City parks in Amsterdam in relation to socioeconomic status of neighborhoods

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Date: 08-07-2021
Word count: 12.259

Abstract

Access to sufficient green space and green space of sufficient quality has proven to be an important factor in both physical and mental health. At the same time however, there is an increasing body of literature that shows that green space and green space quality is unequally distributed over cities. Neighborhoods with a low socioeconomic status seem to have less access, and access to lower quality green spaces than neighborhoods with a high socioeconomic status. In this research, the relationship between access to city parks and their quality and socioeconomic status of neighborhoods in the context of Amsterdam has been researched. The quality of city parks has been measured by using a self administered checklist tool. All of the parks have been visited by two raters to gather the data about park quality. Access to parks has been measured by using the buffer and network analyst tools in Arcgis pro. The results of the research show that there are some weak correlations between socioeconomic features and access in Amsterdam. There were no correlations found between socioeconomic features of neighborhoods and park quality.

Table of Contents

1. Introduction

In recent studies about healthy urban living the access to sufficient green space is one of the most important factors. Especially, the perceived and valued contact with nature has risen to attention in recent years (Hartig et al., 2014). Access to sufficient green space has proven to be of vital importance for personal health, both physical and mental. People benefit from access to urban green because it improves the physical as well as the psychological health, furthermore it also has a beneficial effect on communities and social cohesion (Venter et al., 2020). Access to public parks has shown to have a positive impact on mental health, as residents living closer to a park score higher on mental health indexes than residents living further away from parks (Sturm & Cohen, 2014).
During the recent COVID pandemic sufficient access to parks seems to have become even more important. For instance, a study conducted among 48 countries around the world which used movement data provided by Google has shown that since the Corona outbreak numbers of park visitation have significantly gone up (Geng et al., 2020). The restrictions imposed by national governments seem to correlate with the increased number of park visits. Because of the restrictions, visiting green space is one of the few possible activities to do. Another study, which conducted surveys among six European countries, found that urban green space has been mostly important for relaxation and physical exercise, while it was used less for social reasons during the pandemic (Ugolini et al., 2020). Many respondents reported their need for access to green space. Next to the increased importance of access to sufficient green space, the overall focus on healthy urban living has increased in this period.
Despite the importance of access to green space for everyone, disparities in access to public parks do still seem to exist between different population groups. Multiple scientific studies have shown a relation between socioeconomic status and green space access. An example is a study conducted in Atlanta, United States, in which the results showed that socioeconomically disadvantaged areas had the least green space provision (Dai, 2011). Another example is from a study conducted in Bristol, where respondents who lived in more deprived areas reported poorer green space accessibility and lower perceived safety (Jones et al., 2009) In The Netherlands the relation between socioeconomic status and green space access has been researched as well. Neighborhoods with a relatively low socioeconomic status seem to have less green space and lower qualities of green space than neighborhoods with a higher socioeconomic status. In highly urban areas these inequalities are however less present than in more rural areas. (De Vries et al., 2020) These seeming disparities in access to green space and green space quality between population groups provide a reason to research this in the context of Amsterdam.

The main research question that will be central in this research is: To what extent is the spatial distribution of city parks and their quality in Amsterdam related to the socioeconomic status of neighborhoods? The research will be structured around this question. First, the case of Amsterdam will be explained in more detail and the social and scientific relevance of the research will be described. Thereafter, the theoretical framework will follow. In this part, the concepts of green space quality and the (un)equal distribution will be explained based on the existing literature. This chapter will end with mentioning three sub-questions that will help answer the main research question. After this, there will be a section in which the research methods will be explained. Both the methods of data collection as well as the analysis methods will be mentioned in this chapter. Subsequently, there will be the results section in which the research questions will be answered. After the results, the thesis will end with chapters about the discussion and the conclusions.

1.1 Introducing the case of Amsterdam and Amsterdam's city parks.

Amsterdam aims to be a green city and a city for everyone. To keep achieving this goal of greenness however, the city will likely be facing some serious challenges in the near future. Amsterdam is likely to experience a substantial growth of inhabitants in the years to come (CBS., 2019). To deal with an increasing population there will be a large building challenge for Amsterdam and the city is likely to densify in the coming years. In cities that experience densification, there will likely be less room for public green space (Haaland & Van den Bosche, 2015). To keep the city livable for its residents, the municipality acknowledges the importance of city parks and aims at constructing new parks to accompany the densification. The goal of Amsterdam's municipality is to provide at least one city park within ten minutes walking distance for every resident (Gerritsen, 2020). To provide sufficient access to city parks in a city that experiences rapid densification will be a huge challenge for the municipality of Amsterdam.

In the current situation, the municipality of Amsterdam identifies 20 of its greenspaces as city parks. (maps.amsterdam.nl, 2021) It is important to note that not all the recreational green spaces in Amsterdam are identified as city parks by the municipality. There are a lot of other green spaces in the city that are not seen as city parks, these parks are referred to as 'other recreational green spaces' on the website of the municipality. The city parks are shown in the map below together with Amsterdam's neighborhoods. In the map, the neighborhoods with no residents are excluded. The areas Westpoort, an industrial area, and Landelijk Noord, a rural area are excluded as well. CBS ranks the level of urbanity of areas in five categories, from 'non-urban' to 'very strongly urban' (CBS.nl, n.d.). These two areas were excluded based on the fact that they were ranked as 'non-urban areas' in the Neighborhood statistics from CBS. Below, a table with the 20 parks and their size as well as a map of Amsterdam with the parks are presented.

Park Name	Park size in m2
Amstelpark	438.723
Amsterdamse Bos	7.275.385
Beatrixpark	231.357
Erasmuspark	108.378
Flevopark	283.314
Frankendael	155.344
Gaasperpark	1.239.603
Martin Luther Kingpark	140.458
Nelson Mandelapark	633.274
Noorderpark	315.565
Oeverlanden	495.166
Oosterpark	146.198
Rembrandtpark	312.120

Sarphatipark	42.087
Schinkeleilanden	17.968
Sloterpark	948.958
Vliegenbos	278.750
Vondelpark	460.533
Wertheimpark	7.700
Westerpark	334.114

Figure 1: City parks in Amsterdam and their size

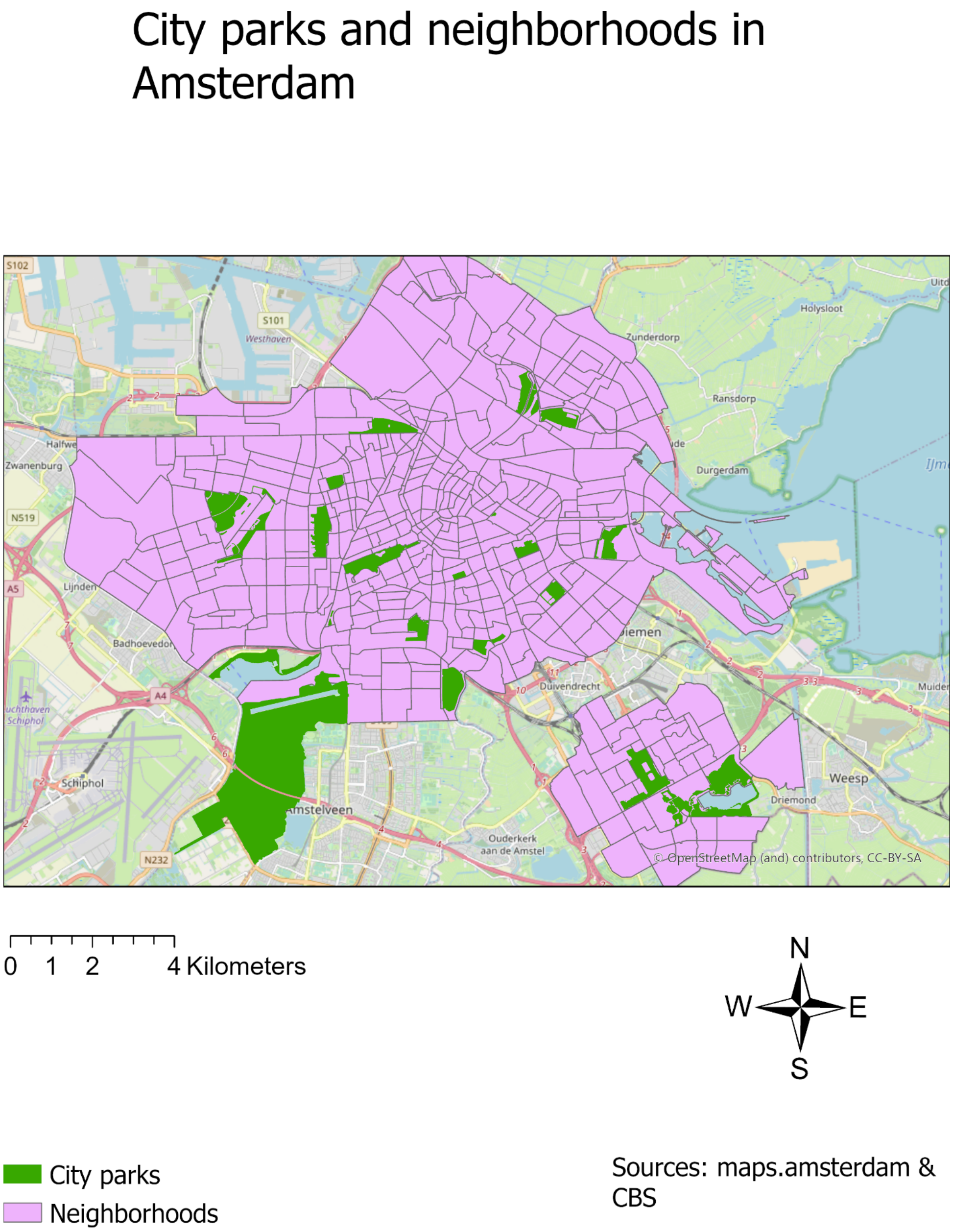

Figure 2: Map of Amsterdam’s neighborhoods and city parks

1.2 Scientific relevance

This will be a research that has a scientific value because it combines both the quantity and the quality of green spaces. In most research about urban green the main focus is on the quantity of the available green space. The topic of quality of green space is somewhat lacking in this field of research. Other researchers have identified the gap in knowledge about the quality of green space as well: ‘To date, most epidemiological studies of urban green exposure effects have only focused on presence (or lack) of urban green spaces, overlooking the quality of these spaces’ (Knobel et al., 2019). Since this research will not only focus on the quantity of the available green space, but will also take into account the quality of green spaces, it will help to fill the knowledge gap in the scientific literature.
Another distinctive feature of this research is that it focuses only on a specific part of green space, namely city parks. Where most other research is about green space in a more broad sense, this research will focus specifically on city parks, leaving other public green space out of the research. This might give a different insight into the topic compared to other studies that do focus on green space in general, since the distribution of parks over the city can be different than the overall distribution of general green space. Furthermore, city parks can offer different services to residents than other green spaces. So, with this research a better understanding of the role of green space quality could be gained as well as an insight in how city parks are distributed in Amsterdam compared to other green spaces.
The aim of this research therefore is to get a better insight in the relation between the spatial distribution of city parks and their quality and the socioeconomic status of neighborhoods in Amsterdam. Another aim is to improve the understanding of the quality of parks in the academic field, where most focus is still on the quantity of parks.

1.3 *Social relevance*

As mentioned before, sufficient access to green spaces and parks has a positive impact on individuals’ health. The health benefits of access to green space can be divided into two categories: physical and psychological. Physical health effects refer to the physical activity that can be conducted in green spaces and psychological effects relate more to social interaction and exposure to nature (Lachowycz & Jones, 2013).
Looking at general health effects there is a negative relation visible between green space and mortality (Kondo et al., 2018). Meaning that an increase of green space quantity is associated with decreased mortality rates.
When it comes to the effects of green space on mental health, clear benefits can be seen with regards to anxiety and mood disorder treatment. For example, a study in an urban area in New-Zealand has shown that the numbers of these treatments decrease when the distance to green space decreases. The number of anxiety and mood disorder treatments also went down when the proportion of green space in the neighborhood increased (Nutsford et al., 2013).
Furthermore, access to green space is also beneficial for local communities. For example, having access to attractive open green spaces leads to higher levels of community attachment in urban areas . It is mentioned as well that preserving and extending green spaces can lead to increased community attachment (Arnberger & Eder, 2012). High levels of community attachment are beneficial in multiple ways. High levels of neighborhood attachment are found to encourage involvement in preserving neighborhood features, lead to

more environmentally responsible behavior and generally foster the relationship between residents and their community (Arnberger & Eder, 2012).

