Chapter 1

Redefining urban areas in OECD countries

by
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This chapter sets out a new methodology for defining urban areas, as functional economic places, in a consistent way across countries. The methodology is applied to 28 OECD countries, where more than 1 000 urban areas (with population greater than 50 000) are identified and compared according to their size, form of development, density and population growth.

The derivation of a methodology able to describe urban areas can help respond to relevant policy questions. First, it can be used to better analyse the links between urbanisation and economic growth, by taking into account that development does not necessarily imply further increases in the size of the metropolitan areas. Development can occur through a strengthening of linkages among medium-sized urban areas. Second, it opens up to monitoring the quality of life of the people living in urban areas and the sustainable use of resources. The work presented is, thus, meant to be a first step towards the development of a new international dataset aimed at monitoring more inclusive forms of growth and sustainable development of both large and medium-sized urban areas.

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Introduction

The share of people living in urban areas is growing worldwide. This is a consequence of the continuous expansion of mega-cities in emerging countries and the coming together of people and business in urban centres of different scales in other parts of the world. In China and India, urbanisation is regarded as a critical component of the development process and the two countries have ambitious goals to build a vast network of new cities to fuel their industrialisation goals (Song and Ding, 2007).[1] While the concentration of people in dense urban centres of "established" OECD cities has slowed down or even decreased in some cases, other agglomerations of varying sizes including London, Milan, Tokyo, Manchester and Lyon have not stopped changing.

Such changes are often changes in form, in what constitutes a city's geographic footprint, rather than increases in population density. Some urban areas are evolving from monocentric agglomerations to more complex systems made of integrated urban centres (cores) and sub-centres. In other territories, a number of cities and towns are increasingly linking up, forming polycentric integrated areas. This changing spatial organisation of cities and the wider territories within which they are located directly affects the quality of life of their inhabitants, the demand for transport infrastructures, the surrounding landscape, the directions of human and capital flows, and the global environmental footprint of urbanisation. Moreover, the reduction of transport and communication costs will continue to make urban centres increasingly interconnected. It is important to better understand the functioning and efficiency of these inter-city connections since they represent key links between urbanisation and productivity growth ("agglomeration economies") and can lead to important changes how and where production takes place.

The role of cities in countries' and regions' economic and social performance has increased policy makers' awareness of metropolitan areas as strategic places. Currently, these areas are experiencing profound economic, environmental and social changes. As a result, attention is turning from traditional conceptions of agglomeration economies to the capacity of urban areas to adopt a sustainable model for their natural resources and to reduce income disparities and marginalisation (Brender *et al.* 2007).

Yet despite the recognised effects of urban development on the economy, quality of life and the environment, urban development is still poorly monitored and statistically robust comparisons of urban areas across countries are lacking. This knowledge gap is mostly due to the absence of an international agreement on what we wish to measure. What do we mean by "urban"? By "functional urban area"? A harmonised definition of functional urban areas can help assess the links between the scale and type of urban growth, better understand processes of change, development and relative performance; and address opportunities and challenges for sustainable development of a country at even the national level.

The poor knowledge of urban dynamics has important consequences on regional policy making. Regional policies need to better account for the fact that urbanisation can take many forms and to recognise that they have an impact on the form and speed of urban development. Key goals of regional policies, such as increased social cohesion, critically depend on how cities grow and on how they interact among themselves and with their urban/rural hinterlands. Therefore, regional policies need sound information on efficient use of resources in urban areas.

This chapter presents recent work carried out at the OECD to develop an international methodology for measuring urban areas. This methodology is based on a harmonised definition that identifies urban areas as functional economic units. Using population density and travel-to-work flows as key information, urban areas can be characterised by densely inhabitated "urban cores" and "hinterlands" whose labour market is highly integrated with the cores. Maximising the sustainable growth potential of urban areas is at the heart of policy agendas in many OECD countries (European Union, 2011a, 2011b; HM Government, 2011; HIS Global Insight, 2011). A harmonised definition of functional urban areas has the potential to improve analysis of urban growth and performance, enabling comparative evidence about drivers and constraints.

This report contributes to the policy debate and to research through its:

- **New international methodology for the definition of urban areas.** This definition is applied to 28 OECD countries and 1 148 functional urban areas are identified. The methodology identifies urban areas as "functional economic units", thus overcoming previous limitations linked to administrative definitions and increasing the possibility of cross-country comparison.[2]
- **Understanding that urban areas can be** polycentric, with physically separated "cores" linked together in the same larger urban area. This better illustrates the economic and spatial organisation of urban areas and the linkages between such places. It thus opens up the analytical possibilities when examining on governance challenges and economic development of these complex systems.

- **Integration of geographical information and population data, allowing a better understanding of urban forms and urbanization processes.** It thus enables further analysis of the ongoing transformations of peri-urban areas and the ways in which urban areas become more "sprawled" or conversely grow more "compact".[3]

- **Identification, for each OECD country, of all urban systems with a population of at least 50 000, enabling analysis of the population distribution among cities of different size.** Within countries, different patterns of urban development can be identified, as some regions are characterised by a single large urban centre, while others host a network of medium-sized urban areas with no clear hierarchy among them. The methodology can represent a useful tool for comparative analysis of these different urban forms. In particular, it can lead to a critical assessment of the potential of medium-sized urban areas as drivers of more sustainable urban development as several studies suggest (OECD, 2010b; Mayfield et al., 2005).

- **Harmonised methodology, a first step to determining an international dataset through which to monitor urban areas performance across countries.** Such methodology helps to overcome the large differences in administrative definitions of cities across countries. The 1 148 urban areas in OECD countries are, for simplicity of analysis, classified in four categories on the basis of population size: large metropolitan areas, metropolitan areas, medium-sized urban areas, and small urban areas. A preliminary set of statistics for these four categories are presented. The OECD intends to increase the set of available statistics for the metropolitan areas and provide annual updates. However, further "populating" the functional urban areas with comparable statistics and improving the information base on urban dynamics require some methodological innovations and a clear engagement for wider dissemination of data for small areas by countries. On the methodological side, the report argues for a more systematic use of geographic data on population, land cover and use, transport networks and service infrastructure and air quality. Data from different sources (censuses, registers, geographical information system) can be applied to the new definition. For the two largest types of cities, statistics can be developed both for the densely inhabited urban core and the hinterland. The comparison of indicators for cores and hinterlands enables a better understanding of within-city differences. Moreover, the finalisation of the dataset will require a high level of co-operation with national statistical offices and Eurostat for the dissemination of data for small administrative units, for their collection and harmonisation, and for the construction of headline indicators of urban economic, social and environmental performance.

The OECD is currently working to apply this methodology to the remaining member countries: Australia, Chile, Iceland, Israel, New Zealand and Turkey. The main constraint to further extend the geographical coverage is the availability of travel-to-work (commuting) data to define hinterlands of the functional urban areas. Further methodological work is in progress to identify a suitable substitute for the commuting data, so that additional countries can be included. Chapters 2 and 3 discuss the possible adaptation of this methodology to South Africa and China, respectively.

On the basis of this new methodology, as applied to the 28 OECD countries, the results suggest:

- A common trend of urban densification across OECD countries especially in the hinterlands of large metropolitan areas.
- A low growth or decrease in population density in the cores of urban areas. Examples from the period 2000-06 include expansions of land for urban uses in the hinterlands of metropolitan areas in Estonia, Ireland, Japan, the Netherlands, Portugal, Spain and the United States. During the same period, the rate of population growth in the cores of metropolitan areas in Estonia, Italy, Japan, Portugal and Spain was lower than the rate of urbanised land growth.
- There is no evidence of a clear linear relation between population size and population growth. Small urban areas and metropolitan areas – respectively the smallest and the second largest type of functional urban areas – have increased their population faster than the medium-sized urban areas or the large metropolitan areas.
- There is evidence of large differences in the levels of estimated CO_2 emissions per capita and air quality across metropolitan areas. These differences suggest that many cities have the potential to better decouple their economic production from carbon emissions. Forthcoming statistics on different aspects of the well-being of urban population (such as poverty, crimes, housing market, quality of education and health, etc.) are crucial to better understand the sustainability of the current urbanisation patterns.

The rest of the chapter is organised as follows: Section 1.2 reviews the methodology and provides details on the data used; Section 1.3 describes the urban systems of 28 OECD countries derived by the application of this definition. Some descriptive statistics are provided on urbanisation and densification according to the size distribution of the functional urban areas. In addition, estimates of economic output, CO_2 emissions and air quality are provided as examples of indicators to be produced for urban areas. Section 1.4 concludes.

Methodology

Data inputs and selection of geographical units

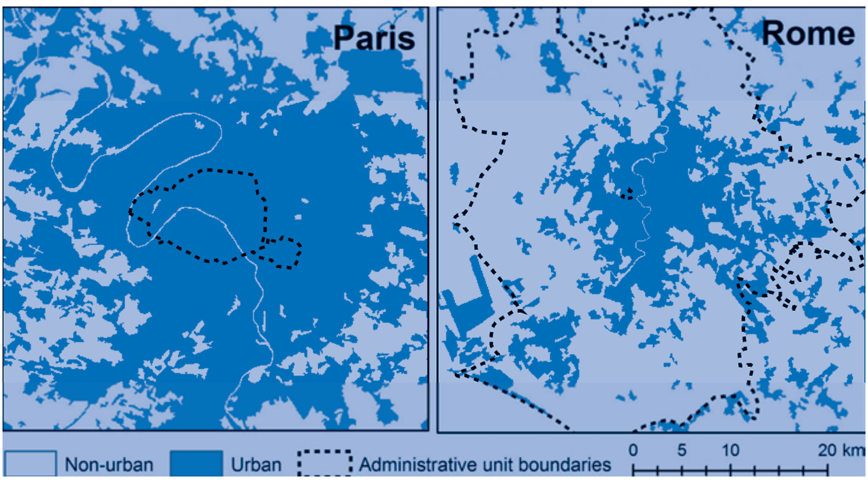
Given that data are generally disseminated according to administrative jurisdictions or statistical geographic units, urban areas are best defined as aggregations of these nationally defined subdivisions. The first key issue for a functional definition of urban areas is thus the choice of an appropriate geographic building block. Here the obvious trade-off is between the precision in the delineation of metro areas and the availability of data for smaller administrative units. For all European countries, the definition uses municipalities (LAU2 in Eurostat terminology).[4] In non-European countries, the selected building block is generally the smaller administrative units for which national commuting data are available. In the following description of the methodology for delineating urban areas, the general term "municipalities" will be used for indicating the building block in the analysis.

