How is urban greenspace distributed within different European cities, as measured from the city's center towards its edges?

This research investigates the distribution of urban greenspace within different European cities.

Source: www.visitgroningen.nl

Author: J. Bonekamp (s2779714)

Supervisor: dr. M.N. Daams

Date: 05-02-2021

1. Abstract

Urban green space (UGS) fulfills an important role in our day to day lives. Performing all sorts of activities in these places which have a profoundly positive impact on our physical and mental health (Kabisch et al., 2015). With different levels of lockdowns across the globe, these places have become more important than ever. Although a lot of research has been done towards the availability of UGS in European cities never has the distribution within these cities been researched. By looking at six different cities with varying levels of UGS coverage per capita and visualizing the distribution of UGS this research attempts to better understand where and why we can find our recreational green places. Results show that several trends can be seen, the most profound being that UGS coverage increases the greater the distance from the city center gets. Although more research will be needed to quantifiably prove this hypothesis.

2. Introduction

With over half of the world population living in urban areas, the residents of these cities rely heavily on publicly available green spaces for their daily recreation (Kabisch et al., 2015). It is understood that urban green spaces (UGS) contribute to liveable cities and well-functioning on several levels. They: (1) provide place for recreation, active living and supporting everyday life; (2) contribute to biodiversity in urban areas where diversity is scarce; (3) support the cultural identity of a city; (4) maintain and a prove a level of environmental quality; (5) provide places for nature experiences: and (6) provide opportunities for technical problems like water management (Sandström et al., 2006). With the outbreak of the covid-19 pandemic people have started to make more use of UGS (Day, 2020). As countries globally turned to different levels of lockdowns in some cases these UGS's have had to close due to overcrowding. Seen in the study conducted by Day (2020) in which spatial data recorded by Google in the case of several UGS's in England when lockdown measures were relieved strong increases of park visitations can be seen. As we move from working at the office to working from home a stroll in the park has become more important. Slater et al. (2020) even go as far to argue that it is of vital importance for not only physical but also mental health to keep UGS's accessible during lockdown. This trend will most likely continue for a considereable amount of time, not only with travel restrictions due to lockdown measures (Pfefferbaum et al. 2020) but a permanent shift towards working from home might be seen globally (Hern, 2020). Today, we understand the relevance of UGS as a component in our urban structures and governments across the globe state its relevance in terms of accessibility for their citizens.

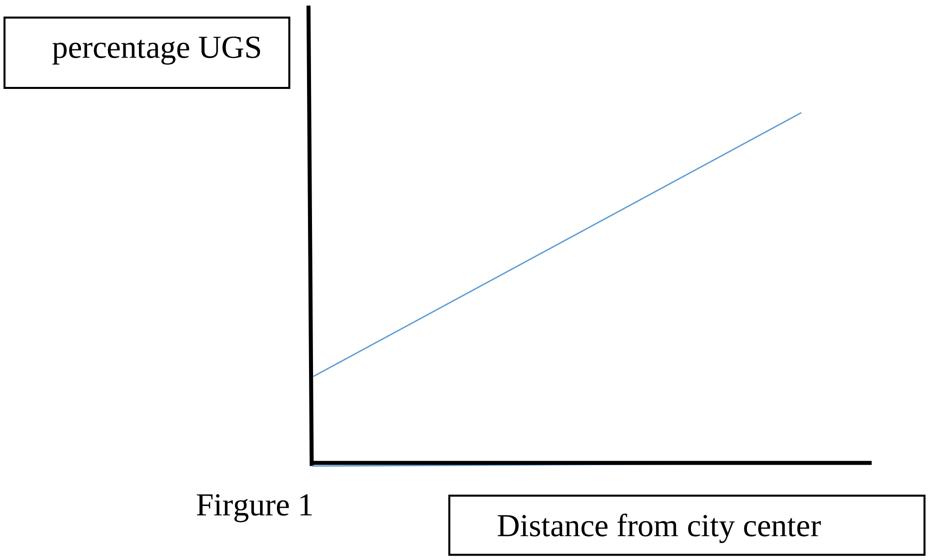
Only a hand-full of studies have been performed to study the accessibility of UGS across Europe. In order to map accessibility Fuller and Gaston (2009) analyzed available UGS in 386 European cities. Showing that compact cities provide very low per capita green space allocation whereas less densely populated and more sprawled cities provide very high per capita green space. This is interesting since however smaller European cities are becoming less densely populated the biggest cities, which house the most people, are becoming denser populated (Kasanko et al., 2006). With the outlook that in 2050 70% of the world population will be living in urbanized areas (United Nations, 2013) this entails that an increasing number of the population will be living with ever decreasing per capita UGS allocation. A later study performed by Kabisch et al. (2016) showed the same results as Fuller and Gaston (2009): the same cities provide little UGS allocation. Kabisch et al. (2016) complemented their work with a case study for the cities of Berlin and ſódź. In this case study they clearly showed that UGS allocation increases when moving towards the city edges. This indicates that even at the city level merely the per capita UGS allocation is insufficient for understanding how UGS is distributed among residents. This spatial distribution of UGS has only been studied once, performed by Wang et al. (2020) across nine different Chinese cities. Showing the contradiction between compact cities and urban greenery. With increasing urban density urban greenery becomes scarcer. Besides, this study gives insight into the actual distribution of UGS across the city’s surface. The spatial distribution gives insights in challenges for urban development and planning for well-being, it helps us to better understand our cities.

