1 A new perspective on urbanisation

This chapter presents novel findings on the number of people living in cities, towns and semi-dense areas, rural areas and metropolitan areas across the world. Furthermore, it illustrates how the population shares of those areas have changed over the last 40 years and how they are projected to change until 2050. This new perspective of urbanisation is based on the application to the entire world of two new, globally consistent definitions, the degree of urbanisation and the functional urban area. These two new definitions are also presented in the chapter.

Key messages

- The population living in cities with more than 50 000 inhabitants has more than doubled over the last 40 years, going from 1.5 billion in 1975 to 3.5 billion in 2015. It is projected to reach 5 billion by 2050.
- The growth of this city population has occurred in three ways. One-quarter of this growth was due to the doubling of the number of cities with more than 50 000 inhabitants from approximately 5 000 to 10 000. Half of the growth occurred through densification within original city boundaries. The remaining quarter was due to the spatial expansion of existing cities, which almost doubled in area.
- As a result of these developments, the overall population density of cities has increased somewhat over the last 40 years. There remain, however, large differences in population densities, both by geographical world region and by level of development. For instance, the average population density of cities in low-income countries is four times higher than in high-income countries.
- Over the last 40 years, the population share in cities has increased from 37% to 48%, while the population share in towns and semi-dense areas as well as rural areas has dropped. However, strong overall population growth has ensured that the overall level of the population has increased in all types of areas.
- Low-income countries have the lowest population share in cities and the highest in rural areas. The link between economic development and the population share in metropolitan areas (cities and their commuting zone) is even stronger than for cities. Only 33% of the population in low-income countries lives in a metropolitan area compared to 70% of the population of high-income countries. The difference is particularly striking for metropolitan areas of at least 1 million inhabitants. In low-income countries, only 12% of the population lives in such large metropolitan areas, while in high-income countries it is 47%.
- The novel findings of this report are based on two new definitions, jointly developed by six international organisations and endorsed by the United Nations (UN) Statistical Commission in March 2020. These new definitions remedy a situation in which the lack of a global definition of cities, urban and rural areas greatly reduced the reliability of international comparisons; the definitions are meant to complement and not replace national definitions.
- The first definition, the degree of urbanisation, captures the urban-rural continuum. It classifies the entire territory of a country into cities, towns and semi-dense areas, and rural areas according to population size and density. The second definition, the functional urban area or metropolitan area, captures the full extent of a city's labour market by adding a commuting zone to each city.
- By relying on these two global harmonised definitions, this report provides a new perspective on urbanisation and new evidence on the shape and trends of metropolitan areas, cities, towns & semi-dense areas and rural areas across the world.

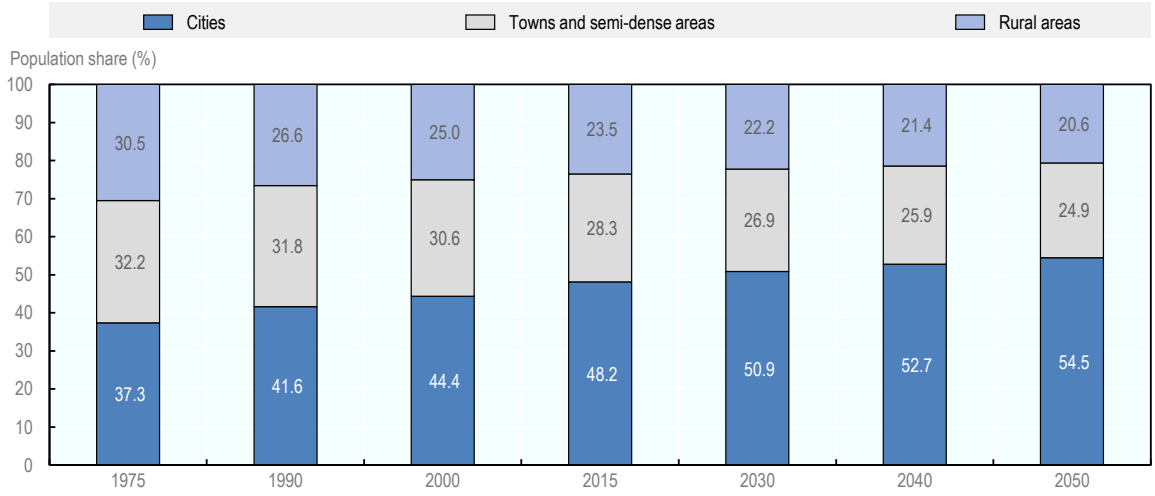
The global population increasingly lives in cities

In 1975, 37% of the world's population lived in cities (Figure 1.1). This share grew to 48% in 2015. It is projected to further increase to 55% by 2050. This shows that urbanisation is slowing down. Up to 2015, the city population share increased by almost 3 percentage points in a decade, while up to 2050 it would be less than 2 percentage points.

The rural population share has been shrinking, from 30% in 1975 to 24% in 2015. The projection indicates this reduction would also slow down. Up to 2015, rural population shares dropped by almost 2 percentage points per decade, while afterwards, this is likely to be less than 1. The population in towns and semi-

dense areas lost 1 percentage point per decade between 1975 and 2015 is projected to continue to do so up to 2050.

Figure 1.1. World population shares by degree of urbanisation, 1975-2050



Source: Florczyk, A. et al. (2019[1]), *GHSL Data Package 2019 (database)*, http://dx.doi.org/10.2760/06297; Jones, B. et al. (forthcoming[2]), *Projecting Global Population Grids to 2100*, Publications Office of the European Union.

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Box 1.1. The degree of urbanisation

This report offers novel findings on changes in urbanisation across the world. The degree of urbanisation (see Annex 1.A for a comprehensive definition) is applied to a global estimated population grid for the years 1975, 1990, 2000 and 2015 (see Annex 1.C) and projections up to 2050 (see Annex 1.D). This allows the report to show the trends in urbanisation over 75 years with unprecedented international comparability.

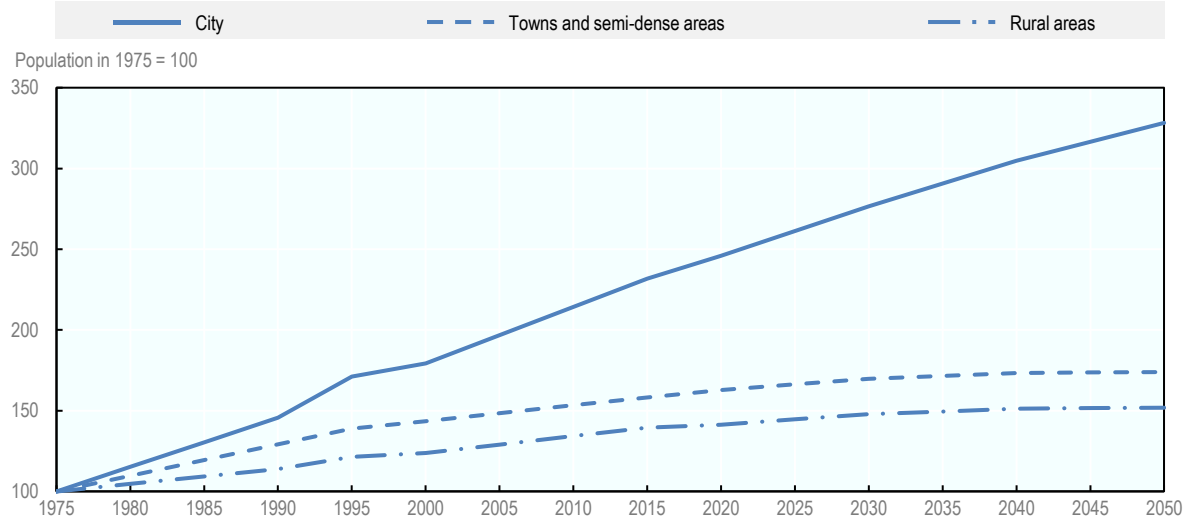
The degree of urbanisation was designed to create a simple and neutral method that could be applied in every country in the world. It relies primarily on population size and density thresholds applied to a population grid with cells of 1 by 1 km. Roughly speaking:

1. **Cities** consist of contiguous grid cells that have a density of at least 1 500 inhabitants per km^2 or are at least 50% built up. They must have a population of at least 50 000.
2. **Towns and semi-dense areas** consist of contiguous grid cells with a density of at least 300 inhabitants per km^2 and are at least 3% built up. They must have a total population of at least 5 000.
3. **Rural areas** are cells that do not belong to a city or a town and semi-dense area. Most of these have a density below 300 inhabitants per km^2.

