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Online Lounge

Work title: Analysis of urban green space accessibility using scaling laws in European cities.

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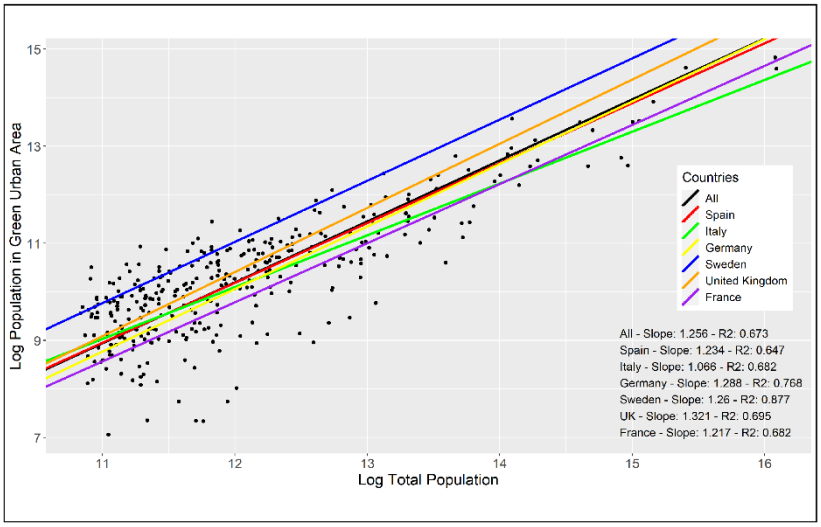

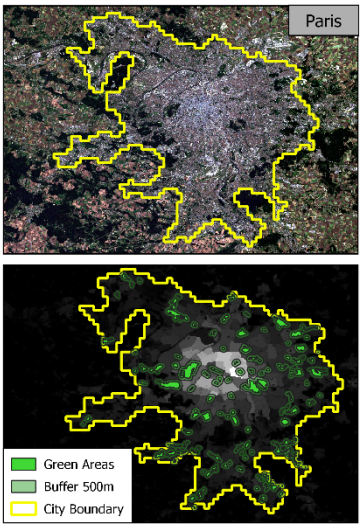

Short project summary

Using a harmonized definition of urban boundaries, population data and data on urban green, we address the varying accessibility of green spaces among European cities using urban scaling laws. The analysis reports superlinear scaling behavior for most of the observed countries.

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Analysis of urban green space accessibility using scaling laws in European cities

Keywords:
Urban green, urban scaling, green space accessibility.

1. Introduction

Urban green areas provide a number of positively associated ecosystem services for the urban society. In times of a more and more urbanizing world cities become denser and sprawl into the hinterlands. Green spaces are a necessity for better urban microclimates, increased air quality and health of citizens as they serve as areas for recreation. As part of the Sustainable Development Goal (SDG) 11, this issue of creating accessible green public spaces is attracting increased awareness among citizens and public authorities (UNDESA 2021). While much effort is dedicated to an equal distribution of urban green spaces for the citizens, the reality proofs that not all urban dwellers profit in the same way. One concern is the inequal accessibility of urban green spaces due to inequal spatial distributions of green space among cities of various sizes (Wolch et al. 2014). Here, we analyze green space accessibility in European cities. We measure it by the share of urban population per city with good access to urban green space compared to the total population of the city using urban scaling laws (Fuller & Gaston 2009).

2. Methods and Data

For our study, we use the land-use class “green urban areas” from earth-observation-based CORINE land cover data. The data has a minimum mapping unit of 25ha and is from the year 2018 (COPERNICUS 2018). For better comparability and to avoid a spatial bias in terms of the modifiable areal unit problem (MAUP), we followed the concept of a harmonized definition of urban areas (Dijkstra & Poelman 2014). City delimitations were based on socioeconomic factors, on satellite-based impervious areas and population data, and not on administrative boundaries. Fine-grained data on urban population at a resolution of 250m was provided by GHS-POP (JRC 2019). Combining all data sets, we calculate the number of urban residents within a distance of <500m to the urban green spaces.

In the concept of urban scaling, cities can be understood as metabolisms and have been found to follow allometric behaviors for many urban properties (Bettencourt, 2013). They are following a ubiquitous urban scaling law:

(1) $Y(t) = Y_o(t)N(t)^{\beta}$

where $Y(t)$ represents the urban property of interest (e.g. social activity or infrastructure; in our case urban green spaces) at time t. Y_o is a normalization constant and the exponent β determines how strongly an urban property increases or decreases with city size $N(t)$. If $\beta = 1$, the urban property scales linearly with increasing population size, e.g. the number of urban residents with access to green urban areas due to their close vicinity increases linearly with the total number of a city's population. If $\beta < 1$, we observe sublinear scaling, i.e. less people have access to urban green with increasing city size. And, if $\beta > 1$, we find a superlinear scaling relationship, i.e. more people have access to urban green in larger cities.

3. Results

We perform the analysis of urban green space scaling for 323 European cities from six countries: France (46), Germany (76), Italy (32), Spain (41), United Kingdom (116), and Sweden (12). In general, our results reveal scaling relationships of a strong superlinear behavior ($\beta = 1.256, R^2 = 0.673$) when all 323 European cities are pooled together. Based on this observation, we can state that in general, the number of urban residents in European cities with access to urban green space increases faster than the city sizes. In short: larger cities provide better access to urban green space to its residents than smaller cities. While this observation is made for all cities, we can observe some differences across the countries under investigation. Five out of the six countries show a strong superlinear behavior, with the highest reported for United Kingdom ($\beta = 1.321, R^2 = 0.695$), followed by Germany ($\beta = 1.288,\ R^2 = 0.768$), Sweden ($\beta = 1.26, R^2 = 0.877$), Spain ($\beta = 1.234, R^2 = 0.647$) and France ($\beta = 1.217, R^2 = 0.682$). Interestingly, Italy reports the lowest scaling exponent among the compared countries ($\beta = 1.066, R^2 = 0.682$), showing an almost linear scaling relationship. This means less people profit from green space accessibility in larger Italian cities than in other European cities.

4. Conclusions

Undoubtedly, cities have a very important role for the future of our planet. While the majority of the global population lives in cites, these areas are also responsible for a large share of the global air pollution or greenhouse gases emissions. But, at the same time, cities are dense agglomerations of population and thus can provide services and infrastructures with increased returns for scale for more people than in rural areas. This is also the case for urban green space. We observe an increased number of urban residents with access to urban green space in close proximity of their homes in larger cities than for smaller cities for almost all countries, and also among various climatic zones. One exception of this observation is Italy. There, a generally very low amount of urban green space per city combined with very high population densities is the reason why we observe only a linear scaling for Italian cities. One explanation for this can be found in the historical development of Italian cities due to their early foundations in Roman and Medieval times and the resulting compact, dense urban structure leaving less space for urban green areas.

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Highlights for social media posts:

- We analyze urban green space accessibility for 323 European cities using urban scaling laws and satellite-based classification of urban green.
- Results report strong superlinear behavior, meaning that larger cities provide better access to urban green than smaller cities.
- Historical urban development, urban form, and population density are important factors for the existence and accessibility of urban green.