Accessibility to social utilities within urban green space

A method-developing thesis

Photo from the walking trail along Säveån in Utby, Gothenburg. Source: Authors own photo.

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ABSTRACT

This thesis aims to develop a methodological framework for analyzing the accessibility to potential social utility environments within urban green spaces from a broad population spectrum within a weekday context. The thesis departs with a scientific literature review, which investigates what types of social utilities urban green spaces potentially can provide to an urban population and what kind of attributes that are important for each utility. The review revealed three main utilities derivable from urban green space; stimulation pf physical activity, mental recovery and social interaction. Important aspects and theoretical concepts of accessibility within a weekday context were also investigated. From these findings, a methodological framework was constructed that first classifies all urban green spaces within the case area quantitatively according to their potential to provide these three main utilities. As urban green space attribute data, a sociotopic classification is used, along with area size and traffic noise pollution. Then, walking accessibility from residential areas to these types of social utility areas for each utility is analyzed. Population statistics is also connected to the accessibility level data. This methodological framework was then applied on this study's case area, the city of Gothenburg. The result revealed that the most common form of utility within Gothenburg is social interaction, followed by stimulation of physical activity. The result indicated that a majority of the population within the study area have an adequate accessibility to these forms of utility, while only a third of the population had it to mental recovery, which also appear to be the generally most desired utility. The main reason for a lack of accessibility to these utilities were lack of larger urban green spaces in the vicinity of residential areas and traffic noise. From these results, four main conclusions were derived. Firstly, urban green spaces are not a homogenous resource. Secondly, accessibility is a key concept in the understanding of urban green space utility potential for urban inhabitants. Thirdly, to quantitatively analyze accessibility to social utilities within urban green space is a complicated process that requires a lot of data. Fourthly, despite several shortcomings, the methodological framework developed in this thesis can reveal important obstacles for the strive towards social sustainable urban environments.

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Preface

The initial idea for the thesis you now have in front of you started with a general desire to know more about the social aspect of green spaces in urban environments. It is a subject that for a long time has interested me in my academic studies, but which I have not earlier immersed myself in. With this last part of my master's programme in human geography I could finally dig in to this exceptionally interesting subject.

It is my wish and hope that this thesis can increase and widen the general understanding for the multifaceted characteristics of urban green spaces and their potential contribution for social sustainable cities in the future. Both for academic researchers but also urban planners, policy makers and other key stakeholders within the urban development sector.

The thesis has been written in collaboration with the City of Gothenburg's Urban Transport Administration, who has helped me to develop my thoughts and ideas during this tough but worthwhile process. They, along with the Park and Landscape Administration and the Environmental Agency has also provided me will crucial data that has made this thesis possible. For this I am hugely grateful. A special thanks should be directed to my external supervisors at the administration Jon Anders Angelbratt and Maria Olsson, without whom this thesis would have been impossible. I also want to thank my academic supervisor from the university, Dr. Anders Larsson, who with his insightful support and expert knowledge on the subject has guided me through this process from start to finish. I also want to thank Dr. Mattias Sandberg for his contribution of perspectives of the multifaceted entity that is public space.

Johan Wedberg
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1 Introduction

Green spaces within the physical urban environment serve many purposes from all three dimensions of sustainability. Apart from stabilization of the local urban climate, rainwater infiltration, noise reduction, biodiversity and other ecosystem services (Kabisch & Haase, 2014) they also provide important social utilities to humans. Literature reviews performed by Baur (2018) and Boniface, Scantlebury, Watkins, & Mindell, (2015), shows that outdoor recreation within green spaces stimulates physical activity and are associated with reduced stress levels, improved mood and concentration, a generally more positive mental and emotional health and an increase in social interaction between people. There are thus many great potential benefits for a society to have green spaces available for its inhabitants.

But to simply have a large amount of green areas available to the public in general does not guarantee that inhabitants are engaging in outdoor recreation (Le Texier, Schiel, & Caruso, 2018). For this, accessibility to green environments is a key component. A general geographical accessibility definition can be found in the theoretical framework outlined by Haugen (2012), where accessibility in general terms are made up by proximity and/or mobility. This means that green spaces need to be available in proximity and/or through adequate mobility networks in order to be accessible for residents living in their vicinity. In relation to urban green spaces, the pedestrian mobility is of most interest, as walking is one of the more common mode of transport when seeking interaction with such places (Higgs, Fry, & Langford, 2012). Especially within a weekday context, during which a substantial part of all urban outdoor recreation are taking place (Boman, Lindhage, & Sandberg, 2014). This tends to be a larger and ever-growing issue in urban environments where the competition for the limited space of many conflicting interests is putting more and more pressure on land use. Especially the green spaces, which often have to take second place to buildings and infrastructure development (Borgström, 2011; Boverket, 2007; Schipperijn et al., 2010). With ever increasing urbanization, this land use conflict will probably intensify in the future.

In this context it is important to acknowledge global and regional spatial differentiations, as the land use conflict is varying in its severity and character with different urban densities, climate prerequisites, legislations, infrastructure, etc. in different parts of the world. At first glance, this potential problem may seem to be of lesser concern in many cities in central and northern Europe today. According to a quantitative analysis performed by Poelman (2018) most of the cities in this region have a substantial part of their area covered by green areas, especially in the Nordic region. Out of 13 analyzed cities in Sweden, 10 had at least 33% of its total area covered by urban green surfaces and forests. One of these cities was Gothenburg, a city that has been shaped by its intertwined relationship and codependence with the manufacturing and shipping industry. It is also often emphasized for its general green character. Previous quantitative studies have also concluded that the spatial distribution of parks and natural areas in Gothenburg in general is sufficient enough to provide adequate walking distance accessibility in relation to scientific findings and walking distance requirements from residential areas to green spaces set by the City Planning Authority (Svanerud, 2017; Göteborgs Stad, 2014; Schipperijn et al., 2010).

However, accessibility to green spaces does not possess any intrinsic value in itself. It is the potential services and utilities for inhabitants that interaction with them can provide that is desirable in this matter. And these studies on green space availability and accessibility have largely been made without a public utilization perspective, which means that the green spaces potential to provide desired social utilities have not been acknowledged. Distanced-based evaluations of the urban landscape like the ones refered to above have also been criticized for their lack of user perspective (Grahn & Stigsdotter, 2010). In order to understand what social utilities that are possible to attain, focus must therefore also be directed to qualities of green spaces. The potential contribution of such utilities is namely determined by numerous attributes such as type of vegetation, park utilities, size and shape of the area and what activities they enable (Chiesura, 2004; Kaplan, 1990; Leslie, Cerin, & Kremer, 2010; Skärbäck, Björk, Stoltz, Rydell-Andersson, & Grahn, 2014; Sugiyama et al., 2015). Attention must thus be directed to green spaces' qualities, their location in relation to people's homes and the infrastructure connecting them together (Boman et al., 2014). In the current quest of creating sustainable cities through densification, this is an important matter to address within the planning process, as the social utilities of urban green spaces is an important factor of the fulfillment of the social dimension of urban sustainable development (Borgström, 2011; Grahn & Stigsdotter, 2010).

In summary, Gothenburg is a green city in general. However, the ability for residents to transpose these urban green space resources into various types of social utilities has not been investigated. This lack of knowledge is also a general issue that is being acknowledged in the academic world today (FORMAS, 2019). In order to address this issue, new quantitative research methods that can incorporate the social utility potential within green spaces and accessibility to these green spaces needs to be developed. With the city of Gothenburg as a case area, this master thesis sets out to do just that.

1.1 Aim and research questions

The aim of this study is to investigate how a methodological framework for quantitative analysis of urban inhabitants' accessibility to social utilities through urban green space interaction within a weekday context could be constructed

Such a framework could be argued to have two central dimensions. One concerns what kind of social utilities different urban green spaces can provide for interacting people. The other concerns what kind of factors that are important for inhabitants' urban green space accessibility in general. In order to concretize these into scientific objectives that could be methodologically addressed, two research questions were formulated, each directed at one of these two central dimensions. Both also focusing on this thesis case study area - the City of Gothenburg.

Research question 1

Which key social utilities do urban green spaces in Gothenburg have potential to provide for interacting people and how are these utility resources spatially distributed in Gothenburg?

Research question 2

What level of accessibility does the population of Gothenburg have to these utility resources and how is it spatially differentiated between residential areas in the city?

1.2 Delimitations

This thesis's main subjects, green spaces, social utilities and accessibility are concepts that can be argued to be very multifaceted and can be approached with a vast amount of different perspectives. A master thesis like this one cannot cover all these perspectives and therefore, several delimitations has to be clarified. First of all, social utilities can be related to the concept of ecosystem services. However, it can be argued that this concept primarily is related to natural science, mainly focusing on biological and physical utilities such as pollination, regulation of local climate, water infiltration, etc. Attempts have been made to incorporate social aspect by introducing the concept of cultural ecosystem services (Millennium Ecosystem Assessment, 2005, p. 39). But in order to avoid that the social dimension of green space utilities is viewed as subordinate to the physical and biological dimensions, the concept of ecosystem services will be avoided within this thesis. Another important aspect is that this thesis departs from a broad population perspective and does not focuses on specific subgroups or individuals in society, even though sub-group perspectives on urban green space and accessibility are discussed. Furthermore, because this thesis mainly uses quantitative analysis methods, the thesis focuses on social utilities that are quantitatively analyzable. From a more multifaceted perspective, it can be argued that there are a larger number and more specific utilities that can be derived from urban green space interaction than are acknowledged within this thesis, especially for specific subgroups and individuals. It is also important to stress that the thesis only analyzes the potential for social utility provision through potential outdoor recreation within urban green spaces, not realized behavior. To do the latter requires much more extensive research and much more empirical data than available for this thesis. In addition, the thesis only focuses on social utilities generated through physical interaction with urban green spaces based on the residential locations. This demarcation is important to make, since there are scholars who suggest that certain utilities can have a positive influence on health and well-being simply by passive observation of green spaces without actually physically interacting with them (Bertram & Rehdanz, 2015). It is also important to acknowledge that separate individuals can have access to utility providing green space within their space-time aquarium. However, to acknowledge both of these aspects would not fit within the time frame of this thesis. The temporal perspective is also limited to outdoor recreation from a weekday perspective, which is undertaken during relatively short periods of time and close to the home. Weekend and holiday outdoor recreation typically takes place further from the home and during longer periods of the day. One reason for this delimitation is that urban outdoor recreation is to a large extent connected to weekdays (Boman et al., 2014).

1.3 Case study area – the City of Gothenburg

This thesis is conducted within one main case area: The City of Gothenburg. The reasons for this are many. First of all, it is one of the municipalities that has performed a sociotopic review of its green spaces, which is a precondition for the methodological approach of this thesis. Secondly, it could be argued that Gothenburg has many similar counterparts in Europe as a city influenced by industrial activities, modernistic tinged suburbs with a relatively high amount of green areas and a relatively low population density due to urban sprawl. This makes the city interesting in an European context to study more in detail, as suggested by Poelman (2018). However, Gothenburg is a municipality that also covers large areas with more rural and agricultural character that surrounds the actual urban city. In these parts the sociotopic classification is not as comprehensive as it is in the urban part of the municipality. The sociotopic classification does not incorporate agricultural land, which are common outside the urban parts of the city. The study area therefore only consists of the urban areas of the municipality, defined as the areas mellanstaden, prioriterade utbyggnadsområden, utvidgad innerstad, innerstaden and älvstaden, see figure 1. Even though only covering a minority of the municipal land surface, this study area houses approximately 480 000 of the city's total 570 000 inhabitants. However, green spaces up to one kilometer outside the study were also incorporated, as was done in a similar study conducted by Svanerud (2017). The reason for this was that some residential areas within the study area could have their closest green space outside the of the study area. If green spaces only located within the study area were to be included, these residential areas could end up with misleading distance values for the closest green space. However, because the study area at some locations were close or in line with the municipal border, the green space area extent zone could not extend beyond the study areas at these location since only the green spaces within the municipality is sociotopically classified.

