Recommendations for Population and Housing Censuses Revision 3 (UNSD 2017) mention the lack of a single definition of urban and rural areas. It suggests that some countries may wish to use additional criteria including "the percentage of the population engaged in agriculture, the general availability of electricity or piped water in living quarters and the ease of access to medical care, schools, recreation facilities and transportation." The method presented here aims to fill the lack of a harmonised method to delineate cities, urban and rural areas. This method deliberately avoids the suggested additional indicators to ensure that a) settlements of the same size are classified in the same way and b) access to services can be monitored.

3.5. A cost-effective approach

This method is highly cost-effective for two reasons. First, a population grid can be created for a relatively low cost. Second, producing data by Degree of Urbanisation can be done by aggregating existing data in a different way.

A population grid can be created using a geo-coded census or a geo-coded population register for little extra costs. These sources provide the exact location of the residents of a country. All that is further required is to add up the population per 1 square kilometre grid cell and, if needed, treat the results to protect confidentiality. If the exact location of the population is not available, a population disaggregation grid can be created by combining the population of census enumeration areas with high resolution land use or land cover data. Such land use cover can be produced using remote sensing. Several organisations offer a free global layer, including the Global Human Settlement Layer[3] produced by the European Commission's Joint Research Centre.

Producing data by Degree of Urbanisation is often simple. If in a household survey, the location of the respondents or the local unit they live in is available, then the response can be aggregated by Degree of Urbanisation. As the Degree of Urbanisation often has a quite balanced distribution of the

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[3] https://ghsl.jrc.ec.europa.eu

population over the three classes, surveys will generally have a sufficiently high sample in each class to produce reliable data. Other types of data, such as administrative data, can also be aggregated by Degree of Urbanisation as long as it is available by local unit.

3.6.   Selecting the density and size thresholds

The selection of the density and size thresholds drew inspiration from several national definitions:

- Out of the 103 countries that use a minimum population size threshold to define urban areas, 84 countries use a minimum population size threshold of 5,000 or lower (Figure 15). Therefore, the 5,000 threshold was used for the urban clusters

- Japan uses a minimum population size threshold of 50,000. This is the threshold selected for urban centres.

- China and the Seychelles use a minimum population density threshold of 1,500 inhabitants per sq km. This is the density threshold for urban centres.

Figure 15 Minimum population size thresholds used to define urban areas
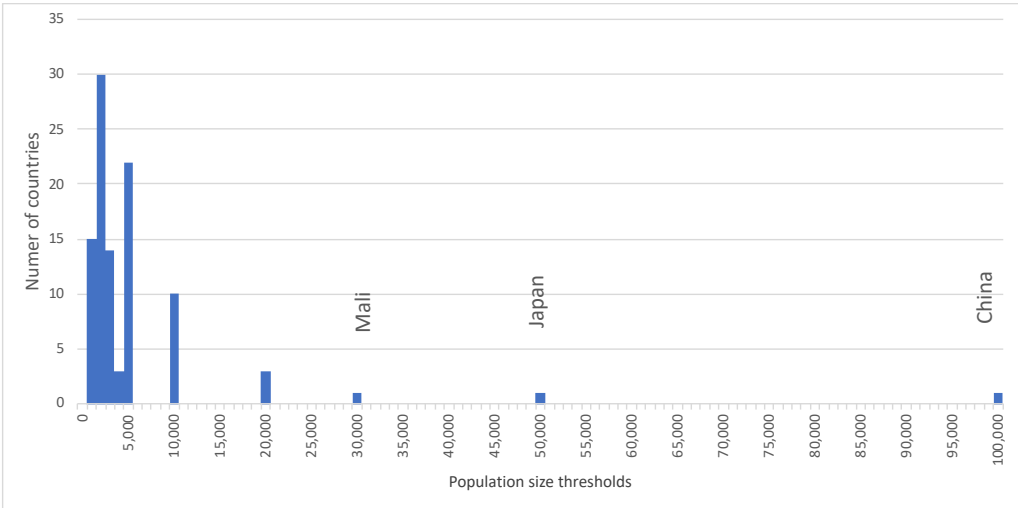
Source: UNPD World Urbanization Prospects 2018

An extensive sensitivity analysis was performed both on official grids in the EU and two global grids (GHS-POP[4] and World POP[5]).

