European
Commission

A WALK TO THE PARK?

ASSESSING ACCESS TO GREEN AREAS IN EUROPE'S CITIES

UPDATE USING COMPLETED COPERNICUS URBAN ATLAS DATA

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> EXECUTIVE SUMMARY

Green areas in cities can fulfil a variety of functions, from ecological and recreational functions to promoting health or enhancing quality of life. Indicators describing the presence, quantity or availability of green urban areas may be more or less appropriate for analysing particular roles.

This paper describes a methodology for developing indicators on access to green urban areas for the populations of cities in Europe. The method is based on harmonised concepts and data sources. The results are available for nearly all cities in the EU and EFTA countries, and are compared to more traditional indicators on the presence of green urban areas.

Our method uses Copernicus Urban Atlas polygons for various urban centres or cities. We determine an area of easy walking distance – around 10 minutes' walking time – around an inhabited Urban Atlas polygon then calculate the median surface area of green areas than can be reached in this time. Our analysis also takes a closer look at the distribution of access to green areas within cities. Overall results highlight disparities in access between and within cities.

Additional information on green urban areas could help refine further the analysis. The high-resolution results of the green urban areas proximity indicator can also open up opportunities for analysis combined with the distribution of demographic, socio-economic or environmental variables in urban areas.

> Contents

ACKNOWLEDGMENTS

We would like to thank the people who contributed to the successful completion of this analysis, especially Veerle Martens (SIGGIS n.v.) for the initial tests and implementation of the ArcGIS tools, Emile Robe (ESRI BeLux n.v.) for the operational scripting and adaptations to all Urban Atlas 2012 datasets and Filipe Batista (Directorate-General Joint Research Centre) for the methodological developments and highly efficient production concerning the Urban Atlas population estimates. Thanks also to Lewis Dijkstra for his stimulating comments and suggestions.

1 Introduction

Green areas in cities can fulfil a variety of functions. These can range from ecological values to recreational functions, aesthetic value, a role in promoting public health, or more generally enhancing inhabitants' quality of life. Indicators designed to describe the presence, quantity or availability of green urban areas may be more or less appropriate for analysing particular roles of green urban areas. The method described in this paper will focus on the relationship between the spatial distributions of population and of green areas. Hence, the resulting indicators are expected to be particularly relevant when discussing urban quality of life issues. In addition, they are closely linked to one of the targets of United Nations Sustainable Development Goal 11[1]: "*By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities*".

1. Goal 11: = "Make cities and human settlements inclusive, safe, resilient and sustainable"; see: http://www.un.org/sustainabledevelopment/cities/ for the full list of targets related to this goal.

2 OBJECTIVE

This analysis aims to measure how residents of a city can easily reach the green areas in their neighbourhood. We will measure the surface area of green urban areas that are within walking distance for people. We will also assess how many people find no green areas in their neighbourhood, and compare the results to more traditional indicators on green urban areas.

3 HOW TO MEASURE THE PROXIMITY OF GREEN AREAS?

3.1 HOW TO OBTAIN COMPARABLE RESULTS?

In order to obtain results that allow benchmarking and comparisons of cities, we should use harmonised concepts and data sources. The method we use can be used to produce summary indicators at the level of an administrative city, by sub-city neighbourhood or for any other spatial concept in an urban setting. Administrative definitions of cities tend to vary substantially from one country to another. Therefore the concept of an "urban centre", which is exclusively based on criteria of population size and population density, will allow for more reliable comparisons. Nevertheless, a city definition based on administrative boundaries also has its merits, because it allows an easier combination of data and indicators collected at the level of municipalities and/or other administrative units. For that reason, we will also consider summary indicators by city and greater city, as these concepts offer the closest administrative approximation of the grid-based "urban centres [2].

We also need a harmonised definition of green urban areas that refers to data that can be found for all major European cities. The Copernicus Urban Atlas data provide such a definition: green urban areas are "public green areas for predominantly recreational use such as gardens, zoos, parks, castle parks; suburban natural areas that have become and are managed as urban parks" . But especially at the fringe of cities, the distinction between "green urban areas" and forests is not easily made. For this reason, we also included the Urban Atlas class "forests" in the analysis. With a minimum mapping unit of 0.25 ha, the Urban Atlas green urban areas are also designed to capture relatively small patches of urban green.

3.2 ASSESSING PROXIMITY OF GREEN URBAN AREAS

To measure the availability of green urban areas, we determine an area of easy walking distance around each inhabited Urban Atlas polygon. These polygons are irregularly shaped areas which typically correspond to an urban building block surrounded by streets. This makes them particularly appropriate for a local proximity analysis. For each of these polygons, we have an estimate of the total residential population[4]. Around each polygon, we calculate the area that can be reached within 10 minutes of walking time along the street network.

The accessibility areas can then be intersected with the green urban areas. For all detected green areas, we take the entire surface area into account. Hence, for each inhabited polygon, we now know the total surface area of those green areas that can be reached within 10 minutes' walking time.

3.3 SUMMARISING THE RESULTS BY CITY OR URBAN CENTRE

From the data by inhabited polygon, we can now derive the population-weighted median surface of green urban areas by urban centre or by city/greater city that can be reached within 10 minutes' walking time. We prefer the use of the median value rather than the arithmetic average because the latter tends to be influenced by outliers in the distribution of green areas. This is especially the case when a small minority of people in the city has easy access to very large green areas in their neighbourhood.

We will also take a closer look at the distribution of the urban population compared to the level of access to green areas.

In addition, we can easily calculate the total urban population share that has no green areas in their neighbourhood.

4 HOW DO CITIES COMPARE IN TERMS OF THE PROXIMITY OF GREEN AREAS?

The population-weighted median surface area of green areas that can be reached within 10 minutes' walking is shown on Map 1. Based on the available data, covering almost all cities in the EU and in the EFTA countries[5], we see substantial diversity in green urban areas' proximity, both in bigger and smaller cities. There is almost no relationship between green areas' proximity and city size. Amongst the capital cities with more than 1 million inhabitants, values vary between less than 12 hectares in cities such as Lisbon, Bucharest, Athens, Dublin, Paris, Budapest and Rome, and more than 50 hectares in Prague and Stockholm.

Some differences between countries can be observed. Taking into account the population of the cities, we see high national averages in countries like Finland, Sweden, the Czech Republic

2. For a description of these concepts, see: Dijkstra and Poelman (2012).

3. For more details, see the Urban Atlas mapping guide: European Commission, Directorate-General for Regional Policy (2016), p. 21. While the public character of the green areas is part of the Urban Atlas definition, and has been assessed by human interpretation of green areas on the basis of satellite imagery, assisted by (local) ancillary data, in practice it can be quite hard to determine if a certain urban green area is actually publicly accessible.