Following from these conclusions this research will provide a more profound understanding of the question: how is UGS is distributed within cities when comparing different European cities. This is done by selecting six cities based on their per capita UGS allocation and attempt to give insight in differences in not only allocation but mainly it’s distribution.

3. Theoretical framework

Uderstanding the distribution of UGS is closely related to how different land uses are distributed across cities. The first and most basic principle that helps us predict land use coverage was first conceptualized by Ricardo as the theory of rent. From this neoclassical reasoning the worth of land is based on its most profitable use. Alonso (1960) added the notion of transportation costs, urban land uses, as well as personal preferences when it comes to housing. This theory suggests that the highest rents are paid near the city center since that is where highest turnover can be achieved. All uses that can afford to pay the highest rents will thus have the steepest bid-rent curves and consequently concentrate near the city center, which is usually business followed by housing, industrial and agricultural use. From this perspective UGS would not be expected anywhere in the city center, since these places are not profitable (Swanwick et al., 2003). Although this seems logical from an economic perspective reality shows otherwise. The desire to recreate in a pseudo-natural environment has kept us from turning our cities into complete concrete jungles. This is of course done through government intervention and planning. This idea was taken to the extreme by Ebenezer Howard (1946), presenting plans for cities with only having a central park for a center. Although the idyl and easy way of living might appeal to many, these plans haven't resulted in mass extinctions of cities or demolished town squares. Although the after war period saw sub-urbanization across Europe, cities have seen their population numbers rise once again between 40% and 300% (Ravetz et al., 2013). Actually, quite the opposite compact city has become increasingly popular (Burton, 2000). Planning towards compacter cities while lowering the impact on the environment and of essence to this case, planning for greenspace. These are still remnants from Howard, traverse populated areas with green spaces. These so-called greenbelts are found in cities all around Europe, for example in Berlin (Kühn, 2002). Building parks at the edge of the city to prevent the city from sprawling, or in some cases functioning as a segregation between settlements within cities (Elson, 1986).

Concluding from these movements towards UGS in urban development over the past decade it becomes clear that benefits of the possibility to recreate in UGS are well known, and this desire has always existed. The city center is still destined for commerce and thus it is not expected to see UGS there. When business land-use transfers to residential use so does the desire to interact with a green environment increase. Given the latest developments regarding UGS and the developments of greenbelts in some cities the percentage of UGS is expected to rise even more towards city edges. This is conceptualized in the curve shown in figure 1 in which the yellow line represents the percentage of land used for greenspace.



Firgure 1

4. Methods

4.1 study area

The study was conducted over six different European cities which were chosen based on the results of Fuller and Gaston (2009). These cities were selected on the basis of their per capita UG allocation choosing two cities having respectively high, medium and low UGS provision per capita. These cities are: Berlin, Amsterdam, Vienna, Rome, Madrid and Budapest.

4.2 Data

To determine the spatial distribution of UGS in European cities, the land-cover/land-use and census data were analyzed in a GIS analysis. Land use data originated from the European Urban Atlas dataset from the European Environment Agency (2012). More recent data from 2018 was available but not for the countries that were of interest for this research. This data was chosen since it carries detailed information especially about public space uses, being based on satellite images.