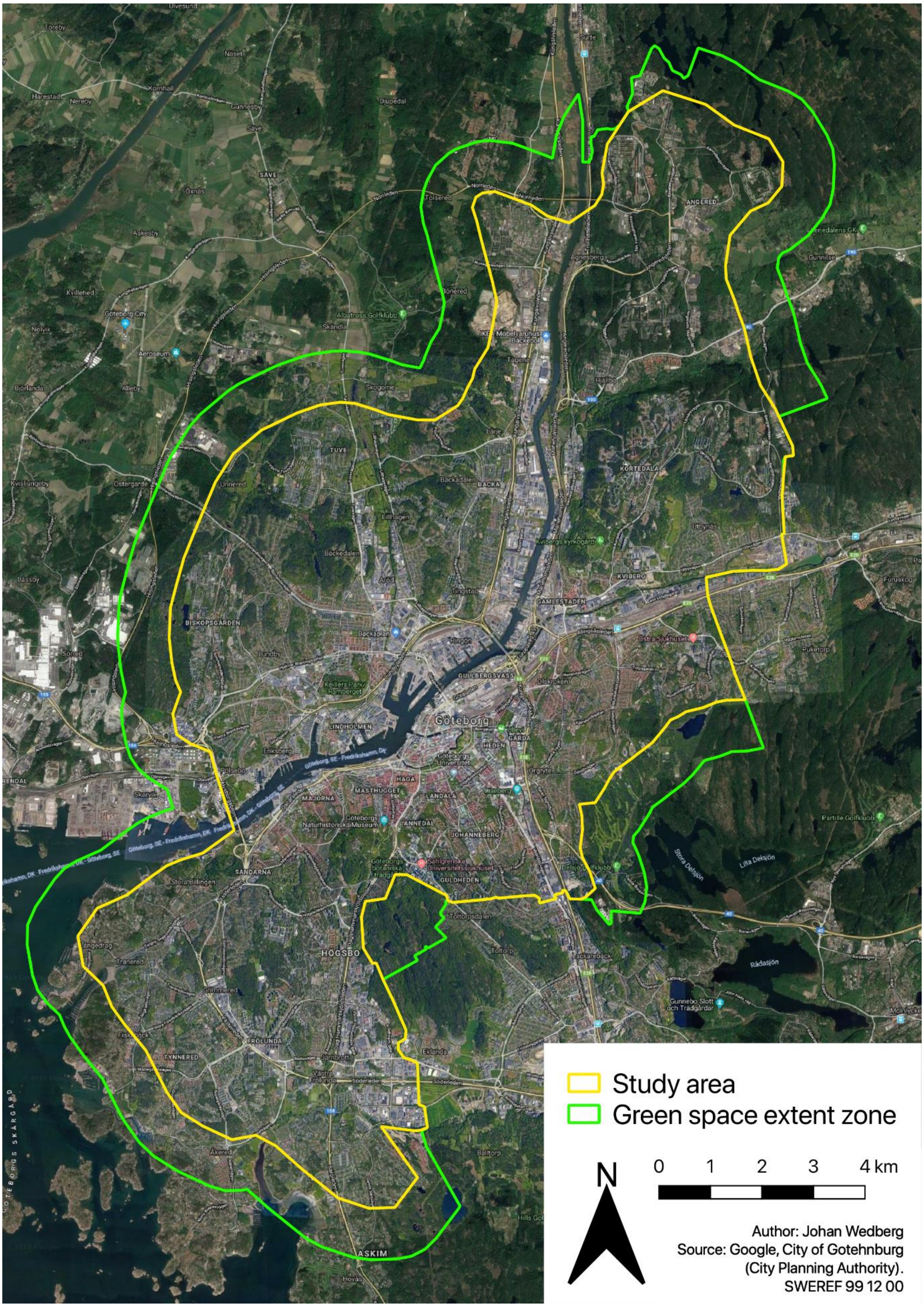


Figure 1. Map of the study area and the green space extent zone.

2 Previous research and theoretical framework

This chapter consist of the thesis's main theoretical and scientific knowledge fundaments. It is arranged under two main pillars upon which this thesis relies and departs from. The first one consists of the concept of accessibility. Here, the concept will be presented and conceptually discussed in relation to the scope of this thesis. This is followed by a description on perspectives of different accessibility measures and how they can be operationalized within accessibility analyses. The second pillar consist of a scientific literature review that outlines the current scientific knowledge on potential social utilities through outdoor recreation in green environments. It is in turn divided into three sections, where the first describe the three main identified utilities that outdoor recreation in green spaces can create and what green space attributes that are important for them. The second one focuses on important factors for green space interaction and the third on different perspectives on accessibility and green space perception for different groups in society. The chapter then ends with concluding remarks of the theoretical approaches and scientific findings raised in the chapter and how it will be utilized within this thesis.

2.1 Accessibility – conceptualization and applications within geographical research

Accessibility is a multifaceted concept, both within the human geography discipline, but also within mobility and land-use research in general. It is used within a vast variety of applications and with many different definitions depending on the contextual approach. In order to make use (and sense) of the concept within this thesis, it is necessary to include a conceptual discussion and definition. As an introducing statement, accessibility can be argued to be a useful concept within this thesis because it relates to the potential to interact with amenities, not actual realized interaction (Miller, 2018). Moreover, Haugen (2012) argue that accessibility on a fundamental level can be understood as the combination of two accessibility dimensions. The first one is locational accessibility, or proximity. This could be described as a land use factor, where access can be achieved through an amenity's, or point of interest's, location in space. A higher degree of proximity thus results in a higher level of access to a certain opportunity. The second one is distance bridging accessibility, or mobility. Access here is based on the ability to overbridged distance in order to assess an amenity of interest. Together these dimensions form the essential basis of geographical accessibility and are illustrated in figure 2 below. Haugen however stress that this is a simplifying model of reality and numerous elements can be added with an increased complexity.

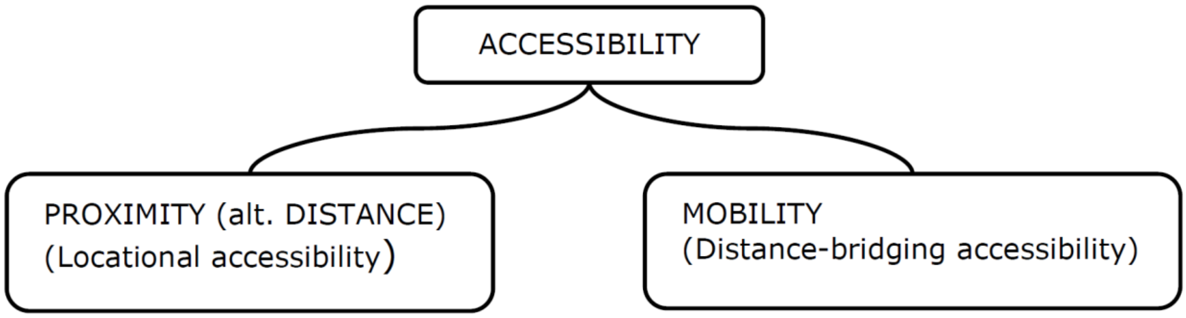


Figure 2. Conceptual model of accessibility as an entity of two main accessibility dimensions. Source: (Haugen, 2012)

Another model of accessibility with a higher degree of complexity is outlined by Geurs and van Wee (2004) and consist of four, partially intertwined, components. See figure 3 for an overview. Accessibility in this model is defined as "the extent to which land-use and transport systems enable (groups of) individuals to reach activities or destinations by means of a (combination of) transport mode(s)" (p. 128). The first component is land-use, which includes locations and characteristics of opportunities and demand for these opportunities. In an exemplifying term: where in space a certain point of interest is located in relation to the actor that is seeking interaction with this point of interest. For example, where a job opportunity is located and where the potential employee lives. This component could be compared with the proximity dimension described by Haugen (2012). The second one is the transport component. This consists of the transportation of goods and people where the prerequisites of different modes of transport are of relevant, along with the infrastructure that are enabling these transports. The third one is the individual component. This mainly concerns characteristics that are of relevance for people's ability to access the different modes of transports, like gender, income, ethnicity, age, educational level, etc. Along with the transport component, it can be related to the mobility dimension, as they together can describe the ability to overcome distance. Both in terms of infrastructure and travel constraints, but also the individual ability to make use of these transportation features. The fourth one is the temporal component. This refers to time restrictions in the access to opportunities, such as opening hours of services and the available time for activities. In terms of urban green spaces, this could represent different seasons, which makes certain activities temporally unavailable during parts of the year, for example picnics, sledging and opening hours of parks. It can be argued that this last one does not have an as clear cut representation in the model described by Haugen (2012) as the other components. However, one can further argue that a tempus feature could be added as an umbrella dimension to both proximity and mobility as both of these entities can be restricted in time.

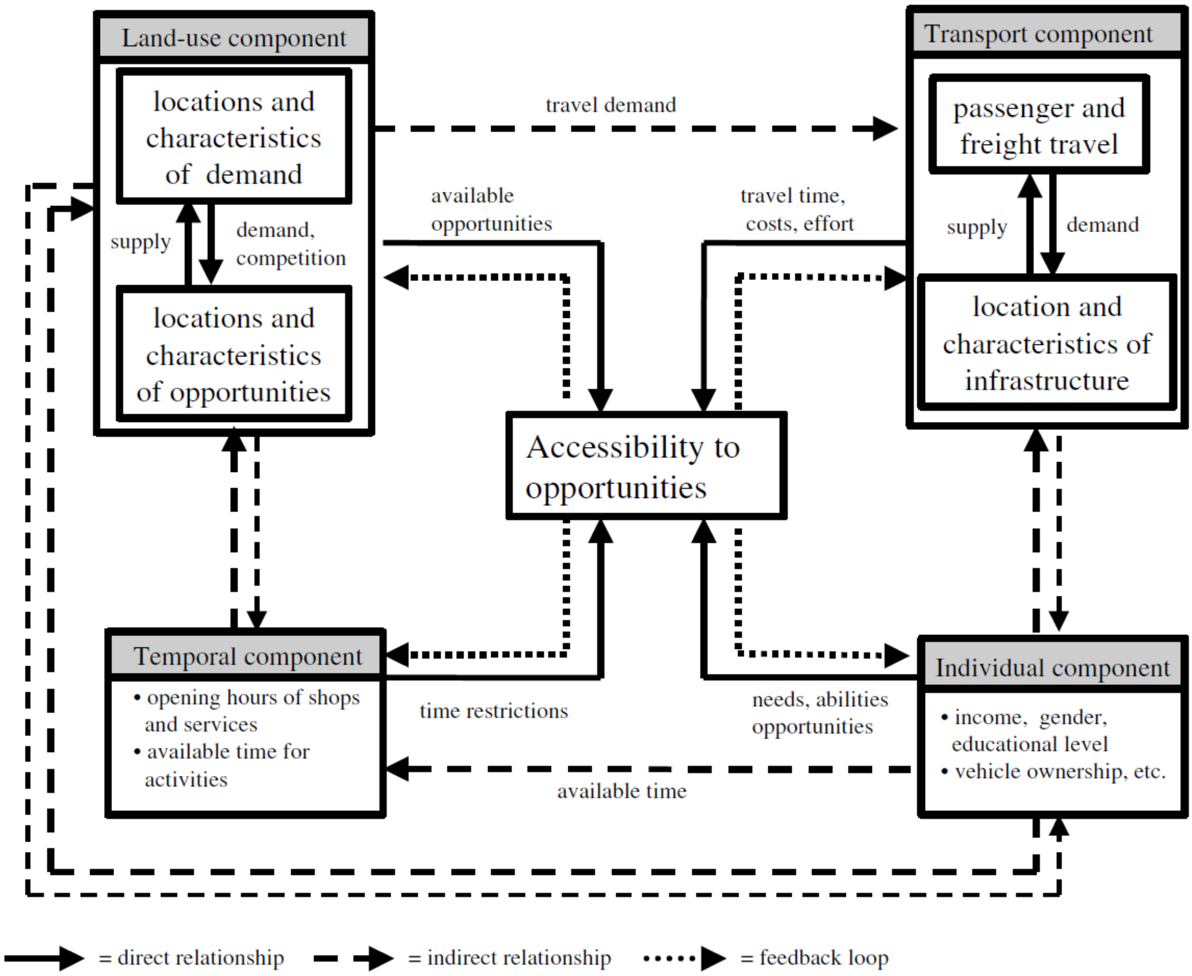


Figure 3. Conceptual model of accessibility as an entity of four main components. Source: (Geurs & van Wee, 2004).

2.1.1 Measures of accessibility

With a conceptual fundament on how accessibility in general can be understood within geographical studies, the next step is to discuss how this could underpin different forms of measures that can be used to evaluate accessibility in a scientific methodology. Geurs & van Wee (2004) outline four main criteria that are important to acknowledge in order to evaluate the limitations and usefulness of different types of accessibility measures. These are primarily relevant for accessibility measures concerning land use and infrastructure matters. The fist is a theoretical basis which amount that, as previously stated, a valid accessibility should be sensitive to changes in all four elements displayed in figure 3. In addition to this, five sub-criteria are derived which describe how an accessibility measure should behave.

1. If the service level of a transport mode changes within a certain area, the level of accessibility to/within/from that area should also change accordingly.

2. If the number of opportunities for an activity changes, it should also be reflected in the level of accessibility to that activity everywhere.

3. If an activity is associated with capacity restrictions, a change in demand for that activity should also affect the level of accessibility.

4. A change in the number of opportunities for an activity should not affect the accessibility level for individuals that are not able to utilize it given their time budget.

5. Changes in mobility or proximity should not affect the accessibility for individuals that are not affected by these changes due to different forms of restrictions (e.g. lack of cycling skill or education level).

These should not be regarded as absolute, but rather something to strive for, as the incorporation of all would create a complexity that would be too hard to grasp for anyone but the modeler.