4. For the estimation method, see Batista e Silva and Poelman (2016). The method uses recent high-resolution population data combined with building locations from the European Settlement Map (ESM) and with the Urban Atlas land use classification. For more information about the ESM, see: http://land.copernicus.eu/pan-european/GHSL.

5. Due to satellite imagery availability issues, Urban Atlas 2012 currently does not cover cities in the French and Portuguese outermost regions. A Copernicus Urban Atlas follow-up project will examine the possibilities to complete this coverage. In addition, the project will create opportunities for a further extension of the analysis to cities in the Western Balkans and Turkey.

and Germany, while Romania, Croatia, Italy and Portugal have rather low averages. Higher scores can also be seen in many of the smaller cities of the Netherlands, or in a series of smaller cities around Paris. The presence of green urban areas has often been measured by calculating the the green areas' surface area share in the total land area of the city, shown on Map 2. It is interesting to examine the relationship between this rather traditional indicator and the new proximity indicator. We find that there is only a weak relationship between surface area share and proximity (r^2 = 0.09), indicating that the proximity indicator adds information when compared to the simple share of green surface area. Graph 1 illustrates this relationship. While a minimum level of surface area share for green areas is definitely a precondition to ensuring decent proximity, a substantial surface area share is by no means a guarantee of adequate distribution within a city's territory. Indeed, green urban areas also clearly need to be spatially distributed in a way suitable to fulfilling relevant functions for the urban population.

In addition, the surface area share indicator is limited to the administrative boundaries of the city, while the proximity indicator also takes into account the presence of green areas located nearby the city, even if they fall just outside its boundaries[6].

Cities presenting the same median value of nearby green areas can still show very different spatial patterns of green areas in comparison to population concentrations: the presence of green urban areas can be more equitable in some cities than in others. An indicator of dispersion such as the interquartile ratio[7] can help show these differences. Graph 2 shows the relationship between the proximity indicator and the indicator of dispersion. In cities with a low interquartile ratio, more people have a relatively similar level of access to nearby green areas than in cities with high values for this indicator.

The differences in the share of population having no green areas in their neighbourhood also shed some light on the spatial distribution of these areas. In almost a quarter of the cities under review, less than 2 % of population has no green areas within walking distance. Some of the outstanding bigger cities in this group are Madrid, Vienna, Torino, Stockholm, Prague and Glasgow. On the other hand, in about 10% of cities, this percentage is higher than 20 % (e.g. in several cities in Romania and Italy.

Graph 3 summarises the distribution of proximity, the lack of nearby green areas and the green areas' surface area share in the city. Here again, the differences in distribution within the three indicators highlight the fact that each of these indicators illustrates complementary aspects of the presence of green areas in cities. The correlations between the three indicators are very weak. Some cities can have a relatively modest share of surface area for green areas but still guarantee good proximity of those areas. For example, while the share of green areas in the total land area of Thessaloniki is only 6.5 %, more than 98 % of the population finds some green areas within walking distance, while the median surface area of nearby green areas is 12.5 ha. In a city like Malmö, 8.1 % of the land area is covered by urban green. There as well, more than 98% of the population finds green areas within walking distance. The median surface area of these nearby green areas is a very decent 30.5 ha. Cities with a very similar share of green surface area can have very different levels of proximity of green areas. This is the case of Düsseldorf and Prague, where the share of green areas is 20.0 % and 19.1 % of total land area, resulting in a green area proximity of 19.1 ha in Düsseldorf but up to a very high 53.9 ha in Prague. In Stockholm, more than half of the land area is green (56.2 %), almost everybody finds some green areas within walking distance (99.6 %) and the median surface area of these areas is high (62.6 ha). Brasov (in Romania) also shows a very high share of green area (40.8 %) but this does not really result in a good accessibility. More than 40 % of population has no green areas within walking distance.

The distribution of urban population according to the level of proximity of green urban areas allows a more detailed comparison between cities. Graphs 4-9 show the results for all capital cities, classified according their population size. The graphs can be read as follows: Y % of urban population finds at least X hectares of green areas within walking distance. The gentler the slope is, the more equitable the distribution of green areas. Within each population size category of capital cities, the graphs show a substantial diversity in access levels and spatial distribution of green areas relative to population.

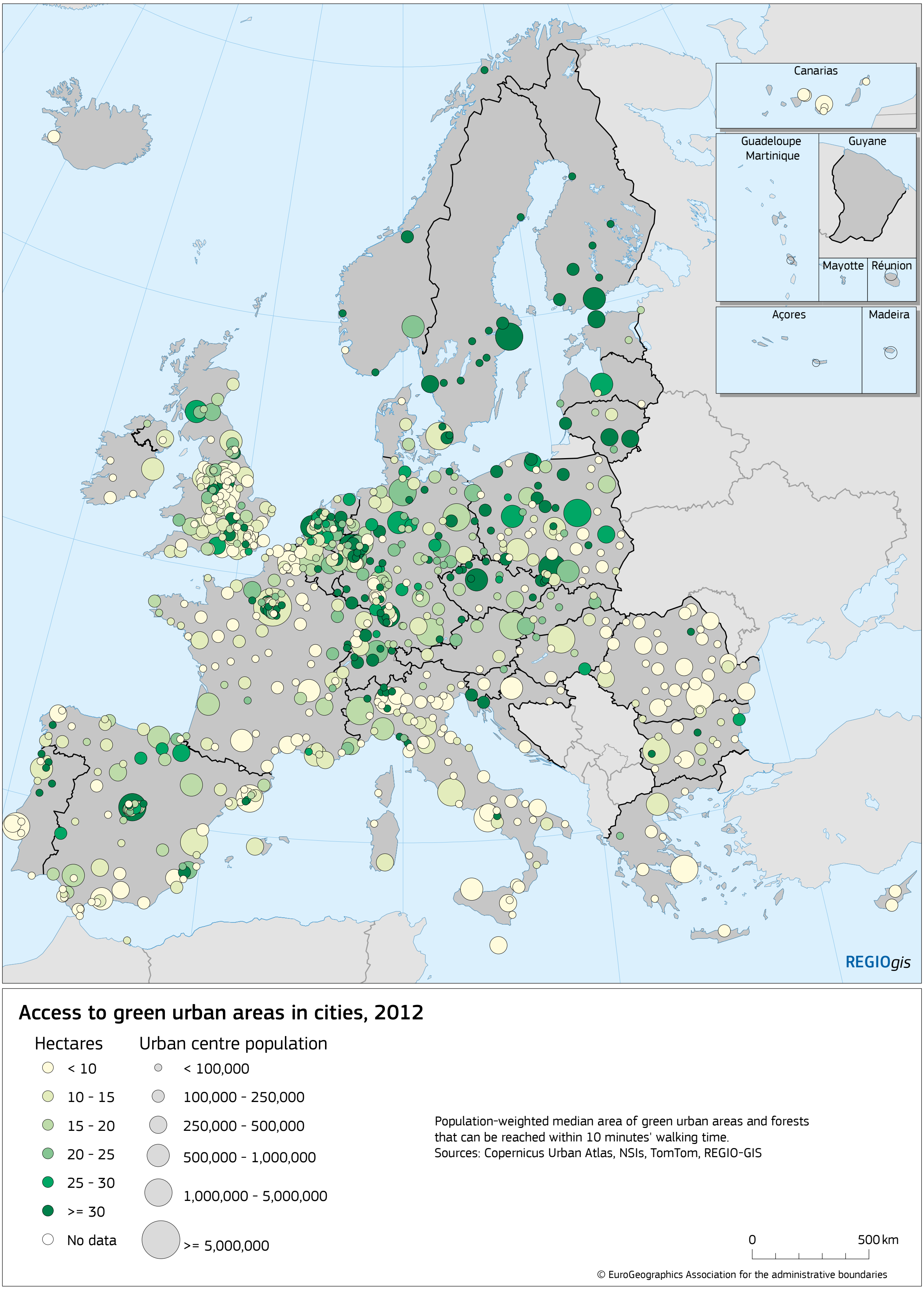
This diversity, both in bigger and in smaller cities, already hints that (city) size does not matter when considering the distribution of green areas. As a matter of fact, we observed no meaningful relationship between proximity of green areas on the one hand and the city's population size or population density on the other. In all very large capital cities (with an urban centre of more than 3 million inhabitants), shown on Graph 4, more than 90% of the population finds at least some green areas in their neighbourhood, while the median area of the nearby green areas is much higher in Berlin and Madrid than in London, Paris and Athens. Amongst these capitals, Madrid stands out with the more equitable distribution of nearby green areas.