The administrative boundaries of these cities were also included in the data. This research focused on the “urban core” instead of the functional urban region since this larger urban zone also included areas outside the urban population.

The data distinguishes 23 thematic classes of land use, including “Green urban areas”, “Forests” and “herbaceous vegetation” the latter also containing beaches and rocky shores which is why it was included in this analysis. Other classes that combined high recreational values like “grasslands” with low recreational characteristics like “cropland” were excluded to ensure only highly recreational areas were included in the analysis. The areas that were included are publicly accessible 24 hours a day.

Each feature within the classes contained the specific information on the population numbers living inside the area. This provided the opportunity to precisely determine the number of inhabitants within the research area. This data was added to the features in 2019.

Lastly the city’s centers were accessed through the European Environment Agency (2011). These are the city centers based on the location of the historical center. It was considered to adjust for the center point based on population distribution, but since UGS is highly related to a cities design and thus the oldest parts of the city which now form the city center this was not adjusted for.

4.3 Analysis

To visualize the distribution of UGS in different cities first the features containing UGS or other green space with recreational value were extracted from the Urban Atlas Data. Second the distance from the distance from the city center to the boundary of the “urban core” was measured. This distance was divided into

10 different buffer zones, this distance might differ between cities. The multi-buffer zones and UGS are overlayed using the intersect tool. Now the total amount of UGS in each buffer zone is determined. This was visualized in several ways.

4.3.1 Scatterplot

To visualize the total per capita allocation of UGS per resident of the research area the buffer zone was intersected with all layers within the Urban Atlas data. Since the population numbers are included in the data these could then be added up and gave the total population of the research area. Dividing this with the total surface area of UGS within the buffer zone provides the UGS per capita allocation.

4.3.2 Curves

The percentage of UGS per buffer zone was plotted out creating a bid-rent like outlook. This shows the distribution of UGS from the city center.

4.3.3 Maps

Performing the before mentioned analysis produced the following maps for the six cities. For illustration purposes one of these is shown in figure 2. The basemap shows the scale at which the cities were analyses, showing that the entire city is taken into consideration, not merely the inner city.