Defining urban cores through gridded population data: rationale and application

The OECD has traditionally used thresholds based on population density (the ratio between population and the total area of the administrative unit) to classify regions as either urban or rural. While this approach has the obvious benefit of simplicity and performs well for several applications, it has clear limitations when applied to the analysis of urbanisation patterns and their effects on the economy, the environment and social relations.

One clear problem when using population density as the unique criterion for defining urban cores is the fact that administrative units are unevenly sized and highly heterogeneous within and between countries. It is fairly common to observe municipalities that, for historic or economic reasons, cover surfaces that are much larger than those of the other municipalities of a country. These municipalities often host a relevant urban centre, but their administrative borders extend also over large mountainous areas, or include vast water surfaces, woodland and shrub. Large administrative borders are a key reason why we can observe low density values even for municipalities that contain non-negligible urban agglomerations (in Europe, more than 250 communes above 20 000 inhabitants have a density lower than 150 and the majority of them host fairly large urban cores). At the other extreme, considering simply the ratio population/area of the municipality, it is easy to end up classifying as "urban cores" some municipalities that have in reality a marked rural connotation.[5] The problem is non-negligible also when we focus only on large metropolitan areas, such as Paris or Rome. In Figure 1.1, it can be seen that the difference in population density between the two cities depends mainly on the boundary definition; the actual population distribution in the cities plays a secondary role.

Figure 1.1. **Urban and non-urban population density: Paris and Rome**



Note: These maps are for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Source: OECD calculations based on population density disaggregated with Corine Land Cover, Joint Research Centre for the European Environmental Agency.

The methodology uses population grid data at 1 km² to define urban cores in a way that is robust to cross-country differences in administrative borders. The source of the population grid data for European countries is the population density disaggregated with Corine Land Cover dataset, produced by the Joint Research Centre for the European Environmental Agency (EEA). For all of the other countries, harmonised gridded population data from the Landscan project are used.

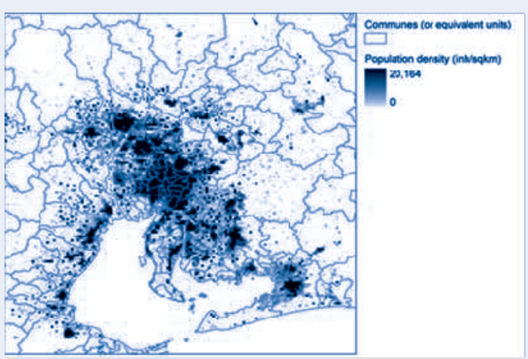
The methodology consists of three main steps: the first step identifies contiguous or highly interconnected densely inhabited urban cores. The second step identifies interconnected urban cores that are part of the same functional areas, and the third step defines the commuting shed or hinterland of the functional urban area.

Step 1. Identifying core municipalities through gridded population data

In the first step of the procedure, the gridded population data are used to define urbanised areas or "urban high-density clusters" over the national territory, ignoring administrative borders. High-density clusters are defined as an aggregation of contiguous high density 1 km² grid cells.[6] High-density cells are those with a population density of at least 1 500 inhabitants per km^2 in Europe, Japan, Korea and Mexico. A lower threshold of 1 000 people per km² is applied to Canada and the United States, where several metropolitan areas develop in a less compact manner. Small clusters (hosting less than 50 000 people in Europe, Canada and the United States, 100 000 people in Japan, Korea and Mexico) are dropped, as they are likely to capture small agglomerations of built-up areas which cannot be characterised as an urban area. As Box 1.1 shows, a municipality is defined as being part of an urban core by calculating the fraction of its population living within an urban cluster. If the percentage of the population of a municipality living within the urban cluster is higher than 50%, then the municipality is considered "densely inhabited". The final part of the procedure consists simply in aggregating contiguous densely inhabited municipalities in an "urban core".

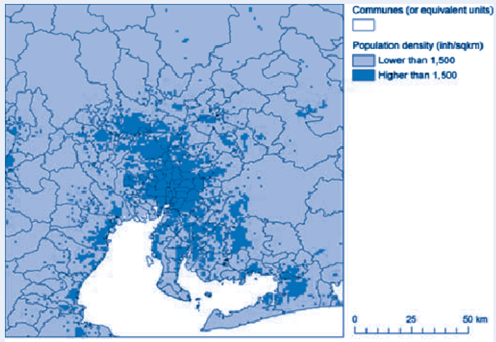
Box 1.1. **Defining the urban cores, an illustration for Nagoya (Japan)**

1. Overlay input datasets – population density grid and boundaries of small administrative units.

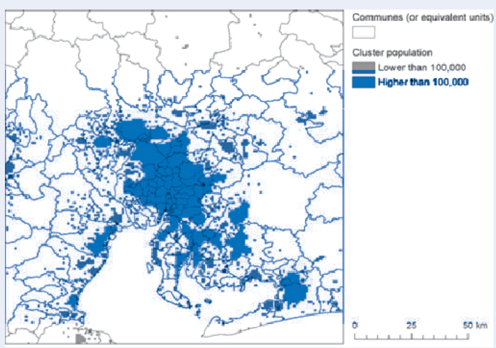


Box 1.1. **Defining the urban cores, an illustration for Nagoya (Japan)** *(cont'd)*

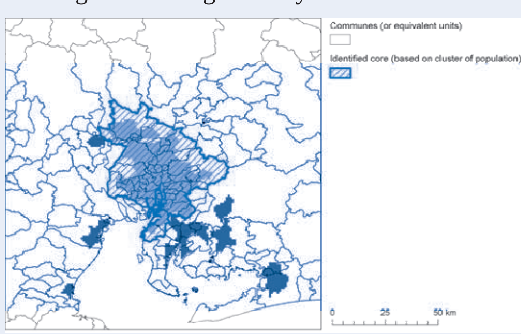
2. Apply a threshold to identify densely inhabited grid cells.



3. Identify contiguous high-density clusters and enhance them by majority filtering. Only clusters with a population over specified thresholds are kept.



4. Identify core commuters are identified as those with more than 50% of the population living within a high density urban cluster.



Note: These maps are for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Source: OECD calculations based on LandScan database.

Step 2. Connecting non-contiguous cores belonging to the same functional area

The urban cores defined through this procedure are found to be good approximations of contiguous, highly built-up surfaces. As already said, not all of the urban areas in the OECD are characterised by contiguity in built-up development. Many of them are developing in a polycentric way, hosting high densely inhabited cores that are physically separated but economically integrated. An important innovation of this work identifies which urban areas have such a polycentric structure. This is done by simply looking at the relationships among the urban cores, using the information contained in the commuting data.[7] Two urban cores are considered integrated, and thus part of the same polycentric metropolitan system, if more than 15% of the residence population of any of the cores commutes to work in the other core. This intermediate step allows a correction for possible discontinuities in population density within the same urban centre (e.g. natural surfaces larger than 1 km^2 splitting one city into two parts).

Using this simple functional criterion, it is possible to identify several polycentric metropolitan areas.[8] These polycentric metropolitan areas are generally constituted by one central city with a large population nucleus and a set of smaller sub-centres which have a high degree of integration with the nucleus. There are also examples within which there are a number of inter-linked smaller areas without a defined core. The direction of the relationship is not necessarily from the small sub-centres to the large central cores, as in many cases the sub-centres develop as dynamic industrial and service hubs, rather than as dormitory spaces for the workers in the big cities. For large metropolitan areas and in countries where commuting distance is steadily increasing, it is easy to find sub-centres situated far from the central city core. This is, for example, the case of London, whose increased connectivity with urban sub-centres has been the result of the combined effect of infrastructural improvements and increasing spatial re-organisation of production activities (firms keeping their administrative headquarters in the central core, and relocating production facilities to well-connected agglomerations outside the central core).

Step 3. Identifying the urban hinterlands

Once the densely inhabited municipalities are aggregated to form urban cores and polycentric metro areas with tied cores are identified, the final step of the methodology consists in delineating the hinterland of the metro areas. The "hinterland" can be defined as the "worker catchment area" of the urban labour market, outside the densely inhabited core. The size of the hinterland, relative to the size of the core, gives clear indications of the influence of cities over surrounding areas. Getting distinct information for cores and for hinterlands is also very important to understand where change is taking place.

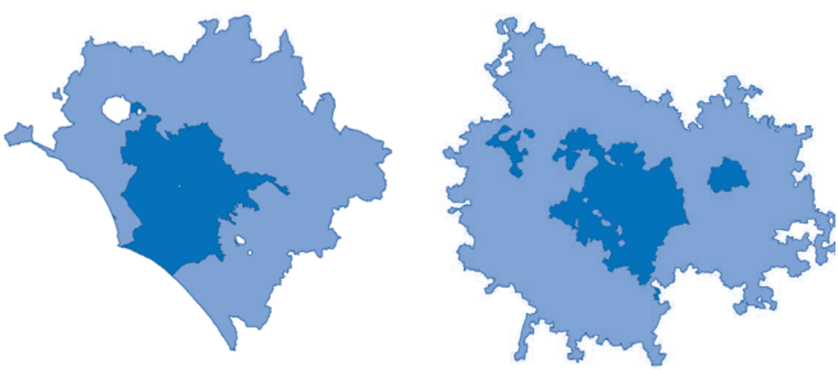
We assign to each core as hinterland municipalities all those municipalities which send to the core a percentage of their workers above a given threshold.[9] After extensive sensitivity analysis, the threshold has been fixed at 15% of the residents employed for municipalities.

We consider the multiple cores within a polycentric metropolitan area as a single destination. In this way, a hinterland municipality is assigned to a polycentric municipal area if the level of its commuting to the tied cores exceeds the threshold. This adjustment is needed to take into account the fact that workers within the catchment areas of a polycentric system tend to commute towards multiple employment centres.[10] For the cases in which a municipality has commuting levels over 15% to cores in different metropolitan areas, it is linked to the core to which it sends the highest share of its employed population.

Municipalities surrounded by a single functional area are included as part of the functional urban areas and non-contiguous municipalities are dropped. Figure 1.2 provides an illustration of the results for the cities of Rome and Paris. As can be seen from the images, Paris has a more marked polycentric structure than Rome.