The diversity is even larger amongst less populated capital cities (see Graphs 5-9). Quite equitable distributions of nearby green urban areas are found in cities like Warsaw, Stockholm, Helsinki, Prague, Vilnius and Luxembourg.

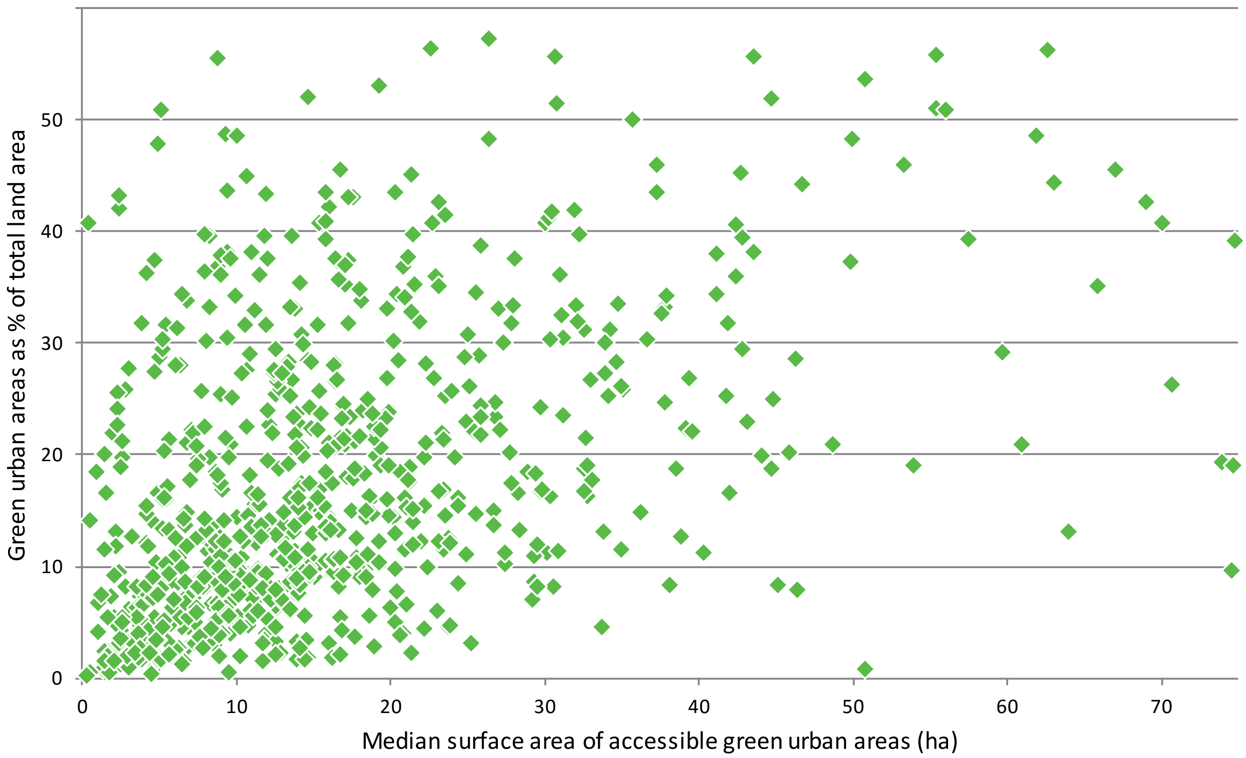
6. This explains some of the very high values of median surface of nearby green areas in cities surrounded by large forests.