The change in population shares, however, does not show how the total population changed. Global population has been changing rapidly. It increased from 4 billion in 1975 to 7.3 billion in 2015 and is projected to reach 9.1 billion in 2050. Between 1975 and 2015, the total population in cities, therefore, more than doubled (Figure 1.1) from 1.5 billion to 3.5 billion. This increase is projected to continue with a further increase to 5 billion by 2050.

The reducing population shares in rural areas and towns and semi-dense areas obscures that the total population in these areas is not shrinking. Population in towns and semi-dense areas increased from 1.3 billion to 2.1 billion between 1975 and 2015 and is projected to reach 2.3 billion by 2050. Rural areas also experienced population growth between 1975 and 2015 from 1.2 billion to 1.7 billion, which is projected to increase to 1.9 billion by 2050. Figure 1.2 shows that, while over the next decades, the population outside cities will be increasing, it will do so at a slowing rate. Population growth in cities is also slowing down but less noticeably so.

Figure 1.2. Changes in global population by degree of urbanisation, 1975-2050



Source: Florczyk, A. et al. (2019[1]), *GHSL Data Package 2019 (database)*, http://dx.doi.org/10.2760/06297; Jones, B. et al. (forthcoming[2]), *Projecting Global Population Grids to 2100*, Publications Office of the European Union.

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The UN publishes population figures for urban and rural areas from 1950 up to 2100 in the World Urbanization Prospects (UN, 2018[3]). These figures show a considerably faster increase in urban population. The UN data shows the urban population quadrupling between 1975 and 2050, while this report estimates that the city population would triple over that period and the population in towns and semi-dense areas (which are considered urban by many national definitions) would increase by only 75%. Finally, the UN data show an increase in the rural population of only by 20% over the 1975-2015 period and rural population declining from 2025 onwards. In contrast, this report shows an increase of 50% and no population decline for the 2015-50 period.

Box 1.2. Why a global, people-based and internationally comparable definition of cities, towns and rural areas is needed

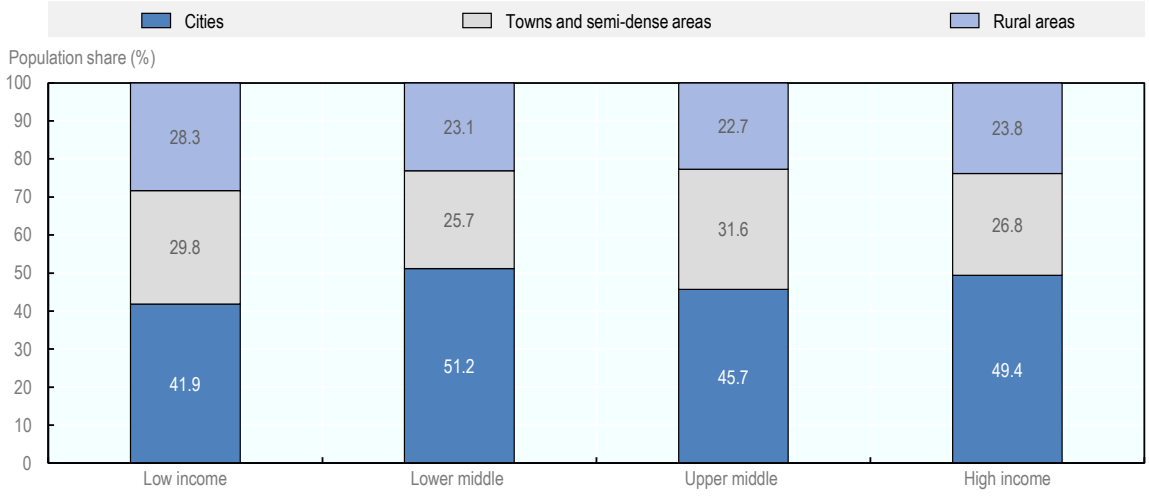
The pursuit of the UN Sustainable Development Goals (SDGs) has so far been hampered by limited international comparability. While a detailed methodology has been provided for SDG indicators that should be collected for cities, urban and rural areas, no clear guidelines for the delineation of these areas exist. This lack of a harmonised definition reduces international comparability. That is why the European Union, the Food and Agriculture Organization of the United Nations (FAO), the International Labour Office (ILO), the OECD, UN-Habitat and the World Bank have joined forces to develop a global,

people-based definition of cities, towns and semi-dense areas, and rural areas. The two resulting methods, the degree of urbanisation and the functional urban area, were endorsed by the UN Statistical Commission in March 2020. This report presents the first global analysis using these two definitions.

The degree of urbanisation was designed to reflect the urban-rural continuum and proposes three classes instead of only two. The three classes are: i) cities; ii) towns and semi-dense areas; and iii) rural areas. By using three classes, areas that are neither cities nor rural get their own category. This helps to create a global consensus, as countries disagree on how to split settlements into urban and rural ones. Most countries classify towns as urban, but some classify them as rural. By grouping these medium-sized settlements into an intermediate category (towns and semi-dense areas) we acknowledge the intermediate nature of these settlements.

The population share by degree of urbanisation differs by income group (as defined by the World Bank income categories in 2015). Low-income countries have the lowest population share in cities and the highest in rural areas (Figure 1.3). The difference between the middle- and high-income countries is small, but this reflects a change in the type of urbanisation. As countries develop, commuting to the city from the surrounding area becomes more common. This allows the labour market of a city to grow without the population of the city itself to grow. Including this commuting zone (see below) shows that high-income countries have a significantly higher share of the population in cities and their commuting zones than middle-income countries.

Figure 1.3. Population by degree of urbanisation and World Bank income group, 2015



Source: Florczyk, A. et al. (2019[1]), *GHSL Data Package 2019 (database)*, http://dx.doi.org/10.2760/06297.

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Cities and towns expand to accommodate more people

Globally, the vast majority of the population lives on a tiny fraction of land. As a consequence, the distribution of land across the degrees of urbanisation is highly skewed. Almost all land is classified as rural. In 1975, rural areas covered 99.2% of the world's land. Over the next 40 years, this declined slightly to 98.5%. Projections show that this would only drop to 98.3% by 2050.

By contrast, cities occupied just 0.2% of the total land area in 1975. The increase of city residents by 2 billion meant that cities needed more space for their residents to live, work and play. As a result, the share of land covered by cities increased to 0.5% in 2015. Projections indicate that this would increase at a slower rate reaching 0.7% in 2050.

Similar to cities, the total population in towns and semi-dense areas has increased significantly between 1975 and 2015. As these people also needed space, the land area of towns and semi-dense areas doubled from 0.5% to 1%. Projections indicate that this area would barely increase by 2050.

City population and land area growth

By using a consistent city definition over time, this report can identify three sources of city population growth: i) towns growing into cities; ii) city expansion; and iii) city densification (Table 1.1). Towns can grow into cities (as defined by the degree of urbanisation) by reaching a population of at least 50 000 inhabitants. City expansion occurs through the building of new dense neighbourhoods at the edge of the city or the densification of existing suburbs. City densification means that the population grows within the initial boundary of the city.

Table 1.1. Sources of city population and area growth, percentage, 1975-2015

	Towns growing into cities	City expansion	City densification	Total
Population change				
1975-90	23.9	26.4	49.7	100
1990-2000	18.3	29.3	52.4	100
2000-15	15.5	24.8	59.7	100
Area change				
1975-90	30.5	69.5	0.0	100
1990-2000	22.8	77.2	0.0	100
2000-15	22.6	77.4	0	100

Source: EC and OECD calculations based on Florczyk, A. et al. (2019[1]), *GHSL Data Package 2019 (database)*, http://dx.doi.org/10.2760/06297.