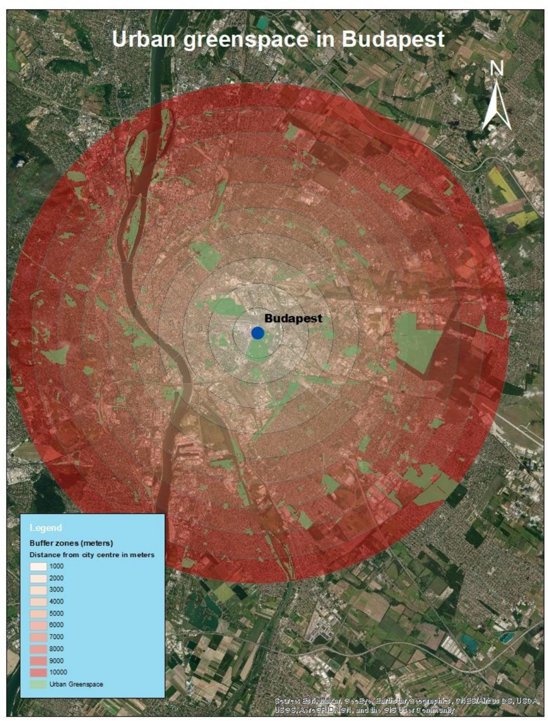


Figure 2

4. Results

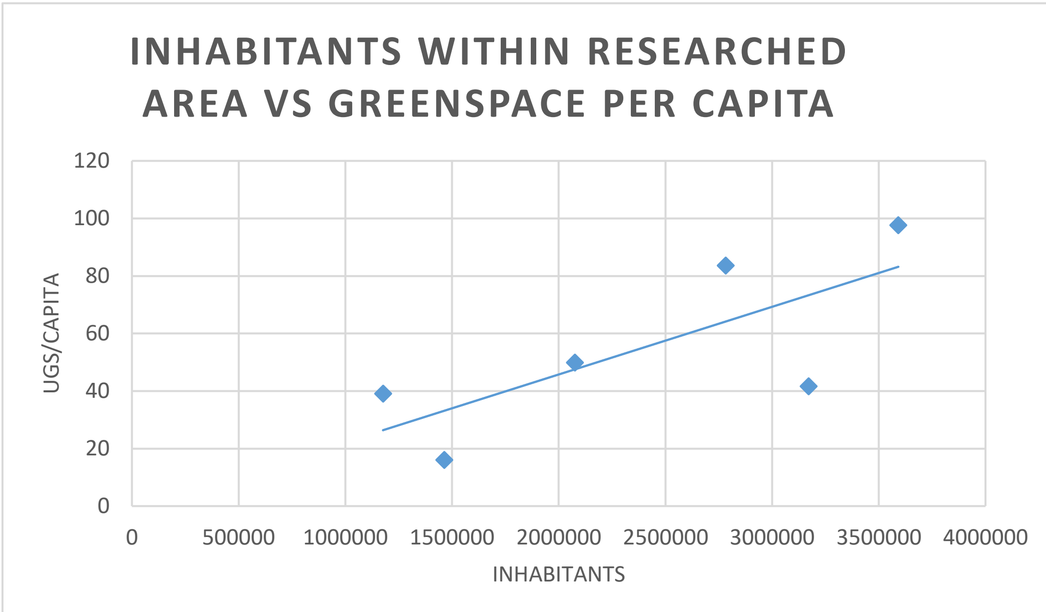


Figure 3

Firgure 3 shows the positive trend between on the x-axis the number of inhabitants that live within the urban core area and the amount of UGS available per capita on the y-axis. Figure 4 states the amount of greenspace that is available per capita within the urban core. The trendline is positive but there are large differences. Madrid has 17,8% more inhabitants but have less than half the UGS compared to Vienna.