Figure 1.2. **An illustration of the results for Paris and Rome**

The functional urban area of Rome | The functional urban area of Paris



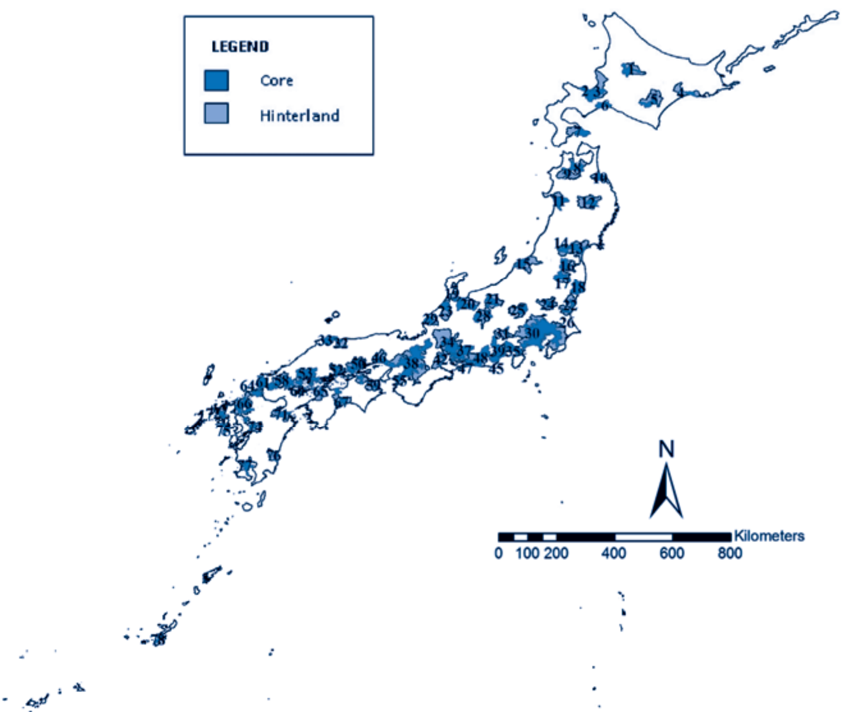
Note: These maps are for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Source: OECD calculations on population density disaggregated with Corine Land Cover, Joint Research Centre for the European Environmental Agency.

As a result of this methodology it is possible to obtain an accurate representation of each country's "urban system".[11] These systems are constituted by all the functional urban areas taking shape around high-density clusters with population higher than 50 000 people (100 000 in Japan, Korea and Mexico). The simple visualisation of the results is already informative about the concentration of urban people in particular regions of a country, and about the size distribution ("hierarchy") among the different urban centres.

The result of this methodology applied to Japan is shown in Figure 1.3. For this country, 76 functional urban areas are identified, of which 6 are large metropolitan areas and 30 metropolitan areas.[12]

Figure 1.3. **Functional urban areas in Japan**



Note: This map is for illustrative purposes and is without any prejudice to the status of or sovereignty over any territory covered by this map.

Source: OECD calculations based on LandScan database.

In order to ensure international comparability of the statistics obtained for the functional areas, a particular effort was made to use administrative building blocks of comparable size and to reduce to a minimum country-specific adjustments in the methodology. Extensive sensitivity analysis was carried out to set the common values of the thresholds in the methodology. Only limited variations in population density and size to define the urban cores and in the commuting threshold of the hinterlands were allowed to adjust for the large cross-country differences in the form of urban settlements. This search for international comparability might come at the cost of a loss of accuracy in the delimitation of the urban borders. In addition, data availability for the resulting functional urban areas may at present be scarce. For these reasons, validation work with national experts has been carried out with national experts both on the data inputs and on the results, to ensure a good representation of the national urban systems and allow adjustment to improve data availability. The relatively simple steps of the methodology make the result replicable by interested countries and possible to update, as new data from censuses become available or administrative units are modified.[13]

Box 1.2. **National definitions of functional urban areas: the examples of Canada and United States**

Several methodologies to identify and classify urban systems have been developed at national and international level. The US Office of Management and Budget (2000) and Statistics Canada (2002) use a functional approach similar to the one adopted here to identify metropolitan areas, respectively, in the United States and in Canada. The conceptual frameworks include the use of a **defined core area** as the starting point of the delineation of functional areas, and the use of **commuting data** as a proxy measurement of the relationship between defined core areas and peripheral or hinterland areas.

The main differences between the American and Canadian methodologies and the one presented in this chapter relate to the choices of geographical units and thresholds for commuting. More precisely:

- **Geographic building blocks:** Statistics Canada uses the Census Subdivision (CSD) as the building block to form Census Metropolitan Areas (CMA) and Census Agglomerations (CA) (functional areas) while the OECD uses the Census Consolidated Subdivision (CCS) as the building block to form functional areas in Canada. In many cases CCSs are larger and often have a lower population density than many of the component CSDs. The US Office of Management and Budget (OMB), the agency responsible for the delineation of metropolitan and micropolitan statistical areas in the United States, uses counties as building blocks while the OECD has used Census tracts as the basic geographical unit for the delimitation of the metropolitan areas in the United States in order to have building blocks of comparable size with the other OECD countries.

Box 1.2. **National definitions of functional urban areas: the examples of Canada and United States** *(cont'd)*

- **Density and population thresholds for defining core areas:** both the density threshold and the minimum population concentration set by the OECD are higher than those established in Canada and the United States. The OECD identifies core areas in Canada and the United States as those high-density clusters with a population density of 1 000 inhabitants per km² grid and a minimum population size of 50 000. Statistics Canada identifies core areas as those with a population density of 400 or more people per km² and a total population of at least 10 000 inhabitants. The US Office of Management and Budget defines a core area as those counties that have at least 50% of their population in urban areas of at least 10 000 populations or have within their boundaries a population of at least 5 000 located in a single urban area of at least 10 000 population. These differences might likely produce fewer OECD cores than the comparable Canadian and American cores.
- **Commuting thresholds:** the OECD uses different minimum forward commuting thresholds than Statistics Canada or the US Office of Management and Budget (15%, 50% and 25% respectively). Additionally, the OECD does not test for commuting from the core, or reverse commuting, to the hinterland areas when considering the strength of the core hinterland relationships. Statistics Canada and the US Office of Management and Budget use a 25% threshold of reverse commuting.

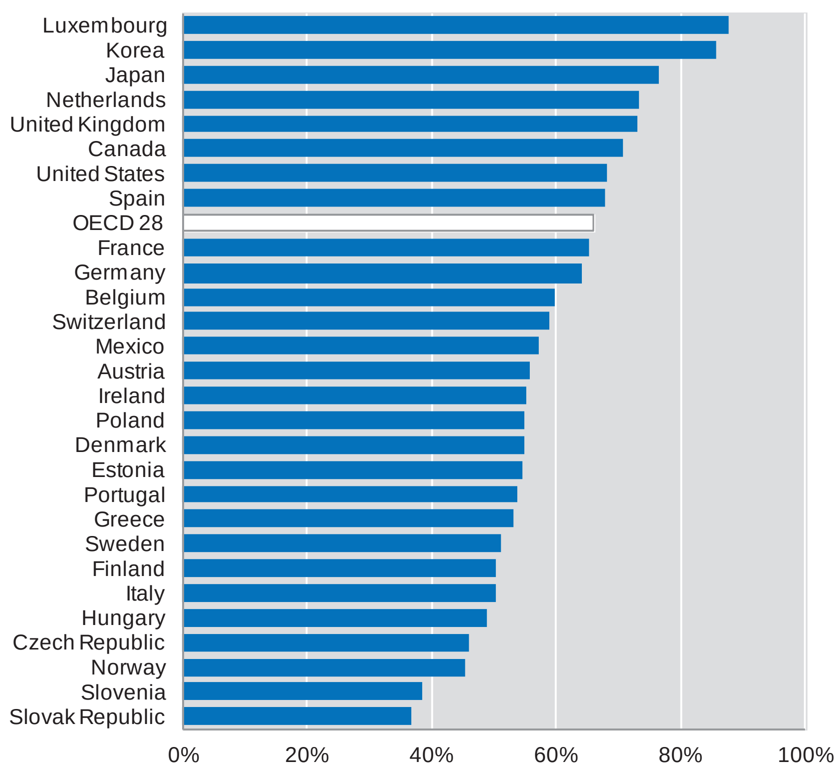
The validation work carried out with national experts has brought some adjustments to specific functional urban areas in Canada. In order to increase the available statistical information to monitor economic, social and environmental changes in functional urban areas in the United States, the US Census Bureau and the US Department of Commerce have suggested adjusting the urban areas derived by the OECD methodology according to the boundaries of counties. This adjustment consists in the following four steps:

1. Step 1: identify the counties that overlap the OECD functional urban areas defined by Census tracts.
2. Step 2: compute the percentage of population in a functional urban area contained in a county.
3. Step 3: select all counties with a percentage above 50% in Step 2.
4. Step 4: drop non-contiguous counties.

A description of urban systems in OECD countries based on the new methodology

The above described methodology is applied to 28 OECD countries, where a total of 1 148 functional urban areas have been identified. According to this definition, the proportion of population living in urban areas with cores larger than 50 000 (100 000) inhabitants in OECD countries is around 66% ranging from almost 90% in Luxembourg, to less than 40% in the Slovak Republic (Figure 1.4).

Figure 1.4. **Percentage of national population living in an urban area, 2006**



Note: The national population living in an urban area is defined as the population living in an identified functional urban area with more than 50 000 people (100 000 in Korea, Japan and Mexico). Population data for Austria, the Czech Republic, Germany, Finland, Greece, Hungary, Ireland, the Netherlands, Poland, Sweden, Slovenia, the Slovak Republic and the United Kingdom refer to 2000; Norway, Japan, Luxembourg and Mexico refer to 2005; the United States refer to 2007; Korea and Portugal refer to 2010 and 2011 respectively.

Source: Author’s calculations based on OECD Regional database.

For the remaining OECD countries (Australia, Iceland, Israel, New Zealand and Turkey), work has not started yet while it's under way for Chile. It is more challenging to extend this definition to those countries for which there are no commuting data available for small administrative units. The absence of commuting data from the censuses is particularly frequent in emerging and developing countries. Different options to approximate the definitions of the hinterlands, either by using proxies for commuting data or by making inference from "matched", similar cores in other countries with defined hinterlands, are under consideration.