Five thousand towns grew into a city

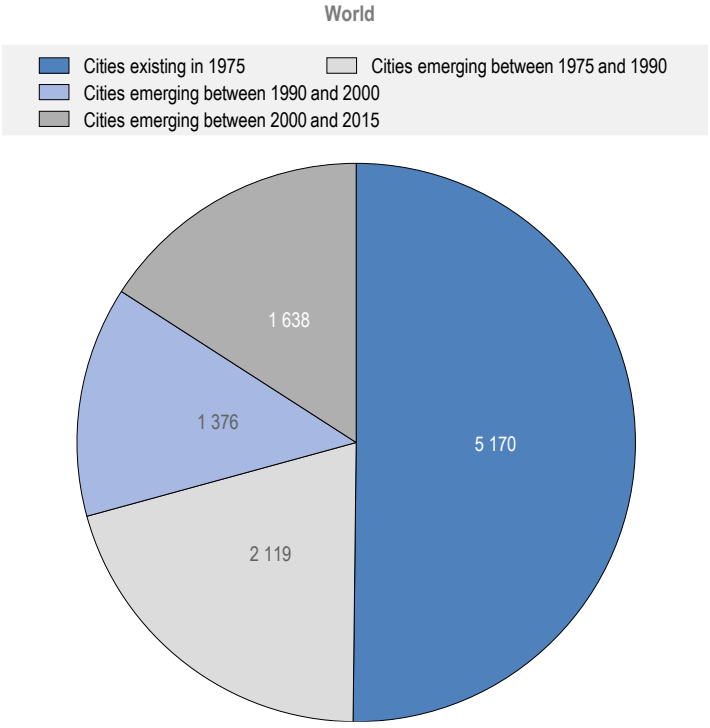
From 1975-90, towns (see Annex 1.A for an explanation) growing into cities accounted for a quarter of the city population growth.[1] Over time, as total population growth slowed, this has become a less important source of city population growth. Between 2000 and 2015, it only accounted for 16% of that growth. In terms of area growth, the emergence of new cities only accounted for around a quarter of the new land covered by a city.

Towns growing into cities has a bigger impact on the number of cities than on city population. Between 1975 and 2015, the number of cities doubled from approximately 5 000 to 10 000 (Figure 1.4). The growth in the number of cities is linked to the income of a country. Low-income countries saw their number of cities triple between 1975 and 2015, compared to a doubling in middle-income countries and an increase of 50% in high-income countries (Table 1.2). The 5 000 cities that emerged since 1975 had half a billion residents by 2015.

City expansion has accounted for roughly a quarter of city population growth (Table 1.1) but it has accounted for two-thirds of new land becoming part of a city. In part, city expansions account for such a

large share of new city land because city densification does not require any land to be converted. City expansion means a new area that will require investments to build new infrastructure and to provide public services. The high speed of city expansion in low-income countries is especially challenging as these countries need to invest large amounts quickly merely to keep providing the same level of service in their growing cities.

Figure 1.4. Cities by the period they emerged



Source: Calculated by EC, based on the Urban Centre Database GHS-UCDB R2019A, Florczyk, A. et al. (2019[1]), *GHSL Data Package 2019 (database)*, http://dx.doi.org/10.2760/06297.

Table 1.2. Number of cities by country income group, 1975-2015

Income group	Number of cities				
	1975	1990	2000	2015	2015/1975
Low	326	518	703	942	2.9
Lower middle	2 025	2 981	3 577	4 266	2.1
Upper middle	1 908	2 740	3 201	3 704	1.9
High	911	1 050	1 184	1 391	1.5
World	**5 170**	**7 289**	**8 665**	**10 303**	**2.0**

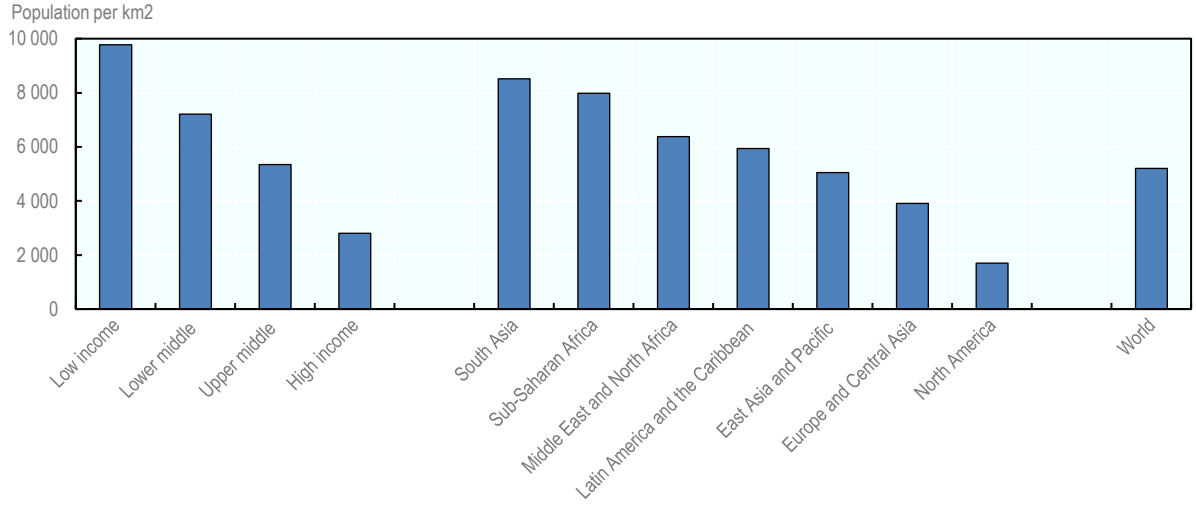
Note: The row 2015/1975 displays the ratio of the number of cities in the 2 time periods.
Source: Calculated by EC, based on Urban Centre Database GHS-UCDB R2019A (Florczyk et al., 2019[4]).

City densification is the main source of city population growth

City densification has accounted for 50% to 60% of the global city population growth (Table 1.1). City densification – increases in the density within the original boundary of the city – by definition does not require any additional land. However, additional investments are still needed to provide more housing, more places to work and more services.

Globally, the combination of city expansion and city densification has led to a slight increase in the average population density of cities. Nevertheless, large discrepancies remain in the population density of cities between income groups and across world regions (Figure 1.5). Cities in low-income countries are four times denser than those in high-income countries. The population density of cities in North America is less than 2 000 inhabitants, while in Sub-Saharan Africa and South Asia it is around 8 000 inhabitants per km².

Figure 1.5. Population density in cities by country income class and world region, 2015



Source: Calculated by EC, based on the Urban Centre Database GHS-UCDB R2019A, Florczyk, A. et al. (2019[1]), *GHSL Data Package 2019 (database)*, http://dx.doi.org/10.2760/06297.

A functional urban area or metropolitan area

Several national statistical offices complement their urban and rural area definition with a metropolitan area definition. Metropolitan areas generally encompass cities together with their adjacent communities that have a high degree of economic and social integration with the city. These adjacent communities represent a commuter belt that generates a daily flow of people into the city and back. The concept of metropolitan areas 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 policymaking in a number of domains, including transport, economic development and planning.

In this report, metropolitan areas are delineated in all countries in the world using the same definition (see Box 1.3). Metropolitan areas build on the degree of urbanisation as they consist of cities (as defined in the degree of urbanisation) and their surrounding areas that are connected to the city in terms of labour market interactions (commuting zones). Differently from the degree of urbanisation, the functional urban area (FUA) does not encompass the entire national territory and focuses on cities and their economic area of influence.