Through this research, an insight can be gained in the spatial division of city parks in Amsterdam and their quality. With the insights gained from this research, improvements can possibly be made regarding the division of city parks. Since an equitable division of parks is strongly beneficial for physical and psychological health outcomes as well as strength of communities, the research can have a positive impact on the society in Amsterdam.

2. Conceptual framework and research questions

2.1 Green space quality

Although the concept is used often, a clear green space definition is missing in most scientific literature on this topic (Knobel et al., 2019). An important factor for green spaces in this research is that they must be open to the public. Urban green space can be defined as : 'All publicly owned and publicly accessible open space with a high degree of vegetation' (Schipperijn et al., 2013, p.2). Another important factor is that these spaces can be used and entered. The city parks of Amsterdam fit within this definition, since they are publicly owned and accessible and can be used by anyone. A city park can be defined by having a large catchment area, diverse vegetation and many different facilities and amenities (Swannwick et al., 2013).
The concept of green space quality is still very broad as well, so it should first be defined further. In scientific literature, a multitude of conceptions about green space quality exist, some of those conceptions will be discussed here. A concept that is used often in scientific literature for assessing green space quality is that of the perceived sensory dimensions. This concept is based around eight quality dimensions related to aesthetics needs (Stoltz & Grahn, 2021). The eight perceived sensory dimensions are; natural, cultural, cohesive, diverse, sheltered, open, serene and social quality. These eight perceived sensory dimensions have been derived from reviewing existing studies and conducting multiple surveys in a Swedish context (Stoltz &Grahn, 2021). Where this approach is leaning more towards the subjective senses of individuals, other researchers have tried to develop a framework and quality assessment tools that are based more on objective features that are present in green space. Knobel et al., (2019) have made a review of all the available quality assessment tools that consist of multiple dimensions. In their review, it was reviewed for all of these tools of what dimensions they consisted of. The most important dimensions that together make up the quality of green space are summarized by Knobel et al., (2019). They mention the following dimensions that together make up the quality of green space: surroundings, accessibility, facilities, amenities, aesthetics and attractions, incivilities, safety, usage/activities, covers, animal biodiversity and vegetal biodiversity. These dimensions are all related to how people can use the public green space; the different characteristics facilitate different kinds of usages. For example, the presence of certain facilities and amenities in a park can encourage people to engage in physical activities (Edwards et al., 2013). The features of safety and incivilities also have a big impact, since high feelings of safety and the absence of incivilities will likely have a positive impact on the usage of green space (Knapp et al., 2018). Furthermore, the attractiveness of green spaces has a highly positive impact on green space usage as well. When green spaces are safe and attractive it

is likely that they will be used more often. It has been found as well that the biodiversity, accessibility and potential usage of green spaces have an impact on psychological benefits from green spaces. The number of accessible parks as well as the potential for recreational or sporting activities is beneficial for mental health (Wood et al., 2017).

The dimensions that together make up the quality of green space do themselves also consist of multiple items, therefore they will be explained in a bit more detail here. The dimension of surroundings is mainly concerned with the buildings that are surrounding a park. The access dimension is not about geographical access to a park such as actual distance to a park. Instead, it focuses more on accessibility features such as parking spaces, paths and handicapped adaptations in parks. The facilities and amenities dimensions both are based on present features that make a stay in the park more comfortable and facilitate certain activities, examples of these features are benches, playgrounds, toilets etcetera. The aesthetics and attractions dimension is mostly about features that make parks visually appealing, such as art and general views in the park. The Incivilities dimension is about things that could make a park visit less pleasant, such as noise or drug use. The dimension of safety is, as the name suggests, about features that make parks safe and make the user feel safe in the park. Lighting and cameras are examples of these features. The potential usage dimension indicates to what extent a park is suitable for certain activities, for example sports or social activities. Finally, covers are about different types of land cover, such as trees or grass and the extent to which they cover the area of the park. The dimensions of vegetal and animal biodiversity are more from a biological nature and require a lot of training to be able to recognize. These two dimensions will thus be left out of this research.

2.2 Green space health benefits

As mentioned before, sufficient access to green space has some important health benefits for people. These benefits will be explained in some more detail here and will be linked to some specific features of green space. The most commonly referred to health benefit of access to parks is that parks can facilitate physical activity and exercise. For fostering physical activity in parks, the quality dimensions of amenities and facilities are the most important. Furthermore, parks do encourage people to engage more in physical activity if the parks are perceived as esthetically pleasant (Veitch et al., 2012). In health studies, the potential for physical activity in parks has been linked to positive health outcomes such as lower morbidity and obesity rates (Wolch et al., 2014).

Besides the physical benefits of green space access there are also psychological benefits. An important factor for psychological benefits of access to parks is the potential for social activity and to meet people in parks. The ability of green space to facilitate social contact is associated positively with mental wellbeing (Nieuwenhuijsen et al., 2017). Another benefit is that access to parks is beneficial for psychological restoration. It has been found that for example the potential usability of parks has a great impact on this, as physical activity in green space for example has a positive effect on stress reduction (Astell-Burt et al., 2014). Furthermore, research has shown that people living close to green space facilities experience less stress in their lives and that green space has the ability to replace negative thoughts by positive thoughts (Van den Berg et al., 2010).

2.3 Environmental justice

Access to public green space can be seen through an environmental justice lense, since green spaces are not distributed over space equally. The environmental justice concept started as the acknowledgement that low income and ethnic groups were exposed disproportionately to environmental hazards (Rigolon & Flohr, 2014). The general conception in environmental justice movements is that no population group should be exposed disproportionately to negative health effects generated by pollution or environmental hazards (Brulle & Pellow, 2006). While most environmental justice research focuses on the exposure of vulnerable population groups to environmental risks, there is also another part within the field of environmental justice that focuses on the provision of 'goods'. Part of the provision of environmental 'goods' is for example access to parks (Floyd & Johnson, 2002).
Often, low income groups are also the groups that have the highest need for public services, because of their vulnerable status. An example of this when it comes to the access to parks is a study conducted in Ankara in which low income residents reported the highest need for access to public parks (Erkip, 1997) This can also be linked to the health benefits of green space, for example when it comes to obesity. Low income groups do not only seem to have the highest need for access to green space, they are also more vulnerable to develop obesity. Access to parks can be related to the development of obesity (Wolch et al., 2014). Therefore, it appears to be even more important that vulnerable population groups have sufficient access to green space.

2.4 Disparities in access to green space

Even though it is clear that having access to sufficient public green space is of vital importance for urban living, not all green space is distributed equally over cities.
In scientific literature there is an increasing understanding about the relationship between access to green space/parks and socioeconomic status. It seems that in general, disadvantaged groups in society experience the least provision of sufficient green space. (Ferguson et al., 2018) With these groups mostly being located in areas that already face more challenges, they are disadvantaged even more as they have less access to green space. For instance, research about green space in Porto has shown that more deprived neighborhoods were located further away from green space. Furthermore, the green spaces that could be accessed from these neighborhoods were reported to be of less quality with less amenities and possible activities, while having more concerns about safety. (Hoffimann et al., 2017). In the context of the Netherlands another research has been done which shows that neighborhoods with a lower socioeconomic status have less access to green space and that the green space quality is less. (de Vries et al., 2020) This relationship seemed to be less present in more urban areas however. But even if the relation between green space and socioeconomic status was less strong in urban areas there still was some correlation between these factors. Another example of disparities in access to green space in a Dutch context is a research in the urban area of Rijnmond. Results showed that high income groups in the area generally had better access to public green space, while the area where low income groups lived had less provision of green space Kruize, 2017). This research differs from the two Dutch studies mentioned here in the sense that this research focuses only on the provision and quality of city parks, while the other two focused on all of the provided green space. Furthermore, there is a difference with the research from de Vries et

al., (2020) because they researched all of the Netherlands, while this research is only in Amsterdam and is therefore only in an urban context. Furthermore this research in only concerned with city parks, while the research of de Vries et al., (2020) use all types of green spaces in their research.
Thus, from the literature it seems that the socioeconomic status of neighborhoods and the access to and the quality of public green space are related to each other. This provides reason to research the relation between socioeconomic status and the access to and quality of city parks.

2.5 Research questions

From the review of existing literature, it seems that there exists a relation between socioeconomic status of neighborhoods and access to and quality of green space. In most research that is done, neighborhoods with a lower socioeconomic status have less access to green space and the green space is of less quality. Based on the conceptual model about the relationship between socioeconomic status of neighborhoods and the access to and quality of city parks, the main research question that will be central in the research has been formulated:

‘To what extent is the spatial distribution of city parks and their quality in Amsterdam related to the socioeconomic status of neighborhoods?’

To help answering this main research question, three sub questions have been defined to serve as as a further guidance for the research:

- How is the quality of city parks spatially distributed in Amsterdam?
- To what extent is access to city parks related to socioeconomic status of neighborhoods in Amsterdam?
- To what extent is the quality of city parks related to socioeconomic status of neighborhoods in Amsterdam?

3. Methodology

3.1 Research design

For this research, a cross sectional research design has been used, with the neighborhoods of Amsterdam as cases of the research. The cross sectional research design is typically defined by having a large number of cases and the data collection takes place at one single point in time (Bryman, 2016). This research falls within the classification of a cross sectional research design since there are a large number of cases, all the neighborhoods of Amsterdam, and the data collection took place at a single point in time. Furthermore, this research uses quantitative data, which is a typical feature of the cross sectional design. The cross sectional design was chosen, because the goal of the research was to identify certain relations between variables. The cross sectional design is suited very well for this according to Bryman. In social research, there are some quality criteria for the research. The criteria of reliability, validity and suitability will be discussed here.
The reliability of the research is about the question whether or not the results of the research are likely to be repeatable (Bryman, 2016). Within the inter-rater reliability is an important

factor, since there is more than one rater for the quality of parks. To measure this reliability, level of agreement between raters will be calculated in the analysis section, using the inter rater consistency tool.
Another important criterion of social research is validity. Multiple types of validity do exist. The first type of validity is measurement validity, which is mainly concerned with the question if the measurement used does really measure the targeted concept. Within this research, the concept of park quality has been measured. The measurement validity has been guaranteed by using a measurement method that resulted from a thorough review of the concept and that has been used before in research. Second, there is the internal validity which is concerned with the question if conclusions about causality are valid. In this research, there won't be any conclusions about causality, since the direction of the possible correlations are not clear. Furthermore, there is external validity. External validity is about the extent to which results from the research can be generalized beyond the context of the research (Bryman, 2016). In this research, it is not likely that the result can be generalized. The quality ratings of parks are derived from only two raters, and the accessibility of parks is highly context specific. Therefore it is not likely that the results can be generalized beyond the context of this research.
The methods used for this research are suitable for answering the research questions, since they have been used in similar studies before.

3.2 Data collection

For this research data about three topics was needed. These are about the quantity (size) of the parks, about the quality of the parks and data about the socioeconomic status of neighborhoods is needed.

3.2.1 Park size data

The municipality of Amsterdam has classified 20 of its green space areas as urban parks on their website maps.amsterdam. (maps.amsterdam.nl, 2021) These 20 parks have been assessed in this study, since 20 parks was a doable amount of parks given the time.

Quantity (size) of parks has been assessed through open data from Amsterdam (maps.amsterdam.ml, 2021). The municipality of Amsterdam provides open data about the urban parks on the website maps.amsterdam.nl This dataset provided the option to switch off the 'other recreational green spaces' that were not included in the research, so only the data for the 20 parks was exported from this website. The data was provided as a .json file, therefore it was necessary to first convert this into a shapefile to be able to work with it in Arcgis. This file includes information about the location of the parks as well as the size of the parks in square meters. Some of the parks in this dataset consisted of multiple polygons however, so they first had to be converted into one polygon, this was done by merging them based on park name.