The second criteria concern the operationalizability of an accessibility measure. To satisfy this requirement, the measure needs to be able to be deployed in practice and within the adequate time and budget. This is highly dependent on the available data, its quality and what type of techniques and analysis tools that are available. The third criteria is related to the interpretability and communicability of the accessibility measure. Its method and results should be easy for relevant target groups to understand and make use of. In the case if accessibility analyses of land use, infrastructure and urban planning, these groups often consists of researchers, planners and policy makers. This is important, because a measure that is too complex and hard to grasp will probably not be utilized in the policy making or the urban planning process. The fourth criteria concern usability within social and economic evaluations. In general accessibility measures can be used as a social indicator if it can provide information about access to essential utilities for humans, such as food, health and social services. Given that the accessibility is spatially differentiated, social (in)equality can then be analyzed. When different groups and individuals are studied in this manner, Geurs & van Wee (2004) states that acknowledging the theoretical criteria are of particular importance. As for economic evaluations, accessibility measures can be used if they can be directly related to economic theory or serve as a basis for economic impacts analyses of changes in land use or transport prerequisites.

In the best of worlds, a universal measurement technique that took all accessibility dimensions, components and criteria described above into consideration would exist that could be deployed everywhere no matter the geographical and scientific context (Geurs & van Wee, 2004). However, as Handy and Niemeier (1997) explains, no such measure exists as it would be way too complex and fail to meet the criteria outlined above, especially the operationalizability, interpretability and communicability. An accessibility measure must thus be chosen and adapted in relation to the specific purpose and prevalent prerequisites in order to be useful. Or, more concretely, to adequately meet the requirements in the criteria (Geurs & van Wee, 2004; Haugen, 2012). Different types of measures have different advantages and weaknesses and how they are adapted affects in which way they meet the criteria. In order to choose the most suitable for the topical subject, it is important to acknowledge these strengths and weaknesses as it ultimately shapes the analysis, its results and what type of conclusion that can be derived from it.

Typically, an accessibility measure tends to focus on one of the accessibility components. In studies where accessibility to and from spatially distributed places is of relevance, a place-based measure (called location-based by Geurs and van Wee (2004)) is often used (Neutens, Schwanen, Witlox, & Maeyer, 2008). These are able to incorporate spatial restraints on a larger scale and are also the most common to use in geographical studies and urban planning. Measures that focuses on other accessibility components, like infrastructure-, person-, and utility-based measures, either does not take land use components into account or focuses on more on the individual level of accessibility (Geurs & van Wee, 2004). For most placed-based accessibility measures, where the mobility dimension is dependent on an infrastructural network (like walking, cycling, public transport, driving, rail transports, etc.), a network approach is superior as it provides the most accurate results. To use Euclidean distance tends to overestimate the level of accessibility, especially if the infrastructural network is coarse and/or provides few opportunities for shortcuts (Elldér, Larsson, Solá, & Vilhelmson, 2018; Handy & Niemeier, 1997; Higgs et al., 2012; Le Texier et al., 2018; Miller, 2018).

Place-based distance measures of accessibility

Place-based measures are in turn diverse and several types do exist, each with its own ability to fulfill the criteria outlined above. Roughly, they can be divided into two main groups. The first one is distance/connectivity measures, which consist of the simpler forms of location-based accessibility measures, measuring time, cost or distance between places in space (Geurs & van Wee, 2004). Which unit accessibility should be measured in depends partly on which mode of travel for overbridging distance that is analyzed. For modes like public transport or car travel, travel time are suitable, as it enables the measure to capture the effects of variation in speed limits and congestion. For walking on the other hand, distance is the most suitable unit, as it can be directly linked to the effort that is required to overbridged distance for different groups. Walking speed can also be considered more homogenous for an individual over space than they are for example a car that can encounter much larger speed variations, depending on the driving preconditions. There can also exist substantial differences in walking speed between different groups in society, like people of different age. This difference is not that present for other modes, e.g. public transport. A train will drive at the same speed independently of what groups of passengers that happens to be on board. If travel time is used for walking, a certain walking speed needs to be set, which limits the ability to use and analyze the results across groups. Travel distance on the other hand provides a more (but not completely) absolute value that, when needed, can be translated into travel time for different groups (Miller, 2018). In addition, distance in meters is also considered one of the central dimensions of accessibility to outdoor recreation within urban green spaces (Boman et al., 2014).

The strengths with this type of place-based accessibility measures is that they often only require relatively undemanding and time efficient analysis methods. The data and its required preparation work are often not that challenging either, compared to other place-based accessibility measures. The measures and their results are also often easy to understand and to communicate, both to other researchers, but also planners and policy makers. Thus, they often adequately satisfy the criteria for operationalizability, interpretability and communicability. Because of this, it is one of the more popular place-based accessibility measures used within the urban planning context (Geurs & van Wee, 2004). As mentioned before however, having a low level of complexity and being easy to operationalize and communicate, it has many weaknesses in relation to the theoretical criteria. Geurs & van Wee (2004) lists three main ones; firstly, these types of measures often cannot evaluate the combined effect of changes in land use or transport. That is, one cannot know if a certain level of accessibility is due to proximity or mobility factors. Secondly, these types of measures do not either incorporate effects related to spatially distributed supply and demand. If accessibility is analyzed in relation to opportunities that are capacity restricted or where demand is concentrated to certain locations in space, these measures can thus be misguiding. The third main weakness is related to the individual component, which is missing within distance-based measures of accessibility. This means that groups' or individuals' perception of entities that are related to accessibility, like differentiated attractivity of different opportunities and transport are not included in the analysis. This means that all opportunities within a study area, for example accessibility to urban green spaces within a city, are considered equally desirable, no matter the required travel time or the quality of the opportunity.

Gravity-based measures of accessibility

The other main measure group of place-based accessibility outlined by Geurs & van Wee (2004) are potential accessibility measures, also called gravity-based measures. Here, more spatially remote and/or less attractive amenities are ascribed less influence in the accessibility analysis. This is usually done by using negative exponential distance decay functions in the accessibility analysis, which are able to incorporate groups' or individuals' combined perception on distances, costs and amenity qualities. An exemplifying scenario could be an accessibility analysis to a large urban park that are considered very attractive due to its characteristics but are located far away from a certain area of interest and interaction from that area is thus associated with a higher travel cost. Since a cost sensitivity parameter can be included, the measure could also catch different perception on travel restraints between transport modes and different groups and individuals. Techniques also exists that makes it possible to incorporate competition effects in different ways into the analysis. Because of these characteristics, this type of accessibility measures can better meet the theoretical criteria that distance measures have trouble doing. On the other hand, they are more complicated and complex, which makes them harder to interpret and communicate to other stakeholders than the researchers themselves. Probably especially so if the measures and their results should be communicated to individuals not previously familiar with accessibility research methods. The measures also put heavy demand on high quality, up-to-date empirical data that should serve as the basis for the parameters describing cost sensitivity and competition. If not available in advance, this would occupy a substantial part of a research project's time budget.

2.2 Outdoor recreation within urban green space – what we know today

Outdoor recreation in terms of the Swedish concept "friluftsliv" has previously often been thought of as activities that are time- and knowledge demanding, taking place far away from urban areas. This traditional view is however disappearing in favor for a more public health-oriented perspective on outdoor recreation that recognizes the importance of weekday urban activities to a larger extent. After all, this is the most common form of recreation within green spaces (see Sandell & Fredman, 2014). In order to be able to analyze potential public health oriented social utilities derivable form urban green spaces, a review of the previous scientific findings on this matter had to be performed. It is divided in three main section. During this process, three main social utilities were identified; stimulation of physical activity, mental recovery/stress reduction and stimulation of social interaction. These and their prerequisites are described in the following section. Attention has also been directed at the variables that are important for green space interaction frequency, as this is just as important when urban green spaces' social utility potential is to be analyzed within an accessibility perspective. The review has been done from a broad population spectrum, meaning that only utilities that were applicable across population aspects like age, gender, socioeconomic status, ethnicity, etc. were considered. In combination with the fact that perceptions of green spaces can be as many as there are people to perceive them, this means that there are many more aspects important for urban green spaces' social utility providence that are not incorporated in this review's first two main sections. The third section aims to shed some light on this matter by acknowledging different sub-groups' perspectives on urban green space and accessibility to this type of public resource.

2.2.1 Social utilities from urban green space interaction

Stimulation of physical activity

The first main social utility identified during the scientific literature that can be derived from urban green space interaction is stimulation of physical activity. (Baur, 2018; Boniface et al., 2015; Kabisch & Haase, 2014). In Sweden, it also seems to be the most common motive for outdoor recreation on weekdays (Sandell & Fredman, 2014). This is in turn associated with an improved mental health, functioning and well-being, long-lasting psychological benefits and longevity. It also reduces the risk of cardiovascular diseases, diabetes, different forms of cancer, osteoporosis, fall-related injuries and depression (Lee & Maheswaran, 2011). These are effects that can be observed throughout all age and income groups in society, although the effect is particularly prominent within the lower income groups (Natural England (Agency) & Faculty of Public Health (Great Britain), 2010; Skärbäck, Björk, Stoltz, Rydell-Andersson & Grahn, 2014). One of the activity forms that is generally increased is walking, but only for recreational purposes. Walking for transportation is generally not affected by urban green spaces, which implies that the level of physical activity for this type of purposes is governed by other driving forces (Leslie, Cerin & Kremer, 2010). This appears to also be true within a Swedish context, were pleasure and cardio walks and stroll in nature are the most common forms of outdoor recreation (Sandell & Fredman, 2014). The size of green areas seems to be of importance for the promotion pf physical activity (Wood, Hooper, Foster, & Bull, 2017). According to one study, areas smaller than 2 hectares are not suitable for the purpose of being physically active, at least not for adults (Coombes, Jones, & Hillsdon, 2010). This notion is supported by (Schipperijn, Bentsen, Troelsen, Toftager, & Stigsdotter, 2013) who in their research on the effect of green spaces' physical attributes on physical activity levels in Odense found that in order for parks to have a significant effect, they had to be at least 1-5 hectares in size, but preferably between 5-10 hectares. Areas smaller than 1 hectare showed no correlation with increased level of physical activity. In fact, some studies of urban green spaces' effect on physical activity levels do not even incorporate areas smaller than 0,8 hectares (2 acers) (Giles-Corti et al., 2005; Sugiyama et al., 2015). In addition, park attributes such as walking/cycling routes, illumination of (some) trails, bicycle and car parking facilities, dog-related facilities, wildlife characteristics and perceived safety are also important for physical activity promoting urban green spaces (Leslie et al., 2010; Schipperijn et al., 2013; Sugiyama et al., 2015).

Mental recovery

The second main social utility that is emphasized within the scientific literature is the providence of a place of peace and quiet which enables stress reduction or mental recovery, a service related to generally improved mental well-being (Baur, 2018; Boniface et al., 2015; Grahn & Stigsdotter, 2010; Kabisch & Haase, 2014; Skärbäck et al., 2014; Wood et al., 2017). Chronical stress is a health condition that has been studied thoroughly and the health-related effects of stress in our modern society are increasing (Wood et al., 2017). In fact, the world health organization has dubbed it "the health epidemic of the 21st century" and in 2002, it was estimated to cost the EU-15 countries at least €20 billion annually (Fink, 2017; Hassard et al., 2014). Chronical stress affects mood, sense of well-being and behavior and generates anxiety, high blood pressure, concentration difficulties, damaged blood vessels, slower wound healing, metabolic disorders, poorer immune response to pathogens, etc. These conditions are in turn associated with an increased risk of depression, upper respiratory diseases, cardiovascular diseases, type II diabetes, etc., some of whom are among the most common causes of death globally (Schneiderman, Ironson, & Siegel, 2005; World Health Organization, 2018). European urban societies are by no means spared from this and mental stress is one of the main causes for lack of good health here today (Arnberger & Eder, 2015).

To acknowledge these negative effects can be a vital aspect within a public health perspective on outdoor recreation. Green spaces can namely contribute in this matter, as availability to natural environments are very important to counteract stress. One can argue that this is particularly important in urban environments, as restorative health effects like these are harder to achieve here due to a general relative shortage in accessibility to urban green areas (Skärbäck et al., 2014). For a green area to have stress-reducing and restorative mental abilities certain characteristics are important. These can be described according to the classification made by Grahn & Stigsdotter (2010) who identifies four major factors that indicates that the urban green spaces have stress-reducing abilities. The first is serenity, which can be described as places that are peaceful, calm and strains of natural element like the sounds of birds, water, wind and insects. The places should be well maintained and be absent of rubbish. Silence is another important factor for serenity and mental recovery (Boverket, 2007). Noise in general, particularly from traffic, are associated with non-auditory stress effects like cognitive deficits, modifications of social behavior, effects on physiological systems (cortisol levels and blood pressure), etc. (Gidlöf-Gunnarsson & Öhrström, 2007). Because of this, a study on urban recreational areas in Malmö sat the upper noise limit for an urban area to be perceived and classified as serene to 55 dB (Skärbäck et al., 2014). This is also the level were people start to get annoyed and is the World Health Organization’s standard guideline value for average outdoor environment (European Commission, 1996). To be able to spend time in the area without encountering too many people is also an important factor for serene places and for stress reduction and mental recovery from urban green spaces in general. For this reason, serenity is a quality that generally is incompatible with activities that are associated with social interactions with other people, as it reduces the stress-reducing capacity of a green space (Grahn & Stigsdotter, 2010; Skärbäck et al., 2014). In the current urban development trend of densification, serene places are at risk of becoming rarer in urban landscapes, as urban green spaces are being visited by more people (Arnberger & Eder, 2015). However, serenity and activities associated with social interactions can coexist in the same green spaces if they are of an adequate size to meet the prerequisites of both. Serenity is also often pointed out to be the most desired environmental characteristics when people are asked to rank urban green spaces qualities. In fact, much more so than features related to social interaction (Grahn & van den Bosch, 2013; F. S. Jensen, 1998). The second factor that Grahn & Stigsdotter (2010) point out as important for mental recovery and stress reduction is called nature (see also Wood et al., 2017). These places are characterized by a wild and untouched character, where plants and trees seem self-sown. There should be lawns that are free growing and terrain with natural formations. All these entities create a feeling of being in nature on the condition of nature where the force, power and intrinsic values of nature can be experienced. There should also be room for outdoor activities, for example making a fire. The third factor is called refuge and can be described as enclosed places, or green oases, where lots of bushes and higher vegetation creates secluded places where people can relax and let their children play freely. Preferably there are equipment present for this, like swings, slides and sandpits. The presence of domesticated animals that can be watched, fed or petted are also contributing factors for the refuge factor.