Box 1.3. Delineating metropolitan areas (aka functional urban areas) in the world

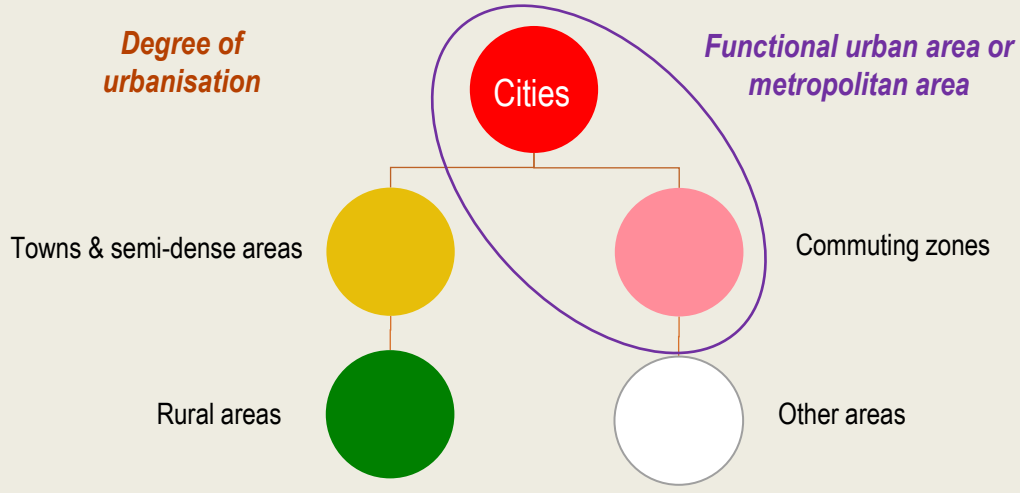
The metropolitan areas used in this report are approximations at the grid level of the functional urban areas (FUAs) definition developed by the European Union and the OECD (Dijkstra, Poelman and Veneri, 2019[5]). This definition specifies that an FUA consists of a cluster of local administrative units that are either part of a city or the commuting zones of that city. Local units in the commuting zones have at least 15% of their working population commuting to the city for work.

Because commuting data and local administrative unit boundaries are not available for most countries, this report relies on estimated metropolitan areas using globally available gridded data. The method delineates about 9 000 estimated FUAs for at least 50 000 inhabitants worldwide (Moreno-Monroy, Schiavina and Veneri, 2020[6]). For more precise information please see Annex 1.B.

The residential population of an administratively defined city does not take into account the people who work in the city but those who live in the surrounding commuting zone. This problem is particularly prominent in high-income countries, where commuting is quite common. To reflect the full extent of its labour market, the FUA consists of both the city and its commuting zone. Through commuting, this definition incorporates the economic function of a city. The area defined by commuting is also likely to be used for many other functions such as education, healthcare and transport. That is why it is called a functional urban area. This concept is often referred to as a metropolitan area.

Several countries have one definition for urban and rural areas and another for their metropolitan areas. This report uses the same dual approach and two definitions, one for capturing the urban-rural continuum – the degree of urbanisation –, and one for metropolitan areas, the FUA. These two definitions are linked because they use the same definition of a city (see Figure 1.6).

Figure 1.6. Schema of the degree of urbanisation and FUA

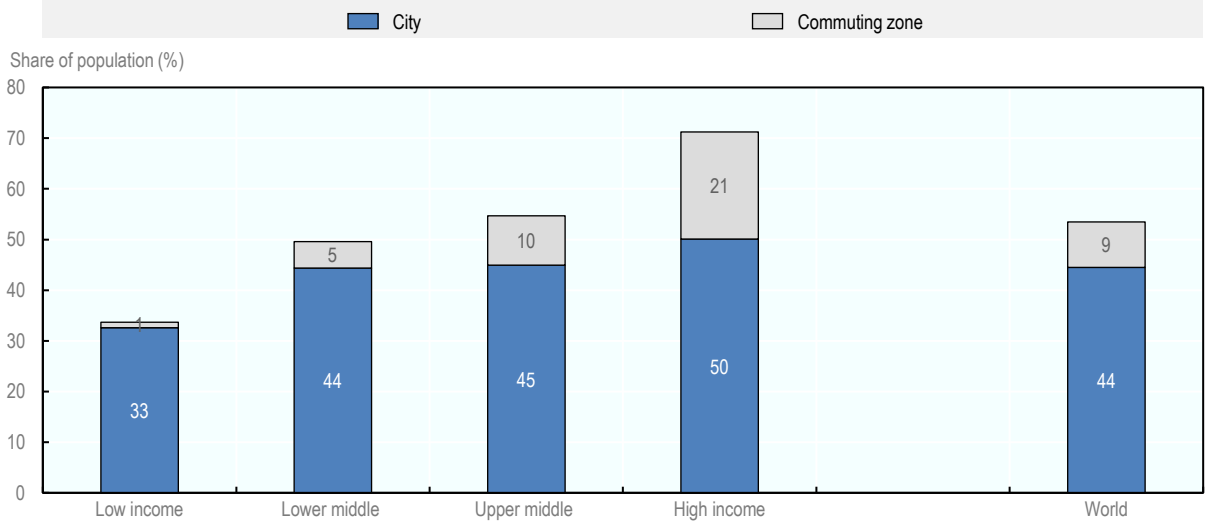


Source: Figure produced by EC and OECD, 2020; Dijkstra, L., H. Poelman and P. Veneri (2019[5]), "The EU-OECD definition of a functional urban area", https://doi.org/10.1787/d58cb34d-en (accessed on 21 October 2019); Moreno-Monroy, A., M. Schiavina and P. Veneri (2020[6]), "Metropolitan areas in the world. Delineation and population trends", http://dx.doi.org/10.1016/j.jue.2020.103242.

In richer countries, more people live in metropolitan areas and especially in their commuting zones

The concentration of people in metropolitan areas is linked to economic development. The population share in metropolitan areas in high-income countries at 71% is more than double that of low-income countries (Figure 1.7). The difference in the population share in commuting zones is even bigger: 21% in high- and only 1% in low-income countries. Middle-income countries are positioned in between, with around 50% of their population in metropolitan areas and between 5%-10% in a commuting zone.

Figure 1.7. World population in cities and commuting zones by World Bank income group, 2015



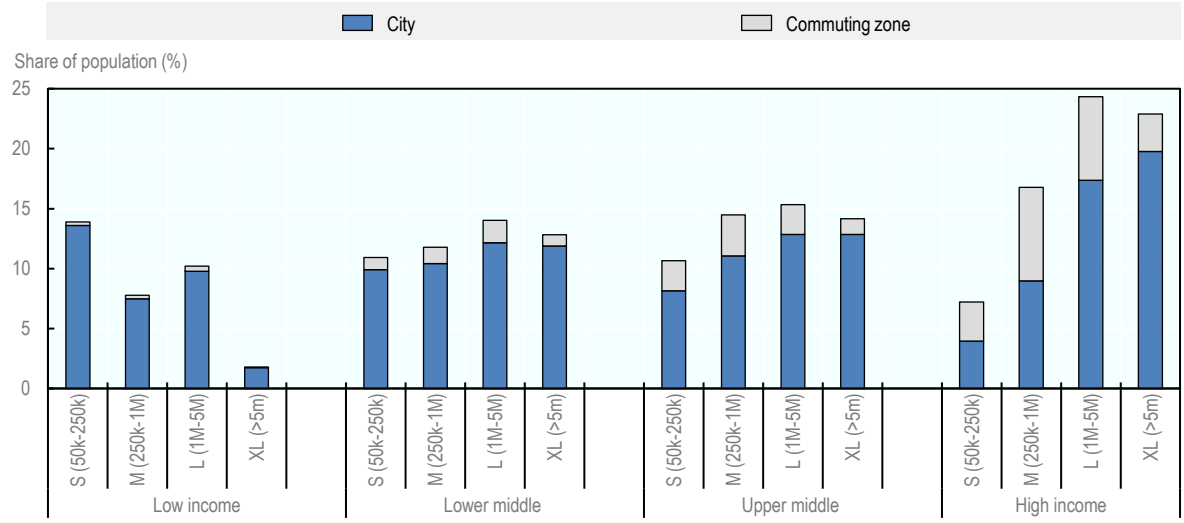
Source: Calculated by EC, based on GHSL Data Package 2019, Florczyk, A. et al. (2019[1]), *GHSL Data Package 2019 (database)*, http://dx.doi.org/10.2760/06297 and the boundaries of Moreno-Monroy, A., M. Schiavina and P. Veneri (2020[6]), "Metropolitan areas in the world. Delineation and population trends", http://dx.doi.org/10.1016/j.jue.2020.103242.