Using GHS-POP, the combination of 1,500 inhabitants per square kilometre and 50,000 inhabitants identifies at least one city in all countries[6] with 250,000 inhabitants or more, with Vanuatu as the only exception. With GHS-POP, all small island developing states either have a city or town. The SIDS estimated to have a town and not a city with at least 50,000 inhabitants area Antigua and Barbuda, Dominica, Grenada, Kiribati, Marshall Islands, Micronesia, Nauru, Palau, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Samoa, Seychelles, Tonga, Tuvalu and Vanuatu.

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[4] https://ghsl.jrc.ec.europa.eu/data.php
[5] https://www.worldpop.org/focus_areas
[6] https://ghsl.jrc.ec.europa.eu/CFS.php

4.   A POPULATION GRID: WHAT IS IT AND HOW CAN YOU BUILD IT

A **population grid** is composed of (usually equally sized, square) grid cells containing population counts for each cell. Population grids are a powerful tool for describing the spatial distribution of a population and are particularly useful for analysing socioeconomic phenomena that are independent of administrative boundaries. When studying such phenomena, a system of equal-size grid cells has many advantages:
•   grid cells all have the same size allowing for easy comparison;
•   grids are stable over time;
•   grids integrate easily with other scientific data (e.g. meteorological information);
•   grid cells can be aggregated to form areas reflecting a specific spatial zone (e.g. mountain regions, water catchments, administrative units, etc.).
Developing grid-based population statistics may raise a concern about confidentiality. A grid cell of 1km^2 offers a good balance between analytical capacity and data protection[7].

Step 1: Define the grid cells

Population grid data are statistics geographically referenced to a coordinate system of grid cells in a grid net with known coordinates. For the unambiguous referencing and identification of a grid cell, a standard GIS coding system requires the cell size and the position of the grid in the upper-left corner.

Step 2: Establish the total number of inhabitants living in each grid cell

In general, there are three methodological solutions for establishing the total number of inhabitants living in each of these grid cells.

Method 1: aggregation method

With the introduction of new technologies and increased computing power, a growing number of national statistical authorities developed the ability to produce statistics for very small areas. For example, during a population census, many statistical authorities are now able to capture data based on geocoded data collection points such as addresses or buildings. The aggregation method ('bottom up') requires the existence of such geo-referenced point datasets with high spatial accuracy. In most cases, these are building and/or address registers geocoded with geographic coordinates to which the population data can be referenced. These point-based population data then can be aggregated to any spatial unit (regardless of their size and shape), including squared grid cells.

Method 2: disaggregation method

The disaggregation method ('top-down') uses population statistics for local statistical or administrative units in combination with auxiliary spatial data (e.g. built-surfaces, land cover). The total population count of a spatial unit can be disaggregated, for example, through the mapping of buildings from satellite images and distributing the unit's population among these built-up areas. Such an approach may have some limitations: for example, it is difficult to define the actual height or functions of buildings from a satellite image and, as a consequence, the number of potential dwellings for each building's footprint. For example, a global population grid was estimated using population data

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[7] www.efgs.info

collected by CIESIN (CIESIN 2016) and built-up area identified in the Global Human Settlement Layer (Florczyk et al 2019).

Method 3: hybrid approach

The hybrid approach for production of population grid statistics is based on combining the aggregation and disaggregation techniques; this method provides a compromise between accuracy and the availability of data. Hybrid solutions may refer to using different source data to establish a geocoded framework, for example, combining geospatial, administrative and statistical sources.