For all these first three dimensions the feeling of safety is also an important entity that are being created by the settings described above. The fourth dimension is called rich in species, which strictly refers to natural qualities. Here, numerous species of plants and animals can be detected and studied, there is a wide range of expression of life and there are natural populations of plants and animals, a place for fascination of the natural wonders.

Together, these four factors indicate that in general, an urban green space with potential for stress reduction can be described as a place with a calm and peaceful character without too many disturbing elements were one can rest and relax. The ability to relax also seems to be one of the most important motives for outdoor recreation in general (Chiesura, 2004; Sandell & Fredman, 2014). Urban green spaces with a sense of natural wilderness do seem to be particularly suitable for this. A statement that is in line with numerous scholars, who has suggested that green spaces with more natural settings are more suitable to provide stress-reducing utilities (Arnberger & Eder, 2015; Chiesura, 2004; Gidlöf-Gunnarsson & Öhrström, 2007; van den Berg, Maas, Verheij, & Groenewegen, 2010). As has been hinted earlier in this section, the size of green spaces is an important aspect for mental recovery services as well. Apart from the fact that the factors important for stress-reduction often require large areas in themselves, larger parks are also able to house more of these green space factors simultaneously. And the more of these that are present within the same green space, the better are its stress-reducing abilities (Skärbäck et al., 2014). Larger parks are also more resistant to noise pollution (Boverket, 2007). In addition, there is one more type of environment that in the context of accessibility from residential areas to green spaces suitable for mental recovery can be highlighted, and that is private domestic gardens. Access to domestic gardens for house owners have showed to increase mental well-being more efficiently than other forms of urban green space exposure (Dennis & James, 2017). It is also reflected in residents' different perception of their local neighborhood. In general, house owners are more satisfied with their neighborhood than people living in tenant housing with access to the same urban green space resources. One reason for this is that private gardens often can provide serene environmental values (Skärbäck et al., 2014). Therefore, peoples' living conditions can offer an important input when evaluating mental recovery utilities from physical environments like green spaces.

Stimulation of social interaction

The third and last social utility identified from the literature review that can be derived from urban green space interaction is stimulation of social interaction. Green environments are here contributing with an arena in which humans can meet, interact with or just observe other people (Boniface et al., 2015; Grahn & Stigsdotter, 2010; Kabisch & Haase, 2014; Wood et al., 2017). To be able to interact with other people is not a negligible motive for outdoor recreation, but is the least important in comparison with stimulation of physical activity and mental recovery (Sandell & Fredman, 2014). The interactions can consist of several activities like conversations, joint activities or paying visits, which are all related to a better health, both mentally and physically (Maas, van Dillen, Verheij, & Groenewegen, 2009). The activities help local residents to maintain and develop neighborhood social ties and strengthen the sense of community and place identity. The underlying mechanism for these benefits are inhabitants' community attachment, emotional bonds and connection to others and with the place and ability for local exploration (Kim & Kaplan, 2004). Scientific research has found that access to natural features like urban green spaces is indeed one of the most important physical features for these factors' promotion of the sense of community (Maas et al., 2009). Social ties and the sense of community in combination with proximate urban green spaces can also significantly increase the sense of feeling safe and adjusted (Lee & Maheswaran, 2011). On the other hand, a lack of green spaces in the vicinity of one's home is associated with an increased feeling of loneliness and a lack of a supportive social network, which in turn are associated with a lower self-perceived health and higher mortality risks. All in all, numerous studies have shown growing amounts of evidence that available urban green spaces in the living environment are associated with stimulation of social interaction and developed and improved social relationships (Maas et al., 2009; Natural England (Agency) & Faculty of Public Health (Great Britain), 2010). As with the utility mental recovery, private domestic gardens can also simulate social interaction. This interaction is however restricted to private social network, which not is suitable for community integration and the strengthening of the sense of community (Barbosa et al., 2007).

In conclusion, these three major groups of social utilities that can be derived from urban green spaces may provide key public health values to an urban population.

The importance of size

The aspect of urban green space size is worth highlighting in a separate paragraph, because it has general impact on their ability to provide social utilities, not just for the ability to house incompatible activities simultaneously but it also accentuates the amplitude of the utilities. In general, the larger the green space is, the larger effect on physical activity and mental well-being can be observed for local residents. This is especially true when the green spaces reaches a size over 5 hectares (Wood et al., 2017). In terms of what size inhabitants desire the most, one survey study performed in Vienna, Austria, reported this to be around 600 hectares (Arnberger & Eder, 2015). Additional findings related to this is that one large park tends to provide social utilities more efficiently that many fragmented smaller ones, even though they together are of the same size (Le Texier et al., 2018; Wood et al., 2017). The shape of an area is also an attribute that can affect the utility level of urban green spaces. In general, areas that are more round-shaped are able to provide higher values than areas of the same size that have a more elongated shape. Larger urban green spaces also tend to provide positive social benefits for people living further away than smaller ones are able to do (Le Texier et al., 2018).

2.2.2 Factors influencing the use of urban green space

In this section of the literature review, important aspects influencing urban green space interaction are investigated and outlined. It is divided into two parts, where the first is addressing the importance of spatial localization in relation to residential areas and other physical elements in the urban environment. The second focuses on the green space attributes' influence on the interaction frequency of near living residents. One again, this review is performed from a broad population perspective and it is important to stress that this section is not an exhaustive declaration of all aspects important for urban green space interaction frequency.

Distance and barriers

According to numerous scholars, one of the most important aspects for urban green space interaction is the distance from the home, where there is a direct relation between proximity and visitation/usage (Arnberger & Eder, 2015; Leslie et al., 2010; Van Herzele & Wiedemann, 2003), especially for outdoor recreation on weekdays (Boman et al., 2014). Higgs et al. (2012) and Schipperijn et al. (2010) found in their respective literature review and empirical research that the distance effects do not appear to be completely linear. Instead, there seems to exist a threshold value of about 300-400 meter, where the daily usage starts to drop rapidly. In fact, the probability for inhabitants to interact with nearby urban green spaces were three times higher when these were located within 300m, in comparison to when they were located within 300-1000 meters from the home. At longer distances of 1-2 kilometers between the urban green spaces and the home, interaction on an everyday basis still takes place (Boman et al., 2014) but presumably to a much more modest extent. Because of scientific findings like these, the Swedish National Board of Housing, Building and Planning [Boverket] has put up a distance criterion for urban green spaces which states that they must be within 300 meters from residential areas in order to be classified as residential adjacent urban green spaces [bostadsnära natur] (Boverket, 2007). The distance influence on interaction is also something that is illustrated in the activity frequency where the most common forms of outdoor recreation are those that takes place in the vicinity of the home. Especially during weekdays where the available time is more restricted for most children and daytime workers. These types of outdoor recreation activities take place during shorter periods of time and generally have lower demands of size and qualities of the green spaces than those undertaken at more remote locations. These are also generally more common during weekends and longer periods of leave. In general, urban outdoor recreation is mostly conducted by near living residents (Boman et al., 2014).

In the context of distances effects on interaction, it should be said that objective distances are only one aspect. Perceived distance is also important to acknowledge, which refers to the fact that different routes with the same distance in meters (or travel time) can be perceived as different in length, which in turn also can affect interaction with points of interest at the endpoints of these routes (Golledge & Stimson, 1997, pp. 192–200). From a broad population perspective, certain physical elements are of particular relevance in this matter. Apart from being absolute barriers that cannot be crossed most of the time, larger traffic routes crossing the urban landscape can hamper residents' interaction with points of interest (including urban green spaces) even when there are facilities like crosswalks or pedestrian underpasses available (Boniface et al., 2015). This phenomenon is known as severance and is influenced by both static and dynamic characteristics. The static ones are for example vertical alignment to the surroundings, level of separation of cross points (e.g. traffic lights or level separation), traffic light time cycles, road width, and the presence and shape of stairs, ramps, tunnels and bridges. Examples of dynamic features are number of vehicles, traffic intensity variation over the day, speed limits and types of vehicles (Korner, 1979). The severance effects on peoples' living and mobility patterns usually are amplified over the course of time after a traffic barrier has been established, as new generations are adapting and limits their lives and activity space in relation to the barrier (Boniface et al., 2015).

Urban green space attributes

Although not as important as the distance from inhabitants' homes (Arnberger & Eder, 2015), the attributes of urban green spaces are also an important factor that influences the interaction level (Boman et al., 2014). Generally, the size of an urban green space is clearly connected to its attraction of near living residents where larger parks are assessed as more desirable (Grahn & Stigsdotter, 2010; Schipperijn et al., 2013). The level of influence of these factors can be variable depending on what type of green space that is considered. While smaller patches of green can be of importance for neighborhood social activities, wooded green spaces might in some cases have to be several hectares in order to attract visitors (Harrison, Burgess, Millward, & Dawe, 1995).

Perceived safety, traffic safety on the path to urban green spaces and ability for social interaction with others are also associated with higher visitation frequencies (Leslie et al., 2010). However, it is important to stress that serenity/peace and quietness has been showed to be a more desired quality and a greater motivation to visits green spaces that social interaction. (Grahn & Stigsdotter, 2010). Furthermore, Schipperijn et al., (2010) found that arranged parks and other forms of green space were used more frequently that forests when these were located within 300m. This might be related to the findings of Arnberger & Eder (2015), who concludes that people generally prefer tidy parks with good trail design but disliked understory vegetation and lack of recreation facilities when visiting urban green spaces.

2.2.3 For whom? – Multidimensional perspectives on accessibility and urban green spaces

When addressing the subject of urban green spaces' potential social utilities and accessibility, it is fundamental to address one central question: Utilities and accessibility to urban green spaces for whom? Because even though this thesis departs from a broad population perspective, it is important for the result interpretation to acknowledge these aspects.

Although distances can be identified as important for walking accessibility on a population level, this can be problematized as perspectives on mobility and proximity is something individual that is differentiated across groups and individuals in society. This in turn can impact the realized interaction over space (Vilhelmson, 2002). Variables that can be argued to have an impact on this matter are gender, age, physical and psychological prerequisites, geographic domicile and socioeconomic status. One of the most obvious factors affected by these is perspectives of distances. Here the physical and mental ability to bridge distance is important, which is related to age. Children and the elderly are generally more sensitive to distance. This is related to their general physical preconditions where a couple of 100 meters generally require a greater effort to overcome than it does for an adult (Boman et al., 2014; Sandberg, 2012). Different forms of obstacles are another important aspect in this matter, were elderly and children are affected to larger extent by the aforementioned phenomenon of severance. For example, elderly with a lower walking speed can perceive a crosswalk with traffic lights almost as an absolute barrier because they might have trouble getting across before the traffic light switches back to red (Boniface et al., 2015). For children, parental anxiety for traffic environment safety is also a factor that can negatively affect interaction with points of interest across traffic barriers (see Boman et al., 2014). An additional hampering factor is that they often are more dependent on slower modes like walking for their transportation (Boman et al., 2014). Thus, a restriction in mobility is present. As outlined earlier in this chapter, if accessibility cannot be achieved through mobility, the importance of proximity becomes vital (Haugen, 2012). Therefore, these groups tend to be more dependent on local green spaces for their outdoor recreation (Worpole & Knox, 2007). This goes in line with previous research that has focused on urban green spaces. Maas et al. (2009) explain that social interaction effects of urban green structures are especially strong for younger people and the elderly. Both for the above outlined social utilities, but also for the personal identity (Andersson, Sandberg, & Öhman, 2014). This makes for greater local rootedness with stronger emotional bonds to the surrounding local environment (Vilhelmson, 2002). Other variables correlating with ability to overcome distance is gender, motivation and disabilities (Boman et al., 2014). In conclusion, one must relate to distances in different ways depending on which groups or individuals that are of relevance.