More people live in large metropolitan areas in rich countries

Low-income countries have a high share of their population in small metropolitan (metro) areas (under 250 000 inhabitants) and a low share in very large metropolitan areas (at least 5 million inhabitants) (Figure 1.8). In contrast, high-income countries concentrate very large shares of their population in large and very large metropolitan areas but lower shares in small metropolitan areas. The two middle-income groups occupy an in-between position: each of the four size classes of the metro areas have approximately the same population share.

In the middle- and high-income countries, the population share in commuting zones of metro areas with between 250 000 and 5 million inhabitants is higher than for metropolitan areas of more than 5 million. In general, one would expect bigger cities to have bigger commuting zones. Cities with more than 5 million inhabitants, however, may be so big and so time-consuming to travel into that people are less willing to live in a commuting zone as this would further add time to their commute.

Figure 1.8. Population in metropolitan areas by size and income group, 2015



Source: Calculated by EC, based on GHSL Data Package 2019, Florczyk, A. et al. (2019[11]), *GHSL Data Package 2019 (database)*, http://dx.doi.org/10.2760/06297 and the boundaries of Moreno-Monroy, A., M. Schiavina and P. Veneri (2020[6]), "Metropolitan areas in the world. Delineation and population trends", http://dx.doi.org/10.1016/j.jue.2020.103242.

A comparison of national definitions and the two global definitions

The global population is distributed across a wide range of settlement sizes. This urban-rural continuum ranges from a village with a few hundred inhabitants to mega-cities of more than 10 million inhabitants. Within this continuum, different countries use different thresholds to distinguish urban from rural. These thresholds range from 200 in Denmark to 100 000 in China. This wide range of thresholds reduces the international comparability of these definitions and makes analysis of global urbanisation based on these definitions less reliable.

The two global definitions presented in this report are meant to complement national definitions, not replace them. National definitions have the benefit that they can be tailored to the country's specific circumstances and policy needs. They can take into account a wider set of data than is available at the global level. National definitions, however, cannot be easily applied to another country, which is why a global definition is needed to enable international comparisons.

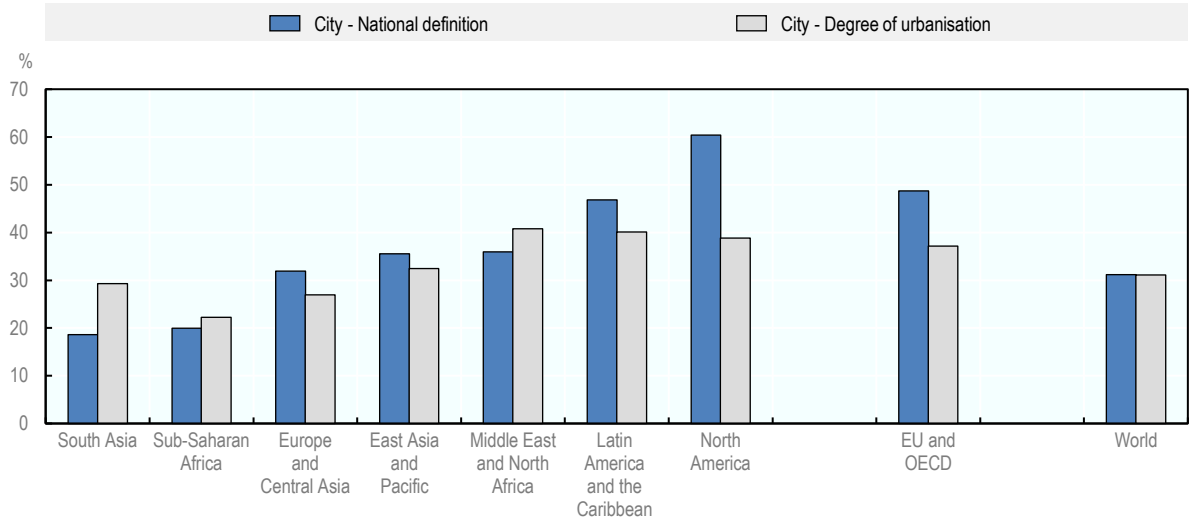
National and global definitions tend to agree on large cities

The degree of urbanisation and national definitions essentially agree on the classification of cities above 300 000 inhabitants. According to the UN World Urbanization Prospects, 1 772 nationally defined cities had at least 300 000 inhabitants in 2015. Of these cities, 1 662 or 95% matched a city as defined by the degree of urbanisation.

In most regions, the population in nationally defined cities with at least 300 000 inhabitants is similar to the share in cities of that size as defined by the degree of urbanisation (Figure 1.9). The difference is less than 5 percentage points in Central Asia and Europe, the Middle East and North Africa, East Asia and the Pacific and Sub-Saharan Africa. In Latin America and the Caribbean, the national definition reports a slightly higher population share in cities with at least 300 000 inhabitants: 47% as compared to 40% using the degree of urbanisation. In part, this may be due to the difference in spatial resolution (municipalities versus 1 km² grid cells). South Asia shows a bigger difference in the other direction: 19% of the population in nationally defined cities with at least 300 000 inhabitants as compared to 29% using the degree of

urbanisation. This is primarily because in India the degree of urbanisation finds more cities with at least 300 000 inhabitants as compared to the national definition.

Figure 1.9. Share of population in cities with at least 300 000 inhabitants, 2015



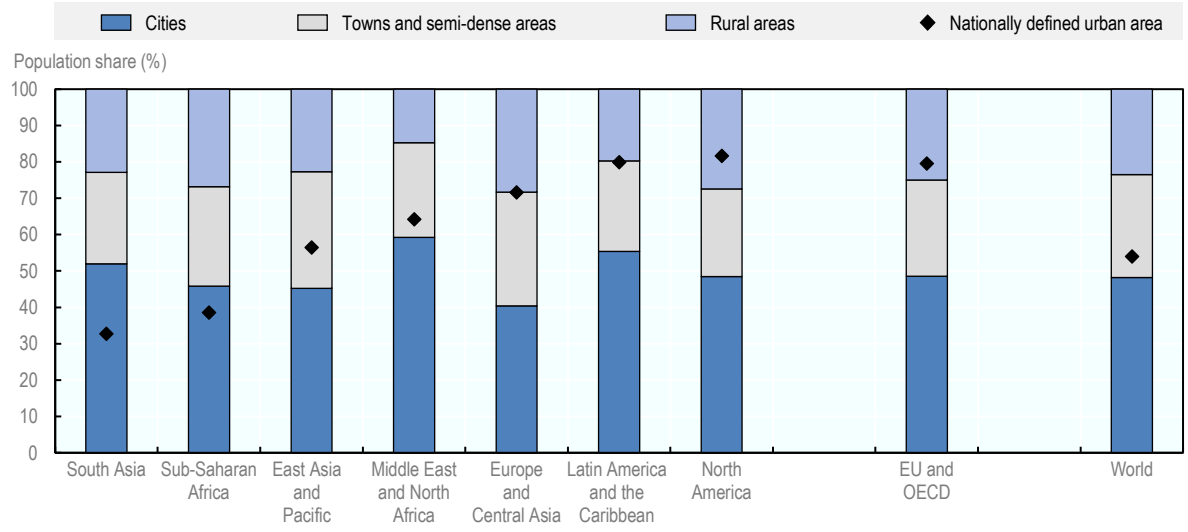
Source: EC Calculations based on GHSL Data Package 2019, Florczyk, A. et al. (2019[1]), *GHSL Data Package 2019 (database)*, http://dx.doi.org/10.2760/06297 and UN (2018[3]), *World Urbanization Prospects*, United Nations.

In North America, the difference between the approaches is largest. National definitions show 60% of people living in a city with at least 300 000 inhabitants, compared to only 39% according to the degree of urbanisation. The difference is primarily due to the use of a different spatial concept. Canada and the United States report the population for urban agglomerations, i.e. city plus its adjacent suburbs. By considering metropolitan areas, i.e. cities and their commuting zones, the results become much more comparable. The population in metropolitan areas with at least 300 000 inhabitants is 65%; a result that is markedly closer to 60% in nationally defined urban agglomerations. Metropolitan areas typically include the adjacent suburbs and may also include some rural areas if commuting flows are high enough.