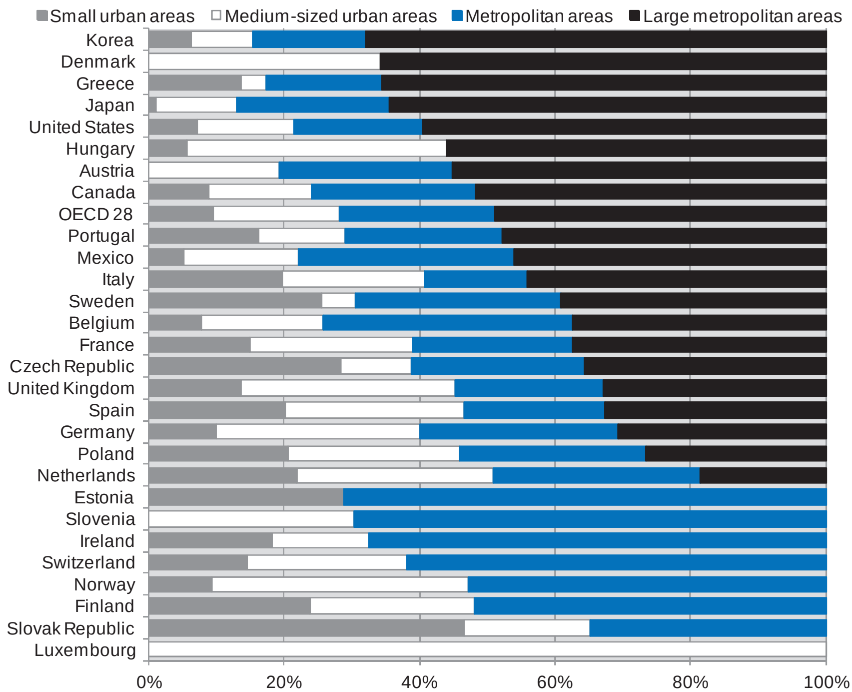
As already mentioned, a crucial innovation of this methodology is the possibility of comparing functional urban areas of similar size across countries. A classification of urban areas into four "types" according to population size is proposed:

- small urban areas, with a population below 200 000 people;[14]
- medium-sized urban areas, with a population between 200 000 and 500 000 people;
- metropolitan areas, with a population between 500 000 and 1.5 million people;
- large metropolitan areas, with a population of 1.5 million or more.

On the basis of this classification, it is possible to study the relative importance of medium-sized urban areas with respect to large metropolitan areas in each country.[15] The eight countries on the bottom of Figure 1.5 do not have any large metropolitan areas, while in all the other countries the urban centres with 1.5 million people or higher host at least 20% of the urban population. The primacy of large metropolitan areas is particularly clear in Denmark, Greece, Japan, Korea and the United States where at least 60% of the urban population lives in cities of this class.

Among the 1 148 functional urban areas identified in the 28 OECD countries, 74 are large metropolitan areas with more than 1.5 million people, 190 are metropolitan areas, 400 are medium-sized urban areas, and 484 are small urban areas (Figure 1.6). A larger share of urban population lives in large metropolitan areas in North America, Japan and Korea than in Europe, and the average size of the large metropolitan areas is much bigger in Japan (more than 10 million inhabitants), Korea (almost 9 million) and North America (around 4 million) than in Europe (around 3 million). On the other hand, the weight of population in small and medium-sized urban areas is bigger in Europe than in Japan, Korea and North America, even though the average size of these two city types is comparable across OECD

Figure 1.5. **Distribution of population across OECD urban areas, 2006**



Note: Population data for Austria, the Czech Republic, Germany, Finland, Greece, Hungary, Ireland, the Netherlands, Poland, Sweden, Slovenia, the Slovak Republic and the United Kingdom refer to 2000; Norway, Japan, Luxembourg and Mexico refer to 2005; the United States refer to 2007; Korea and Portugal refer to 2010 and 2011 respectively.

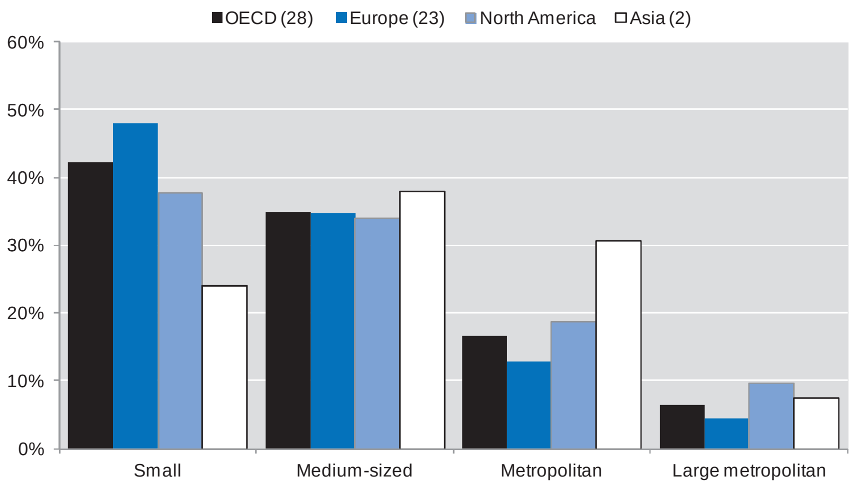
Source: Author's calculations based on OECD Regional database.

countries (Figure 1.6). Additionally, the category of small urban areas is the most represented in Europe and Korea (they account for almost 50% of all functional urban areas), while 45% of the functional urban areas in Japan are classified as medium-sized urban areas.

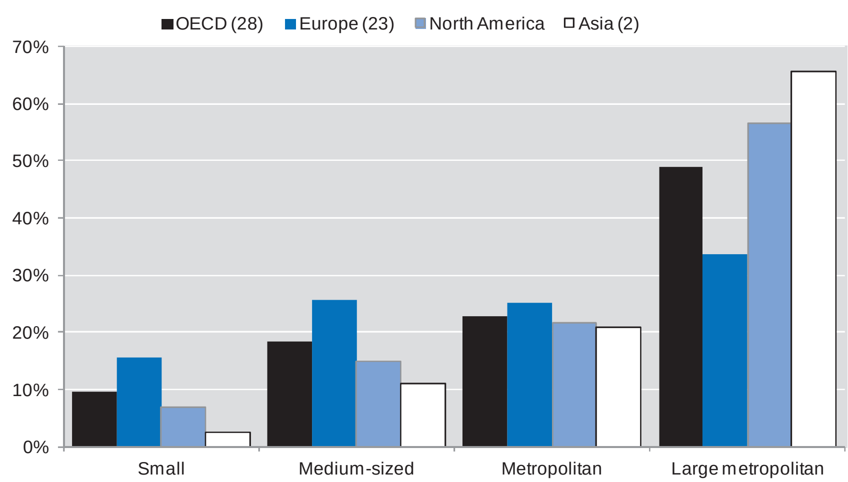
The crucial role of large metropolitan areas as key players of national and transnational flows is well documented. The largest of these cities is the vast urban agglomeration around Tokyo (Table 1.1) that extends on a highly built-up surface of over 10 000 km^2 with few discontinuities in density. This labour market area has integrated different cities over time (Yokohama, Kawasaki, Saitama, Chiba to mention only the largest centres within this functional city). The second and the third largest cities, Seoul Incheon and Mexico City, have a more marked monocentric configuration. Mexico City

Figure 1.6. **Share of urban areas and population by urban area type in OECD countries, 2006**

% of urban areas by city type in OECD areas



% of urban population by city type in OECD areas



Note: North America includes Canada, Mexico and United States. Asia includes Japan and Korea. Population data for Austria, the Czech Republic, Germany, Finland, Greece, Hungary, Ireland, the Netherlands, Poland, Sweden, Slovenia, the Slovak Republic and the United Kingdom refer to 2000; Norway, Japan, Luxembourg and Mexico refer to 2005; the United States refer to 2007; Korea and Portugal refer to 2010 and 2011 respectively.

Source: Author’s calculations based on OECD Regional database.

Box 1.3. **Classification of urban areas by size: absolute versus relative thresholds**

Our main purposes in developing a common definition of functional urban areas are to provide tools to analyse urban systems in an international context and to measure how cities work and contribute to economic, social and environmental imbalances. For these reasons, once all of the functional urban areas in a country have been identified, cities are regrouped in four categories (small, medium, metropolitan areas, and large metropolitan) by setting absolute (and somehow arbitrary) thresholds of population. As a result, almost all countries have cities belonging to all four class types. Differently, if we used relative thresholds on the basis of the share of population in functional urban areas, we would find that one-fourth of the total urban population is concentrated in just 12 large metropolitan areas (less than 2% of total cities), half of the urban population is concentrated in 74 large metropolitan areas (7% of total cities) and a little more than 25% of cities host 75% of the total urban population.

This methodology identifies the urban systems within a country and does not consider functional economic areas which lie in more than one country. Therefore, we have a comprehensive picture of the national urban system which could be used to enhance our capacity to study the relative importance of large *vs* medium-sized urban areas and the interconnections among cities of different sizes within countries.

Countries may be interested in using relative thresholds on national population in urban systems to identify the different categories of cities (small, medium, metropolitan areas, and large metropolitan). For example, by looking at the percentile of national population living in the urban areas ranked by population size, we would obtain a country-specific picture of the relative concentration of population in urban areas.

The extent to which urban systems are balanced, both at national and at other spatial levels, can be also investigated by looking at the estimated coefficient of a regression of the rank of each functional urban area on its size in terms of population (both in log scale, hence applying the so-called rank-size rule). The steeper the slope of the line interpolating data – hence the higher the coefficient in absolute terms – the more concentrated the population in the largest metropolitan areas. Generally, the estimated coefficient ranges, in absolute terms between 0.8 and 1.2, due to an empirical regularity known as Zipf's Law, under which the estimated coefficient is close to 1. This law implies that the largest functional urban area is twice as large as the second largest area, three times the third largest area and so on along the whole urban hierarchy. Preliminary results show that this law approximately also holds for the set of functional urban areas in OECD countries. Similar results hold for urban areas in China (Box 3.1).

has undergone a process of extension of its core area in the last decades, with the emergence of several employment clusters located outside the traditional central business district. As a consequence of this dispersion of employment in the metro area, the vast majority of the population of Mexico City is now living in "core" municipalities. The fourth city in the ranking is a network of urban centres that developed around the main agglomeration of Osaka. The tight integration of Osaka with the other cities of Kyoto, Kobe, Nara and Otsu has generated a very large functional area (more than 7 800 km^2, larger than Mexico City), with continuous, high levels of population density in the large space between the different historical centres.