5.   CONSULTATIONS, WORKSHOPS, EXPERT MEETINGS, PILOT PROJECTS AND PRESENTATIONS

Since the launch of this work at the Habitat III conference in Quito Ecuador in 2016, the six international organisations supporting this work and the UN Statistics Division have organised broad consultation in a variety of formats.

The proposed methodology was discussed at the *United Nations Expert Group Meeting on Statistical Methodology for Delineating Cities and Rural Areas, United Nations, New York, 28-30 January 2019.*[8] The Conclusions and Recommendations of this Expert Group Meeting are presented as APPENDIX I within this document.

The Workshops, pilot projects, and presentations by the six international organisations are presented as APPENDIX II within this document.

5.1.   Challenges to implement this method

Today, only a minority of countries have an official population grid, but a substantial number of countries is preparing a geo-coded census or population register which would allow the creation of an official population grid. The United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) can give further guidance on this. Nevertheless, many countries underlined the need for support, training and capacity building to create such a grid and to apply this method.

In the absence of a geo-coded census or population register, a disaggregation grid can by combining the population of census enumeration areas and high resolution land use data from national or global sources (see below). Thanks to the high mobile phone penetration rate, the night time location of mobile phones can also be used to generate a high resolution population grid (see for example, Deville et al. 2014).

Several countries do not collect commuting data as part of their census. Other sources such as linked population and employment registers or mobile phone data could be used to estimate such flows. Estonia offers an illustrative example where – as reported in two studies commissioned by the Ministry of the Interior and conducted by the Mobility Lab of the University of Tartu (Ahas and Silm, 2013; Ahas et al., 2010) – mobile positioning data made it possible to delineate functional areas. The movements between individuals' anchor points (i.e. residence, work, etc.) are aggregated at the level of local units (i.e. municipalities) in order to produce a matrix of flows. Such matrix has the benefit of providing an estimation of mobility patterns for the entire population, rather than for employees only, at a highly

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[8] https://unstats.un.org//unsd/demographic-social/meetings/2019/newyork-egm-statmeth.cshtml

disaggregated spatial scale. The Netherlands has also produced a flow matrix between all local units in the country using mobile phone data (Van der Valk et al. 2019).

5.2. Modifications to the method

Following these consultations, the method was modified in the following ways:

- Several countries pointed out that suburbs were not very common in low and middle income countries and that peri-urban areas was more appropriate in those countries. As a result, the initial term "town and suburbs" was changed to "towns and semi-dense areas". The term "suburbs" was changed to "suburban or peri-urban areas".
- In some countries, the Degree of Urbanisation would split a single city across multiple urban centres due to the presence in the city of cells with a low population density. These cells typically included shopping malls, factories, office parks or transport infrastructure, such as bus and train stations, airports, harbours, railway lines and highways. Creating urban centres using both cells with a density of at least 1,500 inhabitants and cells that are at least 50% built-up resolves this issue.

A more detailed discussion of smaller technical adjustments will be included in technical report on how to implement the Degree of Urbanisation, which will be published in October 2020.

6. CONCLUSIONS

There is a broad consensus that a harmonised method to delineate cities, urban and rural areas to facilitate international comparisons is needed as national definitions vary considerably and most cannot be applied to other countries. More and more indicators are being collected at these sub-national levels. However, without a harmonised method, it is impossible to know to what extent the results are driven by differences in performance or in delineation.

The UNSD survey, the UN Expert Group meeting, the UN-Habitat workshops and the bilateral pilot projects have confirmed that the Degree of Urbanization produces a functional and harmonized method for comparing cities, urban and rural areas for international and regional comparison purposes. The agreement between cities and rural areas as classified by the Degree of Urbanisation and nationally defined urban and rural areas is consistently high.

The three classes of the Degree of Urbanisation level 1 provide more detail than the traditional urban-rural dichotomy and captures the urban-rural continuum. By identifying intermediate density areas, it helps to create a consensus between countries that define urban as consisting of cities and towns (i.e. large and medium settlements) and those that only include cities (i.e. large settlements).