3.2.2 Park quality data

The quality of parks has been measured by using a checklist tool. Each of the 20 parks have been visited once, during these visits all the aspects of the checklist have been measured to give a score for the quality of the parks. In the field of studying the quality of urban green multiple tools have been developed (Knobel et al., 2019). For this research the tool that will be used to measure quality is the RECITAL tool which is developed by Knobel et al., (2020). This tool is chosen as the most appropriate for the research because it incorporates a vast amount of different dimensions that make up the quality of green space. The dimensions that are present in this tool are: surroundings, access, facilities, amenities, aesthetics and attractions, incivilities, safety, potential usage, land covers, animal biodiversity and bird biodiversity. (Knobel et al., 2020) In this research the dimensions about biodiversity will not be used in the assessment because they are more biological features and do not really fit with the more socially oriented character of the research. Furthermore, two items within the dimension of aesthetics and attractions. These two items were 'seasonal and high maintenance vegetation' and 'year round vegetation'. It was chosen to exclude these items because it would require additional knowledge about vegetation to recognize this. In total the tool that was used eventually consisted of 72 items, divided over 8 dimensions. All of the items were scored based on a five point likert scale, with the scale ranging from 0 to 4. In the scoring list, there were 6 types on which the scores could be assigned to the items. First, there was the type 'quantity', which is about the presence of things and ranged from no presence to always present. Second there was the quality of features, this was about the maintenance and aesthetic pleasantness. This ranged from no presence to 'Exceptionally maintained and aesthetically pleasing'. Another type was the 'combined quality and quantity' which combined the criteria from the quantity and the quantity type. This one ranged from no presence to 'Fit, sufficient, and aesthetically pleasing'. Within the dimension of incivilities, the items were scored based on the reversed quantity type, to make sure the 4 was still the most positive score and the 0 the most negative one. The dimension of potential use was scored on the type that was called 'potential usage' as well. The range of this type went from 'activity completely impossible' to 'perfect conditions for the activity'. Finally, for the lan covers the 'braun-blanquet' score was used. Within this, the lowest score was 5% or less cover with the highest being 75% or more cover. The entire tool with all of the items as well as an explanation of the scoring scales can be found in the appendix.
In order to make sure that the results do not rely on one single opinion all the parks have been rated by a second assessor as well. The two assessors gave their scores for the parks independently, without consultation. After the data on quality of parks had been collected by two assessors for all of the parks, the level of agreement between the raters was calculated for each of the items using the intraclass correlation coefficient in SPSS.

The data about park quality has been collected by visiting each park by foot. Each rater visited the assigned park once. In some cases the two assessors went into the park together, there was however no correspondence about the rating of the items, all the scores have been given independently. In other cases the assessors visited the park individually and the second assessors sent the results after he or she had finished. When collecting the quality data, it was chosen to first walk around through the entire park with the items from the RECITAL tool in mind, while thoroughly observing the park in the meantime. After walking through the entire park the RECITAL scheme was filled in directly afterwards each time. In order to get some more information about the park's features, any information signs giving an explanation of the park were also used as a source of information if these signs were present in the park. The fieldwork was conducted in March and the beginning of April. Park visit durations were heavily dependent on park size and ranged from around half an hour for the smallest park to multiple hours in the largest parks. No fieldwork was conducted when it was raining and all of the visits took place during day time.

3.2.3 Socioeconomic data about neighborhoods

The socioeconomic status of the neighborhoods have been assessed by using open data from CBS. CBS yearly provides data on neighborhood level about all different kinds of neighborhood statistics in the Wijk en Buurt kaart. The most recent version of this dataset will be used.
CBS defines a neighborhood as a part of a municipality that is homogeneously demarcated based on built area or socioeconomic features. According to CBS, typically one function is dominant in a neighborhood, but functions can be mixed as well (CBS., n.d.)
Furthermore, CBS also classifies neighborhoods on their degree of urbanity in five classes. Neighborhoods that fall within the lowest class, called not-urban, are excluded from the dataset because the research focuses on urban areas. A neighborhood is classified as not-urban if there are less than 500 addresses per km². The neighborhoods that are excluded from the dataset based on this criterion were mostly in rural or industrial areas.
In total, the dataset consists of 437 neighborhoods. The mean number of inhabitants per neighborhood is 1980,81, with a standard deviation of 1453,33. The minimum number of inhabitants is 5 and the maximum is 6400.

	N	Minimum	Maximum	mean	Standard deviation
Inhabitants per neighborhood	437	5	6400	1980,81	1453,33

Figure 3: Descriptive statistics of the number of inhabitants per neighborhood

The socioeconomic status of neighborhoods can be classified in a multitude of ways. For this research the classification of the socio economic status of neighborhoods will be done in the same way as in (de Vries et al., 2020), since this will be a similar type of research. The dimension of socioeconomic status of neighborhoods will be divided into three separate variables which are: average residential property, percentage of households with a low annual income and percentage of household with a high annual income
A low annual income in the Netherlands is defined as an annual disposable income below 25,100 euros (de Vries, 2020). The minimum disposable income for households with a high annual income is set at 46,500. The data about these characteristics was not present in the 2020 version of the Wijk en Buurt kaart. Therefore the edition of 2018 was used to provide the data about neighborhood socioeconomic status, as this was the most recent version to provide all the data that was needed for the research.

3.3 Explanation of Analysis

To answer the first sub question "How is the quality of city parks spatially distributed in Amsterdam?" The 20 parks have been given a quality score based on the ratings that were given using the RECITAL tool. The final quality score for a park is the total of all the scores from the quality items added up, this total score will be the mean score of the scores both raters have given. These results will be presented in a thematic map. The thematic map gives a clear overview of the quality of the researched parks by using a clear colour scheme. This map will mostly be used to give an overview of where the parks that score good or bad are located in Amsterdam. The total quality scores have first been calculated in SPSS by adding up all individual scores and dividing this by two, because there were two raters. Besides the total quality score, the mean quality scores have also been calculated for the parks. These scores are on a scale from 0 to 4. These final scores for the parks have been added to the GIS dataset manually.

To answer the second sub question "To what extent is access to city parks related to socioeconomic status of neighborhoods in Amsterdam?" First, a network analysis has been conducted in Arcgis Pro. With this network analysis, the distance from the nearest park to neighborhood centroid has been measured. The network analysis is typically used to answer questions related to linear networks and uses network data such as roads (Comber et al., 2008). A common application of the network analysis tool is to identify service areas, which will be done in this research. In studying access, network analysis is seen as the most accurate method to measure access because it computes the real distance from an access point (Handley et al., 2003). In this analysis, the centroids of the neighborhoods will be used as the points to connect to the network. Overall, centroids are often used in network analyses to link polygons to the actual network (Comber et al., 2008). The road networks for pedestrians and cyclists in Amsterdam were downloaded from Geofabrik.de. This website provided a network dataset from openstreetmap that contained data about all the streets in Amsterdam. The openstreetmap is a dataset created and maintained by the GIS community and in the context of Amsterdam contains all the data about the road network. Furthermore, two separate buffers were created around the parks, one based on walking distance and another based on cycling distance. The buffer based on cycling distance is used in this analysis because nearly everyone owns a bike in Amsterdam and cycling is a very commonly used mode of transportation in Amsterdam. The aim of the municipality of Amsterdam is to have a park within a 10 minute walking distance for all inhabitants (Gerritsen, 2020). Translated to euclidean distance this would be a distance of 840 meters. This distance is based on a walking speed of 1,4 meters per second. 1,4 meters per second is the preferred walking speed for average, normal weight adults (Browning & Kram, 2005) For the buffer size that is used in the analysis based on walking distance, the size of the buffer will be rounded to 800 meter. When the same criterion of a park within 10 minutes is used for the analysis based on cycling speed, this results in a buffer size of 2,48 kilometer distance based on a cycling speed of 14,9 kilometer per hour. The size of the buffer used in the analysis will be rounded to 2.5 kilometer. 14,9 kilometer per hour is the average cycling speed in the Netherland based on data collected in the 'Bike count week' by collecting data from people who used an app on their mobile phone for all their bike rides during a week (Bikeprint.nl, 2018)' Using these buffers the overlap between the area (neighborhood) and the park buffer could be calculated. Using the data about distance to the nearest park and the overlap between park buffer and area the access to parks could be related to the socioeconomic data about the neighborhoods.

For answering the final sub question “To what extent is the quality of city parks related to socioeconomic status of neighborhoods in Amsterdam?” Both the quality scores and the access to parks were used to analyse the relationship between access to quality of parks and socioeconomic status. To answer this final question, the nearest park was assigned to each park based on walking distance from the neighborhood centroid to the park access points along the street network. After the nearest park was defined, the quality of this park was assigned to each neighborhood. To incorporate both the quality scores of the parks and the availability of parks per neighborhood in the analysis, the quality scores have been multiplied with the overlap of parks buffers in the area. To answer the question, correlations between socioeconomic features and the access to quality parks have been calculated.

4. Results

4.1 Inter Rater Consistency

After the data about the quality of the parks was collected by two different raters for each park, the level of agreement between the raters had to be measured. First, a total of the ratings given by the first rater as well as a total of the ratings given by the second raters have been calculated. With these totals, the level of agreement between the raters could be calculated. This was done using the intraclass correlation coefficient (ICC) in SPSS. Within the options environment for calculating the ICC, multiple choices can be made for the type of ICC that will be calculated. In this case the option of ‘two way random’ was used, because the raters were a random sample of all possible raters. Further the choice has been made to measure ‘consistency’ and not the ‘absolute agreement’ type. In this case the interest was in the cohesion between the raters. The ICC gives a score between 0 and 1 that estimates the level of agreement between the raters. A score below 0,5 indicates poor agreement, scores between 0,5 and 0,75 indicate moderate agreement, between 0,75 and 0,9 is good agreement and everything above 0,9 is excellent agreement (Knobel et al., 2020).
After all of the data was processed from the paper RECITAL forms onto an SPSS dataset, two new variables have been created. One variable listed the total scores for each item given by the first rater. The second variable contained the total scores for all the items given by the second raters. After this, the ICC could be calculated between these two variables. Calculating the ICC resulted in a score of 0,971. Since this score is above 0,9 it indicates that there is excellent agreement in ratings between the raters, therefore there do not seem to be major differences between the scores given by the first rater and the second raters. Because there are no major differences between the raters, it is plausible that the results about the quality of the parks are reliable.

4.2 How is the quality of city parks spatially distributed in Amsterdam?

The answer to this sub question will be visualized in a thematic map. The scores that were given on all of the items in the RECITAL tool were combined to get an overall quality score of the parks. The results are shown in a map below that shows the 20 researched parks and the neighborhoods in Amsterdam. The quality of the parks is shown by using graduated colors. The color green is used for the map, as this is the color that symbolizes green space. One map showing the total quality scores will be presented below, another map that shows the mean quality scores of the parks will also be presented here. Along with these maps, there will also be a table showing the scores for each of the parks.