Another important dimension is the perception of urban green spaces, which also is differentiated across the variables age, gender, physical and psychological prerequisites, geographic domicile, socioeconomic status and ethnicity. First of all, all people do not have the same demand for different types of urban green spaces (Boman et al., 2014). Some groups or individuals might have a larger need of stress-reducing urban green spaces, while other have a larger demand of urban green spaces that supports high-quality social interaction or physical activities. This can be illustrated with national empirical studies on outdoor recreation activities in Sweden, which indicated that realized activities are differentiated across gender, ethnicity, age- and socioeconomic groups. The results showed that jogging was more common among men and young adults. Meanwhile, recreational walking was more common among women, an activity that were less common among individuals with non-European ethnicity along with roaming in natural environments (Karlsson, Bladh, & Haraldson, 2014). General differences have also been observed across socioeconomic groups, where the most frequent outdoor recreational wielders are well-educated individuals within the public and private sector, while people with low disposable income and foreign born reported a lower level of outdoor recreation. One reason for this could be that scientific findings shows that people from areas with a low socioeconomic status tends to perceive nearby green spaces as less safe, less attractive, poorer maintained and less feasible for social interaction than people from areas with higher socioeconomic status (Leslie et al., 2010).

As mentioned before, the sense of security is negatively affecting both the ability for urban green spaces to provide social utilities but also the general level of interaction with urban green spaces which also is the case for individuals living such areas (Leslie et al., 2010). This was also illustrated in a study conducted on ten-year-old children from two separated areas, one with a high socioeconomic status and one with a lower one. The children from the area with low socioeconomic status reporter much more disagreeable experiences and insecurity factors while their interaction with proximate green spaces were indeed at a lower level (Sandberg, 2012). At the same time, social benefits from urban green spaces tend to have a larger ameliorative effect on groups with a lower socio-economic status. Therefore, urban green areas with characteristics that promote physical activities and improves mental well-being are being increasingly recognized as an important tool to assuage health inequalities in society (Maas et al., 2009; Skärbäck et al., 2014). So, two physically equal urban green spaces could have different meaning and asset for local residents, depending on which type of environment they are located in. (Bullock, 2008; Leslie et al., 2010). Differences in perceptions of green environemnts might thus not be reflected in the actual physical environment, but from a user perspective they are nonetheless important to acknowledge.

2.3 Concluding remarks on previous research

This chapter's main purpose has been to give a conceptual scientific background that will underpin the continued chapters of this thesis. As a departing statement it can be said that both the urban green spaces' meaning and inhabitants prerequisites for interaction with the urban green spaces need to be understood in order to evaluate inhabitants' prerequisites for recreational relations with these types of public recourses.

From a public health-oriented perspective, the main utilities are stimulation of physical activity, mental recovery and social interaction, and these are the utility classes that will be used within this thesis. These utilities seem to be mainly related to the characteristics of green spaces, where different utilities have different prerequisites. With the right quantitative data of urban green space attributes, it seems possible to quantitatively analyze the utility potential for different green space within a case study area. However, in order to further understand urban inhabitants' prerequisites for harnessing these social values from green environments, their ability to interact with these areas also needs to be understood. The concept of accessibility seems to provide a theoretical frame within which these prerequisites can be analyzed and clarified. In the light of the finding on urban green space interaction within a weekday context, the place-based accessibility concept seems to be particular useful for this thesis. However, between the different measures available within this accessibility concept there appears to be a trade-off between theoretical correctness on one hand and communicability and operationalizability on the other. Because this thesis aims to reveal general pattern on a municipal level of scale and offer a basis for both continued research on the topic as well as a knowledge base for planners and policy makers, the latter will be prioritized. Therefore, the places-based distance measure of accessibility will be used to analyze accessibility to potential utilities within urban green spaces.

In the following chapter, it will be discussed how this theoretical and scientific basis can be used in order to quantitatively analyze potential social utilities within urban green spaces and the accessibility to these social services.

3 Methods for mapping social values within urban green space

In this chapter the basis for the thesis urban green space analysis is outlined. The chapter starts with the concept of sociotopes and its methodological approach for analysis of public open space. It incorporates a description of the concept and how it has been applied in Gothenburg, along with a critical discussion of these aspects. In the second section, the methodology for evaluation of potential social utilities is outlined. By combining the current scientific knowledge on social utilities from urban green space interaction with the sociotopic methodology, along with other relevant data, a framework is created for how potential social utilities from urban green spaces can be quantitively analyzed. In order to be able to analyze the potential accessibility to these green spaces, an analysis framework is developed. Together, these form the methodological structure for this thesis.

3.1 Sociotopes and sociotopic mapping of public open space

The term "sociotope" is a concept that was developed by the landscape architects Alexander Ståhle and Anders Sandberg in the beginning of the 2000s as a counterpart to the concept "biotope". It can be seen as a reaction to the increased emphasizing of ecological aspects of urban green spaces in spatial planning processes since the 80s and 90s (Skärbäck et al., 2014; Ståhle, 2006). It is meant to incorporate both environmental characteristics important for outdoor recreational purposes and the outdoor recreational activities in themselves that are being undertaken within public open space into one concept. These characteristics and activities are then arranged into sociotopic values that can be identified within public open spaces through field research and resident consultation. The sociotopic values can then help planners to get a more diversified understanding of public open spaces, how they are used and their meaning for local residents' identity and life pattern. The concept, along with a cartography, has today been used within the urban planning sector in numerous cities in Sweden. The first city to be mapped was Stockholm, who performed their cartographic process between the years 2000-2002 (Stockholms Stad, 2002). Inspired by the work of the capital city, numerous urban municipalities followed and produced sociotopic maps of their public open spaces. Gothenburg was one of them, which produced its sociotopic maps during the period 2005-2013, one borough at a time. However, the methodology is not universally homogenous. Differences are present in both concepts definitions, the interpretation of public open space and the sociotopic values. Ask (2013) illustrates this in her bachelor thesis where she compares the methodology between the sociotopic mapping of Stockholm (which was the city the concept was first developed for) with the one preformed in Gothenburg. In the latter, sociotopic values were defined as "place for human activities" and the areas that were ascribed sociotopic came to more distinctly consist of urban green spaces (even though some other open spaces are included as well), were as in the former it also refers to places like squares and other forms of undeveloped land. Gothenburg also uses fewer sociotopic values that are coarser in their description than those used in Stockholm. In total, they were 20 of them and these are listed and described in table 1 below. The original Swedish term is written within the brackets and the identification code is written within the parentheses. A common for all these values is that actual usage is an essential element. For example, this means that an area was only assigned the value *Natural experience* (N) if it, apart from having stated natural characteristics, also actually were used as a place to experience natural settings as described in the list below (Ask, 2013).

Table 1. List of sociotopic values and their definition. Source: (Ask, 2013), Unpublished material from City of Gothenburg - Park and Landscape Administration.

Swimming [Bad] (Ba) This value refers to beach-like activities such as bathing, swimming or sun-bathing. This could take place at beaches, cliffs or jetties, but also at public pools.	**Cardio Training [Motion] (Mo)** Indicates cardio workout activities like jogging, Nordic walking, recreational cycling, ice skating, cross-country skiing. Also refers to the presence of cardio training tracks.
Flowering [Blomning] (Bl) Refers to the presence of flowering vegetation in the form of flower beds, wild flowering plants and flowering trees and bushes.	**Meeting place [Mötesplats] (Mp)** Refers to locations where people tend to gather in larger numbers where one can interact with, or just observe other people. These could be open-air cafés, public transport nodes, playgrounds or square activities. It could also be used to indicate that the urban green space is generally used intensely by people.
Ballgame [Bollsport] (Bo) Refers to a variety of ball game activities, such as football, basketball, volleyboll, miniature golf, tennis, frisbee golf, etc., taking place at asphalt, gravel or grass fields.	**Natural experience [Naturupplevelse] (N)** Indicates that an urban green space has a wilder natural character with forests, wild animal life and more non-maintained natural habitats, creating a sense of wilderness.
Recreational harbor activities [Båtliv] (Bå) Refers to activities related to publicly accessible harbors, dockyards, marinas and general water-based activities like kayaking.	**Public space gardening [Odling] (O)** Refers to recreational gardening and agriculture activities taking place in publicly accessible location. Are mostly used for allotment gardens.
Events [Evenemang] (E) Include activities related to temporal events of different kinds like demonstrations, sporting events, markets, festivals and performances.	**Picnic [Picknick] (Pi)** Indicates that picnic activities are present within the urban green space examples that are mentioned are barbecuing and excursion picnics. Also refers to the presence of arranged outdoor resting places.
Fishing [Fiske] (F) Non-commercial fishing activities, from land, boats or jetties	**Walk [Promenad] (Pr)** Indicates walking and saunter activities, both with and without dogs. Also refers to the presence of passing walking routes and arranged walking trails.
Green oasis [Grön oas] (Go) Refers to places that through its secluded, enclosed, green and leafy character offers a contrast to the surrounding environment.	**Social outdoor games [Sällskapslek] (S)** Indicates social games preformed in natural and parklike environemnts. Examples are boule, kubb and rounders. Also refers to the presence of grass fields where these types of activities are being undertaken by inhabitants.
Street sports [gatusport] (Gs) Refers to activities undertaken in hard-made parks and surfaces. Examples are skating, roller skating, bmx-cycling and street-basketball.	**Vantage [Utblick] (U)** Refers to vantage points with view of the surrounding landscape which also are used as such by inhabitants.
Cultural history [Kulturhistoria] (K) Different types of cultural historic environments containing ancient remains, etc.	**Sense of water [Vattenupplevelse] (Va)** Refers to locations where people experience different type of water environments like shorelines, rivers and streams.
Play [Lek] (L) Indicates presence of playing activities mainly connected to children such as building huts and games in natural environments, sledding, sandbox activities, and water games.	**Rest [Vila] (Vi)** Indicates that a location is used for relaxation in a peaceful and calm environment. Also refers to the presence of arranged or natural seating facilities.

According to unpublished material from City of Gothenburg, Park and Landscape Administration, the sociotopic mapping of these values were made in four essential steps in Gothenburg. The first was the *place inventory*, where a borough [stadsdelsnämnd] (the pre-2011 borough division) was inventoried by landscape architects in the field, where different locations were evaluated in regard with the 20 sociotopic values described above. Most parks were visited at least once during spring, summer or early autumn. Some visits were also done during the winter. The second step was the *public consultation*, where local residents' perspectives on these sociotopic values were gathered through focus groups, inquiries, field interviews abd/or discussion strolls. The process was not completely standardized as there was a need to adapt this step according to the prerequisites of the different boroughs in order to incorporate perspectives from as heterogenic a group as possible. The third step was the *collocation*, were the input from the public consultation were combined with the results from the place inventory. In this process, the input from the residents were given higher precedence, with some considerations to how many inhabitants that had agreed on the input. The result from this process were then gathered together in a preliminary map and were evaluated and reviewed by borough public planning officials, park managers and biologists. In the last step, called the *finishing*, the results were digitized to a GIS format. In this process the catchment area of all parks was also estimated on the levels of local neighborhood, borough, or the entire municipality. This resulted in the final sociotopic maps and an example can be seen in figure 4, which shows the sociotopic map of Kortedala borough. Within the sociotopic mapping process the amount of leisure space within the residential properties has also been evaluated and then classified within three leisure space availability groups. The one with largest amount of leisure space typically includes single-family homes and smaller row houses where every living unit have access to a private domestic garden. The other two typically includes 2-3 story apartment blocks, apartment towers [punkthus], landshövdingehus and Million Programme areas. The classes are represented by the color yellow to red in in figure 4 below.

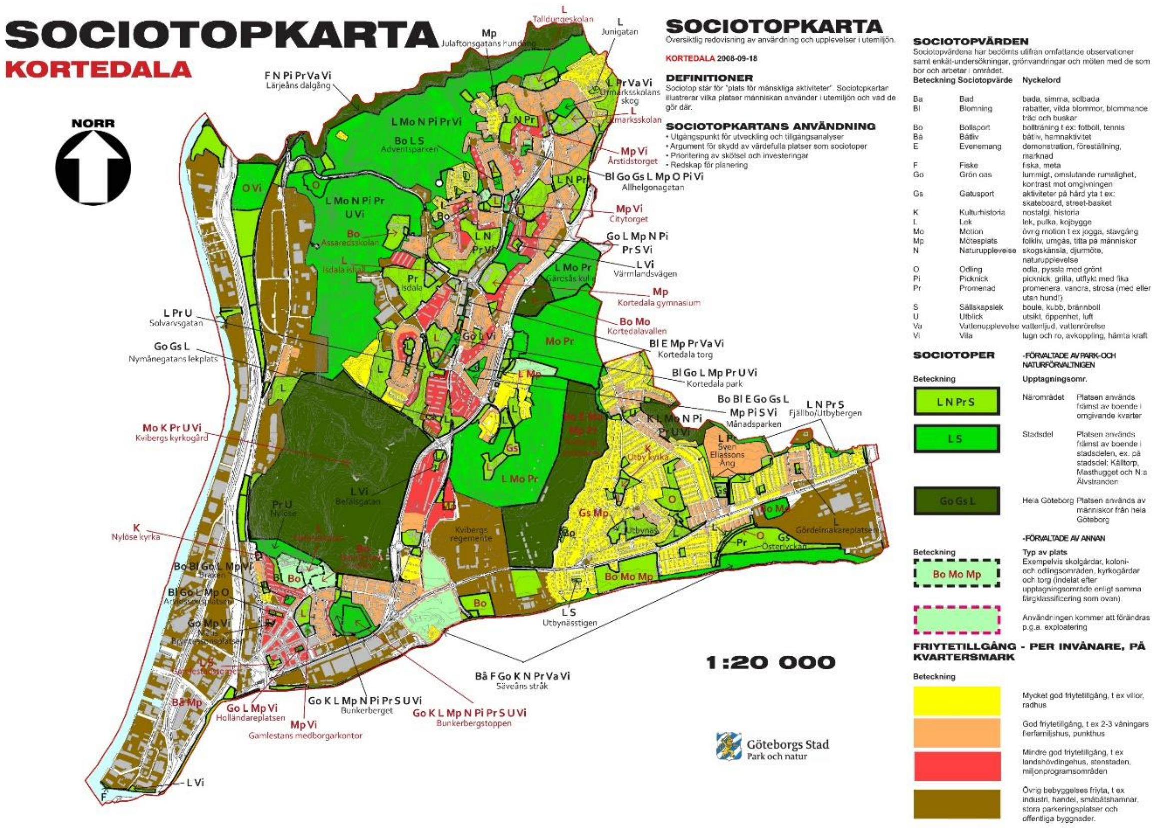


Figure 4. Exemplifying sociotopic map over the borough of Kortedala.