National definitions disagree on the classification of towns

The standard dichotomy that classifies places into either urban or rural cannot capture the urban-rural continuum. Maybe unsurprisingly, countries, therefore, disagree where on this continuum rural ends and urban starts. The degree of urbanisation is more nuanced than the simple dichotomy between rural and urban and identifies a middle category: towns and semi-dense areas. In Chapters 2 and 5, the findings of this report will demonstrate that towns and semi-dense areas have a distinct character and thus merit a separate category. Interestingly, the classification of these settlements differs across regions of the world. Most towns are classified as urban in the Americas and Europe, while in Africa and Asia most towns are classified as rural (see Figure 1.10). As a result, the nationally defined rural population share is very similar to the share in rural areas as defined by the degree of urbanisation in the Americas, Europe and Central Asia. In the other regions, the population in nationally defined rural population share is closer to the share in rural areas plus towns and semi-dense areas.

Figure 1.10. Population by degree of urbanisation and nationally defined urban areas by World Bank region, 2015



Source: EC Calculations based on GHSL Data Package 2019, Florczyk, A. et al. (2019[1]), *GHSL Data Package 2019 (database)*, http://dx.doi.org/10.2760/06297 and UN (2018[3]), *World Urbanization Prospects*, United Nations.

Box 1.4. Understanding national classifications of rural and urban

Most of the minimum population thresholds used in national definitions would agree with the degree of urbanisation by classifying towns as urban. Out of the 103 countries with such a threshold, 85 use a threshold between 200 and 5 000 inhabitants. In these countries, one would expect a town to be classified as urban. Some definitions, however, combine a minimum population threshold with other criteria that may lead some towns to be classified as rural. For example, several definitions include a maximum share of male employment in agriculture for urban areas. If a town has a population above a minimum size threshold, it will still be classified as rural if it has a high share of employment in agriculture. Furthermore, a few countries use a high minimum population size threshold to classify a settlement as urban, which might cause a deviation from the degree of urbanisation. For example, Japan uses 50 000 and China 100 000 inhabitants, indicating that towns will be classified as rural and only large settlements will be classified as urban.

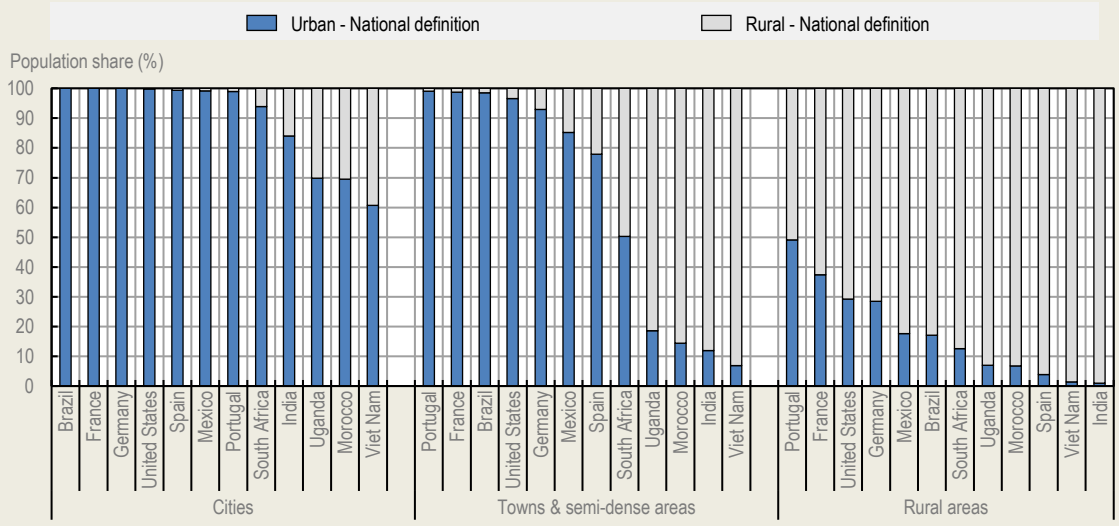
Administrative designations are another reason for differences across countries and between national classifications and the degree of urbanisation. More than half of the world's urban and rural national definitions rely (entirely or in part) on such administrative designations, i.e. (some) areas are simply declared urban or rural. Administrative designations can produce an accurate classification of a country, but they cannot be replicated in another country. They are often the results of long-standing institutional or political history, often without a clear set of criteria to distinguish the urban status from the rural one. In these countries, the description of the definition does not indicate whether all, some or none of the towns will be defined as urban.

A comparison of national definitions of urban and rural areas to the degree of urbanisation for 12 countries provides further insights (Figure 1.11). It shows that cities, as defined by the degree of urbanisation, are typically classified as urban by the national definition and that rural areas as defined by the degree of urbanisation are almost entirely classified as rural by national definitions. Some differences do appear, with some of the population in rural areas classified as urban by the respective

national definition. In part, this is due to the use of a different population threshold. For example, the United States (US) uses 2 500 as the minimum population for an urban area and France and Portugal use 2 000.

The biggest differences, however, are found in the way national definitions classify towns and semi-dense areas. Brazil, France, Portugal and the US classify more than 90% of the population in towns and semi-dense areas as urban. India, Morocco, Uganda and Viet Nam classify more than 80% of this population as rural (Figure 1.11).

Figure 1.11. Population by degree of urbanisation by urban-rural national definition in 12 countries



Source: EC Calculations based on data from National offices of Statistics and GHSL Data Package 2019, Florczyk, A. et al. (2019[11]), *GHSL Data Package 2019 (database)*, http://dx.doi.org/10.2760/06297.

Advantages of the new definitions

The two new global definitions presented here have four key benefits: i) they rely on a population grid and not on administrative boundaries; ii) they are designed to monitor access to services and capture agglomeration economies; iii) they measure the spatial concentration of population directly; and iv) they classify settlements of the same size in the same way.

- The biggest innovation is that both definitions start from the population grid. Because each grid cell has the same size and shape (1 by 1 km), it overcomes many of the distortions created by using administrative or statistical units that vary in size and shape, known by geographers as the modifiable areal unit problem or MAUP. For example, using a minimum population size threshold with administrative units would classify some rural areas with a very large area as urban because it contains a large but dispersed population. Using a population density threshold with administrative units would classify some cities with a large area as rural because of its low density.
- These definitions were developed to monitor and improve access to services and infrastructure. The SDGs include indicators measuring access to public transport, electricity, a mobile phone network, safe drinking water, waste management, an all-weather road, healthcare services or financial services. The costs of providing such services and infrastructure depend to a large degree

on the number of people who live nearby. The concept of agglomeration economies is exactly what underpins these people-based definitions. This is also why such services are not included in the definitions. If the definition of a city included the presence of hospital, then by definition all cities would have a hospital. This would make it impossible to identify which cities lacked a hospital. Similarly, if the definition of rural areas included low access to electricity, it would become impossible to monitor access to electricity in rural areas.

- This people-based definition measures the concentration of people in space directly. Using indirect measures of population concentration, such as built-up areas, reduces the population share in urban areas in low-income countries and increases it in high-income countries. That is why a people-based definition is more suitable for international comparisons than one based on land use.
- These definitions consistently classify settlements of the same population size in the same way. The population size criteria are not combined with other criteria such as the share of agricultural employment. Including the share of agricultural employment would mean that settlements of the same size would no longer be consistently classified, as those with more agricultural jobs would be rural and those with less urban. Because agricultural employment is much lower in high-income countries, including it in the definition of urban and rural areas would also make high-income countries far more urban, making it less suitable for international comparisons.

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Note

[1] New cities almost exclusively consisted of towns as defined by the degree of urbanisation level 2, presented in Annex 1.A.