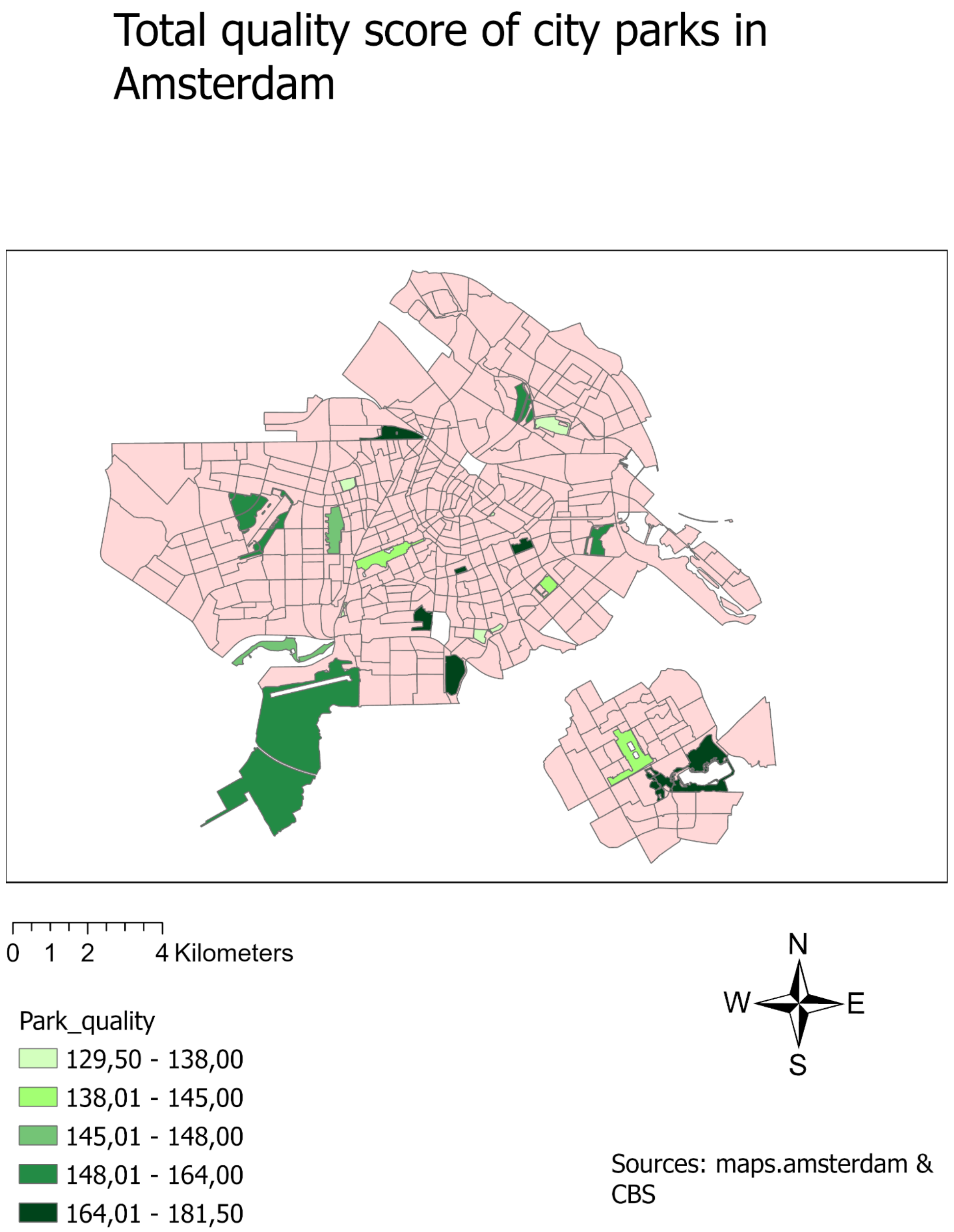

Figure 3: Map of the total quality scores of parks in Amsterdam

As can be seen on the maps there are 6 parks that can be qualified as the best parks in Amsterdam based on this analysis. These 6 parks are: Amstelpark, Beatrixpark, Gaasperpark, Oosterpark, Sarphatipark and Westerpark. All of these 6 six parks have a mean quality score that is above 2,5, on a scale from 0 to 4. From all the parks, the Westerpark has the highest quality score, with the mean quality score being 2,71.
The worst parks in this analysis are: Martin Luther King Park, Vliegenbos and Erasmuspark. Both Martin Luther King Park and Vliegenbos had a mean quality score below 2, respectively 1, 93 and 1,94.
When looking at how the quality of city parks is spatially distributed, no real spatial pattern is directly visible. The only thing that could be remarkable is that some of the highest rated parks are located in the southern part of Amsterdam, especially with the Amstelpark and Beatrixpark that are located very close to each other. Other than this the quality of parks seems to be spreaded out pretty evenly across the city. There do not seem to be any parts in the city where clusters of really high or low quality parks are present.

Park name	Total quality score	Mean quality score
Amstelpark	173,5	2,59
Amsterdamse Bos	160	2,39
beatrixpark	173,5	2,59
Erasmuspark	136	2,03
Flevopark	161	2,4
Park Frankendael	144,5	2,16
Gaasperpark	168	2,51
Martin Luther Kingpark	129,5	1,93
Nelson Mandelapark	141,5	2,11
Noorderpark	164	2,45
Oeverlanden	148	2,21
Oosterpark	170,5	2,54
Rembrandtpark	148	2,21
Sarphatipark	169,5	2,53
Schinkeleilanden	136	2,03
Sloterpark	163	2,43
Vliegenbos	130	1,94
Vondelpark	145	2,16
Wertheimpark	138	2,06
Westerpark	181,5	2,71

Figure 4: Quality scores per park

When looking at the descriptive statistics of the quality scores, the mean total quality score for the 20 parks is 154,05 with a standard deviation of 16,17. The total scores range from 129,50 to 181,50

	N	Minimum	Maximum	Mean	Standard

					deviation
Total quality scores	20	129,5	181,5	154,05	16,17

Figure 5: Descriptive statistics of the total quality scores

When taking into account the mean scores, the mean score for all of the parks is 2,30 on a scale from 0 to 4. The minimum is 1,93 and the maximum mean score 2,71.

	N	Minimum	Maximum	Mean	Standard deviation
Mean quality scores	20	1,93	2,71	2,3	0,24

Figure 6: Descriptive statistics of the mean quality scores

4.3 To what extent is access to city parks related to socioeconomic status of neighborhoods in Amsterdam?

4.3.1 *Walking distance buffer*

First, the access from neighborhoods to city parks in Amsterdam has been analyzed based on buffers around the parks. The buffers that were created are euclidean buffers. Euclidean buffers calculate the distance between two points and are generally seen as the most commonly used type of buffers when analyzing distance within a projected coordinate system and when the features are concentrated in a relatively small area (pro.arcgis.com, 2021) The buffer based on walking distance was created using a distance of 800 meters around the parks. The 800 meter buffers around parks are shown in the map below.

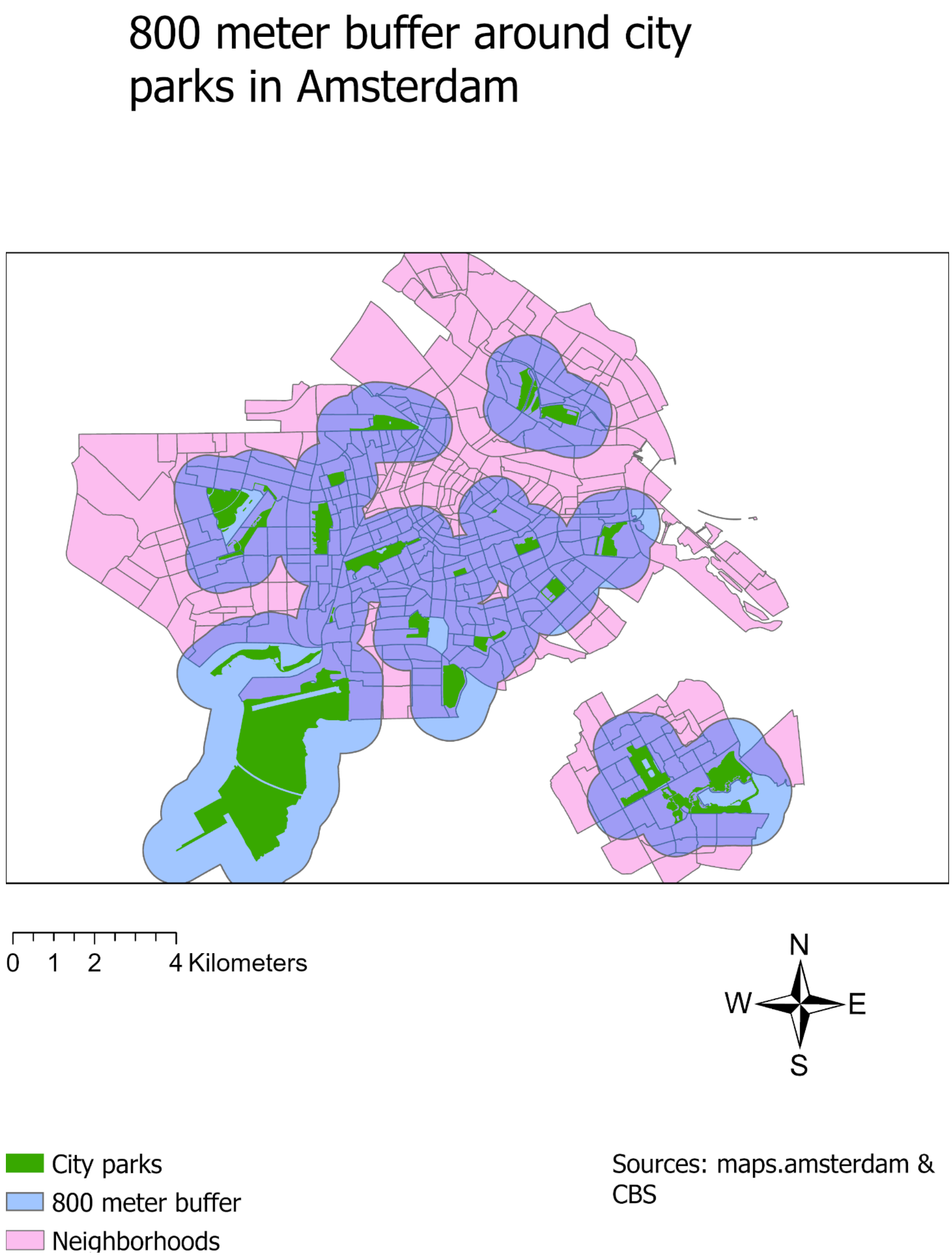

Figure 7: Map with an 800 meter buffer around the city parks in Amsterdam.

As can be seen on the map above, most of the neighborhoods in Amsterdam are covered by at least a bit of the 800 meter buffer around the city parks. However there are also some neighborhoods where there’s no overlap between neighborhood area and the buffer. In total, 366 of the 437 neighborhoods do have at least some coverage of the 800 meter buffer. This means that 83,75% of the neighborhoods are covered by the buffer.

After this buffer was created, the percentage of overlap between neighborhood area and the buffers was calculated. When the first buffer was created, it was chosen to dissolve the buffer features into a single polygon to avoid neighborhoods from having more than 100%

overlap if there would be more loose buffers. To calculate the percentage of neighborhood area that is covered by a buffer around the parks the tabulate intersection tool has been used. With this tool, the percentage of each neighborhood that is covered by a buffer is presented in a table. The features of this table have been added to the neighborhoods dataset using the joins & relates tool. The percentages of coverage are presented in a thematic map below.

Percentage of area covered per neighborhood by an 800 meter buffer around city parks in Amsterdam

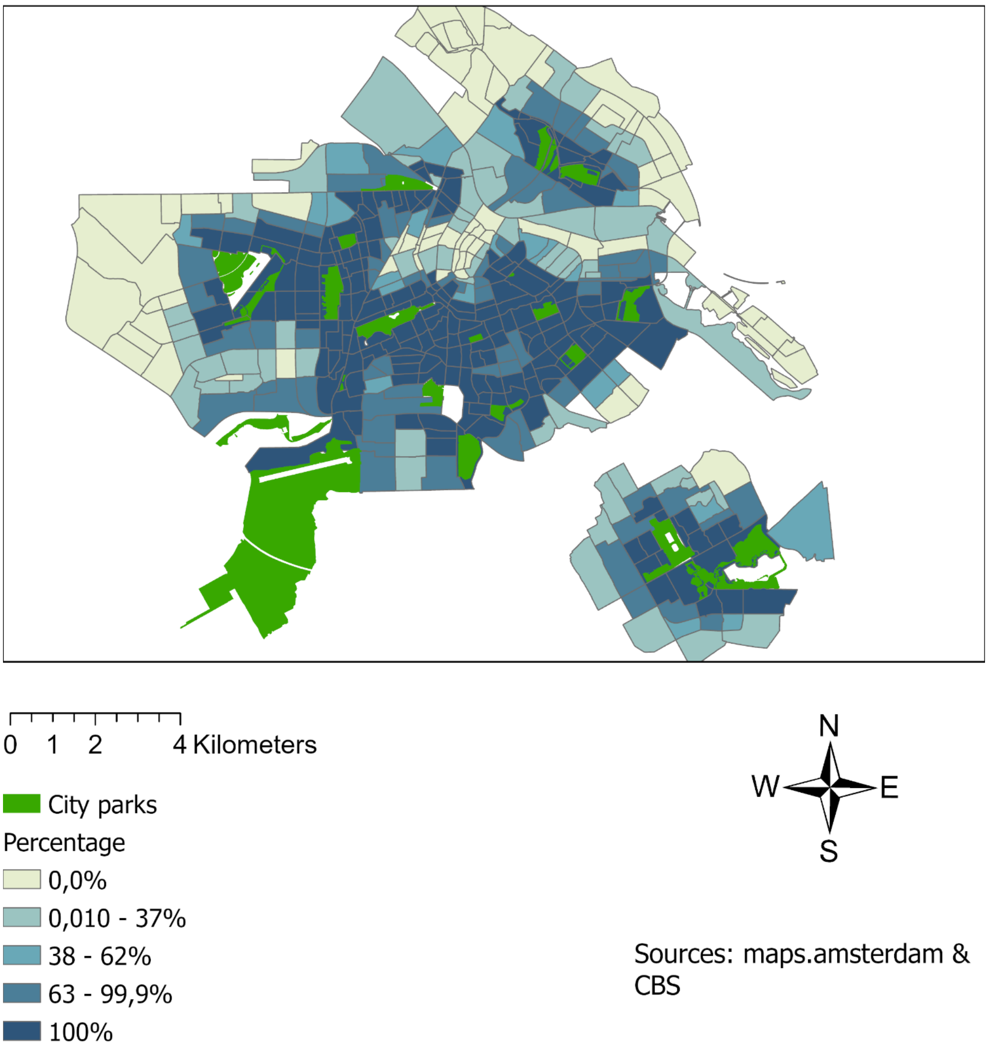

Figure 8: Map with the percentage of neighborhoods that is covered by the 800 meter buffer.