7. Defined as the difference between the third and the first quartile, divided by the median.

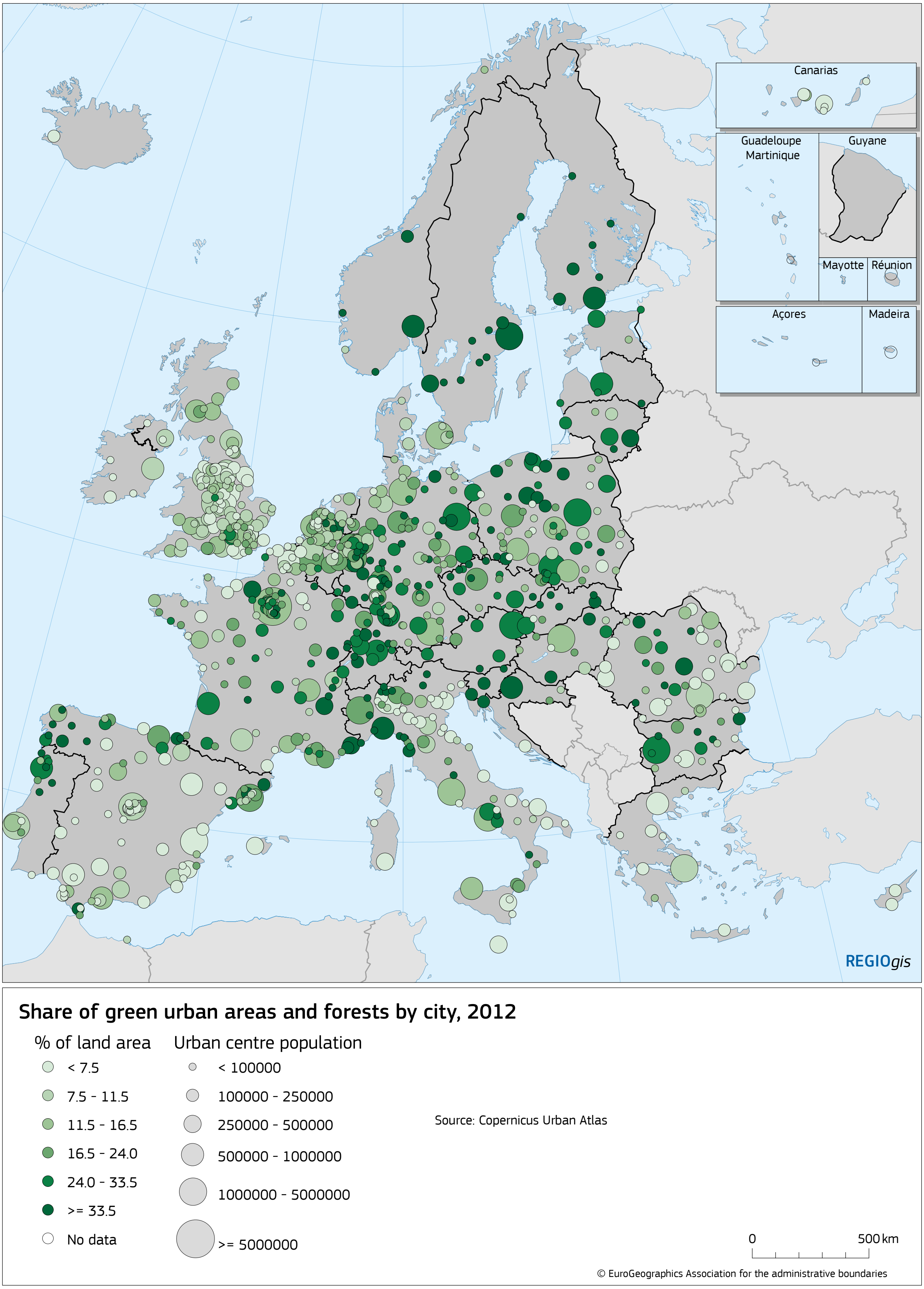
Map 1: Access to green urban areas in cities and greater cities



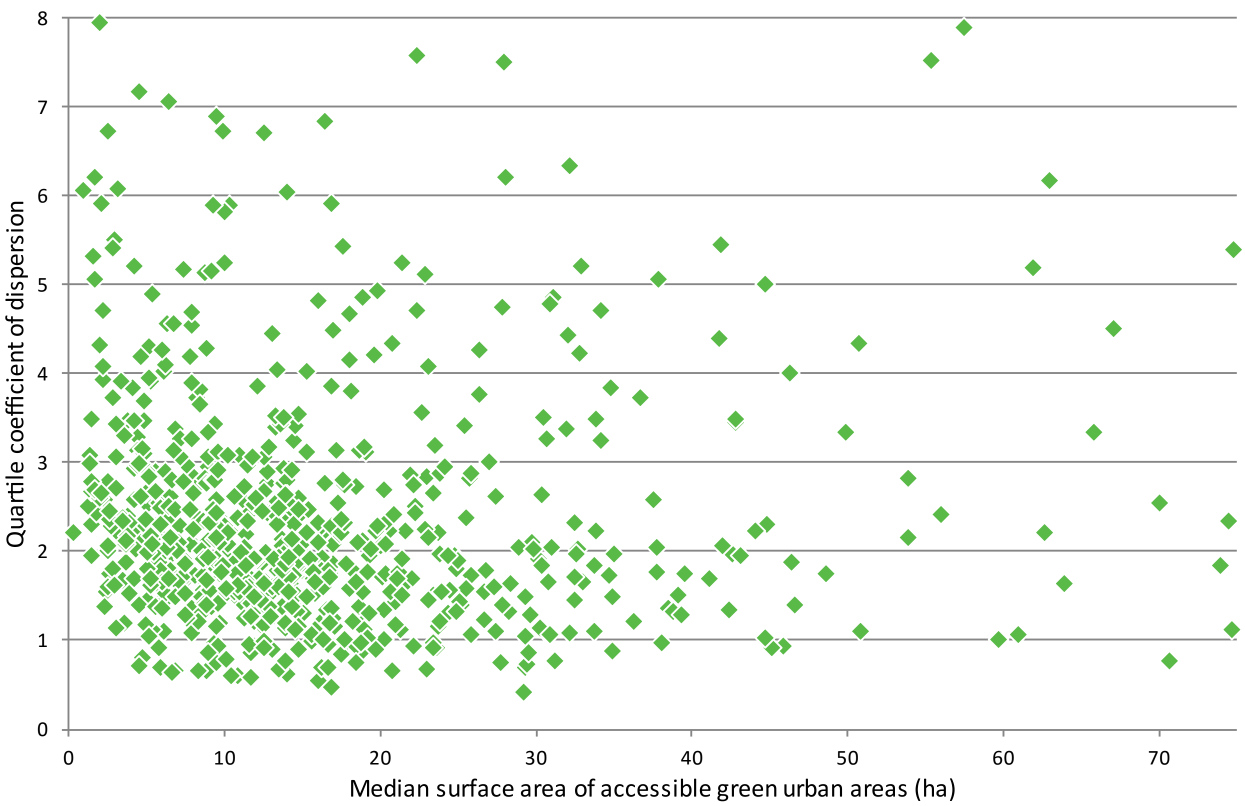
Graph 1: Proximity of green urban areas and share of total land area



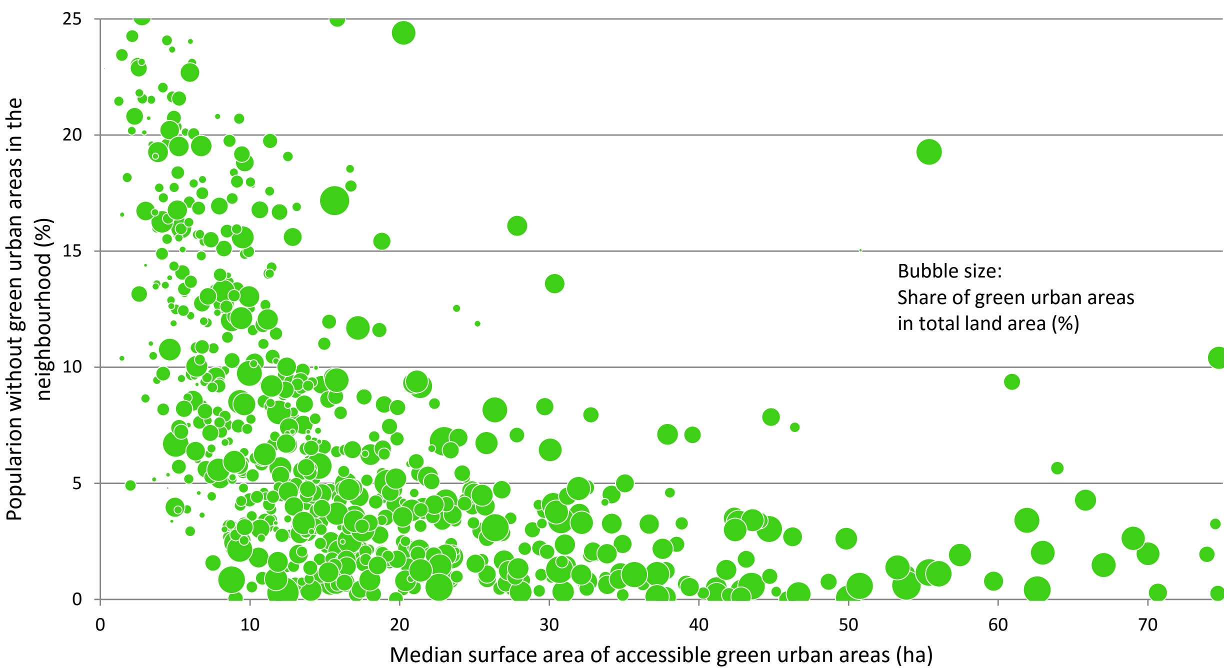
Map 2: Share of green urban areas and forests in total land area, by city/greater city