3.1.1 Critical reflections on the concept of sociotopes and its operationalization in Gothenburg

The fact that sociotopic classification is based on a combination of the perspectives of local inhabitants and landscape architects and borough officials is another important aspect to discuss. It could also be argued that this methodological approach makes the concept of sociotopes relatable to the landscape concept. The incorporation of perspectives from cultural experts (local residents) along with technical experts (landscape architects and borough officials) makes it possible to broaden the perspectives of public space from a static entity defined by physical attributes to a product of human activities (see Jones & Stenseke, 2010). The human activities that are being undertaken in the urban landscape becomes an essential part that defines public spaces.

It could be argued that this has several practical implications in evaluating of, in this case, urban green spaces. For one thing, it makes sociotope an important tool for highlighting social values of informal green spaces that have not been detected by planners and policy makers. This is otherwise often a problem with expert-driven evaluations of urban green spaces and other forms of open urban land (Skärbäck et al., 2014). From this aspect, it also makes the sociotopic maps a more reliable green space data source, since informal green spaces more often are missing within official green space data (Le Texier et al., 2018). It could further be argued that it makes it possible to create more credible divisions of otherwise uninterrupted continuous green areas based on their social importance and the perceptions of local residents. The fact that this must be done from time to time within the sociotopic mapping method can be argued to be both a strength and a weakness. An advantage is that it enables the identification and distinctions of parts of green spaces that holds especially important landscape values from surrounding green areas. This could make evaluations of social utilities in public spaces more reliable. On the other hand, it also opens for criticism from a relational geographical perspective in which places are considered a relational entity; defined and constructed just as much by their outside as by their inside (see Cresswell, 2013, Chapter 11). An example of this can be made with a forest trail used for experiencing wilder settings of nature (like the sociotopic area of Lärjeån). Even though it is only the trail and its absolute vicinity that is actually used for this purpose, one could argue that the surrounding forests and landscape in general are just as important for the creation of the sense of wilderness. When such areas are quantitively analyzed with variables like areal coverage, this could be a potential problem since the analysis would separate areas from their surroundings, which in a relational geographical perspective are just as essential part of them as the places themselves.

It is also important to discuss which individuals and groups this cultural expertise is deriving from. Are all voices heard within the participatory classification process or are voices of marginalized groups missing? (Jones, 2010). In the case of Gothenburg, it could be argued that this concern is to some extent counteracted by the fact that the sociotopic process has been done within the pre-2011 borough organizations. These individual boroughs were more socioeconomically homogenous than the current ones are (Göteborgs Stad, 2011). That the public consultation can be adapted to better fit whit the preconditions of the borough with the objective to incorporate the perspectives of as many groups as possible can also be a strength in this sense. But how this has been done in practice in the case of Gothenburg is not stated and can therefore not be evaluated. This is another potential weakness with the sociotopic values that also must be considered when used in research projects and landscape evaluations. Furthermore, Jones (2010) states that even though being an important entity within landscape perspectives, it can be a risk of idealizing local knowledge. Often, many other "outsiders" also have legitimate interest in landscape values and are important contributors in the creation of them. These stakeholders are also important to acknowledge. In the case of Gothenburg's sociotopic maps, it could be argued that this has to some extent been addressed through the catchment classification. If this also has influenced the sociotopic classification is however unclear.

There are also several aspects with the sociotopic values themselves that are important to discuss. First of all, there is no standardized workflow procedure description that states exactly how the sociotopic values and their descriptions should be implemented in the sociotopic mapping process. This means that the process to some extent rely on the subjectivisms of involved stakeholders of each borough. One can however ask oneself if such a description is possible to create in this type of process.

Another aspect is that the sociotopic values typically are made in a binary fashion. This means that an area can either qualify for a sociotopic value or not qualify. There is thus no gradient within the sociotopic classification that can be used to evaluate different areas with the same sociotopic value in relation to each other. On way this could be done in the case of Gothenburg is through the three-scale catchment area classification, which has been done for almost all sociotopic areas. However, in terms of evaluating potential social utilities, one could argue that such a classification cannot be directly used to evaluate the magnitude of, for example, stress reducing abilities. There might exist very important places for such values without them being used by people from all over the municipality. This lack of a gradient factor has several important implications. First, it becomes complicated to distinguish between areas that are crucial for certain social values for a large amount of people and areas that only has a moderate importance. This can in turn make the sociotopic classification less reliable over time. If a value should be based on the activities of a limited group of people, there is a risk that the classification becomes obsolete if these activity patterns changes due to new life phases, migration, etc. With the binary classification, there are limited measures to evaluate these types of risks. However, it could be argued that the binary classification of sociotopic values can be a strength, since sociotopic values of marginalized areas becomes equally “prized” as values in more affluent areas that have been identified by more vocal groups in society. In addition, although numerous, 20 categories aren’t nearly enough to describe all varieties of activities that are taking place within green spaces. They are just simplifications of reality. For example, the sociotopic value “play” can entail a myriad of different activities that require different attributes of green environments. This is also an aspect that the sociotopic values has been criticized for (Westin, 2010, p. 161). Another important question on the same theme is who these 20 sociotopic values are constructed for? This is a relevant question because green spaces has been shown to have an ethnic dimension, where the perception of green spaces can be different across cultural contexts (Jensen & Ouis, 2014).

In conclusion, the sociotopic values offers unique green space attribute data on a high level of detail. However, as all quantitative simplifications of reality, the values have several shortcomings that must be acknowledged. In the following section, it will be outlined how these values, along with the thesis’s theoretical framework and scientific knowledge fundament will be used to create the thesis’s main methodological structure.

3.2 Methodological framework for urban green space utility accessibility analysis

In this section the methodological structure will be outlined and described. It consists of two main frameworks, the first consisting of the social utility classification framework and the other of the social utility accessibility analysis framework. A comprehensive model of this methodological structure can be observed in figure 5 below.

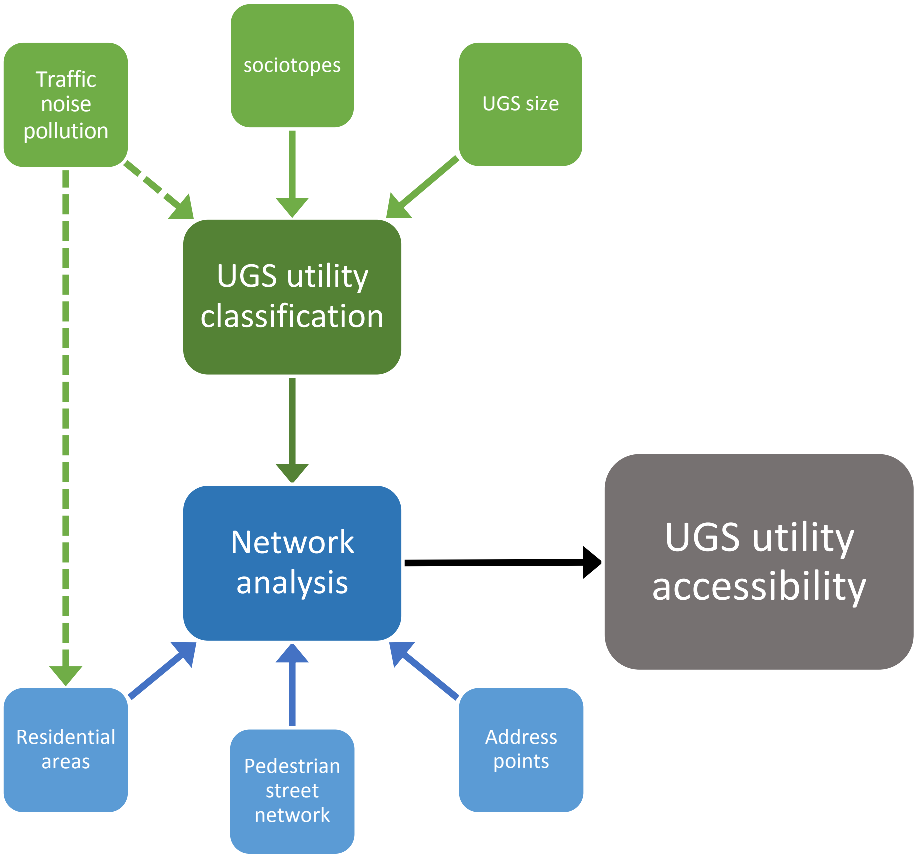


Figure 5. Comprehensive model of the thesis methodological framework structure. UGS = urban green space

3.2.1 The classification of potential social utility within urban green space

In the light of the main social utilities produced by urban green spaces identified in the scientific literature review for this thesis, the urban green spaces of Gothenburg have been evaluated for their ability to provide these three types of utilities for local residents. This is done by using three main variables; The sociotopic values, noise data from road and rail traffic and the area coverage size. Using the findings from the scientific literature review these variables are used to develop criteria for the different utility values that can be applied to the urban green spaces. An overview of these criteria can be seen in table 2 below. It is important to stress that the qualification for a social utility criterion does only mean that an urban green space shows potential to provide that utility in relation to considered previous scientific findings, not that it actually provides it to the interacting inhabitants. In the same way, a non-qualification does not mean that the area does not have the actual ability to provide such social utilities, only that it does not shows the investigated attributes of having such a potential. In addition, like the sociotopic classification, this classification is also performed in a binary manner, meaning that the urban green spaces can qualify for a type of social utility, or it can be dismissed for that particular utility. One urban green space can qualify for all the three social utilities or none. This means that the classification cannot estimate the magnitude of the potential, only that it to some extent exist.

As has been outlined earlier in the thesis, there are a lot more variables not considered in this classification process that can affect the social utility realization for individual urban green spaces. One main aspect is the sense of security, which is not only important for interaction frequency in general, but also for the creation of stress reducing utilities (Grahn & Stigsdotter, 2010; Leslie et al., 2010). Another is general park quality and maintenance, as tidy parks with different forms of facilities without litter, vandalism and crime do promote interaction with them (Giles-Corti et al., 2005; Leslie et al., 2010; Sugiyama et al., 2015). It would have been favorable if these aspects could have been incorporated, but since no data comprising these entities were available, this was impossible within the extent of this thesis. The result should therefore only be used to identify spatial patterns of available potential social utilities from urban green spaces and not as standalone basis to evaluate individual green spaces importance for local residents. Because the thesis does not focus on one particular group of people, like age, socioeconomic status, etc., the classification process is done from a broad population spectrum perspective. This means that if a combination of variables only indicates potential for a social utility for a distinct group of people, the combination is not used. An example could be an activity that require certain skills or equipment not possessed by people in general.

By performing this methodological process, research question number one can be answered and a necessary fundament for answering research question number two is created.

Table 2. Comprehensive matrix of the criteria of each social utility.

<table>
<tr><th></th><th>Physical activity</th><th>Social interaction</th><th>Mental recovery</th></tr>
<tr><td>Indicating sociotopes</td><td colspan="2">Bl Bo E
F Go K
L Mo Mp
N Pi Pr
S U Va
Vi</td><td>N Vi</td></tr>
<tr><td>Disqualifying sociotopes</td><td colspan="2">-</td><td>Bo E
Gs L
Mp Pi
S</td></tr>
<tr><td>Disqualifying traffic noise level</td><td colspan="2">-</td><td>LAeq24h < 55</td></tr>
<tr><td>Disqualifying size</td><td>< 2 hectares</td><td>< 0,25 hectares</td><td>< 0,25 or < 5 hectares</td></tr>
</table>

Physical activity criteria

According to the scientific literature review, the size of an urban green space is an important attribute for the promotion of physical activity. In general, parks smaller than 1 hectare seems to have a poor effect on the activity level of near living residents. Instead, a lower size limit of 2 hectares is suggested and will therefore also be used in this thesis (Coombes et al., 2010; Schipperijn et al., 2013). Furthermore, no specific indicator relatable to sociotopic values has been found that could distinguish if urban green spaces are stimulating physical activity or not. Instead, it appears as most green spaces are promoting increased physical activity for near living residents to some extent, especially walking. As stated by Leslie et al. (2010), urban green spaces seem to generally stimulate recreational walking. Apart from walking within the perimeters of green spaces, an interaction of any form is associated with the physical effort of getting to the urban green space, given that most journeys to urban green spaces on an everyday basis is done by walking (Higgs et al., 2012). The increase in physical activity can thus be an effect of increased interaction frequency of near living residents, no matter the purpose for the interaction. In this aspect, it is a methodological strength that the sociotopic values are partly based on actual realized interaction as they thus can be used to evaluate if an area is generally used or not. Because of this, the criteria for potential physical activity is one or more sociotopic value that are applicable to a broad population spectrum. These are almost all values, with a few exceptions.