The image of this map corresponds with the buffer map in the sense that neighborhoods that were covered the most by the buffer are the darkest color blue. The mean percentage of coverage for all of the neighborhoods is 66,72%, with a standard deviation of 42,23%.The

percentages of coverage logically range from 0 to 100%. in 206 of the 437 neighborhoods, 100% of the neighborhood is covered by the park buffer.
An interesting image that can be observed in this map is that the outskirts of the city in the west, north and east seem to have relatively less access to parks compared to other parts of the city.

With the coverage percentages calculated, correlations between access to the parks and socioeconomic status of neighborhoods could be calculated. In order to open the table from Arcgis in SPSS, the table to excel tool has been used to create an excel table.

For measuring the correlations between socioeconomic features and the coverage percentage, Spearman's rho has been used as correlation coefficient. Spearman's rho provides a number as correlation coefficient between -1 and 1. A coefficient of -1 would indicate a strong negative correlation, while 1 indicated a strong positive correlation. Even though Spearman's rho indicates if a correlation is positive or negative, it does not tell anything about the direction of the correlation. However, in this case the influence of socioeconomic features on access to parks is being researched, and not the other way around.

First the correlation between the average property value and the percentage of coverage is measured. Average property value is represented as WOZ value, which means 'value of real estate', in the CBS dataset. The outcome of the calculation shows a correlation coefficient of 0,129, meaning that there is a weak positive correlation. A positive correlation means that if one variable increases, the other variable will go up as well. The significance of this correlation is set at 0,007, meaning that the correlation is significant. This means that the observed correlation is not likely to be based on chance.

			Property value	Coverage percentage
Spearman's Rho	property value	correlation coefficient	1,00	0,129
		Sigma (2-tailed)		0,007
		N	437	437

Figure 9: relation between property value and the percentage of coverage

Next, the correlation between the percentage of households with a low annual income in a neighborhood and the percentage of coverage has been measured. Based on Spearman's rho there is only a very small positive correlation between these variables. The correlation is not significant however with a p value of 0,5. This means that the correlation that was found is likely to be based on chance.

			Low income households	Coverage percentage
Spearman's Rho	Low income households	correlation coefficient	1,000	0,032
		Sigma (2-tailed)		0,500

		N	437	437

Figure 10: Relation between the percentage of low income households and the percentage of coverage

Finally, the relation between high income and percentage of coverage has been analyzed as well. No data about the percentage of inhabitants with a high income was available in the CBS dataset unfortunately. To solve this, another variable has been used. This variable is the percentage of inhabitants that are within the 20% highest incomes nationwide. When the correlation between this and the coverage percentage is measured, the correlation coefficient is 0,138 and is significant with a p value of 0,004. This means that there is a weak positive correlation between high incomes and access to parks.

			high income residents	Coverage percentage
Spearman's Rho	High income residents	correlation coefficient	1,000	0,138
		Sigma (2-tailed)		0,004
		N	437	437

Figure 11: Relation between the percentage of high income residents and the percentage of coverage

4.3.2 *Cycling distance buffer*

Besides park accessibility based on walking speed, accessibility has also been measured based on cycling speed. Again, the first step was to create a buffer around the parks that represents a 10 minute travel time range. Based on the average cycling speed, the buffer size was set at 2.5 kilometer.

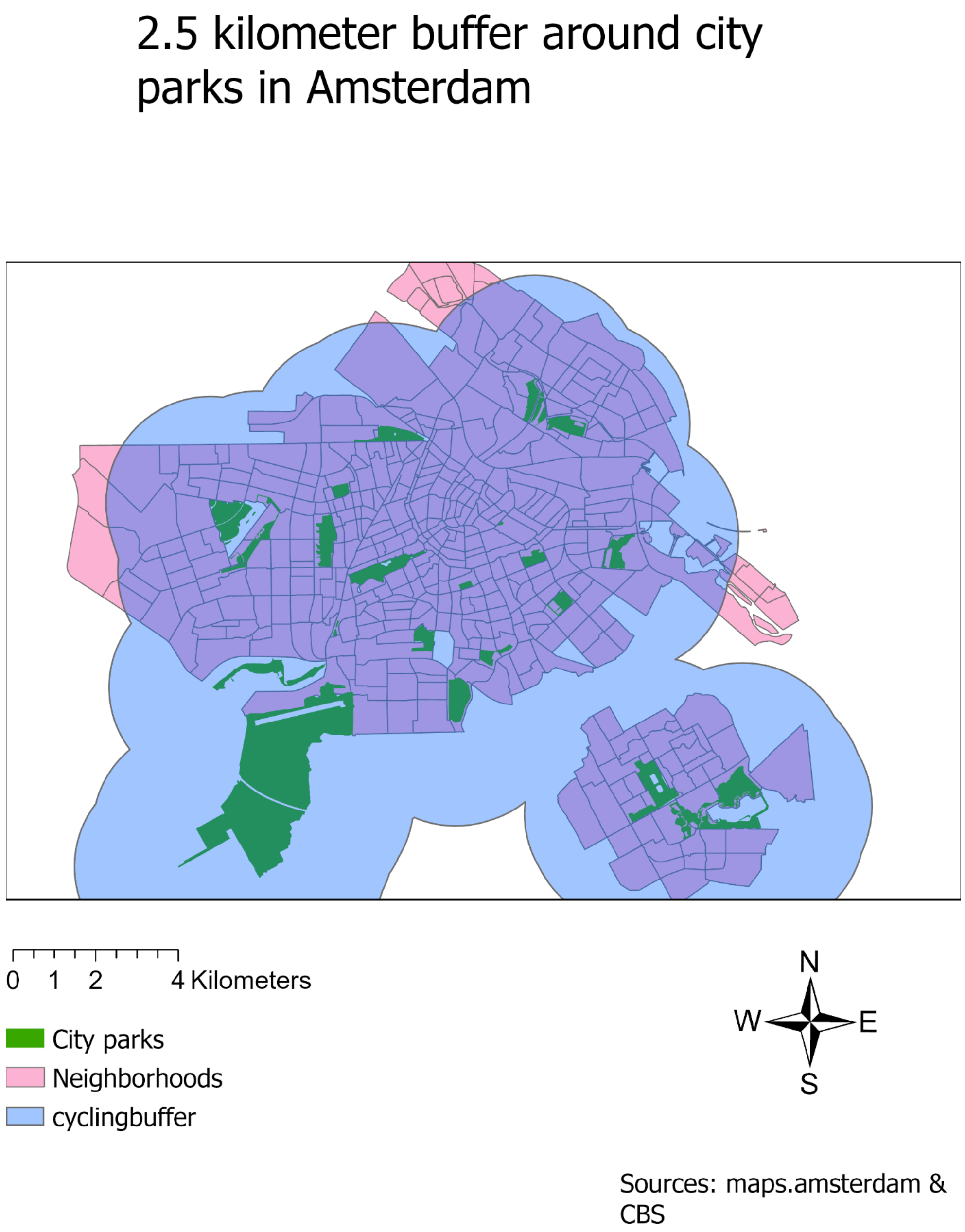

Figure 12: Map of the 2.5 kilometer buffer around the city parks in Amsterdam.

As can be seen on the map above. nearly all the neighborhoods fall within the 2,5 kilometer buffer for cycling distance. Only 7 neighborhoods do not have any coverage of the buffer. The only areas of Amsterdam that are not covered by this buffer based on cycling distance are in the northwest and the east.

Again, after calculating the buffer around the parks, the percentage of overlap between neighborhood area and buffer has been calculated using the tabulate intersection tool, these percentages have again been added to the neighborhoods dataset by using the join tool. With these percentages, another thematic map has been made that is shown below.

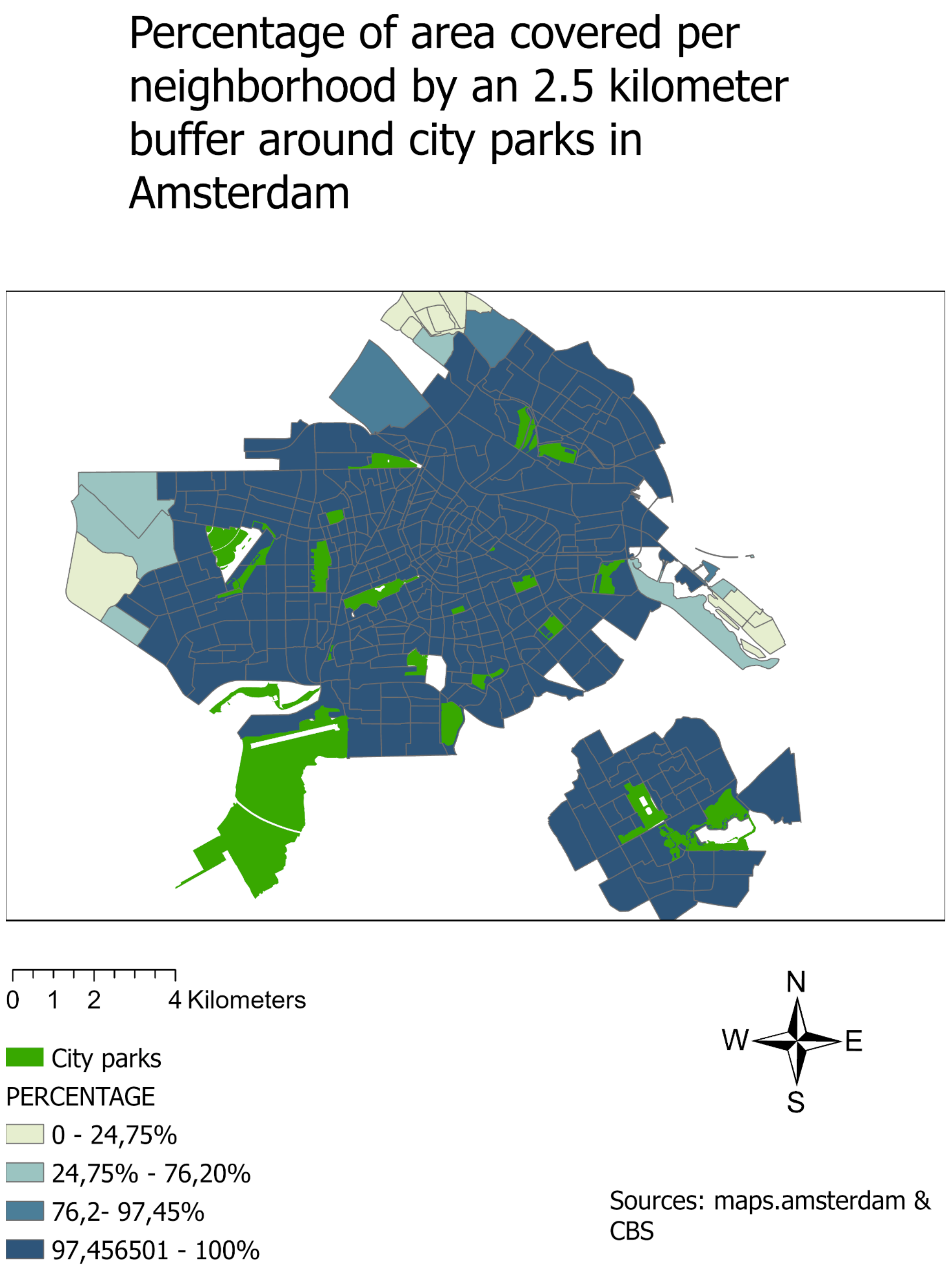

Figure 13: Map with the percentage of neighborhoods that is covered by the 2.5 kilometer buffer.