Once a richer set of statistics are available for the functional urban areas belonging to the types "large metropolitan areas" and "metropolitan areas", this dataset can replace the current *OECD Metropolitan Regions database* with the clear advantage of an improved comparability among the metropolitan areas in different countries, as they are defined using the same methodology.

Urbanisation and densification of OECD metropolitan areas

Dynamics of population change and distribution can be described using population and land cover data from different points in time. Figure 1.7 provides statistics by type of metro area and by core/periphery for a first set of countries[16] for which data in three points in time (around 1990, 2000 and 2006) have been collected. Faster rates of population growth are observed in the metropolitan areas and small urban areas rather than in large metropolitan areas and medium-sized urban areas. In small urban areas, the acceleration of population growth after 2000 is particularly marked in the city cores. Across all the four types of functional urban areas, the population of the hinterland has been growing at a faster rate than the population of the core, suggesting a common trend of "sub-urbanisation" or densification of peri-urban areas. The largest increases in population are observed in the hinterlands of the large metropolitan areas, with a yearly population growth of 2% in the period between 2000 and 2006 (and around 1.8% for the whole period 1990-2006). This evidence on the fast growth of the hinterlands of metropolitan cities warrants further analysis on the consequences of such a trend. The development of peri-urban areas has, in fact, important impacts on liveability and equity in access to job opportunities, as well as relevant effects on the environmental footprint of cities. Important lessons for spatial planning could be derived by comparing cities growing according to the classic monocentric model with respect to polycentric cities, where the hinterland's space, the transport infrastructures and the provision of services are organised around multiple cores.

Table 1.1. **20 largest metropolitan areas among 28 OECD countries, 2006**

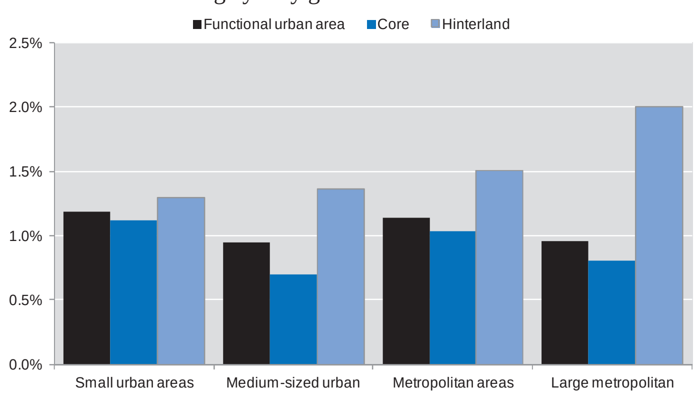
Country	Functional urban area	Total population	Core population	Hinterland population
Japan	Tokyo	33 775 770	31 498 118	2 277 652
Korea	Seoul Incheon	22 451 402	20 493 781	1 957 621
Mexico	Mexico City	18 538 957	17 776 591	762 366
Japan	Osaka	17 161 637	15 664 318	1 497 319
United States	Los Angeles	16 741 516	16 741 516	0
United States	New York	16 548 400	16 152 383	396 017
France	Paris	11 435 042	9 088 394	2 346 648
United Kingdom	London	10 609 400	8 397 221	2 212 179
United States	Chicago	9 309 853	6 654 126	2 655 727
United States	San Francisco	6 636 738	4 636 987	1 999 751
Japan	Nagoya	6 305 108	5 213 180	1 091 928
Spain	Madrid	6 166 200	4 912 893	1 253 307
Canada	Toronto	5 965 105	5 236 325	728 780
United States	Miami	5 465 183	5 465 183	0
United States	Houston	5 289 344	4 417 499	871 845
United States	Washington	5 000 254	4 151 593	848 661
United States	Atlanta	4 408 952	1 724 536	2 684 416
Germany	Berlin	4 334 215	3 522 837	811 378
Mexico	Guadalajara	4 075 595	3 728 465	347 130
Italy	Milano	4 061 399	3 092 874	968 525

Note: Population data for Berlin and London refer to 2000; Tokyo, Mexico City, Osaka, Nagoya and Guadalajara refer to 2005; Los Angeles, New York, Chicago, San Francisco, Miami, Houston, Washington and Atlanta refer to 2007; Seoul Incheon refer to 2010.

Source: Author's calculations based on OECD Regional database.

Figure 1.7. **Population growth by urban area type and core/hinterland**

Average yearly growth rates 2000-2006



Note: The period of growth in the case of Korea is 2005-2010 and Portugal 2001-2011.

Source: Author's calculations based on OECD Regional database, LandScan database and population density disaggregated with land cover.

There is important heterogeneity in population growth across countries. On average, urbanisation was faster in Mexico (with the exception of large metropolitan areas), the United States (especially in metropolitan areas) and Canada (especially in large metropolitan areas) than in Japan and European countries during the period 1995-2006. However, in Spain, population in small urban areas and in large metropolitan areas has grown at an annual rate higher than 1%, likewise Oslo (Norway) and Luxembourg. A decrease of urban population is observed in the small urban areas of Japan as well as in the three functional urban areas of Estonia (Table 1.2).

The urban population density, that is to say the ratio of total population and the area which is urban (see Box 1.4 for the definition), in large metropolitan areas and metropolitan areas is around 2 000 persons per km^2. The concentration of population in the cores of cities is clear in both city types: the urban population density of the cores is more than 3 000 people per km^2 in large metropolitan areas and 2 600 people per km^2 in metropolitan areas (Figure 1.8).

Table 1.2. **Population growth by country and urban area type**

Yearly growth rates, 1995-2006 circa

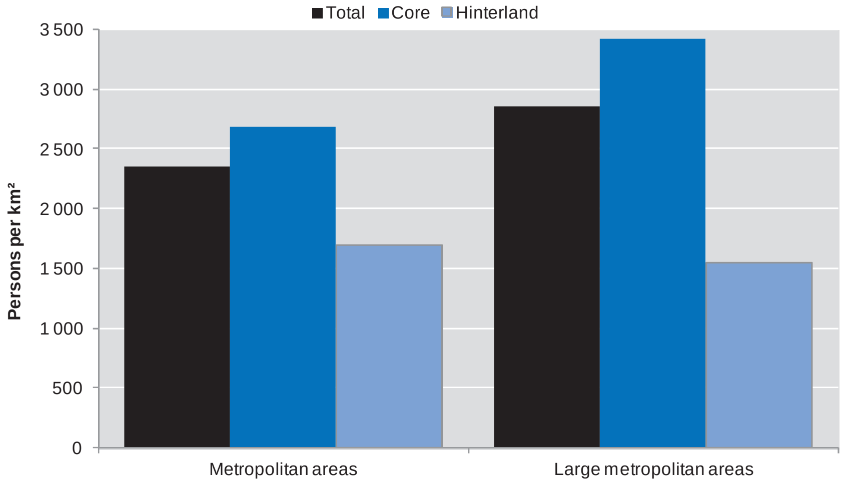
	Small urban areas	Medium-sized urban areas	Metropolitan areas	Large metropolitan areas
Belgium	0.01%	0.19%	0.19%	0.57%
Canada	0.85%	0.79%	1.33%	1.45%
Denmark		0.46%		0.49%
Estonia	-0.17%		-0.14%	
France	0.44%	0.50%	0.83%	0.55%
Italy	0.26%	0.43%	0.01%	0.29%
Japan	-0.02%	0.25%	0.50%	0.48%
Korea	0.52%	0.98%	0.53%	0.79%
Luxembourg		1.29%		
Mexico	2.04%	1.87%	2.09%	1.31%
Norway	0.81%	0.91%	1.41%	
Portugal	0.68%	0.55%	0.46%	0.42%
Spain	1.35%	0.92%	0.80%	1.05%
United States	1.24%	1.12%	1.42%	1.20%

Note: The period of growth in the case of Korea is 2000-10, Estonia 2001-06 and Portugal 1991-2011.

Source: Author’s calculations based on OECD Regional database, LandScan database and population density disaggregated with land cover.

Figure 1.8. **Urban population density in metropolitan areas**

Total population over urbanised land, 2000

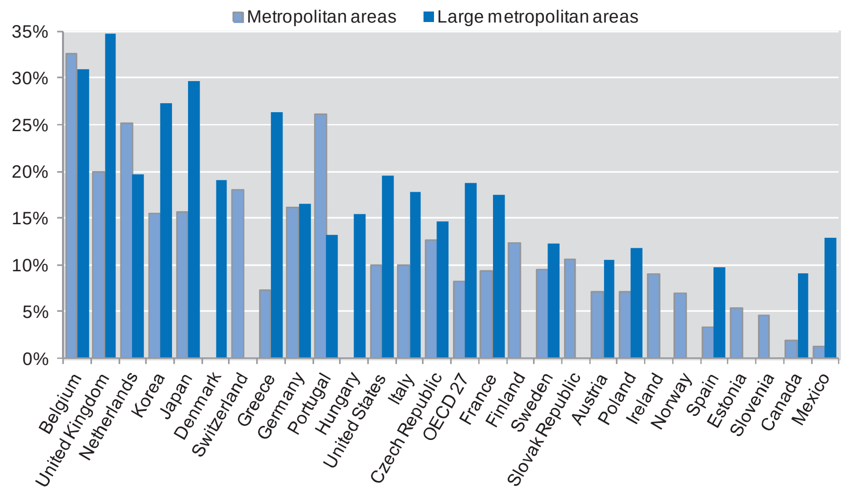


Source: Author's calculations based on OECD Regional database, Corine Land Cover, Japan National Land Service Information data, Modis and National Landcover Dataset.

Urbanisation not only concentrates people but also triggers a variety of land-change processes in natural environments. Recent analysis at the OECD has argued that policy makers concerned with sustainable development should focus more on the form and quality of urbanisation processes rather than simply on the volume and speed of urbanisation (OECD, 2010). Detailed spatial information on the changes in land cover can help identify which areas have been exposed to larger urban pressure, guiding targeted policy interventions where this expansion threatens the quality of the landscape or bio-diversity.

Making use of global land cover datasets at high geographical resolution, we can derive a measure of the share of "urbanised land" (land with built-up cover or urban use such as parks and sport facilities) within the functional urban areas and its change over time (see Box 1.4). The percentage of urbanised land over total area in metropolitan areas varies from less than 4% in Canada and Mexico to around 30% in Belgium, the Netherlands and the United Kingdom. This percentage is generally higher in large metropolitan areas than in metropolitan areas, especially in Japan, Korea and the United Kingdom, with the exception of Belgium, the Netherlands and Portugal (Figure 1.9).