It could be argued that two of the sociotopic values only are relevant to certain groups of people. The first is the value *Public space gardening* (O), which mostly refers to allotment gardens. This could be described as private goods since it is excludable and rivalrous, not available to the general public on a day-to-day basis as other public green spaces (Boman et al., 2014). The other one is *Street sport* (Gs), which mostly refers to activities like skateboarding, roller skating, and BMX cycling. It could be argued that these are activities requiring special skills not possessed by people in general. In addition, a Swedish national survey on outdoor recreational activities on people 18-74 years of age concluded that skateboarding and roller skating were not performed of at least 9 out of 10 of the population in the last 12 months of the survey (Sandell & Fredman, 2014). For the same reason, Recreational harbour activities (Bå) were left out. According to the survey, the same share of respondents had not engaged in sailing or kayaking. A larger share had ridden motor boats, 38 %, but combined with the low engage frequency of the other activities, the value was judged as insufficient to be used in a broad population spectrum. There was also one value, *Swimming* (Ba), which could be argued to be heavily restricted to certain times of the year, making it problematic to apply within a broader seasonal spectrum. However, the presence of these values did not disqualify the green spaces from potential physical activity promotion. If any of the other values also were present, the area was also categorized as suitable for this utility.

Mental recovery criteria

The literature revealed numerous factors that either could help make an urban green space suitable for mental recovery and stress reduction or queer such abilities. As many scholars pointed out, green spaces with natural features and a wilder character often appear to be very suitable environments for mental recovery and stress reduction in interacting people (Arnberger & Eder, 2015; Chiesura, 2004; Gidlöf-Gunnarsson & Öhrström, 2007; Grahn & Stigsdotter, 2010; Skärbäck et al., 2014). Therefore, Natural Experience (N) is the first sociotopic value used as an indicator for potential stress reducing abilities. The value is estimated to be a suitable indicator for this type of environment as it refers to green space with a wilder, more non-maintained natural character which people use to experience natural environmental features. Although some scholars have pointed out that forests and green spaces with understory vegetation can appear less appealing (Arnberger & Eder, 2015; Schipperijn et al., 2010), the sociotopic values are based on realized activities. This means that areas that are not used to experience nature because of too much understory vegetation, or other appalling factors, should not be included. The second value to be used as an indicator for potential stress reducing abilities is Rest (Vi). The description of this sociotope as a peaceful and calm green space environment is in line with both the serenity factor described by Grahn & Stigsdotter (2010) and the findings from Chiesura (2004), who explains that calm and peaceful areas that offers ability to rest and relax is one of the most sought after environments for mental restorative services. Rest therefore seems suitable to use as an indicator for potential mental recovery as well. The literature review also came up with scientific findings stating that private gardens in connection to small houses have a larger beneficial effect on the mental well-being (of which stress reduction is a component) and that private domestic gardens often can be experienced as serene places (Dennis & James, 2017; Skärbäck et al., 2014). Because of this, residential areas with access to private domestic gardens were also classified as areas with potential for mental recovery. But consisting of private gardens, these areas were handled separately from the other mental recovery areas, as they are only accessible to the residents of those residential areas.

As the literature review also revealed, there are also numerous entities that are incompatible with potential stress reducing abilities in green spaces. Two main ones were able to be covered using the data available for this thesis. The first were too much social stimuli through frequent encountering with other people (See Arnberger & Eder, 2015). In the sociotopic maps it is possible to identify green spaces that often tend to gather large amounts of people or that just have a generally high visitation pressure through the sociotopic value *Meeting place* (Mp). In addition, there are more sociotopic values indicating presence of social events and activities that are associated with social interaction. These are *Social outdoor games* (S), *Picnic* (Pi), *Ballgame* (Bo), *Events* (E) *Street sport* (Gs) and *Play* (L). All of these values indicate that frequent encountering with other people or disturbing social activities probably are likely and could thus be estimated to hamper stress reducing abilities. Green spaces with any of these sociotopic values were therefore not considered suitable for potential stress reducing utilities. With one exception, some scholars stated that some parks are able to house stress reducing utilities and social activities at the same time if they are large enough (Arnberger & Eder, 2015; Skärbäck et al., 2014). In this thesis, the minimum size for this coexistence were estimated to 5 hectares, based on the findings of Wood et al. (2017), who found that parks larger than this were particularly good at providing positive mental well-being effects, of which low levels of stress are an essential component (Arnberger & Eder, 2015). The second entity not compatible with potential stress reducing utilities was high noise levels from traffic. As was found in the literature review, noise levels above 55 dB are both generally perceived as disturbing and can ruin serene values of a place, which is one of the most important elements for stress reducing environments (Europeian Commission, 1996; Skärbäck et al., 2014). Because of this, areas with noise levels above this value were also not considered suitable for potential stress reducing utilities.

Social interaction criteria

The literature review revealed that urban green spaces can act as arenas where people can meet, interact or just observe other people, helping residents to strengthen their sense of community and their place identity (Boniface et al., 2015; Grahn & Stigsdotter, 2010; Kabisch & Haase, 2014; Kim & Kaplan, 2004; Maas et al., 2009; Wood et al., 2017). In this sense, the presence of people and human activities in general seems to benefit this type of social utility. In fact, the only factor assessable with available data for this thesis that could indicate a hampering effect would be the absence of human activities. Given the theoretical concept of sociotopes, which states that one essential part of a sociotopic grading is actual realized human activities, such green spaces will not have any sociotopic value assigned to them. Or expressed the other way around, the presence of sociotopic values indicates the presence of human activities, and thus a potential for social interaction. Therefore, the sociotopic criteria for potential social interaction becomes the same as for potential physical activity, but for different reasons; one or more sociotopic values that are applicable to a broad population spectrum. The fact that Gothenburg's sociotopic maps mostly focuses on green spaces is a strength in this sense, since green spaces are one of the most important features for the promotion of sense of community and place attachment (Maas et al., 2009). However, no lower green space size limit for the promotion of social interaction could be found in the same way as for physical activity and mental recovery. Therefore, the lower size limit was set to 0,25 hectares. This value were chosen because it is the same used within the Urban Atlas urban green space data, provided by the European Environmental Agency and thus used in many urban green space research project (Poelman, 2018).

3.2.2 The accessibility analysis framework

The main objective of this framework was to provide a suitable measure for inhabitants' accessibility to the social utility evaluated green spaces. Given the scope of this study, along with the data and time resources available, a network analysis measuring the distance to each of the closest social utility green spaces from all residential areas through the pedestrian road network seemed most suitable for this. In relation to chapter two, this could be described as a place-based accessibility approach with a distance measure technique. One of the main reasons that this type of measure was selected was that spatial locations and distributions of green spaces (the land-use component) were a crucial aspect in this thesis research focus, making the alterative infrastructural-based measures less suitable. Since the focus also is of a more quantitative and broad population character, not aiming to incorporating personal or sub-groups' preferences, individual- and utility-based measures were not suitable either. This of course poses a potential weakness for the method and its results, since the perception on both accessibility and urban green space environments are highly differentiated, both between induvial and groups in society (Boman et al., 2014; Karlsson et al., 2014; Maas et al., 2009; Sandberg, 2012; Vilhelmson, 2002). This must be kept in mind when the result of this methodological step is evaluated. Partly in order to enable this emphasization to some extent, absolute distance in meters were choose as the distance unit. By using a standardized measure, it becomes possible to evaluate the results with different perspectives where distance has different implications. If travel time would have been used instead, it would have been harder to utilize the results for groups with different walking speeds than the one used. Distance in meters is also generally superior when evaluating accessibility by walking (Miller, 2018), especially in relation to urban green spaces (Boman et al., 2014). This type of measures are also time efficient to operationalize (Geurs & van Wee, 2004). Given the limited time and human resources available for this thesis, this was not a neglectable factor. In addition, it also has a high degree of interpretability and is easily communicated to a larger group of stakeholders. This is a relevant aspect since the result of this thesis are to be communicated to stakeholders active within the urban planning sector. As is stated in chapter two however, place-based distance measure of accessibility has some main theoretical weaknesses that are important to acknowledge. Firstly, it cannot tell witch of the dimensions of accessibility (proximity or mobility) that are the restricting one. It cannot either evaluate the supply and demand for, in this thesis case, social utility through outdoor recreation within urban green spaces. However, because the result is to partly consist of GIS-generated maps, one could argue that there is a possibility to interpret which dimensions that are hampering accessibility in certain places. Furthermore, there are no data available for this thesis that are suitable to describe cost sensitivity and competition, which is needed for accessibility measures that takes demand aspects into consideration. And to acquire such data would take up too much resources, given the extent of this thesis. Competition has to some extent also been acknowledged for the social utilites that this is important for (mental recovery) given the sociotopic classification framework described in the previous section. Nonetheless, it should still be kept in mind that if accessibility is analyzed in relation to opportunities that are capacity restricted or where demand is concentrated to certain locations in space, these measures can thus be misguiding (Geurs & van Wee, 2004). In terms of distance measurement techniques, a complete pedestrian road network was available for the thesis. Therefore, it was logical to measure the distance through this and not by Euclidean distance. As stated by numerous scholars, this would have risked overestimating the accessibility level, especially in the vicinity of absolute barriers without pedestrian passages (see Handy & Niemeier, 1997; Higgs et al., 2012; Le Texier et al., 2018; Miller, 2018).

The next step was to decide which exact locations that should be used as starting and destination points. According to Higgs et al. (2012), a sort of "golden standard" when conducting potential accessibility analyses for inhabitants to urban green spaces could be defined as measuring access from individual household points to entrance points of urban green spaces through network distance. This could serve as the ideal to which a methodology should strive for. However, due to restrictions in available data and trade-offs between accuracy and computational limitations, this is often hard to implement in practical research work. This study is no exception, as entrance points were not available within the urban green space data. The destination points therefore had to be set according to another standard. According to Boone, Buckley, Grove, & Sister (2009), green spaces are in many cases accessible along most of the boundary and can thus be used as entry points within urban green space accessibility analyses. Higgs et al. (2012) explains that by calculating accessibility to the neared boundary point, the analysis can take the shape of a green space area into consideration, which is a particular advantage when a difference in distance of a few hundred meters can have a big impact on the results' meaning. It is important to note however that this might provide misguiding results if there are barriers along an urban green space boundary, such as steep hillsides, larger roads, etc. In order to counteract this potential issue, only the urban green space boundary point proximate to the pedestrian road network were used as entry points. As individual household points, street address points were used, which represent the spatial location of households with a high level of accuracy. In order to give an idea of how this measurement technique can affect the distance values in comparison with other means of measures, an illustration of this can be seen in figure 6 below.

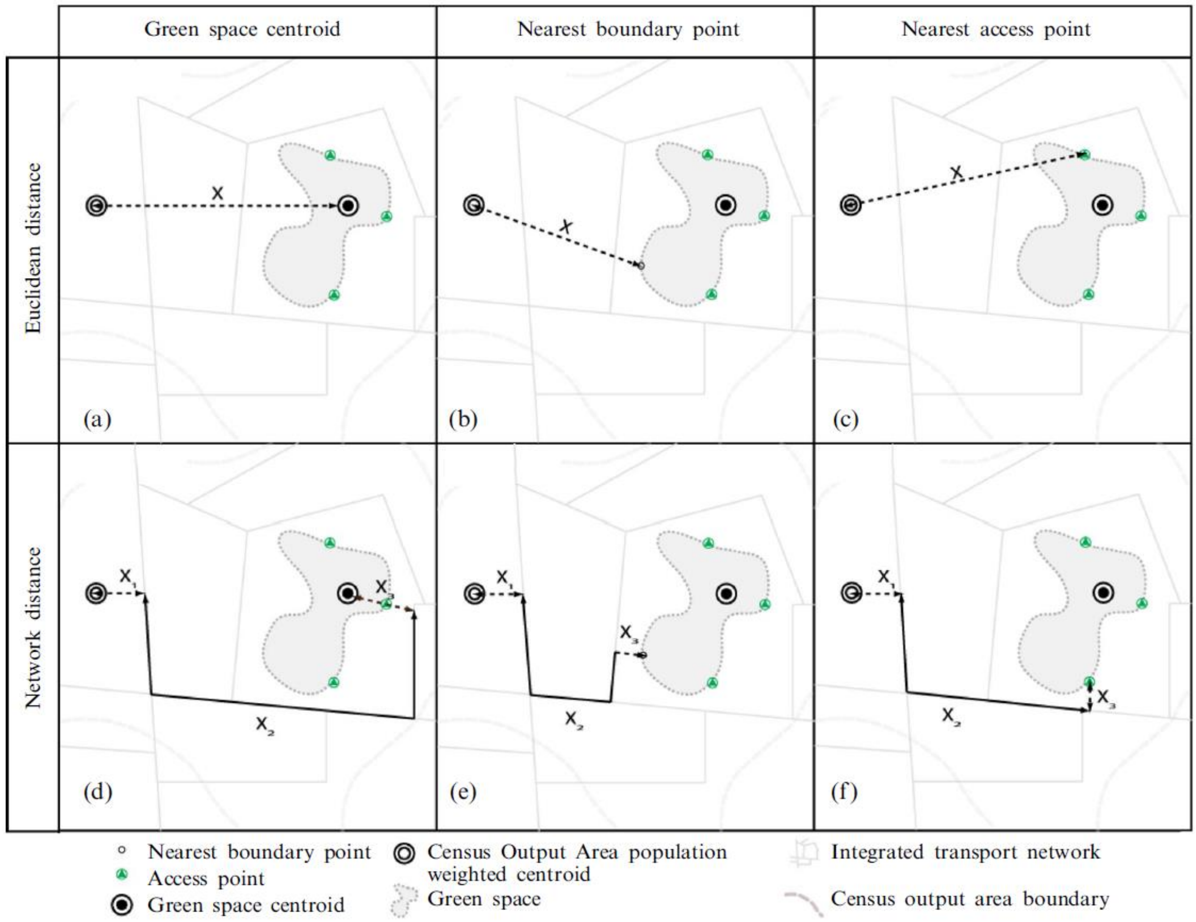


Figure 6. Exemplifying image of the effect on network distance of different green space network analysis techniques. Source: (Higgs et al., 2012).