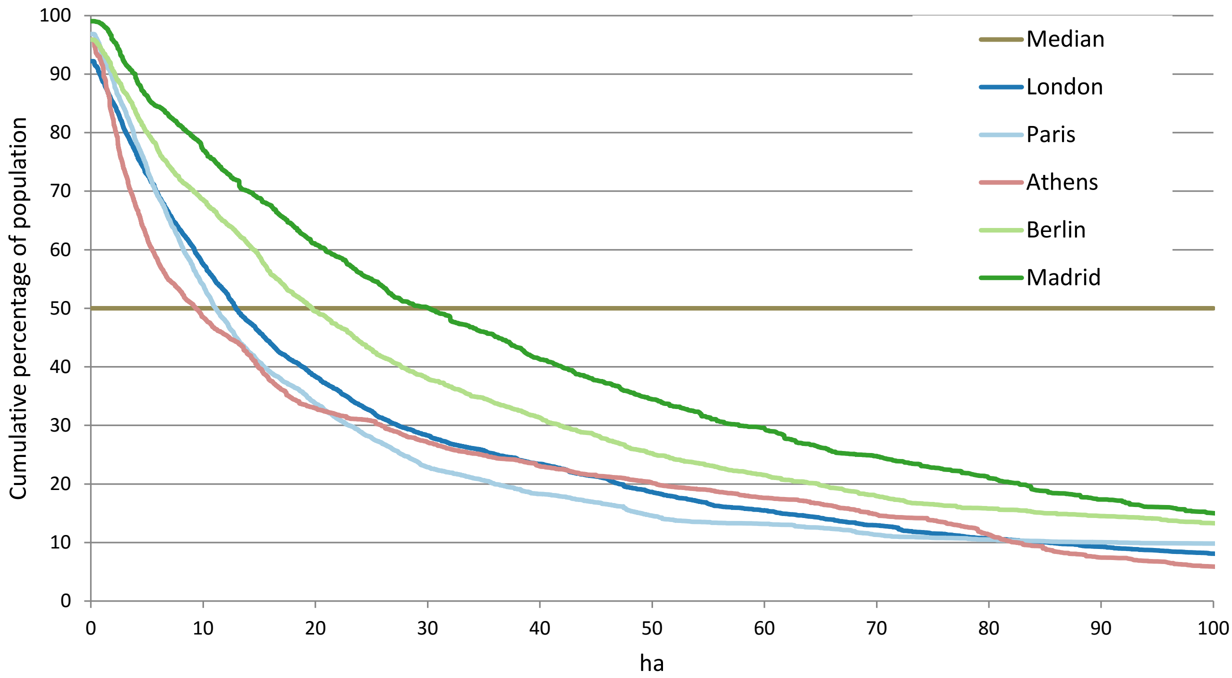
Graph 2: Proximity of green urban areas and its interquartile dispersion



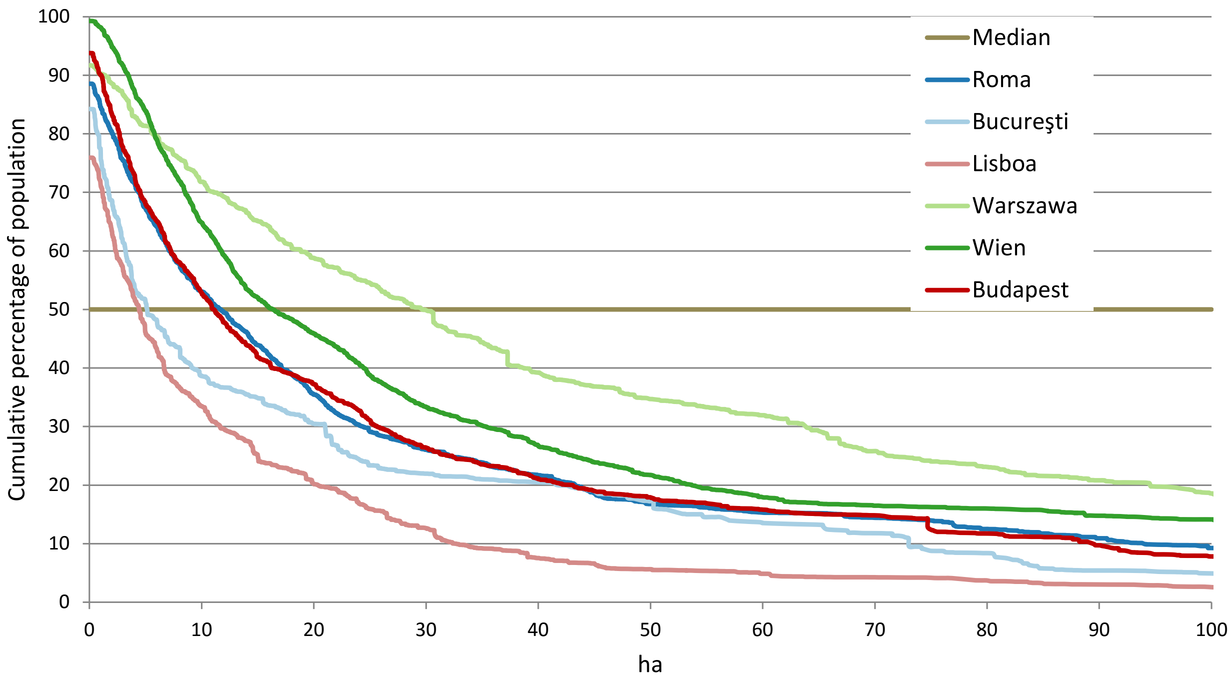
Graph 3: Proximity of green areas, population without green areas nearby and share of green areas in the total land area