Annex 1.A. The degree of urbanisation level 1 and 2

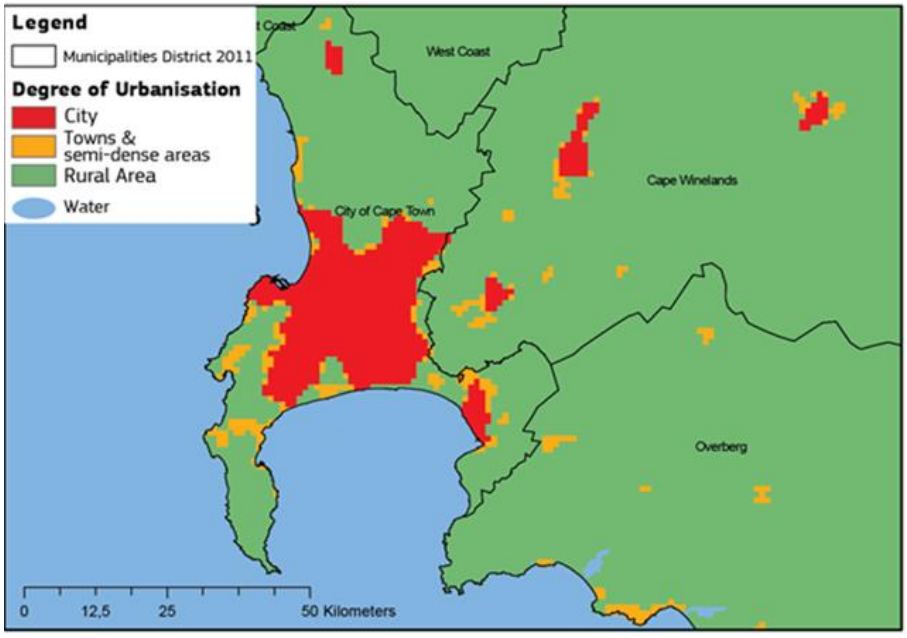
A detailed description of the degree of urbanisation

The degree of urbanisation was designed to create a simple and neutral method that could be applied in every country in the world. It relies primarily on population size and density thresholds applied to a population grid with cells of 1 by 1 km.

The three types of grid cells are classified as follows.

1. **Cities** consist of contiguous grid cells that have a density of at least 1 500 inhabitants per km^2 or are at least 50% built up. The cluster of contiguous cells must have a population of at least 50 000. Gaps in this cluster are filled and its edges are smoothed.
2. **Towns and semi-dense areas** consist of contiguous grid cells with a density of at least 300 inhabitants per km^2 and are at least 3% built up. This cluster of contiguous cells must have a total population of at least 5 000. Once the minimum population has been verified, city cells that are part of this cluster are removed.
3. **Rural areas** are cells that do not belong to a city or a town and semi-dense area. Most of these have a density below 300 inhabitants per km^2.

Annex Figure 1.A.1. City, towns and semi-dense areas, and rural areas around Cape Town, South Africa



Source: GHSL Data Package 2019, Florczyk, A. et al. (2019[1]), *GHSL Data Package 2019 (database)*, http://dx.doi.org/10.2760/06297.

The degree of urbanisation as approved by the UN Statistical Commission includes first classification of grid cells and subsequent classification of local spatial units. As the boundaries of local administrative or statistical units are not globally available, this report only uses the grid cell classification. For ease of reading, it uses the terminology of the local units. For example, we refer to cities, not urban centres.

One small modification has been applied as a correction to GHS-POP, the population grid used in this report: a cell must be at least 3% built up to be considered part of towns and semi-dense areas. GHS-POP may overestimate the concentration of population in countries where population data has a coarse spatial resolution and a significant share of built-up areas are not detected. This 3% rule is not part of the definition and should not be applied to other population grids.

How to identify towns and villages: Degree of urbanisation level 2

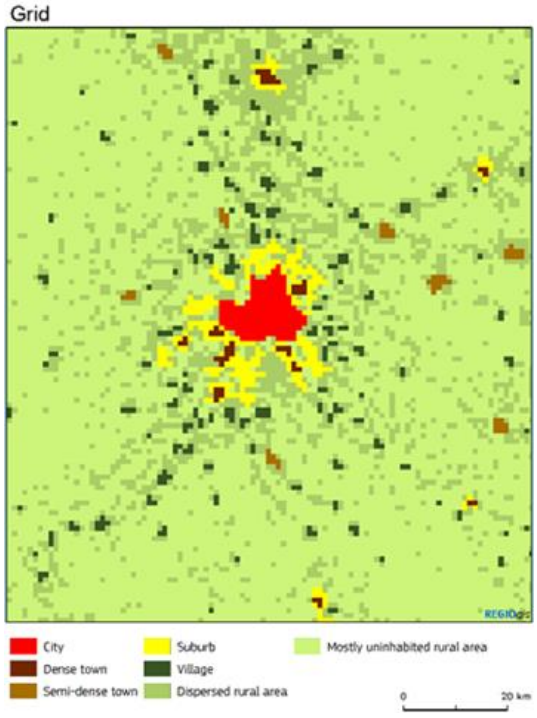
Towns and villages can play an important role in providing access to services, such as education, healthcare and shops, for the surrounding areas. To identify these, a sub-classification of the degree of urbanisation was created as follows:

- Towns and semi-dense areas were split into three categories.
  - **Dense towns** consist of contiguous cells with a density of at least 1 500 inhabitants per km^2. The total population in the cluster has to be between 5 000 and 50 000.
  - **Semi-dense towns** consist of contiguous cells with a density of at least 300 inhabitants per km^2, with a population of at least 5 000 that is neither contiguous with nor within 2 km of a dense town or a city.
  - **Suburban or peri-urban areas** consist of the remaining towns and semi-dense area cells. These cells are part of a cluster that is contiguous with or within 2 km of a city or a dense town.
- Rural areas were also split into three categories.
  - **Villages** consist of contiguous cells with a density of at least 300 inhabitants per km^2. The total population in that cluster has to be between 500 and 5 000.
  - **Dispersed rural areas** consist of rural area cells with a density between 50 and 300 inhabitants per km^2.
  - **Mostly uninhabited areas** are defined by rural area cells with a density of 50 inhabitants per km^2 or less.

As with the degree of urbanisation level 1, this report uses the local unit terminology instead of the grid level terminology.

The income level of a country has a significant impact on the population distribution by degree of urbanisation level 2. In low-income countries, the population share in cities is relatively low, while a larger share of the population lives in towns and villages. In high-income countries, the population share in suburban areas is much higher, while the share of population living in villages and towns is much lower than in the other income groups.

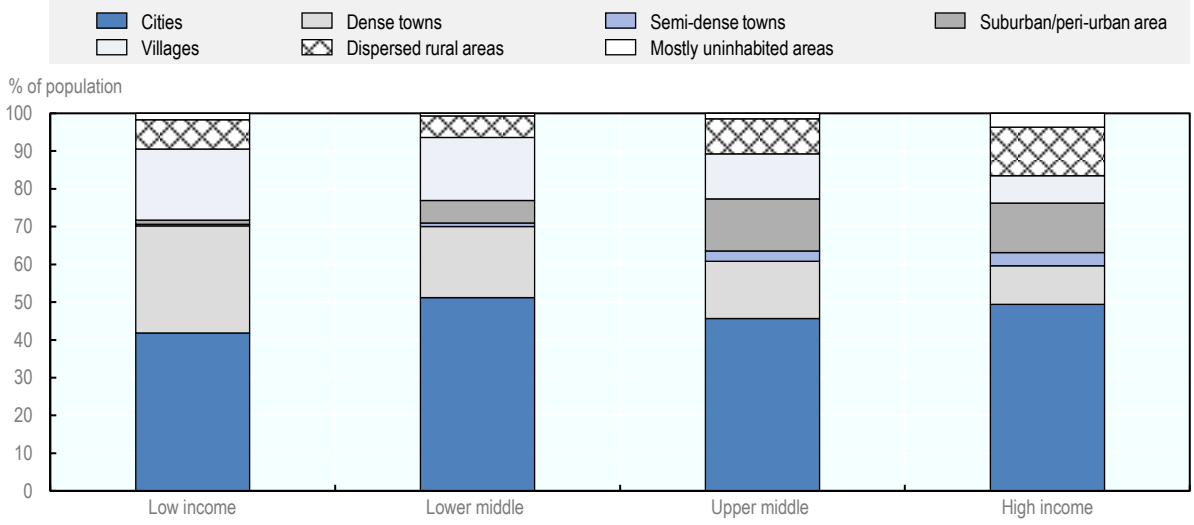
Annex Figure 1.A.2. Degree of urbanisation level 2 classification around Toulouse, France



Source: GHSL Data Package 2019, Florczyk, A. et al. (2019[1]), *GHSL Data Package 2019 (database)*, http://dx.doi.org/10.2760/06297.