Using the buffer based on cycling distance, the mean percentage of overlap is 96,59%, with a standard deviation of 16,91. With the 2.5 kilometer buffer, 414 of the 437 neighborhoods have an overlap of 100% with the buffer. This means that 94,74% percent of the neighborhoods are covered entirely by the buffer.

Again, the correlations between socioeconomic features and the percentage of buffer coverage have been measured in SPSS. However, all three correlation shows only a very small correlation coefficient and none of them are significant. This is likely due to the large proportion of neighborhoods that have a coverage of 100%. Therefore it doesn’t really make sense to dig deeper into any possible correlations with the accessibility based on cycling distance. The correlations are presented together in one table below.

			Coverage percentage
Spearman's rho	property value	correlation coefficient	-0,036
		sigma (2-tailed)	0,448
	low income households	correlation coefficient	0,028
		sigma (2-tailed)	0,557
	high income residents	correlation coefficient	-0,029
		sigma (2-tailed)	0,539
		N	437

Figure 14: Relation between socioeconomic features and the percentage of coverage.

4.3.3 *Network analysis*

Through a network analysis, the distance from each neighborhood to the closest park has been calculated. Firstly, centroids have been created for each of the neighborhoods to calculate the distance from neighborhood centroid to the nearest park. The centroids have been created using the feature to point tool in arcgis. Since the network analysis tools in arcgis require all input features to be point features, the layer containing the parks first had to be converted to point data first. To do this, the layer of the parks was intersected with the dataset containing the streets of Amsterdam. The points that resulted from this intersection represent the places where the parks can be accessed. In Arcgis, the closest facility analysis tool was used to identify the closest park access point and calculate the distance from the neighborhood centroids to the closest access point. Within the closest facility tool, the park access points were used as the facilities and the neighborhood centroids as incidents. The travel mode was set to walking distance (in kilometers) and the direction was set as 'towards facilities'. The resulting distance in kilometers from neighborhood centroid to the nearest park is shown in a thematic map below. In the map, the darker the colour blue is, the closer a neighborhood is located to a park.

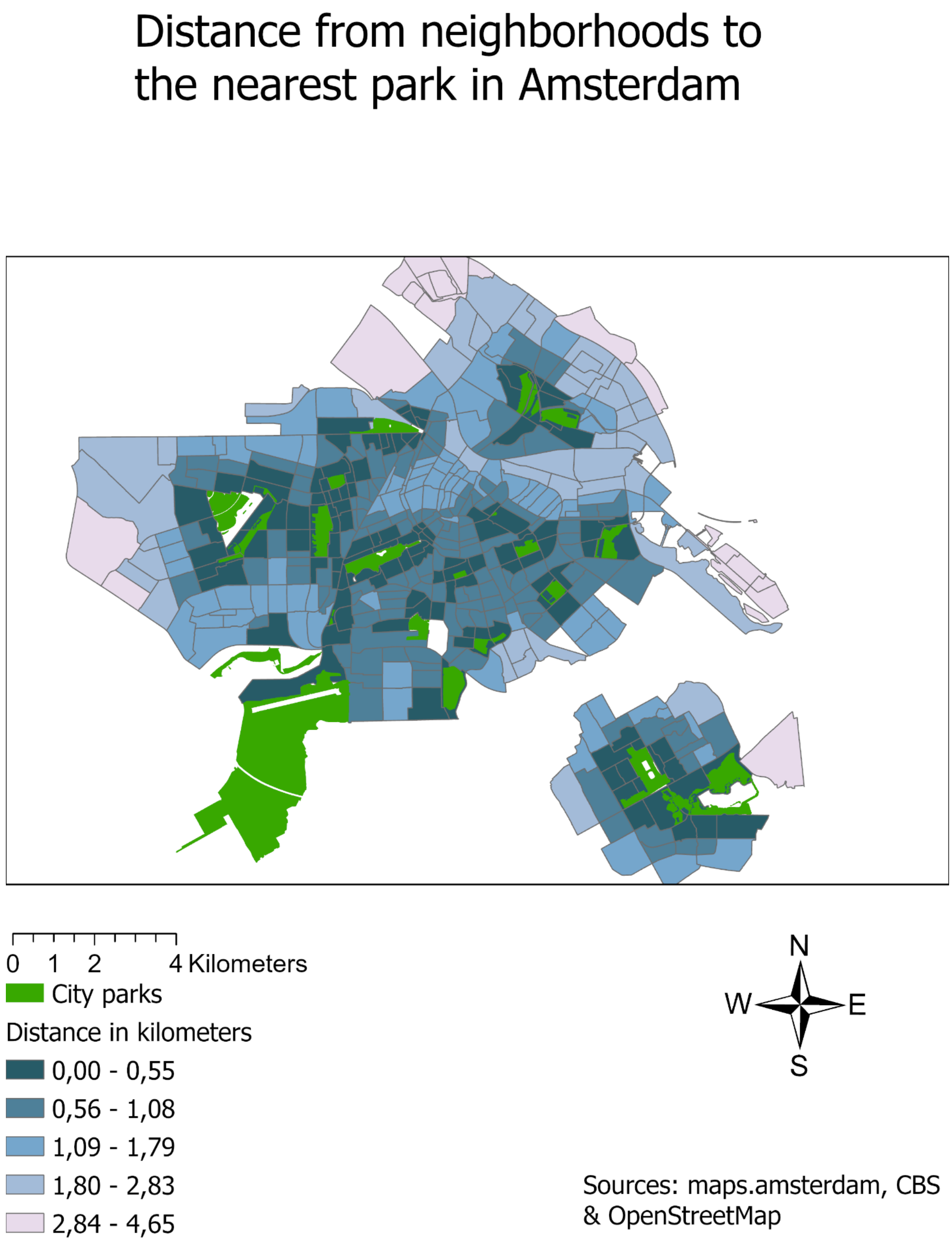

Figure 15: Distance to nearest park from neighborhood centroid.

The pattern of the map above corresponds with the previous pattern that was observed with the 800 meter buffer in the sense that neighborhoods in the northern, eastern and western outskirts of Amsterdam are located the furthest away from a park. As expected, the neighborhoods surrounding the parks obviously have the shortest distance towards a park. The distance in kilometers towards the nearest park was rounded to two decimals. The neighborhood with the shortest distance only has a distance of 0,00 kilometer while the neighborhood that is the furthest away from a park has a distance of 4,65 kilometer. The mean distance from neighborhood centroid to the nearest park is 1,06 kilometers with a standard deviation of 0,86.

	N	Minimum	Maximum	Mean	Standard deviation
Distance to nearest park	437	0,00	4,65	1,06	0,86

Figure 16: Descriptive statistics of distance from neighborhoods to nearest park

After the distance from each neighborhood centroid to the nearest park was calculated, this data was added to the neighborhoods dataset by using the join tool. This way, the distances were added to the table containing the information about all the neighborhoods. Thereafter, the table was converted to an excel file to be used in SPSS. In SPSS, correlations between socioeconomic features and distance were measured by using Spearman's Rho again as correlation coefficient.

First the correlation between property value in neighborhoods and the distance to the nearest park was calculated. The results show a correlation coefficient of -0,108, which indicates there is a weak negative correlation between property value and distance to the nearest park. A negative correlation indicates that when the value of one of the variables increases, the value of the other variable decreases. This correlation has a p value of 0,023 and is significant at the 95% confidence interval.

			Property value	Distance to nearest park
Spearman's Rho	property value	correlation coefficient	1,00	-0,108
		Sigma (2-tailed)		0,023
		N	437	437

Figure 17: Relation between property value and distance to nearest park

The second correlation that was measured is the correlation between the percentage of low income households and the distance to the nearest park. Again, there appears to be a weak negative correlation, with a Spearman's Rho value of -0,102. This correlation is significant as well at a 95% confidence interval, with a p value of 0,033.

			Low income households	Distance to nearest park
Spearman's Rho	Low income households	correlation coefficient	1,000	-0,102
		Sigma (2-tailed)		0,033
		N	437	437

Figure 18: Relation between the percentage of low income households and distance to nearest park

As a third variable of socioeconomic status, the correlation between high income residents and the distance to the nearest park has been measured. The correlation coefficient resulting from this calculation is -0,117, which indicates a weak negative correlation between high income residents and distance to the nearest park. This correlation is also significant with a p value of 0,015.

			high income	Distance to nearest

			residents	park
Spearman's Rho	High income residents	correlation coefficient	1,000	-0,117
		Sigma (2-tailed)		0,015
		N	437	437

Figure 19: Relation between the percentage of high income residents and distance to nearest park

In both the analysis which uses the percentage of the neighborhood that is covered by the 800 meter park buffer as well as in the analysis where walking distance along the street network is used to determine accessibility there appears to be a weak correlation between property value and access to parks. Within the buffer analysis there is a weak positive correlation, while in the walking distance analysis there is a weak negative correlation. In both of these analyses however, property value is positively correlated with access to parks because a shorter distance means better access. The negative correlation with distance is therefore actually a positive correlation with accessibility.
For the variable of the percentage of high income residents per neighborhood, there were weak correlations with the accessibility measures as well. Just as with property value, the correlation with accessibility was positive in both analyses.
With the variable of low income households there was no significant correlation with the percentage of the neighborhood that was covered by the 800 meter buffer. There was a weak negative correlation with distance to the nearest park however, meaning that the percentage of low income households is also positively correlated to access to city parks when walking distance is used as the measure of accessibility.

4.4 To what extent is the quality of city parks related to socioeconomic status of neighborhoods in Amsterdam?

4.4.1 *Quality of the nearest park per neighborhood*

Besides analyzing the park accessibility for neighborhoods, the goal of the research was to get an insight in the distribution of park quality as well. Therefore, this part will be about analyzing the division of park quality and the accessibility of park quality.
For every neighborhood, the nearest city park has been identified through the network analysis that was mentioned before. After doing this, the quality score of the nearest park has been added to each of the neighborhoods, resulting in a table where each neighborhood has a variable that represents the total quality score of the nearest city park. A thematic map showing the quality of the nearest parks for all of the neighborhoods is presented below. From the thematic map, there does not seem to be a spatial pattern of how the quality of the nearest park per neighborhood is distributed over Amsterdam.