Berlin: 97,6
Vienna: 83,6
Rome: 49,8
Madrid: 41,6
Amsterdam: 39,1
Budapest: 16,0

Figure 4

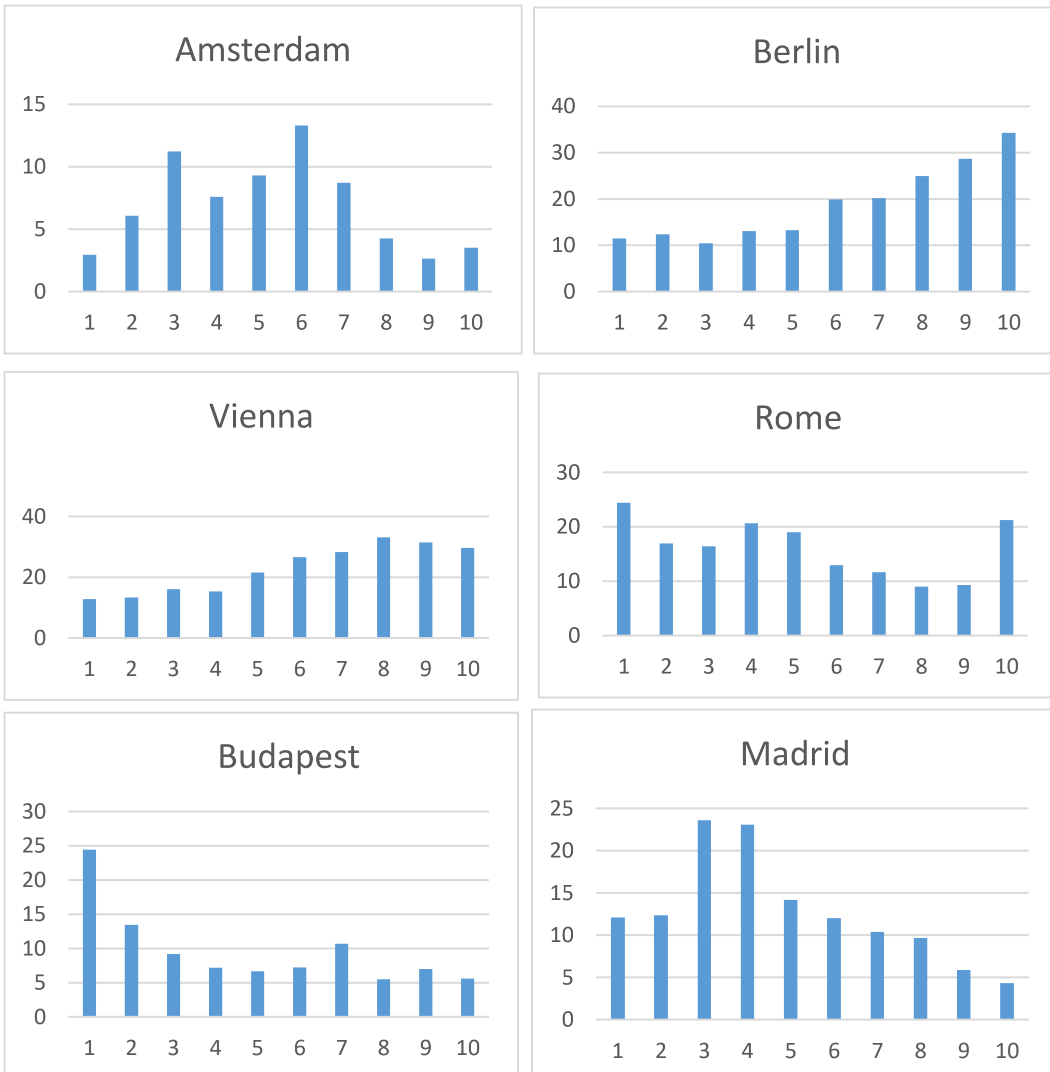


Figure 5

Figure 5 shows the distribution of UGS as a percentage of the total surface of that part of the city. The “1” represents the first buffer and thus the city center. As you can see the city of Budapest although having the smallest amount of UGS per capita (figure 3) it has Together with Rome seen the largest percentage of greenspace in its center. Vienna and Berlin show comparable distribution with increasing land-use for UGS towards the city edges. Cities like Madrid, Amsterdam and Rome show a distinct increase in the percentage of UGS. This does suggest a distribution for all citizens. Though these increases are most likely just on one side of the city.