The Degree of Urbanisation has deliberately been kept as simple as possible to facilitate a global application. It classifies local units meaningfully and systematically, in exhaustive and structured categories that are defined according to a set of well-defined criteria linked to the urban-rural continuum. The method has a good statistical balance and a good comparability over time. It can facilitate the collection and organisation of statistics in a cost effective manner as demonstrated by the experience of the statistical offices in 43 European and OECD countries.

The method has been widely consulted with around 100 countries participating in dedicated workshops, pilot projects or bilateral discussions. The feedback from these sessions was very positive. Many countries, however, highlighted that guidance, support and training will be needed to allow the statistical offices to develop their own population grid and apply this method.

Therefore, the next steps of this work should focus on the creation of national population grids and the implementation of this method.

In addition, as the preferred goal related to the introduction and development of this methodology for delineation of cities, urban and rural areas would be to establish an international reference classification, further testing and implementation at the national level will be undertaken in the forthcoming period. An initial assessment of compliance of this methodology with the principles of international statistical classifications has been carried out. It will be further refined based on the results of the further testing and implementation and presented accordingly.

7.   APPENDIX I

United Nations Expert Group Meeting on Statistical Methodology for Delineating Cities and Rural Areas

United Nations, New York, 28 – 30 January 2019

Conclusions and recommendations

1. The expert group meeting took place in the United Nations Headquarters, New York, from 28 to 30 January 2019 and was hosted by the United Nations Statistics Division with full support of the European Commission. The United Nations Statistics Division chaired the meeting; experts from the following countries and organizations participated: Brazil, Canada (by remote connection), Ecuador, France, India, Indonesia, Mexico, Mongolia, Poland, Portugal, Republic of Korea, United States of America, Zambia (by submitting the presentation), European Commission, Eurostat, ILO, OECD, UN Geospatial Information Section, UN Global Geospatial Information Management (UN GGIM), UN Habitat, UN Population Division, UNICEF, UNFPA and the World Bank.

2. The meeting was requested by the 49th session of the United Nations Statistical Commission, as per the Report on its 49th Session:
    E/2018/24-E/CN.3/2018/37, Decision 49/112, paragraph (i).
    The purposes of the meeting were to:
    a. Assess the technical comprehensiveness of the Degree of Urbanization methodology (DegUrba) as developed by the European Commission and partners;
    b. Assess the applicability of the parameters for delineation of urban and rural areas in terms of levels of density;
    c. Assess the implementation of the DegUrba methodology, and the concept of functional urban areas as developed by OECD, in national circumstances through the presentation and elaboration of national practices and examples;
    d. Elaborate on the suitability of submitting the proposed methodology to the United Nations Statistical Commission for discussion and possible recommendation for the purpose of achieving regional and international comparison and harmonization of urban and rural areas and their statistics;

3. The participants noted that the meeting is very timely, especially from the point of view of the monitoring of the implementation of the 2030 Sustainable Development Agenda and accompanying goals, targets and indicators; the 2020 World Programme on Population and Housing Censuses main recommendation regarding the production of geo-referenced small-area census statistics; the New Urban Agenda; and the overall need for comprehensive international and regional comparison purposes.

4. In that context, the meeting outlined the need for the integration of statistical data and geospatial information, aligned with the UN-GGIM activities, including the implementation of the principles based on the Global Statistical Geospatial Framework in the geo-referencing of small areas and geo-coding of unit record data; and that the population driven one-square-kilometer grid as applied in the DegUrba methodology may be a starting point in that direction while at the same time developing and maintaining national definitions and urban/rural classifications; it also encouraged NSOs to collect and tabulate data by grid cells.

5. The DegUrba methodology is based on a two-level hierarchy; at level 1 it recognizes three different classes; at the more detailed level (level2) it recognizes six different classes of areas based on a combination of population density applied to 1 square km cells and population size thresholds which are applied to clusters of cells above the respective density thresholds. The two density thresholds are 300 residents per square kilometer and 1,500 per square kilometer. The three population size thresholds are 500, 5,000 and 50,000 residents. The meeting discussed in detail the universality of these thresholds, especially for populous and low-density countries as well, and noted that for international and regional comparison purposes the use of identical thresholds would be an advantage. The meeting also underscored the valuable information that the methodology offers in terms of cross-border comparisons and cross-border urbanization patterns.