Annex Figure 1.A.3. Population by degree of urbanisation level 2 and income group, 2015

Countries by income level



Source: Florczyk, A. et al. (2019[1]), GHSL Data Package 2019 (database), http://dx.doi.org/10.2760/06297.

Annex 1.B. Functional urban areas

Delineating metropolitan areas (aka functional urban areas, FUAs) in the world

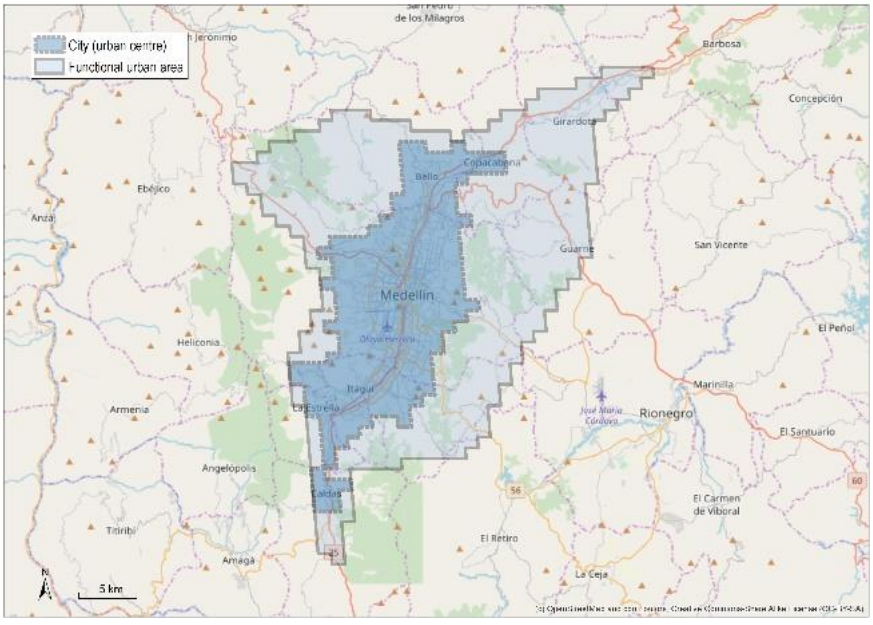
The metropolitan areas used in this report are approximations at the grid level of the functional urban areas (FUAs) definition developed by the European Union and the OECD (Dijkstra, Poelman and Veneri, 2019[5]). This definition specifies that an FUA consists of a cluster of local administrative units that are either part of a city or the commuting zones of that city. Local units in the commuting zones have at least 15% of their working population commuting to the city for work.

Because commuting data and local administrative unit boundaries were not available for most countries, this report relies on estimated metropolitan areas using globally available gridded data. The delineation of these metropolitan areas is done in two steps (Moreno-Monroy, Schiavina and Veneri, 2020[6]):

- **Delineation of cities** (or urban centres). Consistently with the degree of urbanisation, cities are clusters of densely populated cells, with at least 1 500 inhabitants per km² and 50 000 inhabitants overall. They are defined using the GHSL population grid.
- **Commuting zones**. They are defined through a probabilistic approach performed through a logistic regression model – which is trained using information on actual FUA boundaries in OECD countries where the EU-OECD definition was already available.

The logit model uses about 0.5 million one-km^2 cells with at least 300 inhabitants in OECD countries. The predictors of whether a cell is part of a commuting zone are: i) the travel time of the cell to the closest urban centre; ii) the size of the urban centre; iii) population of the cell; and iv) the gross domestic product (GDP) per capita of the country. The logit model parameters are then used to obtain estimated probabilities for around 2.5 million cells in and outside baseline countries, which are then compared to appropriate optimal thresholds calculated by world region to define which cells belong to FUAs and which do not.

Annex Figure 1.B.1. The metropolitan area of Medellin, Colombia



Source: GHSL Data Package 2019, Florczyk, A. et al. (2019[1]), *GHSL Data Package 2019 (database)*, http://dx.doi.org/10.2760/06297.

The method delineates about 9 000 estimated FUAs of at least 50 000 inhabitants worldwide (Moreno-Monroy, Schiavina and Veneri, 2020[6]). Only cities that have been validated were used to create metropolitan areas. As a result, the population in the cities used for metropolitan areas is slightly lower (44%) than the total population in cities (48%) according to the degree of urbanisation.

Annex 1.C. The Global Human Settlement Population Grid (GHS-POP)

The Global Human Settlement Population Grid (GHS-POP) estimates the population in each grid cell of 250 by 250 m in the world for the years 1975, 1990, 2000 and 2015. It disaggregates residential population estimates for smallest census unit provided by CIESIN (Columbia University, United States) for the years of interest. Disaggregation is based on built-up areas as mapped by GHSL for the same years (Freire et al., 2018[7]). The disaggregation is within each census unit and proportional to the share of built-up area of the census unit in that cell. If a cell contains 2% of the total amount of built-up area within a census unit, it will be allocated 2% of the total population.

The Global Human Settlement Layer (GHSL) project mapped built-up areas using Landsat imagery collections for the years 1975, 1990, 2000 and 2014 (Pesaresi et al., 2013[8]; 2016[9]). The GHSL approach is grounded on the concept that buildings and their agglomerations (i.e. settlements) are the main visible and direct manifestation of human presence on the Earth's surface.

At the time of the first public release (2016), GHS-POP was the highest resolution gridded global population time series. It remains the only detailed grid spanning 40 years. GHS-POP is produced in an equal-area projection (World Mollweide), which makes it easy to calculate population densities. It is the only disaggregated global dataset relying on a single, time-specific and consistent proxy (built-up areas). For the latest release (R2019), areas declared as unpopulated were revised critically and the representation of population along coastlines was improved (Freire et al., 2018[7]). These grids can be downloaded as bulk or in regular tilesin World Mollweide (WGS84) for free from https://ghsl.jrc.ec.europa.eu/ghs_pop2019.php.

GHS-POP is part of an integrated suite of geospatial products, aiming to constitute a detailed and consistent time series of lightly modelled population distributions that is based on reproducible methods for sustainable data production (Melchiorri et al., 2019[10]). It can be used in policy support in numerous domains including monitoring exposure trends (Ehrlich et al., 2018[11]). These grids are created using consistent, open and free input data integrated using a clear and transparent approach.

Annex 1.D. Population projections for the world

The projections used in this report rely on two models, one that produces spatial explicit projections of the population and one that produces the corresponding spatial projection of built-up land. They are independent models but each informs the other. Both models require aggregate (national level) projections of population and built-up land change, which are then downscaled to produce spatially explicit gridded outcomes. The models produce population and built-up land from 2020 to 2100 in 10-year intervals over a global 1-km² grid. Base-year data were the 2015 GHS-POP distribution (Florczyk et al., 2019[1]) and the 2014 GHSL layer (built-up).

The model is a form of gravity-based spatial allocation (downscaling) approach applied over all the 1-km^2 grid cells in a country. The relative attractiveness of each location is modelled as a function of its population, characteristics of the local built environment and the agglomeration effect. The agglomeration or neighbourhood effect is based on potential accessibility to population calculated using a calibrated exponential distance decay function within a 50-km window. In past research, the agglomeration effect has been shown to correlate with the various socio-economic factors that make a place attractive to human populations (e.g. jobs, social opportunities, etc.).

National population totals (2020-2100) were taken from the IIASA population projections up to 2100 developed for the Shared Socioeconomic Pathway 2 (SSP2) and the UN World Population Prospects 2019 medium variant for countries or territories not included in the SSPs. National changes in built-up land are based on the historic relationship between population change and change in built-up land at the national level between 1990 to 2015. Changes in built-up land were then estimated (2020-2100) as a function of total population change. In the case of projected population decline, the relationship between population and built-up land change of a different country, one that lost population in the historic period, in the same world region was used. The models were calibrated using GHS-POP and GHS-BUILT for 1990, 2000 and 2015. For each of the 20 world regions used, parameters were estimated for 1 or more marker countries for which good historic data were available. For countries with insufficient historic data, parameters are estimated from the regional marker country were used.