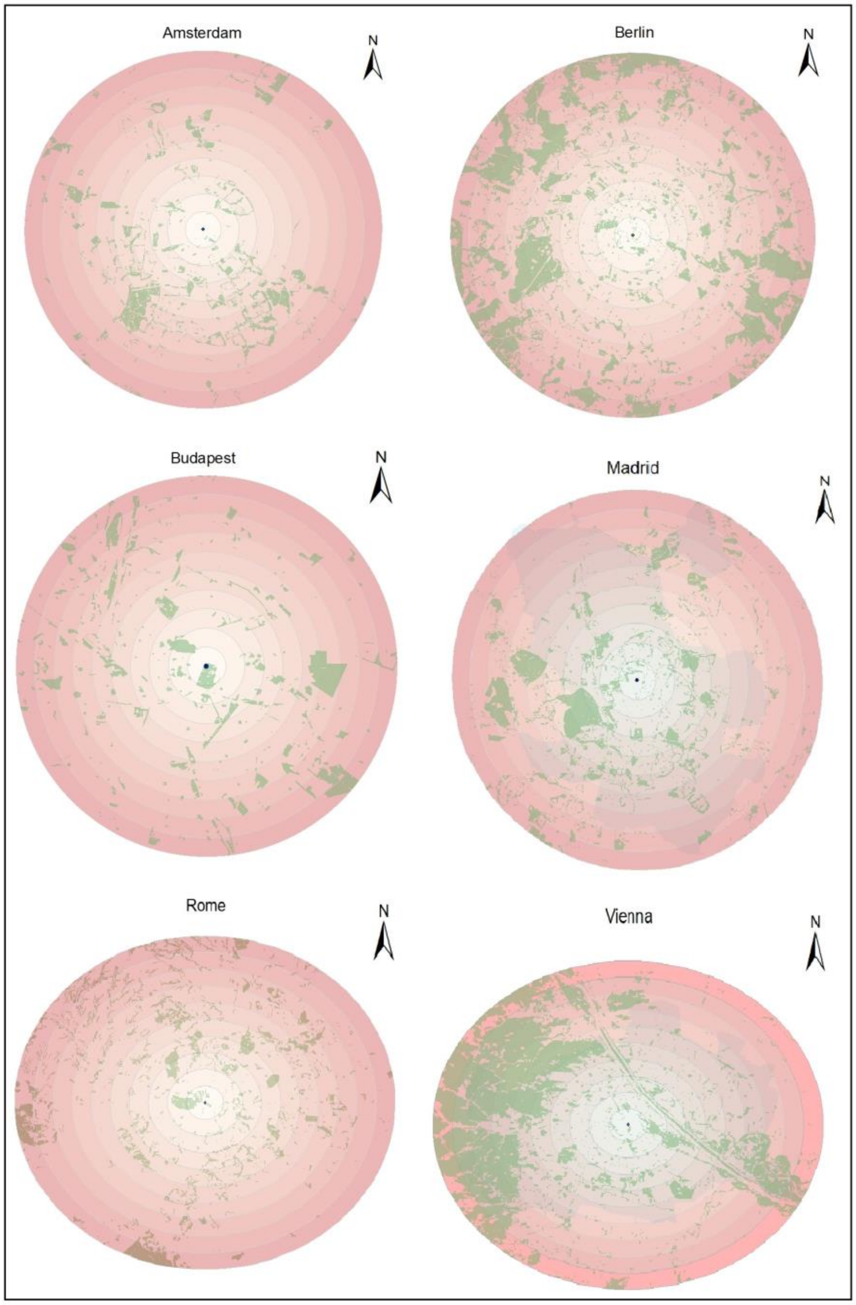


Figure 6

Figure 6 shows how UGS is distributed across the bufferzones from the city center. This clearly shows another aspect of spatial distribution. Vienna clearly shows a concentration of UGS towards the west of the city. What is striking for Budapest is the large park that is close to the city center whereas other cities have only small areas of UGS close to the city center. Bodies of water obviously also play a role. The city of Amsterdam has large bodies of water close to the city, the land-use in buffer zone 9 and 10 (the outer two zones) are partially covered by bodies of water. The city of Berlin clearly shows larger concentrations of UGS towards the city edges.

5. Discussion

Large inconsistencies can be seen in the UGS per capita allocation between the results of this analysis compared to the results from Fuller and Gaston (2009). Vienna for example shows 83 square meters of UGS per capita from this analysis and according to earlier studies the city provided only 38 square meters of UGS per capita. On the other hand, in the analysis performed by Kabisch et al. (2016) who compared the percentage of population that lives within 500 meters and 300 meters from an UGS larger than 2 ha the city of Vienna performed reasonably good. In their study they decided to stick to the urban core boundary as set by the European Environment Agency, just as this analysis has. It is unclear what boundary Fuller and Gaston (2009) applied in their analysis. As it can be seen in figure x Vienna provides more UGS towards its edges, it is most likely that the analysis by Fuller and Gaston (2009) stayed closer to the city center. This proves that at which scale the availability is researched should be considered and can give different outcomes for different cities.

These results also counteract statements by Fuller and Gaston (2009) and Kabisch et al. 2016) that the availability is influenced more by city size than its residential population.

When looking at the distribution of UGS across the six cities that were involved in this research we can see that there is no clear-cut trend. These differences might be explained by cultural attitudes towards UGS. Northern European citizens might expect to be provided with some forest area near their homes (Hauru et al., 2015) whereas in Southern European cities these expectations are less visible.

Future research should mainly be focused on increasing the scale of this analysis, in order to find out whether the trends that are seen hold true on a larger scale or if these results misrepresent reality. Besides, accessibility and availability are not the only indicators for the use and added value of UGS (Hillsdon et al., 2006). Thus besides scaling up also the impact of qualitative better but smaller UGS can be researched. Since this might provide options for densely populated city centers where UGS is in short supply.

In the past urban sprawl has led to urban degradation, to prevent this UGS is a key factor. Since, whoever leaves the city will move to a greener place. Our cities are still expected to expand over the next few years planning for UGS non-built-up areas now can provide quality space in the future. Besides this the amount of UGS in our city centers in underwhelming. These are the most densely populated areas, combining different uses and hereby attracting visitors. Like mentioned before, there might be possibilities for smaller but high quality UGS.

6. Conclusion

This analysis proves that when performing GIS analysis, scales and institutional boundaries play an important role. When looking at the distribution of UGS some interesting findings have been made. Showing that land-use in the city center is reserved for other activities and that the share of land-use reserved for UGS increases when moving towards a city's edges. The conceptual model can not yet be confirmed due to the diverse outcomes of the analysis.