6. The meeting pointed to the fact that the long-standing dichotomy of urban and rural areas is in need of adjustment in terms of the realities on the ground and thus the introduction of six classes in the DegUrba methodology provides a more nuanced overlook. The meeting also noted that the use of colloquial terms in the DegUrba methodology such as cities, villages, towns, suburbs might not suit all circumstances and augmenting this terminology with a more technical terminology might be beneficial; yet it also requires further consultations and testing.

7. Aside from basing the DegUrba methodology on population density and similarity of contiguous one-square-kilometer cells, the meeting noted that DegUrba methodology may include, where available, corrections based on the characteristics of built-up areas. In that context, and especially from the point of view of distinguishing slum settlements, the meeting underscored the need to work on the further development of this parameter while finalizing and improving the methodology.

8. In terms of the elaboration of the DegUrba methodology, the meeting underscored the need to produce a comprehensive technical presentation, an introductory guide, and a detailed methodology including relevant metadata with translation to other languages.

9. From the presentations of experts from national statistical offices the meeting concluded that adjustments and adaptations of the DegUrba methodology were needed in a number of participating countries, to better reflect national circumstances. Furthermore, the meeting concluded that a recommendation can be made to use a parallel approach – using the DegUrba methodology for international and regional comparison as well as estimates based on national definitions for national purposes. A good communication strategy needs to be put in place to explain to the users the purpose of the parallel approach, and the potentially different outputs of the DegUrba methodology versus the national methodology in any given country.

10. Critical to the development and implementation of the DegUrba methodology is the quality of underlying statistical data on population. These data are usually coming from population and housing censuses. Thus, it is becoming imperative, the meeting concluded, to insist on georeferencing the housing units during the 2020 round of population and housing censuses and assigning the households to units they inhabit – as recommended by the 2020 World

Population and Housing Census Programme. These data would result in a much more precise and accurate population grid that can then be used for adding layers of valuable information.

11. In that context, the meeting outlined the importance of implementing geo-referencing of census statistics in 2020 round of censuses as this would be crucial in establishing time series for the 2030 round of population and housing censuses and beyond, thus allowing the monitoring of changes affecting societies in a more precise manner.

12. In discussing the various characteristics of urban, semi-urban and rural areas, the meeting underscored that the density of the population that is now used in DegUrba methodology is one of the indicators and that it would be valuable to explore adding additional parameters for delineating these different areas, such as employment, industry, services and infrastructure. It was concluded that at this point of time the inclusion of these variables at the global level could not be implemented due to the lack of proposed harmonized methods and limitations regarding available data from official sources of statistics across different regions.

13. The meeting noted the usefulness and relevance of the concept of "Functional Urban Area". Such a concept allows the functional extent of cities to be assessed by combining population density with people's daily mobility. While the implementation of functional urban areas would not be universal at this point due to the lack of data on daily commuting in many countries, efforts are underway to assess people's daily mobility through other sources of data, including labour force surveys, mobile phone data or other sources in the big data domain. Countries with already available commuting data are encouraged to implement the functional urban area definition along with the degree of urbanisation.

14. The meeting inquired about the possibility to develop universal one-square-kilometer grid cells covering the whole planet, each with a unique identifier, and further discussion among the DeGurba partners will be initiated, including possibilities to integrate already existing city databases to the grid systems.

15. In terms of implementing DeGurba methodology in as many countries as possible, the meeting noted with appreciation a series of workshops organized by UN Habitat in that respect. It also urged that more comprehensive and structured efforts are necessary in terms of providing capacity building and technical assistance to national statistical offices and that would necessitate bringing this issue to the UN Statistical Commission.