Figure 1.9. **Share of urbanised land over total area in metropolitan areas by country, circa 2000**



Note: It must be noted that for Canada, Korea and Mexico data are derived from medium spatial resolution (500m) satellite imagery (MODIS) and should be taken as rough estimates. The functional city of Luxembourg is classified as a medium-sized city so it is not included in this figure. The data for Japan refer to 1997.

Source: Author's calculations based on Corine Land Cover, Japan National Land Service Information data, Modis and National Landcover Dataset.

Box 1.4. **Measuring land use and change in urbanised land**

In order to measure the different uses of land and its changes with respect to small portions of territory, we take advantage of data from the Earth's surface collected using remote sensing and geographic information systems. In particular, we use the Corine Land Cover for Europe, the Japan National Land Information, the National Land Cover Database for the United States, and MODIS Land Cover Data for Canada, Korea and Mexico (OECD, 2011a).

"Urbanised land" is defined by including the land classified as artificial with built-up cover or urban use in the different datasets. It includes, for example, residential and non-residential buildings, major roads and railways, port and airports, open urban areas like parks and sport facilities. The remaining land of the functional urban areas is classified as water, agriculture, forest or natural vegetation (no forest).

The growth in urbanised land is defined as the ratio between the net change of urbanised land (i.e. the newly formed areas of urban class minus areas that changed from urban to another class) and the total area of urban class at the beginning of the observed period. It is expressed in average yearly growth rates.

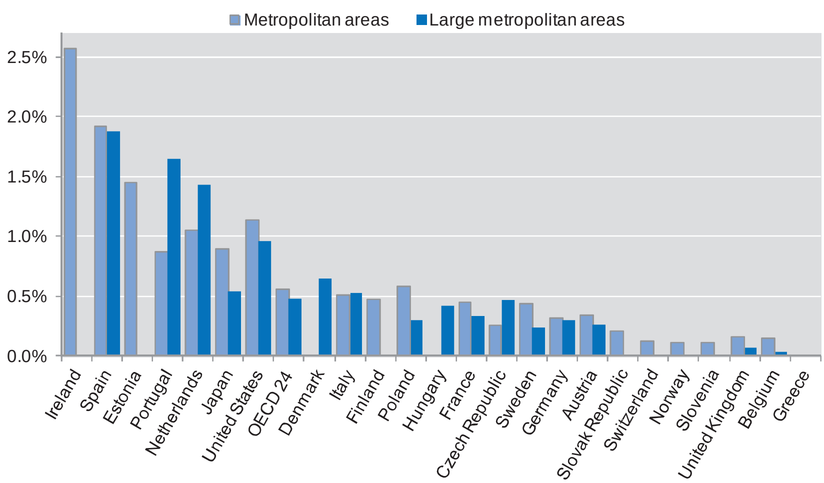
Urbanised land in the metropolitan areas and large metropolitan areas in the United States have grown at almost 1% per year, while at 0.7% in Japan and 0.4% in Europe. Among European metropolitan areas, a very steep increase in urbanised land is observed in Dublin (Ireland); La Palmas, Madrid, Murcia and Zaragoza (Spain); Tallin (Estonia); and Lisbon (Portugal) (Figure 1.10).

The pace of urbanised land growth has been faster in the metropolitan areas (0.5% yearly) than in large metropolitan areas (0.4% yearly) in Europe, Japan and the United States. In both types of cities, the growth of urbanised land is mostly concentrated in the hinterlands.

As a result of the population and urbanised land dynamics, i.e. fast population increases in the hinterlands of large metropolitan areas in particular and sustained growth of urbanised land in metropolitan areas, on average we observe an increase of population density in the hinterlands and a decrease of urban population density in the cores[17] (Figure 1.11).

Figure 1.10. **Growth of urbanised land in metropolitan areas, by country**

Average annual growth, 2000-2006

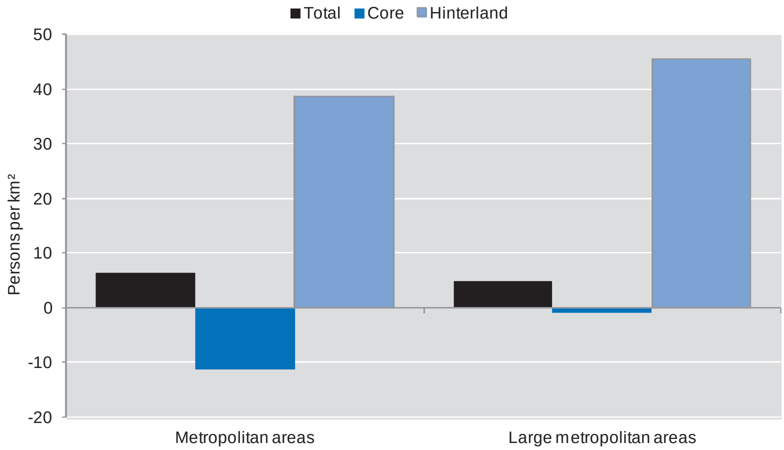


Note: The functional city of Luxembourg is classified as a medium-sized city so it is not included in this figure. The data for Japan refer to 1997. In Canada and Mexico data are only available for one year, so changes cannot be computed.

Source: Author’s calculations based on Corine Land Cover, Japan National Land Service Information data, and National Landcover Dataset.

Figure 1.11. **Difference in urban population density in metropolitan areas**

Difference between 2006 and 2000



Note: The calculations are made on a sample of ten countries for which population and land changes refer to the same period.

Source: Author's calculations based on OECD Regional database, Corine Land Cover, Japan National Land Service Information data, and National Landcover Dataset.

We define a **densification index** as the ratio between the increase of population and the increase of urbanised land. This ratio gives an indication of tendencies towards a more "compact" residential development – i.e. when population increases at a faster rate than urbanised land. Increases in "compactness" are observed in Brussels (Belgium) and Oslo (Norway), in particular in the city cores. Similarly, large metropolitan areas in France and Italy and also metropolitan areas in the United States have increased their population faster than the built-up area. On the contrary, Denmark, Japan, Portugal and Spain experienced a reduction of density. In Japan this is essentially due to an increase of land dedicated to urban use in the city hinterlands despite a very low growth of population. In Spain, even if population has increased in the core of cities, the densification of land has been faster (Table 1.3).

Caution has to be taken in the interpretation of the densification index, in particular when considering the average growth of population and urbanised land for different functional urban areas in a country, as we do in Table 1.3. The densification index is not normalised (so it can take any value) and it takes negative values if either the population or the built-up area has decreased in the period. In addition, we keep the boundaries of the functional city fixed over the two periods of time, therefore these measures do not catch the rate of expansion of urban areas in the surroundings.

Table 1.3. **Densification index of metropolitan areas, by country**

2000-2006

Country	Metropolitan areas			Large metropolitan areas		
	Total	Core	Hinterland	Total	Core	Hinterland
Belgium	2.13	2.35	1.85	16.92	-106.39	11.08
Denmark	.	.	.	0.41	0.17	0.67
Estonia	-0.10	-0.41	-0.02	.	.	.
France	2.37	2.28	2.96	2.69	4.84	2.00
Italy	0.70	-0.11	1.64	1.55	1.26	2.44
Japan	0.16	0.22	0.03	0.74	0.92	0.05
Norway	5.07	12.64	5.56	.	.	.
Portugal	0.37	0.21	0.92	0.28	0.00	0.77
Spain	0.66	0.54	0.92	0.89	0.57	2.21
United States	1.41	1.37	2.47	1.05	0.97	1.71

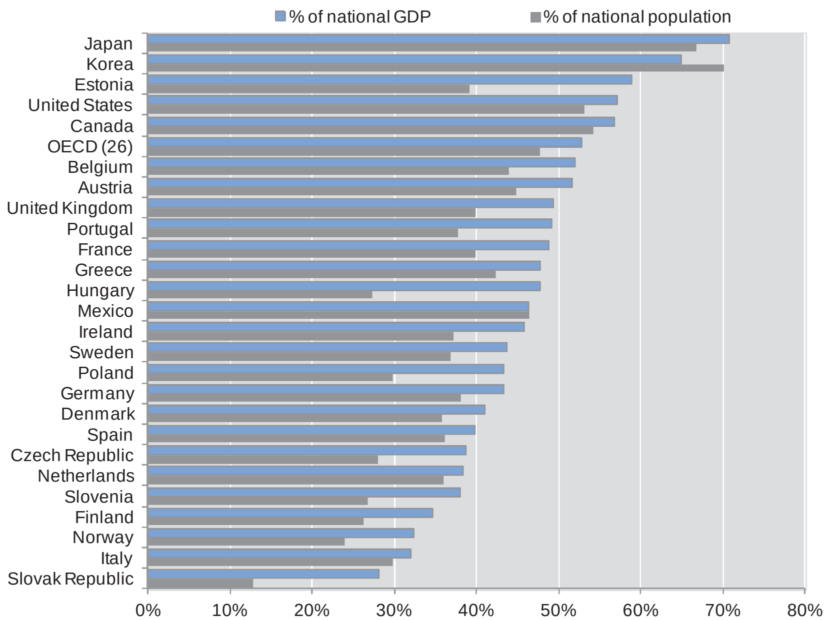
Note: The densification index is defined as the ratio between the population growth rate and urbanised land growth rate. It is computed on a sample of ten countries for which population and land changes refer to the same period.

Source: Author’s calculations based on OECD Regional database, Corine Land Cover, Japan National Land Service Information data, and National Landcover Dataset.

GDP concentration in metropolitan areas

Metropolitan areas concentrate high shares of population and economic activity. Economies of scale brought by economic agglomeration can be powerful drivers of national growth. On the basis of the new definition of functional urban areas, 53% of the OECD national GDP is produced by the 261 metropolitan areas with population above 500 000. More than half of GDP and population are concentrated in metropolitan and large metropolitan areas in Canada, Japan, Korea and the United States (Figure 1.12). High economies of agglomerations are observed in metropolitan areas of northern and Eastern Europe, Portugal and the United Kingdom where the share of GDP is higher than the share of national population (Figure 1.12). On the other hand, these results seem to suggest that in Korea and Mexico large metropolitan areas concentrate a higher share of national population than of economic output.

Figure 1.12. **Concentration of population and economic activity in OECD metropolitan areas**



Note: GDP values year 2008, current prices and PPPs. Population data for Austria, the Czech Republic, Germany, Finland, Greece, Hungary, Ireland, the Netherlands, Poland, Slovenia, the Slovak Republic, Sweden and United Kingdom refer to 2000; Japan, Mexico and Norway refer to 2005; the United States refer to 2007; Korea and Portugal refer to 2010 and 2011 respectively. The figure includes the 261 metropolitan and large metropolitan areas with a population of more than 500 000 inhabitants.