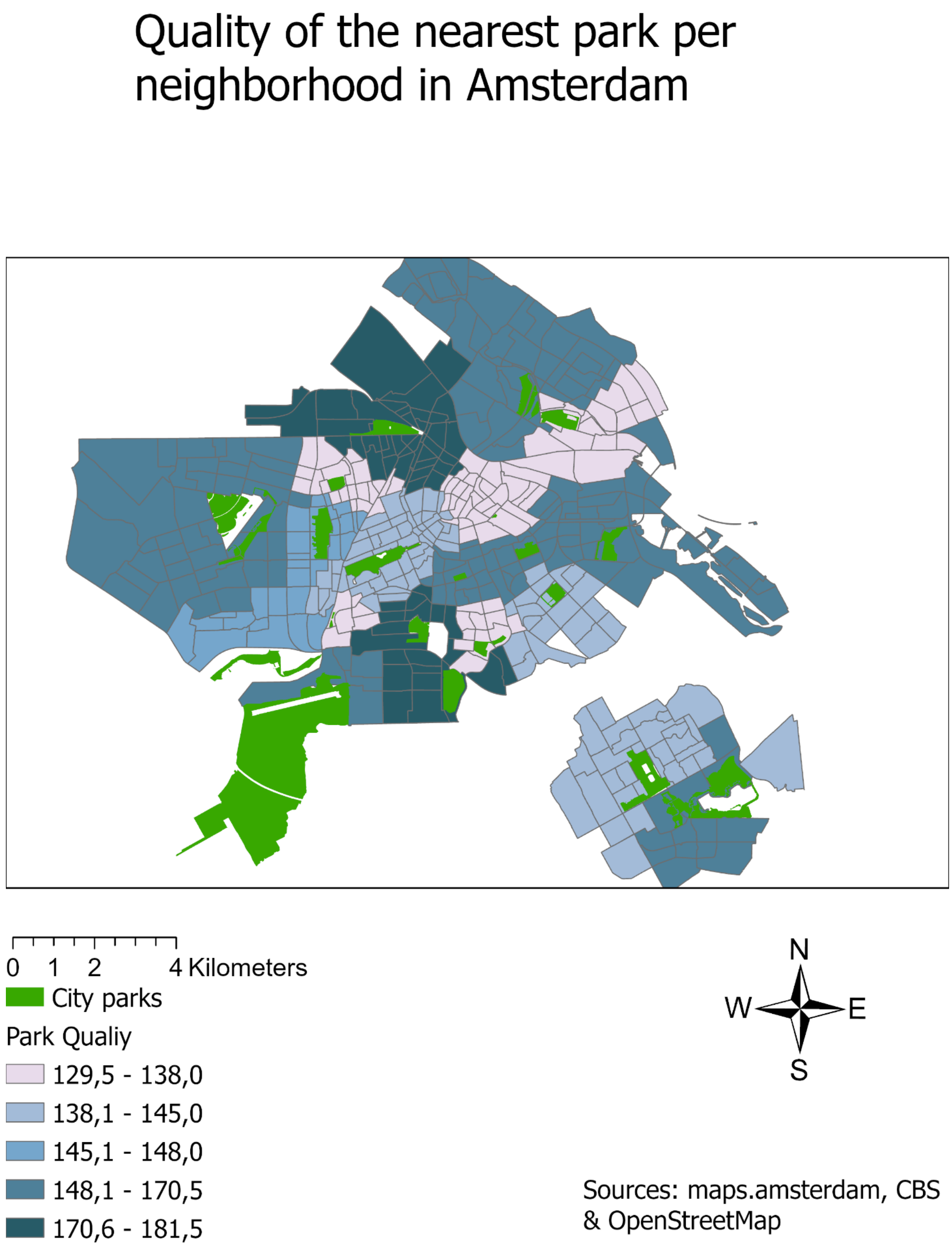

Figure 20: Map showing the quality of the nearest park per neighborhood

Along with this map which shows the spatial distribution of nearest park quality, correlations between socioeconomic status and the quality of the nearest park have been calculated. Again the three socioeconomic variables have been used to calculate correlations, this time correlations with the quality score of the nearest park per neighborhood. For all three of the socioeconomic variables, there was only a very weak correlation with the quality of the nearest park and all of these weak correlations were statistically insignificant. So, no clear correlation between socioeconomic status and quality of the nearest park has been found.

			Nearest park quality
Spearman's rho	property value	correlation coefficient	-0,012

		sigma (2-tailed)	0,799
	low income households	correlation coefficient	0,003
		sigma (2-tailed)	0,954
	high income residents	correlation coefficient	-0,003
		sigma (2-tailed)	0,944
		N	437

Figure 21: Correlations between socioeconomic variables and the quality of the nearest park

4.4.2 *Combined quality and access to parks*

The map and correlations that were analyzed above only tell something about the quality of the nearest park for each neighborhood. Only looking at the quality of the nearest park does however not tell anything about the accessibility of these parks from the neighborhoods. The accessibility of the nearest park from each neighborhood has not been taken into account here. Therefore, to take the accessibility in it is needed to multiply the quality scores with a measure of accessibility. This way there is a better understanding about the access to park quality. Firstly, the nearest park quality for each neighborhood has been multiplied with the percentage of the neighborhood covered by the 800 meter buffer around the city parks. The result of this is presented in another thematic map below. For this map, the quality of the nearest park of each neighborhood has been multiplied with the percentage of the neighborhood that was covered by the 800 meter buffer around the city parks. The map shows that around some of the parks, the combined quality and access is the greatest. It also becomes clear that there are some major differences between neighborhoods when it comes to this combined quality and access.

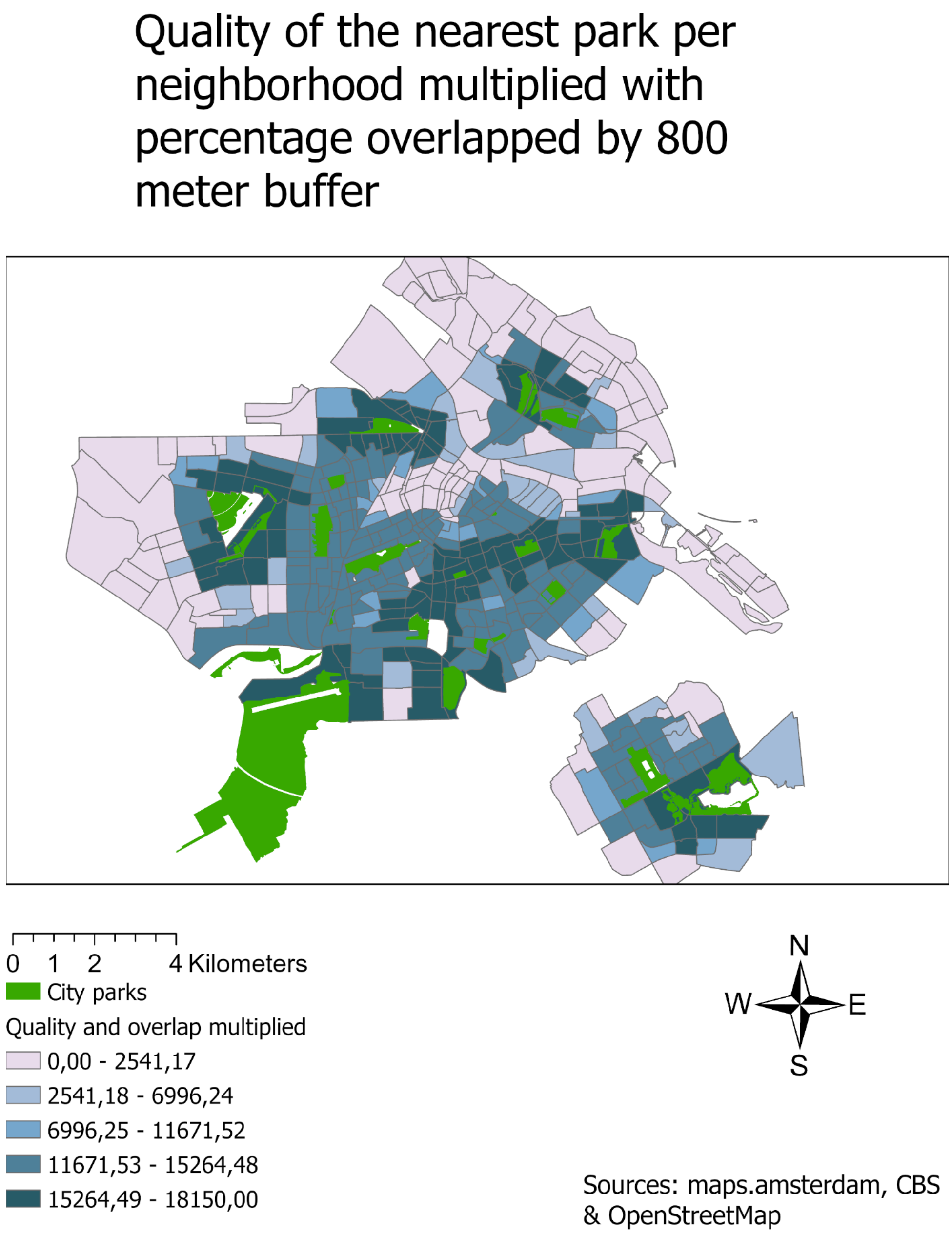

Figure 22: Map with the nearest park and buffer overlap multiplied

Besides presenting this map, correlations between socioeconomic status and the combination of quality and access to parks have also been calculated. The same three variables of socioeconomic status as were used before were used here to calculate correlations. All three variables show a weak positive correlation with the combined quality and access to city parks. However, none of these correlations prove to be statistically significant. So, in the end no clear correlation between socioeconomic status and the combination of quality and access to parks has been found.

			Quality access
Spearman's rho	property value	correlation coefficient	0,088

		sigma	0,068
	low income households	correlation coefficient	0,078
		sigma	0,105
	high income residents	correlation coefficient	0,085
		sigma	0,076
		N	437

Figure 23: Correlations between socioeconomic status and quality and overlap multiplied

In contrast to the analysis that was solely about park accessibility, where some correlations with socioeconomic status were found, no clear correlations have been found between the socioeconomic status of neighborhoods and the quality of city parks.

5. Conclusion

The aim of this research was to get a better understanding of the spatial distribution of city parks and their quality in Amsterdam. In order to achieve this goal, a main research question was formulated to structure the research. This main research question is: ‘To what extent is the spatial distribution of city parks and their quality in Amsterdam related to the socioeconomic status of neighborhoods?’ To help answer this research question, three sub questions had been formulated as well to guide the research. These sub questions are the following:

- How is the quality of city parks spatially distributed in Amsterdam?
- To what extent is access to city parks related to socioeconomic status of neighborhoods in Amsterdam?
- To what extent is the quality of city parks related to socioeconomic status of neighborhoods in Amsterdam?

In the research, quantitative data from various sources was used. The socioeconomic data needed about the neighborhoods was openly available from CBS. Data about the quality of Amsterdam’s city parks had to be gathered by using a self administered tool. To gather the data, each park was visited by two persons who independently filled in the form. After this data had been processed into a dataset, the research questions could be answered by analyzing the data. To analyze the data, Arcgis pro has been used for the spatial component of the analysis. Furthermore, SPSS has been in the analysis to calculate correlations.

For answering the first sub question, a thematic map was created showing the city parks and their quality scores. This map functioned as a visualization of the distribution of city parks and their quality. From this map, there did not seem to be a very obvious spatial pattern of how the quality was distributed, it seemed to be distributed pretty evenly over the city. There were some more of the high quality parks in the southern part of the city, but there were no real clusters of high or low quality parks.

For answering the second sub question, multiple measures of access to the parks have been used. These were the percentage of the neighborhood that was covered by an 800 meter buffer around the parks, the percentage of the neighborhood that was covered by a 2.5 kilometer buffer around the parks and walking distance to the nearest park. In the analysis which used the 800 meter buffer, a weak positive correlation was found between

property value and access to parks. Between the percentage of high income residents and access to parks there was a weak positive correlation as well.
When the 2.5 kilometer buffer was used as the measure of accessibility, no correlations between socioeconomic features and access to parks was found. This is likely a result of the fact that almost every neighborhood was entirely covered by the 2.5 kilometer buffer.
When walking distance was used as the measure for access to parks, there was a positive correlation with park access for all three of the socioeconomic variables: average residential property value, percentage of low income households and percentage of high income residents.

The third sub question was about to what extent the quality of city parks is related to the socioeconomic status of neighborhoods. To find an answer to this, first the closest park was identified for each neighborhood, the quality score of the nearest park was then assigned to the neighborhood as well. When analyzing the relation between the quality of the nearest park and socioeconomic status, no correlations were found.

Eventually, the research and analysis has shown that there are some correlations between socioeconomic status and access to parks. Correlations between socioeconomic status and park quality have not been found.
Based on the theory, the expectation was that in neighborhoods with a low socioeconomic status, the access to and quality of green space would be less than in high income neighborhoods. Weak positive correlations with green space accessibility were found for both average residential property value and the percentage of high income residents. This would indicate that neighborhoods with a higher socioeconomic status would have slightly better access to city parks. The fact these positive correlation were only weak can be explained by that the differences in accessibility between high and low income neighborhoods tend to be smaller in highly urban areas, as de Vries et al., (2020) found in their research.
However, there was a weak positive correlation as well between the percentage of low income households and access to city parks.
Another expectation derived from the theoretical framework was that neighborhoods with a high socioeconomic status would have access to city parks of higher quality than neighborhoods with a lower socioeconomic status. In the analysis however, no correlations between socioeconomic status and the quality of city parks were found.

One of the potential aims of the research was to give possible recommendations to the municipality about improving the distribution of green space and green space quality. With the weak correlation between socioeconomic status and city park access and the absent correlation between socioeconomic status and city park quality however, it is not possible to give any valuable recommendations about this. However, it became clear that there are neighborhoods that are located far away from a city park. The goal of Amsterdam's municipality to have a city park within a ten minute walking distance for each resident is clearly not met. Therefore, it is advisable for the municipality of Amsterdam to invest in new parks, to make sure they reach their goal.

6. Reflection

The research that was conducted has some limitations and there are some things that could be improved in future research to improve the understanding in the relation between socioeconomic status of neighborhoods and the access to and quality of city parks. The limitations of the research, as well as some recommendations for possible future research will be mentioned here.