16. The meeting concluded to propose to the UN Statistical Commission that the work of this expert group should convert from *ad hoc* to continuous, thus providing a continuing forum to discuss relevant methodologies for delineation of urban, rural and other areas, including discussions on sources of data and metadata, and their implementation at national level.

17. The meeting suggests discussing the DeGurba approach with the Inter Agency and Expert Group on SDG Indicators (IAEG-SDGs) to help with monitoring SDG indicators. For national level reporting for SDGs, national definitions of urban-rural are used. For global reporting aggregations, however, a harmonized approach is worth considering, for specific SDG targets and for rural-urban dis-aggregations. The EGM can liaise with the IAEG-SDGs group to discuss some practical options on monitoring.

8. APPENDIX II

Workshops, pilot projects and presentations by the six international organisations

UN-Habitat has also organised seven regional workshops to present these methods and discuss how they could be improved and applied to national data. A total of 86 countries have participated in these workshops (see below).

- Abuja, Nigeria, 15-19 October 2018 with representatives from Nigeria, Ghana, The Gambia, Sierra Leone, Kenya, Ethiopia, South Sudan, Liberia and Uganda.
- Abidjan, Ivory Coast, 13-16 November 2018 with representatives from Burundi, Burkina Faso, Central African Republic, Chad, Congo, Comoros, Democratic Republic of Congo, Madagascar, Djibouti, Mali, Niger, Senegal, Guinea, Togo and Ivory Coast
- Lusaka, Zambia, 22-25 January 2019 with representatives from Botswana, Malawi, Tanzania, Mauritius, Angola, Zimbabwe, Mozambique, South Africa, Eswatini, Lesotho, Namibia and Zambia
- Cairo, Egypt, 18-21 March 2019 with representatives from Egypt, Morocco, Sudan, Tunisia, Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, Palestine, Saudi Arabia, Syria and Yemen
- Lima, Peru, 25-28 June 2019 with representatives from Argentina, Bolivia, Brazil, Chile, Costa Rica, Colombia, Cuba, Dominican Republic, Ecuador, Mexico, Peru and Uruguay
- Delhi, India, 23-26 September 2019 with representatives from Azerbaijan, Armenia, Bangladesh, Bhutan, India, Kyrgyzstan, Maldives, Nepal, Sri Lanka and Uzbekistan.
- Kuala Lumpur, Malaysia, 22-25 October, with representatives from Afghanistan, Australia, China, Iran, Kazakhstan, Lao PDR, Malaysia, Mongolia, Myanmar, New Zealand, Thailand, Timor-Leste and Vietnam, Malaysia.

UN-Habitat also organised an expert group meeting to discuss this method in Brussels in 2017.

The FAO and GSARS have presented the work at several forums that include the 7th International Conference on Agricultural Statistics in 2016, the Inter-Agency and Expert Group on Food Security, Agricultural and Rural Statistics in 2016, 2017 and 2018 and at various meetings of the Scientific Advisory Committee (SAC) of GSARS. FAO and GSARS have engaged with seven countries to test and discuss in particular the level 2 of the Degree of Urbanisation: Brazil, Colombia, Ethiopia, France, Malaysia, Pakistan and the USA (GSARS 2018).

The European Commission has discussed this method with Australia, Brazil, Korea, Malaysia, India, South Africa, Turkey, the USA and Uganda.

The OECD has organised a bilateral workshop in Uzbekistan and in Kazakhstan in July 2019 and in Moscow in September 2019. It has also discussed this method with Morocco, Tunisia and Vietnam. The World Bank has discussed this work with Haiti, Jordan and Turkey.

This work has also been presented at multiple international conferences. It was presented in a side-event during the last three meetings of the UN Statistical Commission and during the last two meetings of the UN Global Geospatial Information Management (UN-GGIM). It was also presented during two UN World Data Forums, two World Urban Forums, the IAOS conference in 2018, the World Statistical

Congress in 2017, the OECD World Forum in 2018 and the Inter-Agency Expert Group on Sustainable Development Goals in 2019.

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