Source: OECD calculations based on methodology described in Box 1.5.

The results of Figure 1.12 are estimates of gross domestic product (GDP) at functional urban level, hence they are subject to errors and they should be carefully interpreted. Since most of the socio-economic indicators of interest to monitor the characteristics and the performances of the functional urban areas are usually available at administrative levels, some estimates are necessary. Future steps will involve applying the adjusting technique to different years (so as to increase evidence on the competitiveness of urban areas of different sizes), to all the typologies of urban areas (so as to assess the economic prospect of medium-sized cities), and to other economic and social variables (so as to have a more comprehensive picture of the quality of life in urban areas).

Box 1.5. Methodology to adjust GDP at metropolitan level

Socio-economic statistics at sub-national level comparable across countries are generally available for administrative regions (TL2 and TL3 regions of the *OECD Regional database*). While a set of indicators may in the future become available for the OECD functional urban areas defined in this chapter, at present we suggest to derive estimates of the main economic indicators by adjusting existing regional data to the non-administrative boundaries.

Two broad typologies of methods have been used in the literature to adjust indicators at small-scale geography. The first one makes use of Geographic Information System (GIS) tools to disaggregate socio-economic data. GIS techniques are increasingly adopted in the literature, especially in the field of environmental indicators and other issues that are particularly attached to the geography of the territory, rather than their functional or political organisation (Nordhaus et al., 2006; Milego and Ramos, 2006; Doll et al., 2000). The second typology, instead, scales down the values of interest by using correlated statistics available at different levels of geography from surveys or other statistical sources. Such a methodology, for example, is used by the UK Office for National Statistics to provide income estimates at ward level, downscaling the regional values through Census data such as household size, employment status, proportion of the ward population claiming social benefits, proportion of tax payers in each of the tax bands, etc. (Goldring et al., 2005). A similar method is used by the US Bureau of Economic Analysis to estimate the GDP for US Metropolitan Statistical Areas (Panek et al., 2007).

The methodology applied in this Chapter uses a GIS-based methodology for the estimation of GDP at the functional urban level in OECD countries, since the amount of data required is relatively small and already available; in addition, this methodology is less dependent on the types of information available from surveys in different countries and therefore more easily applied consistently in different countries. The methodology is similar to that applied by Milego and Ramos (2006) to downscale socio-economic data from European administrative regions to a 1 km² regular grid level within the context of an Espon research (European Observation Network for Territorial Development).

The proposed methodology is composed by four main steps, each of which is to be carried out using GIS software.

1. Taking the GDP at TL3 level and intersecting with the population grid (LandScan 2000).
2. Attributing each 1 km² cell a GDP value by weighing for population in each cell.
3. Intersecting the layer of GDP in each cell with the boundaries of metro areas. Cells that are not entirely included in one metropolitan area can be aggregated proportionally to the share of their area that falls within each metropolitan area (proportional calculation criteria) or, alternatively, by using a maximum area criterion.
4. Sum of cells' GDP values belonging to each metro area.

Environmental impact of metropolitan areas

The development of statistics on the state and changes of local environmental assets is a challenging task. While countries have started to invest more resources in the monitoring of key environmental variables, data are rarely collected and analysed at the sub-national level. This is problematic given that national averages hide great geographical differences in contributions to natural resource depletions and exposure to environmental risks.

In this section, we present a novel attempt to build estimates of environmental indicators for metropolitan areas from geographical data sources. In particular, among the set of indicators that can be covered through geographical data, we derive estimates for CO_2 emissions and air quality because of their relevance as measures of current life quality and sustainability.

Both indicators are obtained through data that are available at the national level and downscaled to the geographical level of interest using additional data inputs that capture how the phenomenon is distributed across space. So, for example, the estimates of CO_2 emissions are obtained by the *EDGAR Global Emission database* that provides country emissions levels, and have been downscaled to regularly spaced "grids" (e.g. 1 km by 1 km squares) using additional data inputs that are correlated with the production of emissions, such as population density, roads and factories, energy and manufacturing facilities.[18]

Greenhouse gas carbon dioxide (CO_2) from the combustion of fossil fuels and from biomass is a major contributor to greenhouse gas (GHG) emissions and to the enhanced greenhouse effect. Accounting for over 80% of total GHG emissions, CO_2 is a key factor in countries' ability to deal with climate change. The levels of atmospheric concentrations of CO_2 continue to increase worldwide due to anthropogenic activities, having roughly doubled since the early 1970s (OECD, 2011b). Given the increasing urbanisation and industrialisation in emerging and developing countries, there are projections of further increases in CO_2 concentrations over the next decades unless strong national and international strategies are put in place to decouple CO_2 and other GHG emissions from economic growth. In Table 1.4, estimates of CO_2 emissions in the ten largest metropolitan areas are derived. With respect to available data, our estimates enable a high level of comparability of the results for metropolitan areas in different countries. In fact, the data do not depend on the location of monitoring stations and the boundaries of the metropolitan areas are defined in a consistent way across countries.

Table 1.4. **Estimates of CO_2 emissions in the ten largest OECD metropolitan areas, 2006**

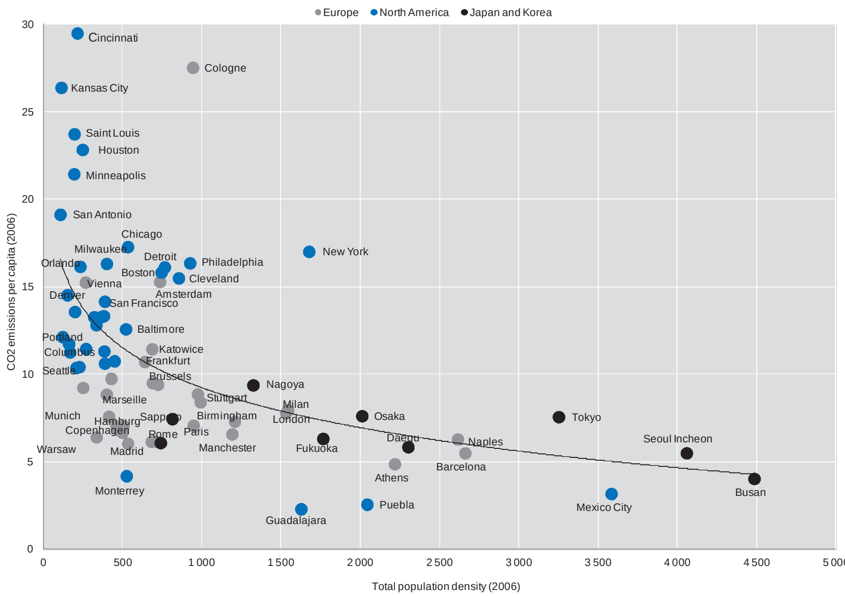
Rank	Country	Metropolitan area	CO_2 emissions per capita (tons)	Share in country's total emission (%)	Share in country's total population (%)
1	Japan	Tokyo	7.81	22.47	25.75
2	Korea	Seoul-Incheon	5.87	26.11	42.69
3	Mexico	Mexico City	3.42	12.59	17.47
4	Japan	Osaka	7.66	11.50	13.44
5	United States	New York	17.44	4.77	5.72
6	United States	Los Angeles	14.50	3.85	5.56
7	France	Paris	7.45	18.19	18.38
8	United Kingdom	London	7.78	15.62	18.02
9	United States	Chicago	17.92	2.73	3.18
10	United States	San Francisco	14.39	1.59	2.31

Source: Piacentini, M. and K. Rosina (2012), "Measuring the environmental performance of metropolitan areas with geographic information sources", *OECD Regional Development Working Paper*, OECD Publishing, Paris.

Several studies suggest that the urban structure can provide some partial explanations to the different levels of CO_2 emissions. Since Newman's and Kenworthy's work in 1989, the role of urban density has been discussed as a means to reduce CO_2 emissions. There is increasing understanding that urban and regional policies (e.g. compact city policies) can complement global climate policies (e.g. a carbon tax) by reducing global energy demand and CO_2 emissions. Figure 1.12 shows an inverse relation between population density and per capita CO_2 emissions. American and Canadian cities are in the top left side of the figure. These cities are characterised by large per capita CO_2 emissions but low levels of population density. For the same levels of population density, European cities produce lower levels of CO_2 emissions. Korean, Japanese and Mexican large metropolitan areas are located at the bottom, showing thus lower CO_2 emissions per capita and high population density levels. However, this relation should be further investigated by controlling for other variables such as level of GDP, source energies such as coal, oil or gas and energy prices.

Similarly to CO_2 emissions per capita, the population's exposure to air pollution is a key indicator of quality of life in metropolitan areas. The increasing use of private vehicles for commuting in urban areas of emerging economies is greatly increasing the number of people that are exposed to toxic pollutants. Urban air pollution is estimated to cause about 2 million premature deaths (a loss of 6.4 million years of life) each year (OECD, 2010).

Figure 1.13. **Population density and CO_2 emissions per capita in large metropolitan areas**



Source: Author's calculations based on Piacentini, M. and K. Rosina (2012), "Measuring the environmental performance of metropolitan areas with geographic information sources", *OECD Regional Development Working Paper*, OECD Publishing, Paris.

Health-damaging air pollution is often measured by the concentration of particulate matters (PM) in the air.[19] By overlaying these data on fine particulate matter with data on population distribution, it is possible to conclude that a large fraction of the world population breathes air whose pollution exceeds the World Health Organisation's recommended level of 10 micrograms of $PM_{2.5}$ per cubic meter. The average concentration of $PM_{2.5}$ in the ten largest metropolitan areas is shown in Table 1.5. The highest level of $PM_{2.5}$ concentration is observed in Seoul (Korea) while the inhabitants of San Francisco (United States) are exposed to the lowest level in this sample of cities (Table 1.5). It has to be noted that, as for ground-based measurement, it is not possible to distinguish the fraction of particulate matters originating from human activities and the fraction that is due natural sources.