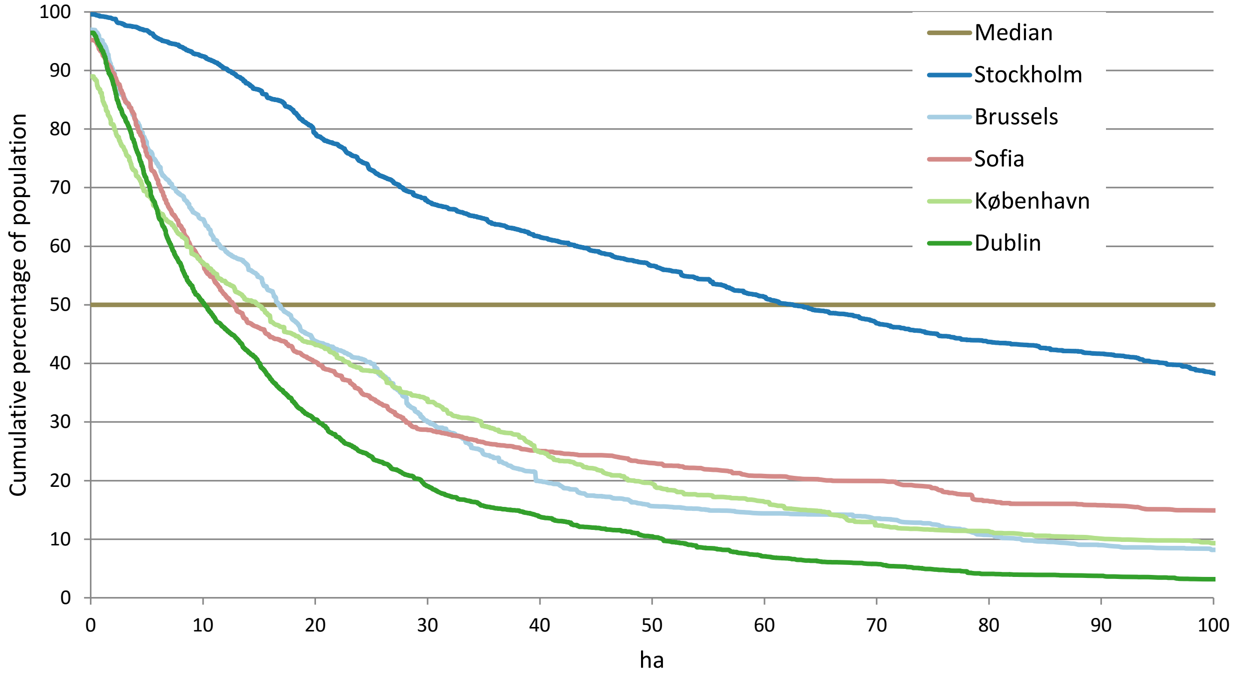
Graph 4: Distribution of population according to the surface area of nearby green areas in very large capital cities (urban centre with more than 3 million inhabitants)



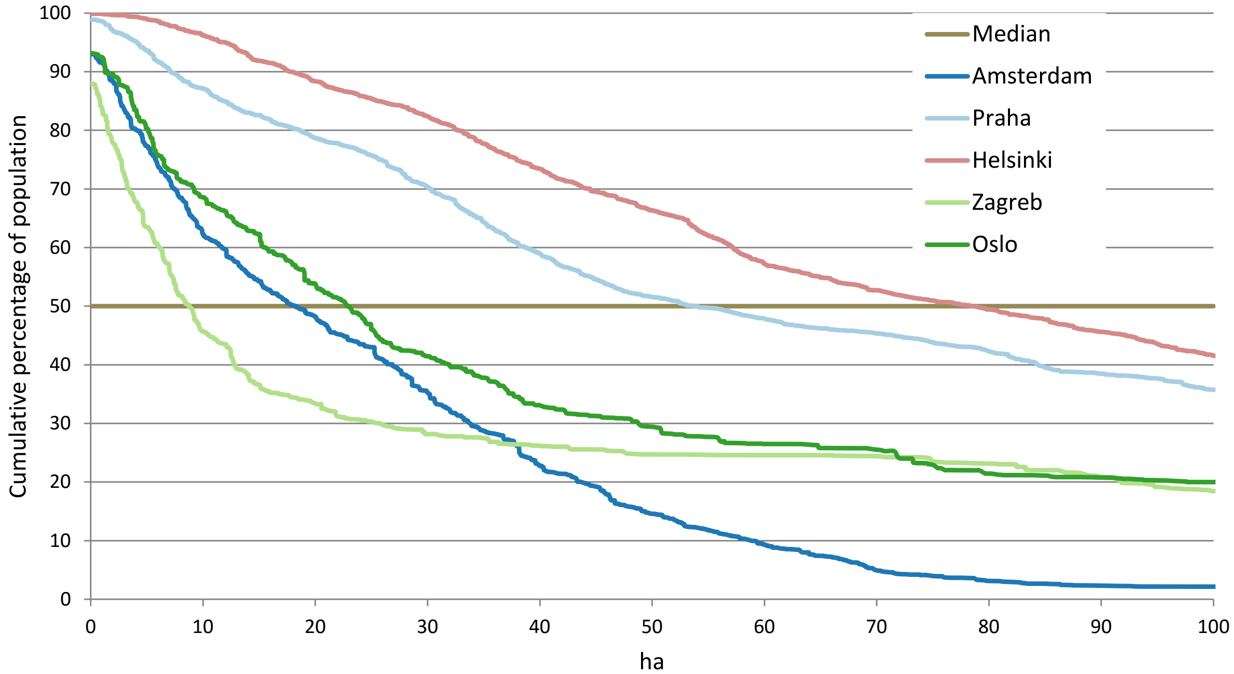
Graph 5: Distribution of population according to the surface area of nearby green areas in large capital cities (urban centre between 1.5 and 3 million inhabitants)