In this research, only city parks were considered, while in Amsterdam there are many other recreational green spaces as well. Due to limited time, these other recreational green spaces were excluded from the study. The results may have been different if all green spaces were considered in the research as well. Obviously, if more green spaces would have been considered in the research, the distances to green space would be shorter and more neighborhoods would have been covered by a green space buffer. Furthermore, the distribution of all these green spaces over the city could be different than the spatial division of the researched parks. Therefore, if all of the recreational green spaces in Amsterdam would have been studied, the results of the research could have been different.

The time when the parks were visited and the conditions under which the park visits have taken place could have had an impact on the outcome of the park quality scores.
The field work, in which the data about park quality has been collected, has only been conducted on days with good weather, this might have made the results slightly more positive, and therefore the park quality scores higher. If the weather would have been worse during visits the quality scores could have been worse as well. For example when it is raining it is very plausible that some features appear less pleasing than when the sun is shining.
Furthermore, all of the park visits have taken place during day time. Some of the feature scan be observed differently at night time compared to daytime, for example the incivilities such as alcohol use and sex work. So, for further research it would be advisable to make visits on a variety of times, to observe the difference between day and night as well.

All the parks that were studied have been rated by two persons, if there would have been more raters it could have resulted in more representative scores. Even though there was a high level of agreement between the raters, differences in how people rate specific features do exist. Therefore the quality scores of the parks could be more representative if there would have been more raters. Different people can have different opinions about the parks and might rate things in a different way. In future research towards park quality, it would be better to have more people to assess the quality of parks, to make the results more representative.

In reality, differences between people and groups of people exist in what things they find important in green space. In this research a static tool is used that was developed by researchers, this might not completely represent what everyone values as features of green space quality. It might be that it misses some features that particular groups find important in a park or that it lays too much emphasis on features that some groups do not value as very important.

In the network analysis, the assumption is made that everyone has the same travel speeds for walking and cycling. However, in reality there are differences between people in the speed at which they walk or cycle. These differences between people have not been taken into account here. Furthermore, some people have reduced mobility and therefore have a lower walking or cycling speed or are unable to walk or cycle at all. The accessibility analysis in this research has not taken into account the reduced mobility some people face. So, the network analysis does not take into account any speed differences between people and therefore does not completely represent everyone's mobility. In future research, an increased understanding in people’s mobility could lead to a better overall understanding of accessibility.

If these improvements would be made in future research, it could lead to more representative results and to an even better understanding of the relation between the spatial distribution of city parks and their quality and the socioeconomic status of neighborhoods

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Appendix 1: RECITAL tool

Park:

Dimension	**Item**	**Type of scoring**	0	1	2	3	4
Surroundings	Surrounding buildings visibility	Reversed quantity					
	Surrounding buildings facades maintenance	Quality					
	Surrounding buildings facades greenness	Quality					
	Connection to the site	Quality					
			0	1	2	3	4
Access	Space entries	Combined					
	Fences	Combined					
	Walking paths	Combined					
	Bike lanes	Combined					
	Car parking spaces	Quantity					
	Guiding signage	Quantity					
	Handicapped	Combined					

	adaptations						
	Slope	Quantity					
Facilities	Playgrounds	Combined					
	Grass pitches	Combined					
	Courts	Combined					
	Dog playing grounds	Combined					
	Skateboard/BMX ramps	Combined					
	Open space for multichoice usage	Combined					
	Water-related facilities	Combined					
	Outdoor gym	Combined					
			0	1	2	3	4
Amenities	Seating and benches	Combined					
	Litter disposal	Combined					
	Informational signage	Combined					
	Picnic tables	Combined					
	Drinking	Combine					

	fountains	d					
	Public toilets	Combined					
	Shelter	Combined					
	Shade	Combined					
	Dog excrement bins	Combined					
	Specific sports amenities	Combined					
	Barbeques	Combined					
	Cafe/kiosk	Combined					
	Bike Parking	Combined					
	Vegetable garden	Combined					
	Aromatics garden	Combined					
			0	1	2	3	4
Aesthetics and attractions	Views	Combined					
	Primary surface	Quality					
	Material of primary surface	Quality					
	Water fountain	Combined					
	Public	Combine					

	art	d					
	Historic structures or buildings	Combined					
	Public attractions	Combined					
			0	1	2	3	4
Incivilities	General liter	Reversed quantity					
	Alcohol use	Reversed quantity					
	Other drugs	Reversed quantity					
	Sex work	Reversed quantity					
	Vandalism	Reversed quantity					
	Noise	Reversed quantity					
	Smells	Reversed quantity					
			0	1	2	3	4
Safety	Lighting	Combined					
	Visibility from ground level	Quality					
	Visibility form surrounding	Quality					

	buildings						
	Safety adaptations form cars	Quantity					
	Safety adaptations from bikes	Quantity					
	CCTV	Quantity					
Potential usage	Sports activities in courts	Potential use					
	Informal games	Potential use					
	Walking or running	Potential use					
	Children's play	Potential use					
	Conservation or biodiversity	Potential use					
	Enjoy landscape	Potential use					
	Dog walking	Potential use					
	Social activities	Potential use					
	Relaxing	Potential use					
	Cycling	Potential use					
	Water sport	Potential use					
	Fishing	Potential					

		use					
			0	1	2	3	4
Land covers	Tree cover	Braun Blanquet					
	Bush cover	Braun Blanquet					
	Grass	Braun Blanquet					
	Soft soil cover	Braun Blanquet					
	Tough soil cover	Braun Blanquet					

Appendix 2: Scores scale for RECITAL tool

	0	1	2	3	4
Quantity	no presence	Almost no presence	Present in some areas	Mostly present	Always present
Quality	no presence	poorly maintained and aesthetically unpleasant	Poorly maintained or aesthetically unpleasant	Well maintained and aesthetically pleasant	Exceptionally maintained and aesthetically pleasing
Combined quantity and quality	Not present	Not fit for purpose	Fit but need repair or insufficient amount	Fit and sufficient.	Fit, sufficient, and aesthetically pleasing.
Reversed quantity	Always present	Mostly present	Present in some areas	Almost no presence	No presence
Potential use	Activity completely impossible	Activity possible but with many limitations	Activity possible with some limitations	Good conditions for the activity.	Perfect conditions for the activity.
Braun blanquet	5% or less cover	5% to 25% cover	25 % to 50 % cover	50 % to 75 % cover	75 % or more cover

Appendix 3: SPSS outputs

Intraclass Correlation Coefficient

	Intraclass Correlation[b]	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	,944[a]	,912	,965	34,775	72	72	,000
Average Measures	,971	,954	,982	34,775	72	72	,000

Two-way random effects model where both people effects and measures effects are random.

a. The estimator is the same, whether the interaction effect is present or not.

b. Type C intraclass correlation coefficients using a consistency definition. The between-measure variance is excluded from the denominator variance.

Correlations

			Buurten2018.WOZ	Buurten2018.Percentage
Spearman's rho	Buurten2018.WOZ	Correlation Coefficient	1,000	,129**
		Sig. (2-tailed)	.	,007
		N	437	437
	Buurten2018.Percentage	Correlation Coefficient	,129**	1,000
		Sig. (2-tailed)	,007	.
		N	437	437

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

			Buurten2018.P_LKOOPKRH	Buurten2018.Percentage
Spearman's rho	Buurten2018.P_LKOOPKRH	Correlation Coefficient	1,000	,032
		Sig. (2-tailed)	.	,500
		N	437	437
	Buurten2018.Percentage	Correlation Coefficient	,032	1,000
		Sig. (2-tailed)	,500	.
		N	437	437

Correlations

			Buurten2018.P_HOOGINKP	Buurten2018.Percentage
Spearman's rho	Buurten2018.P_HOOGINKP	Correlation Coefficient	1,000	,138**
		Sig. (2-tailed)	.	,004
		N	437	437
	Buurten2018.Percentage	Correlation Coefficient	,138**	1,000
		Sig. (2-tailed)	,004	.
		N	437	437

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

			Buurten2018.P_LKOOPKRH	Neighborhoods_TabulateInters2.PERCENTAGE
Spearman's rho	Buurten2018.P_LKOOPKRH	Correlation Coefficient	1,000	,028
		Sig. (2-tailed)	.	,557
		N	437	437
	Neighborhoods_TabulateInters2.PERCENTAGE	Correlation Coefficient	,028	1,000
		Sig. (2-tailed)	,557	.
		N	437	437

Correlations

			Buurten2018.P_HOOGINKP	Neighborhoods_TabulateInters2.PERCENTAGE
Spearman's rho	Buurten2018.P_HOOGINKP	Correlation Coefficient	1,000	-,029
		Sig. (2-tailed)	.	,539
		N	437	437
	Neighborhoods_TabulateInters2.PERCENTAGE	Correlation Coefficient	-,029	1,000
		Sig. (2-tailed)	,539	.
		N	437	437

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Parkdistan	437	.0000000000	4.650000000	1.064027460	.8621419768
Valid N (listwise)	437				

Correlations

			woz	Parkdistan
Spearman's rho	woz	Correlation Coefficient	1,000	-,108*
		Sig. (2-tailed)	.	,023
		N	437	437
	Parkdistan	Correlation Coefficient	-,108*	1,000
		Sig. (2-tailed)	,023	.
		N	437	437

*. Correlation is significant at the 0.05 level (2-tailed).

Correlations

			p_lkoopkrh	Parkdistan
Spearman's rho	p_lkoopkrh	Correlation Coefficient	1,000	-,102*
		Sig. (2-tailed)	.	,033
		N	437	437
	Parkdistan	Correlation Coefficient	-,102*	1,000
		Sig. (2-tailed)	,033	.
		N	437	437

*. Correlation is significant at the 0.05 level (2-tailed).

Correlations

			p_hooginkp	Parkdistan
Spearman's rho	p_hooginkp	Correlation Coefficient	1,000	-,117*
		Sig. (2-tailed)	.	,015
		N	437	437
	Parkdistan	Correlation Coefficient	-,117*	1,000
		Sig. (2-tailed)	,015	.
		N	437	437

*. Correlation is significant at the 0.05 level (2-tailed).

Intraclass Correlation Coefficient

	Intraclass Correlation[b]	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	,944[a]	,912	,965	34,775	72	72	,000
Average Measures	,971	,954	,982	34,775	72	72	,000

Two-way random effects model where both people effects and measures effects are random.

a. The estimator is the same, whether the interaction effect is present or not.

b. Type C intraclass correlation coefficients using a consistency definition. The between-measure variance is excluded from the denominator variance.

Correlations

			woz	parkqual
Spearman's rho	woz	Correlation Coefficient	1,000	-,012
		Sig. (2-tailed)	.	,799
		N	437	437
	parkqual	Correlation Coefficient	-,012	1,000
		Sig. (2-tailed)	,799	.
		N	437	437

Correlations

			p_lkoopkrh	parkqual
Spearman's rho	p_lkoopkrh	Correlation Coefficient	1,000	,003
		Sig. (2-tailed)	.	,954
		N	437	437
	parkqual	Correlation Coefficient	,003	1,000
		Sig. (2-tailed)	,954	.
		N	437	437

Correlations

			p_hooginkp	parkqual
Spearman's rho	p_hooginkp	Correlation Coefficient	1,000	,003
		Sig. (2-tailed)	.	,944
		N	437	437
	parkqual	Correlation Coefficient	,003	1,000
		Sig. (2-tailed)	,944	.
		N	437	437

Correlations

			woz	qualoverla
Spearman's rho	woz	Correlation Coefficient	1,000	,088
		Sig. (2-tailed)	.	,068
		N	437	437
	qualoverla	Correlation Coefficient	,088	1,000
		Sig. (2-tailed)	,068	.
		N	437	437

Correlations

			p_lkoopkrh	qualoverla
Spearman's rho	p_lkoopkrh	Correlation Coefficient	1,000	,078
		Sig. (2-tailed)	.	,105
		N	437	437
	qualoverla	Correlation Coefficient	,078	1,000
		Sig. (2-tailed)	,105	.
		N	437	437

Correlations

			p_hooginkp	qualoverla
Spearman's rho	p_hooginkp	Correlation Coefficient	1,000	,085
		Sig. (2-tailed)	.	,076
		N	437	437
	qualoverla	Correlation Coefficient	,085	1,000
		Sig. (2-tailed)	,076	.
		N	437	437