7. References

Affairs, United Nations Publication (2013) via: http://www.un.org/en/development/desa/policy/wess/wess_current/wess2013/WESS2013.pdf

Alonso, W. (1960). A theory of the urban land market. *Papers in Regional Science*, *6*(1), 149-157.

Burton, E. (2000). The compact city: just or just compact? A preliminary analysis. *Urban studies*, *37*(11), 1969-2006.

Day, B. H. (2020). The Value of Greenspace Under Pandemic Lockdown. *Environmental and Resource Economics*, *76*(4), 1161-1185.

Elson, M. J. (1986). *Green belts: conflict mediation in the urban fringe*. Butterworth-Heinemann

European Environment Agency (2012). Urban Atlas LCLU 2018 [Data Set] https://land.copernicus.eu/local/urban-atlas/urban-atlas-2012

European Environment Agency (2011). Urban Atlas LCLU 2011 [Data Set] https://land.discomap.eea.europa.eu/arcgis/rest/services/UrbanAtlas/UrbanAtlasV2_WM/MapServer/2.

Fuller, R. A., & Gaston, K. J. (2009). The scaling of green space coverage in European cities. *Biology letters*, *5*(3), 352-355.

Haaland, C., & van Den Bosch, C. K. (2015). Challenges and strategies for urban green-space planning in cities undergoing densification: A review. *Urban forestry & urban greening*, *14*(4), 760-771.

Hauru, K., Eskelinen, H., Yli-Pelkonen, V., Kuoppamäki, K., & Setälä, H. (2015). Residents' perceived benefits and the use of urban nearby forests. *International Journal of Applied Forestry*, *2*(1), 1-23.

Hern, A. (2020). Covid-19 could cause permanent shift towards home working. *The Guardian*, *13*.

Hillsdon, M., Panter, J., Foster, C., & Jones, A. (2006). The relationship between access and quality of urban green space with population physical activity. *Public health*, *120*(12), 1127-1132.

Howard, E. (1946). *Garden cities of tomorrow* (pp. 9-28). London: Faber.

Kabisch, N., Qureshi, S., & Haase, D. (2015). Human–environment interactions in urban green spaces—A systematic review of contemporary issues and prospects for future research. *Environmental Impact Assessment Review*, *50*, 25-34.

Kabisch, N., Strohbach, M., Haase, D., & Kronenberg, J. (2016). Urban green space availability in European cities. *Ecological indicators*, *70*, 586-596.

Kasanko, M., Barredo, J. I., Lavalle, C., McCormick, N., Demicheli, L., Sagris, V., & Brezger, A. (2006). Are European cities becoming dispersed?: A comparative analysis of 15 European urban areas. *Landscape and urban planning*, *77*(1-2), 111-130.

Pfefferbaum, B., & North, C. S. (2020). Mental health and the Covid-19 pandemic. *New England Journal of Medicine*.

Ravetz, J., Fertner, C., & Nielsen, T. S. (2013). The dynamics of peri-urbanization. In *Peri-urban futures: Scenarios and models for land use change in Europe* (pp. 13-44). Springer, Berlin, Heidelberg.

Sandström, U. G., Angelstam, P., & Khakee, A. (2006). Urban comprehensive planning–identifying barriers for the maintenance of functional habitat networks. *Landscape and urban planning*, *75*(1-2), 43-57.

Slater, S. J., Christiana, R. W., & Gustat, J. (2020). Recommendations for Keeping Parks and Green Space Accessible for Mental and Physical Health During COVID-19 and Other Pandemics. *Preventing chronic disease*, *17*, E59.

Swanwick, C., Dunnett, N., & Woolley, H. (2003). Nature, role and value of green space in towns and cities: An overview. *Built Environment (1978-)*, 94-106.

United Nations, 2013 United Nations (UN) Sustainable Development Changes. *World Economic and Social Survey 2013* Department of Economic and Social Affairs, United Nations Publication (2013) via: http://www.un.org/en/development/desa/policy/wess/wess_current/wess2013/WESS2013.pdf

Wang, J., Zhou, W., Wang, J., & Yu, W. (2020). Spatial distribution of urban greenspace in response to urban development from a multi-scale perspective. *Environmental Research Letters*, *15*(6), 064031