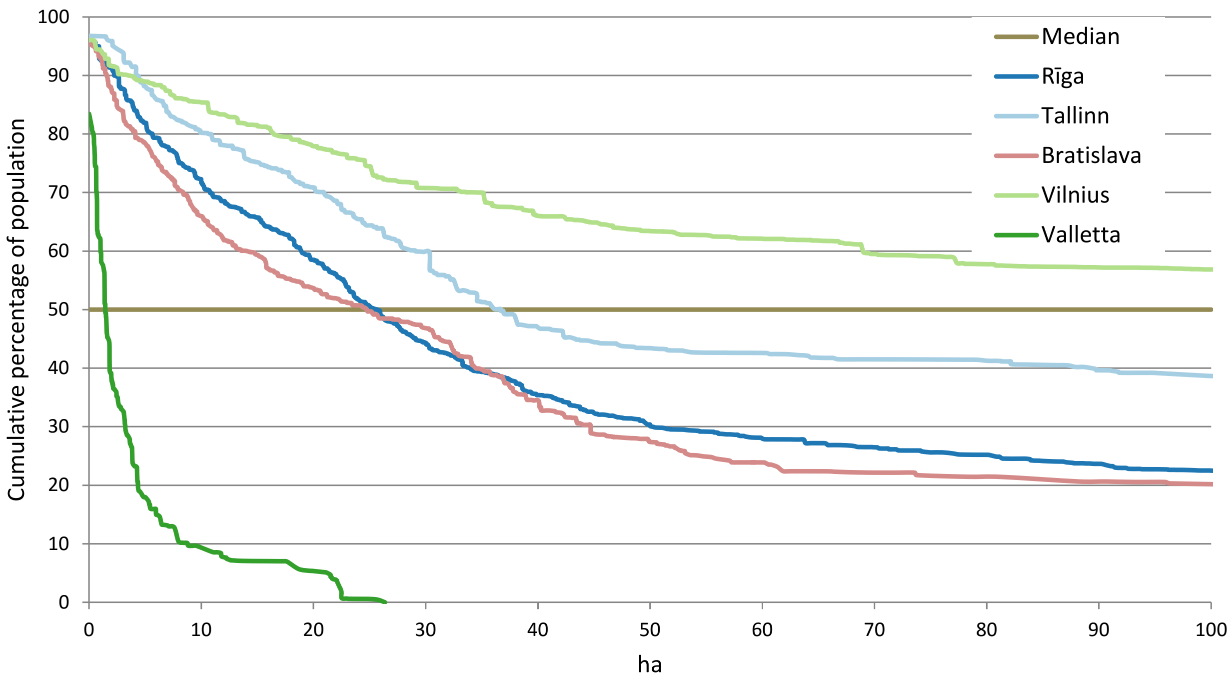
Graph 6: Distribution of population according to the surface area of nearby green areas in capital cities with an urban centre between 1 and 1.5 million inhabitants



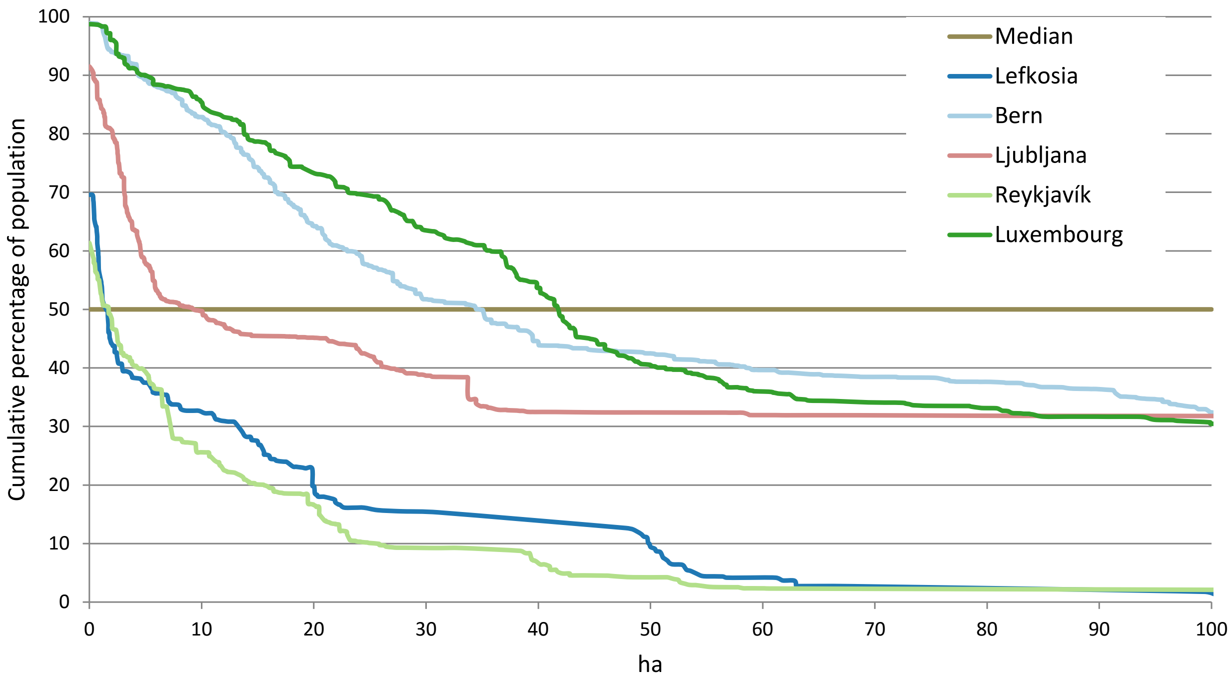
Graph 7: Distribution of population according to the surface area of nearby green areas in capital cities with an urban centre between 600 000 and 1 million inhabitants



Graph 8: Distribution of population according to the surface area of nearby green areas in capital cities with an urban centre between 250 000 and 600 000 inhabitants



Graph 9: Distribution of population according to the surface area of nearby green areas in smaller capital cities (with an urban centre of less than 250 000 inhabitants



5 CONCLUSION

Measuring proximity to green urban areas enhances our information on the presence and availability of green urban areas in their functions for urban population. The indicator is complementary to more traditional indicators and provides a harmonised view enabling easy comparisons amongst cities, based on comparable concepts, datasets and methodologies.

Additional information on typology, effective access and functions of green urban areas could help refine further the analysis, provided that such information is comparable and consistent. Otherwise, case studies on particular cities could explore the relationship between the harmonised concepts of green urban areas and the specific local definitions, possibly also taking into account the presence of very small public green areas that are not captured by Urban Atlas.

The high-resolution results of the green urban areas proximity indicator can also open up opportunities for analysis combined with the distribution of demographic, socio-economic or environmental variables[8] iin urban areas. Its comprehensive spatial coverage of EU and EFTA cities is an additional asset for analyses and assessments, and provides a showcase how detailed geospatial data can be used to enhance the monitoring of specific urban sustainable development goals.

6 METHODOLOGICAL ANNEX

6.1 INPUT DATA

The following datasets are used in this analysis:

1. Copernicus Urban Atlas land use datasets. We used the latest version, i.e. referring to the year 2012[9].
2. Population distribution inside urban areas. We use the population estimates related to the Urban Atlas polygons. These estimates are the result of a downscaling methodology using spatially detailed input data on residential population (i.e. at the level of census tracts, high-resolution grids if available, or 1 km² grid cells)[10].
3. Road network data. This analysis requires a comprehensive road network that contains relevant attributes to enable selection of streets accessible to pedestrians. We used the TomTom Multinet data.