Table 1.5. **Estimated air pollution in the ten largest metropolitan areas**

Average levels of $PM_{2.5}$, 2001-2006

Rank	Country	Metropolitan area	Population weighted average levels of $PM_{2.5}$ concentration (µg/m³)
1	Japan	Tokyo	22.35
2	Korea	Seoul-Incheon	27.10
3	Mexico	Mexico City	25.75
4	Japan	Osaka	21.16
5	United States	New York	19.61
6	United States	Los Angeles	13.35
7	France	Paris	18.28
8	United Kingdom	London	19.67
9	United States	Chicago	16.37
10	United States	San Francisco	8.07

Source: Piacentini, M. and K. Rosina (2012), "Measuring the environmental performance of metropolitan areas with geographic information sources", *OECD Regional Development Working Paper*, OECD Publishing, Paris.

The estimates of CO_2 emissions and air quality have the clear advantage that they can be compared across countries – data from satellite observations are available worldwide – and across metropolitan areas, since the boundaries are defined through a common methodology. However, the main limitations of these environmental indicators are due to the difficulty to obtain comparable measures over time so as to monitor improvements induced by targeted policies and behavioural changes. In addition, since data are downscaled from national data, the resulting values may differ from the ones obtained by surface-based air pollution sensors, for those cities where ground sensors have been installed.

Conclusions

The lack of an agreed definition of urban areas across countries has halted our capacity to compare the economic, environmental and social performances of cities. This chapter presents the results of a joint effort of the OECD and the European Commission to:

- develop a harmonised definition of urban areas that reflects the functional connections among places;
- apply this definition to more than 1 000 urban areas in 28 OECD countries;

- identify a preliminary set of socio-economic and environmental indicators to be produced with different methods according to the functional boundaries of urban areas;
- provide such a definition, so as to move towards robust comparative assessments of urbanisation trends and city performance.

The derivation of a methodology able to describe the full set of cities characterising an urban system (including medium-sized urban areas) has clear advantages. First, it allows the identification of the "urban hierarchy" within countries and the linkages between cores and hinterlands, showing that the pattern of urban development differs from place to place. Second, it can be used to better analyse the links between urbanisation and economic growth, by taking into account that development does not necessarily imply further increases in the size of the large metropolitan areas but can happen through a strengthening of medium-sized urban areas. Third, it opens up to further analysis on the potential of inclusive growth in medium-sized urban areas, by comparison with large metropolitan areas on a wide range of indicators. Finally, it would potentially produce new relevant evidence in the policy areas of urban competitiveness, social equity across space and within cities, and the environmental sustainability of urbanisation.

Notes

1. In the next two decades, China will create nearly 30 new cities of 1 million inhabitants; India is expected to add 26 cities of this size during the same period (Seto, 2009).

2. The definition of functional urban area was agreed on with member countries participating in the OECD Working Party on Territorial Indicators and applied in collaboration with the European Commission.

3. Different definitions of "compact" cities are in use and often the concept is subject of debate. OECD (forthcoming) addresses this issue and proposes that the key characteristics of a compact city are: *i)* dense and contiguous development patterns; *ii)* built-up areas linked by public transport systems; and *iii)* accessibility to local services and jobs.

4. The only exception is Portugal, for which commuting data are only available for LAU1 regions.

5. An example is the municipality of Aldea de Trujillo, a small rural town of 439 inhabitants in 2000 which has very high density because its communal territory measures only 0.3 kilometres. See other examples by Gallego (2008)

6. Contiguity for high-density clusters does not include the diagonal (i.e. cells with only the corners touching). Gaps in the high-density cluster are filled using the majority rule iteratively. The majority rule means that if at least five out of the eight cells surrounding a cell belong to the same high-density cluster, the cell will be added. This is repeated until no more cells are added.

7. The integration of different clusters of urbanised areas in a unique functional urban area considers only the information provided by travel-to-work data. In some countries, additional sources of information on functional linkages between different areas could be used to better identify polycentric patterns of development. For example, the Northern Way has used information on relative concentrations of employment by 4-digit sector across neighboring urban centers to proxy sectoral business linkages, and thus the likelihood that different centers form part of the

same economic area (Northern Way, 2009). In general, different choices on how to measure the economic linkages among areas would of course result in different boundaries and size for the functional urban areas.

8. For example, the application of the criterion leads to the pairing of 94 urban cores in 20 countries in Europe.

9. Because of unavailable data in most OECD countries, reverse commuting is not considered in this methodology.

10. Without the adjustment, a hinterland municipality with 14% commuting to three tied urban cores (thus strongly integrated into the urban agglomeration, with 42% [14 times 3] of its resident population moving to work to the urban centres), would be excluded from the metropolitan area.

11. It must be noted that few functional urban areas in Europe spread over national borders.

12. The complete set of maps of the functional urban areas in the 28 OECD countries can be found *www.oecd.org/gov/regional/statisticsindicators*.

13. Such consultation, carried out by the European Commission-Eurostat for European countries and by the OECD for the non-European countries, has introduced some changes described in the document available at *www.oecd.org/gov/regional/statisticsindicators.*

14. Given that cities are identified on the basis of high-density clusters with a minimum size of 50 000 people, there is a lower bound in the population of the functional urban areas. The smallest cities identified (Thousand and Palm Desert in the United States, Granollers in Spain) have a total population of around 45 000 people.

15. Several studies confirm the important role that medium-sized cities play in the national economic development. In fact, medium-sized cities are often seen as a vehicle of diffusion of opportunities of growth and as a more sustainable form of urbanisation, with lower footprints on the natural environment (Mayfield et al., 2005).

16. Belgium, Canada, Denmark, Estonia, France, Italy, Japan, Korea, Luxembourg, Mexico, Norway, Portugal, Spain and the United States. The population in urban systems of these 14 countries represents around 80% of the population in urban systems of the 28 OECD countries included in this report.

17. The results refer to the following countries where data on population and land changes are available for the same period: Belgium, Denmark, Estonia, France, Italy, Japan, Norway, Portugal, Spain and the United States.

18. A thorough discussion of the larger set of environmental indicators produced with different methods from geographical sources can be found in Piacentini and Rosina (2012).

19. Particulate matters (PM) consist of small liquid and solid particles floating in the air and include sulphate, nitrate, elemental carbon, organic carbon matter, and sodium and ammonium ions in varying concentrations. Particular focus in the measurement has been given to particles that are less than 2.5 microns in diameter ($PM_{2.5}$) as they are considered of greatest concern to public health.

Bibliography

Brender, N., M. Cappe and A. Golden (2007), "Mission possible: successful Canadian cities", in The Conference Board of Canada, Ottawa, Ontario, Canada.

Doll, C.N.H., J.P. Muller and C.D. Elvidge (2000), "Night-time imagery as a tool for global mapping of socio-economic parameters and greenhouse gas emissions", *Ambio*, 29(3): 157-162.

European Union (2011a), *Cities of Tomorrow: Challenges, Visions, Ways Forward,* European Union, Brussels.

European Union (2011b) *Territorial Agenda of the European Union 2020. Towards an Inclusive, Smart and Sustainable Europe of Diverse Regions*, European Union, Brussels.

Gallego, J. (2008), "Mapping rural/urban areas from population density grid", *JRC Working Paper*, available from *www.ec-gis.org/docs/F11116/RURAL%20URBAN%20%20POPDENS.PDF.*

Goldring, S., J. Longhurst and M. Cruddas (2005), "Model-based estimates of income for wards in England and Wales, 2001/02", Technical Report, United Kingdom Office for National Statistics, London.

HIS Global Insight (2011), *U.S. Metro Economies*, prepared for the United States Conference of Mayors and the Council for the New American City.

HM Government (2011), *Unlocking Growth in Cities*, Cabinet Office, London.

Mayfield, L., P. Courtney, R. Tranter and P. Jones (2005), "The role of small and medium-sized towns in rural development. Final report", Centre for Agricultural Strategy, University of Reading, Reading, United Kingdom.

Milego, R. and M.J. Ramos (2006), *Espon 2013 Database*, Espon Publishing.

Newman, P. and J. Kenworthy (1989), "Gasoline consumption in cities: a comparison of US cities with a global survey", *Journal of American Planning Association*, Vol. 55.

Nordhaus, W., Q. Azam, D. Corderi, K. Hood, M.N. Victor, M. Mohammed, A. Miltner, J. Weiss (2006), "The *G-Econ Database on Gridded Output*: methods and data", available online at *gecon.yale.edu*, Yale University, 75.

Northern Way (2009), "City relationships: economic linkages in northern city regions", Methodology Paper, November.

OECD (2010), *Cities and Climate Change*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264091375-en*.

OECD (2011a), *OECD Regions at a Glance 2011*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/reg_glance-2011-en*.

OECD (2011b), *Towards Green Growth: Monitoring Progress: OECD Indicators*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264111356-en*.

OECD (2012), *Compact Cities Policies: A comparative assessment*, OECD Publishing, Paris.

Panek, S.D., F.T. Baumgardner and M.J. McCormick (2007), "Introducing new measures of the metropolitan economy. Prototype GDP-by-metropolitan-area estimates for 2001-2005", *Survey of Current Business*, 87(11): 79-87.

Piacentini, M. and K. Rosina (2012), "Measuring the environmental performance of metropolitan areas with geographic information sources", *OECD Regional Development Working Paper*, OECD Publishing, Paris.

Seto, Karen C. (2009), "Global urban issues: a primer", in *Global Mapping of Urban Settlements*, *Experiences*, Datasets and Prospects 2009 Taylor & Francis Group.

Song, Y. and C. Ding (eds) (2007), "Urbanization in China: critical issues", in Lincoln Institute of Land Policy (2007), *An Era of Rapid Growth*, Cambridge, MA.

Statistics Canada (2002), Census Metropolitan Area (CMA) and Census Agglomeration (CA), *www12.statcan.ca/english/census01/Products/Reference/dict/geo009.htm*.

US Office of Management and Budget (2000), "Standards for defining metropolitan and micropolitan statistical areas", *Federal Register*, Vol. 65, No. 249.

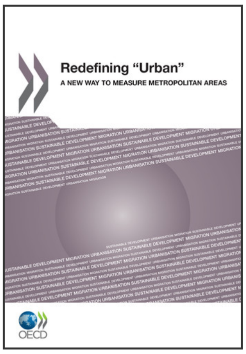
Sources of urbanised land cover changes

Canada, Korea and Mexico: MODIS 500m Map of Global Urban Extent (2001), SAGE at University of Winsconsin-Madison, available at *www.sage.wisc.edu/mapdatamodels.html.*

Europe: Corine Land Cover (2000-2006), Joint Research Centre for the European Environmental Agency.

Japan: Japan National Land Service Information data (2000-2006).

United States: National Land Cover Dataset (NLCD) (2000-2006).



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