6.2 WORKFLOW

6.2.1 CREATION OF AN URBAN PEDESTRIAN ROAD NETWORK

The goal is to create an urban transport network, containing the streets which are accessible to pedestrians. This city network is created by generating a selection of features from the TomTom Multinet road network data. First, we select all streets that are within an envelope of a selected functional urban area[11], extended by a buffer of 1 500 metres. Second, we select the streets which are accessible for pedestrians, using three queries[12]. Finally, we calculate the time (in minutes) needed to walk along each segment of the network, based on the length of the segment and a walking speed of 5 km/h, and we create a network dataset.

6.2.2 CREATION OF SERVICE AREAS AROUND INHABITED POLYGONS

In this step, we create service areas of 10 minutes' walking time. These areas will be used to assess the proximity of green urban areas.

First, we select all Urban Atlas polygons that have a population greater than 0. For this selection, we create centroid points. These will be used as the starting points to create the service areas. A service area will cover the total area a pedestrian can reach within 10 minutes of walking time. Each of the service areas is connected with a particular Urban Atlas polygon and its population figure.

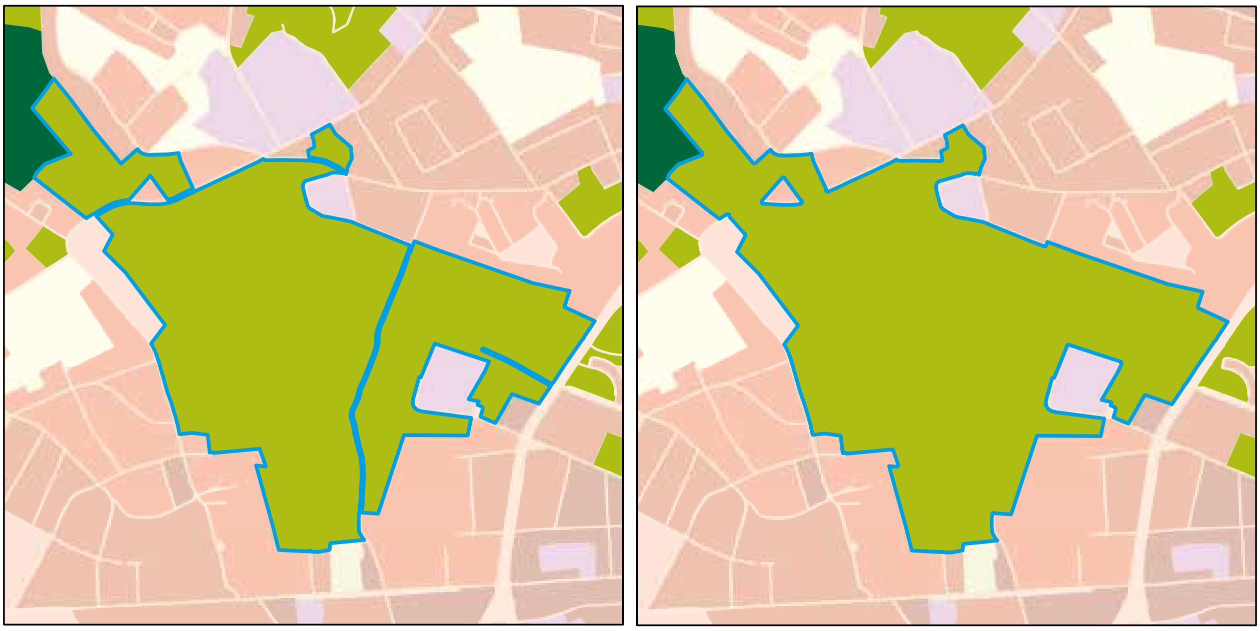
6.2.3 CALCULATION OF THE SURFACE AREA OF THE GREEN URBAN AREAS

In this analysis, we want to take into account the total area of a park. It is not appropriate simply to intersect the green urban areas polygons with the service areas. This is because in the Urban Atlas datasets, bigger parks are often represented by more than one polygon, separated by narrow roads or paths. To ensure that we take into account the total surface area, all roads less than 7 metres wide and crossing the parks will be eliminated, using the following steps.

First, we select all the green urban areas and forests. We buffer the selected areas by 4.5 meters. Then we dissolve the buffered areas using the Urban Atlas land use code, to create single-part polygons. The dissolved areas are finally buffered by -4.5 meters. The effect is that the roads and paths of interest have disappeared, but the external borders of the green urban areas stay the same, as shown on Maps 3 and 4.

8. E.g. population by age category, household income, unemployment rate, local air quality, exposure to noise, etc.
9. http://land.copernicus.eu/local/urban-atlas
10. Methodology described in: Batista e Silva and Poelman (2016); For the 1 km² population grid, see: http://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/population-distribution-demography/geostat
11. All Urban Atlas datasets are organised by functional urban area. For this reason, the workflow is also organised by functional urban area.
12. NEW_SELECTION: ("FOW" <> 1 AND "FRC" not in (0, 1, 2) AND "FEATTYP" <> 4165) AND ("F_ELEV" <>-1 AND "T_ELEV" <>-1); ADD_TO_SELECTION: "FOW" = 3; ADD_TO_SELECTION: "SPEEDCAT" >= 6

Maps 3 and 4: Left: selected green urban areas polygons, intersected by narrow roads. Right: the result of the process to eliminate paths and small roads that separated adjacent park polygons



6.2.4 DETERMINING THE PROXIMITY OF GREEN URBAN AREAS

In this step, we determine the total surface area of all green urban areas to which the population of a polygon has easy walking access. For each service area we select all the dissolved green urban areas that intersect with that service area. We sum the surface area of the selected green urban areas then add this sum to the attributes of the polygon around which the service area was created. Hence, for each building block, we now have the residential population and the total surface area of green areas that can be reached.

Aggregated values of accessible green urban areas surface areas can now be calculated for any spatial object that falls within the boundaries of the functional urban area. For the sake of comparability, the high-density clusters (or urban centres) are in principle the preferred units of analysis. However, it is also very useful to calculate aggregates at the level of cities and greater cities, especially because these aggregates can be compared to many other indicators that are part of the Eurostat city statistics[13]. For that purpose, the Urban Atlas polygons should be enriched with attributes representing the codes of the urban centres, cities and greater cities. For each unit of analysis (urban centre, city, etc.), we create a frequency table of the surface area of green urban areas, containing the cumulative distribution of the corresponding population shares. These frequency tables are needed to produce the distribution graphs. In addition, we calculate the population-weighted median value of the accessible surface area of green urban areas, and the share of population that has no green urban areas in its neighbourhood.

6.3 TOOLS USED

The spatial analysis of this workflow has been implemented using ESRI ArcGIS tools, and scripted using Python. To produce frequency tables and calculate the summary measures, we used SAS Enterprise Guide.

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13. Urban Audit; see: http://ec.europa.eu/eurostat/data/database > Data > Data Navigation Tree > Database by themes > General and regional statistics > Urban audit > Cities and greater cities

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