4 Method

In this chapter the method process of the operationalization of the frameworks described in the previous chapter is outlined. It can be described as a quantitative method, where standardized data are being quantitatively analyzed. However, it could be argued that one of the main data sources, the sociotopic values, to some extent can be described as qualitative. The overall method that forms the basis for this thesis can thus be described as quantitative with qualitative strains (See Gren & Hallin, 2003, pp. 36–38). In the following section, the thesis GIS method is described. The chapter then ends with a concluding methodological discussion, focusing on validity and reliability. The GIS software used in this thesis were QGIS 3.4 Madeira with GRASS 7 core plugin.

4.1 GIS method

This section is divided in two main parts. In the first one, the data used in the thesis is presented. In the second, the main operationalization of the framework described in the previous chapter is outlined.

4.1.1 Data and data preparation

Here, this thesis's main empirical data and their respective data preparation process is outlined and motivated. All data were provided by different administrations within the City of Gothenburg, which are listed in the heading of each data section. Additional GIS-data were used for background information in the final maps presented in the result chapter, but these are only presented in those maps.

Study area – Urban Transport Administration

This dataset consisted of numerous shapefiles, divided up between the different urban development strategy areas (see section 1.3). Together, they covered the entire study area and were therefore merged to a single polygon. This polygon was then used to generate the green space extent zone, using the tool *Fixed distance buffer*. The buffer distance was set to 1 000 meters, generating a polygon covering the study area and all areas within one Euclidean kilometer of the study area. In order to take the municipal border into account (see introduction chapter) the polygon was also differentiated using a municipal mask layer.

Sociotopic maps – Park and Landscape Administration

This dataset consisted of polygons covering most of the urban green spaces (with sociotopic classification) and residential areas (with open space classification) in Gothenburg. As a first step, these two data types were separated into two separate shapefiles. The one consisting of green space polygons were then doubled-checked in relation to the sociotopic maps published on the City of Gothenburg's web page in order to control that the sociotopic values and polygons were correct in the GIS data. In one borough, Kortedala, the values did not correspond. After evaluating the values in both the pdf and the GIS data, the pdf was determined to represent the correct values. The values therefore had to be manually corrected in the GIS data. In all other boroughs, the values and polygons were the same, with a few exceptions where some polygons were missing in the GIS data. These were manually added. In addition, the sociotopic value code (written within parenthesis in table 1 in section 3.1) also had to be standardized in the GIS attribute data as different condes sometimes were used to indicate the same value. After this step, the area of the polygon features was added, as the original size of the green spaces were needed later on. Because the precision of the area values was set to 0,1 m^2, this value could also be used as an ID number for the green spaces further into the data management process. As the data also consisted of green spaces without sociotopic values (because none had been identified at these locations during the sociotopic mapping process), these polygons were removed. The data also covered all schools and schoolyards in Gothenburg. Being of great sociotopic importance for pupils at these institutions, it could however be argued that there is a risk that they are repelling to all other groups in society, hampering any potential for social utilities. Especially so since lots of them are surrounded by fences. Therefore, all areas with the phrase "skola" in the "*sociotopna*" attribute field were also removed. Even though Gothenburg's sociotopic classification are more focused on green spaces that its predecessor Stockholm, it still contained some squares as well. Since this thesis solely focuses on green spaces, these features were also removed in the same way as school (selecting on the phrase "torg"). The shapefile of green spaces now only consisted of green spaces with (correct) sociotopic values assigned to them. However, the topology quality of the data was of a very low quality, containing over 600 invalid geometry errors. To process the data further, these had to be fixed. First, the GRASS tool *v.clean* (cleaning tool *bpol*) were used, both to eliminate topology errors, but also to erase gaps narrower than 1 meter between adjacent polygons. This step solved almost all topology errors in the data, except for a dozen or so, which were manually corrected. In the cleaning process, the GRASS tool had split numerous polygons into individual features. These were now dissolved back together using the area value as ID number. This made sure that every polygon was joined back together under the right feature. With a valid geometry, the data was now ready be applied in geoprocessing operations. The last step was to isolate the urban green spaces that fell within the green space study area extent. Using the tool *Clip* and the green space area extent polygon as clip input, all green space falling within this area were extracted. This resulted in 1 200 individual sociotopic areas, covering an area of 7 284 hectares combined, which can be observed in figure 7 below.

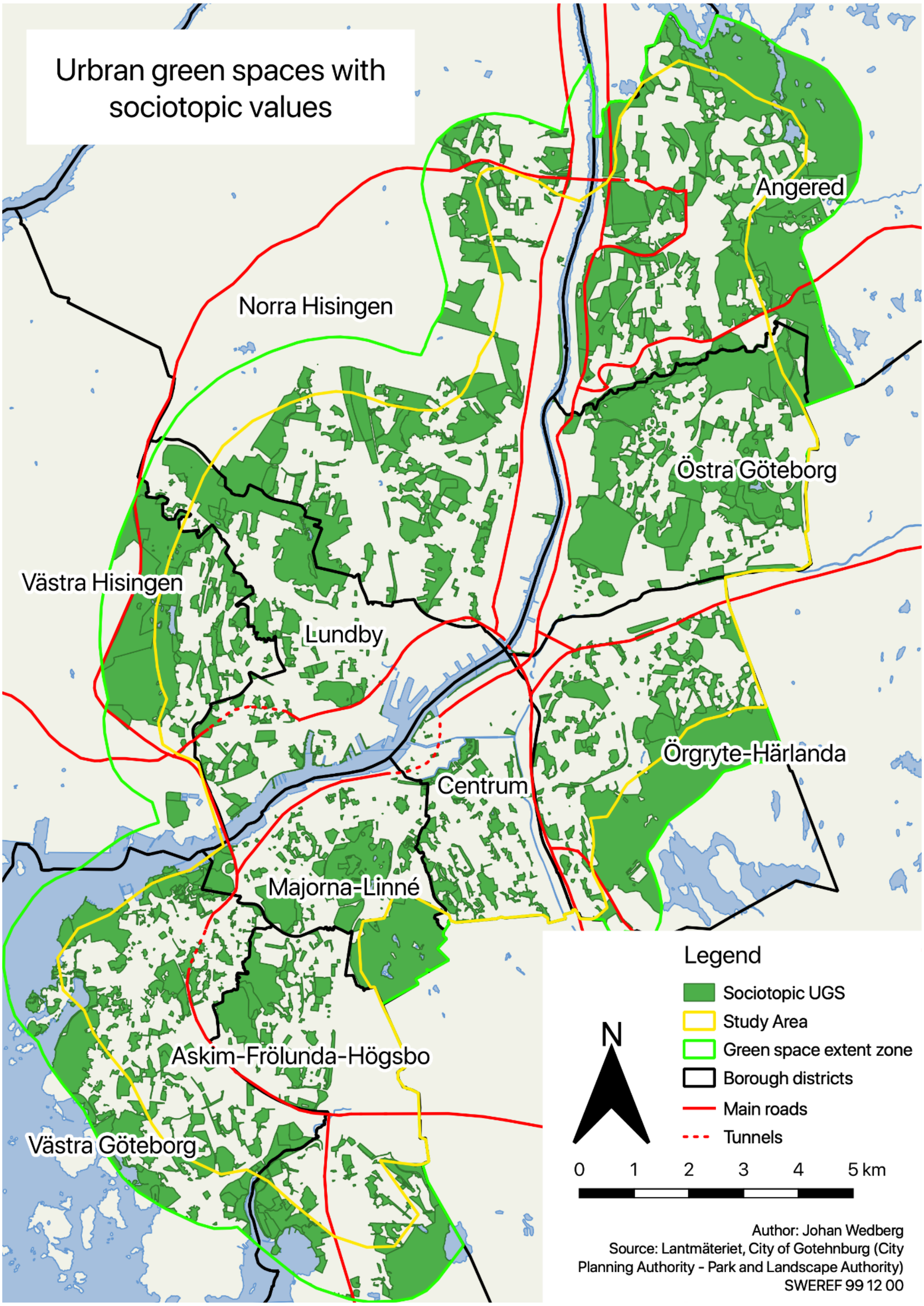


Figure 7. Map of green spaces with sociotopic values within the green space extent zone.

As can be seen in the figure, Gothenburg appears to have a large amount and well distributed number of urban green space that are used by the city's population to such an extent that they have been assigned with sociotopic values. However, the general spatial pattern is not homogenous across the entire study area and some discrepancies can be identified. Parts of the boroughs Lundby and Västra Hisingen as well as the northeast part of the study area appears to be characterized of larger interconnected bands of green spaces with forests that surround the built physical environment. Similar patterns can be observed in other boroughs as well. In centrum and parts of Örgryte-Härlanda, Majorna-Linné and Lundby on the other hand, there are areas that are characterized by smaller and more fragmentated green spaces. In some areas, such as parts of Centrum, Lundby and Askim-Frölunda-Högsbo, green environemnts with sociotopic values appear to be completely missing. Most of these areas are industrial land that are planned to be turned into residential areas in the future. Some parts however, like within the city moat, are one of the most densely built areas in the entire city. Sociotopic urban green spaces also seem to be relatively rare along the banks of Göta river that flows thought the city.

When examined closer, most green patches that can be found via satellite images within the study area also appear to have sociotopic values assigned to them. It is however important to stress that there also are numerous green spaces that does not have sociotopic values assigned to them and was according to the sociotopic mapping method not used to any larger extent by the time the mapping were done. This is more common in certain parts of the study area. In the northeast parts of the city, larger forests areas adjacent to residential areas are lacking sociotopic values which is illustrated in figure 8. These areas a consequently not included in the potential utility classification process in this thesis.

Figure 8. Exemplifying image of residential adjacent green spaces without sociotopic values assigned to them.

The other shapefile, consisting of residential areas, was split once more into two separate shapefiles, one containing areas with access to private domestic gardens and the other containing the remaining residential areas with poorer open space availability and no general access to private domestic gardens. They also contained numerous topology errors, which were all fixed with the tool QGIS tool *Fix geometries*. Unlike the *v.clean* GRASS tool, this did not leave any residual errors that had to be corrected manually. The layers were then clipped with the study area polygon layer so that they only consisted of the areas that fell within the study area. A weakness in this part of the dataset was that a few residential areas were not classified according to open space availability. This was due to two main reasons. The first was that many new residential areas have been built in recent years. Many of these did not exist at the time when the sociotopic maps were made and had thus no open space availability classification. The other was that they simply lacked open space availability classification for other reasons, which are unknown. These areas unfortunately had to be left out of the study, meaning that some residential areas' access to potential green space utilities were not evaluated.

Pedestrian road network – Urban Traffic Administration

This dataset consisted of the Urban Transport Administration pedestrian road network. It is based on the pedestrian network from OpenStreetMap. It is of a very fine resolution, the finest available for this thesis, even incorporating many smaller forest trails. However, the dataset did contain two main type of errors in some locations, the first and most common one was missing network connections across roads. At these locations, there were no network links that connected opposites sides of roadways, which is exemplified in figure 9 below. At the same time, such links should not exist within the network. This made it impossible to merge such detachments across the entire dataset and to manually correct them were judged to be too time consuming, giving the time constraints of this thesis. The second, less common type of network errors were longer stretches of roads that were missing in the dataset all together and is exemplified in figure 10 below. As with the previous type of error, it was judged too time consuming to go through the entire dataset to eliminate them all. The topology of the data was correct from the beginning and no further data preparation was needed.

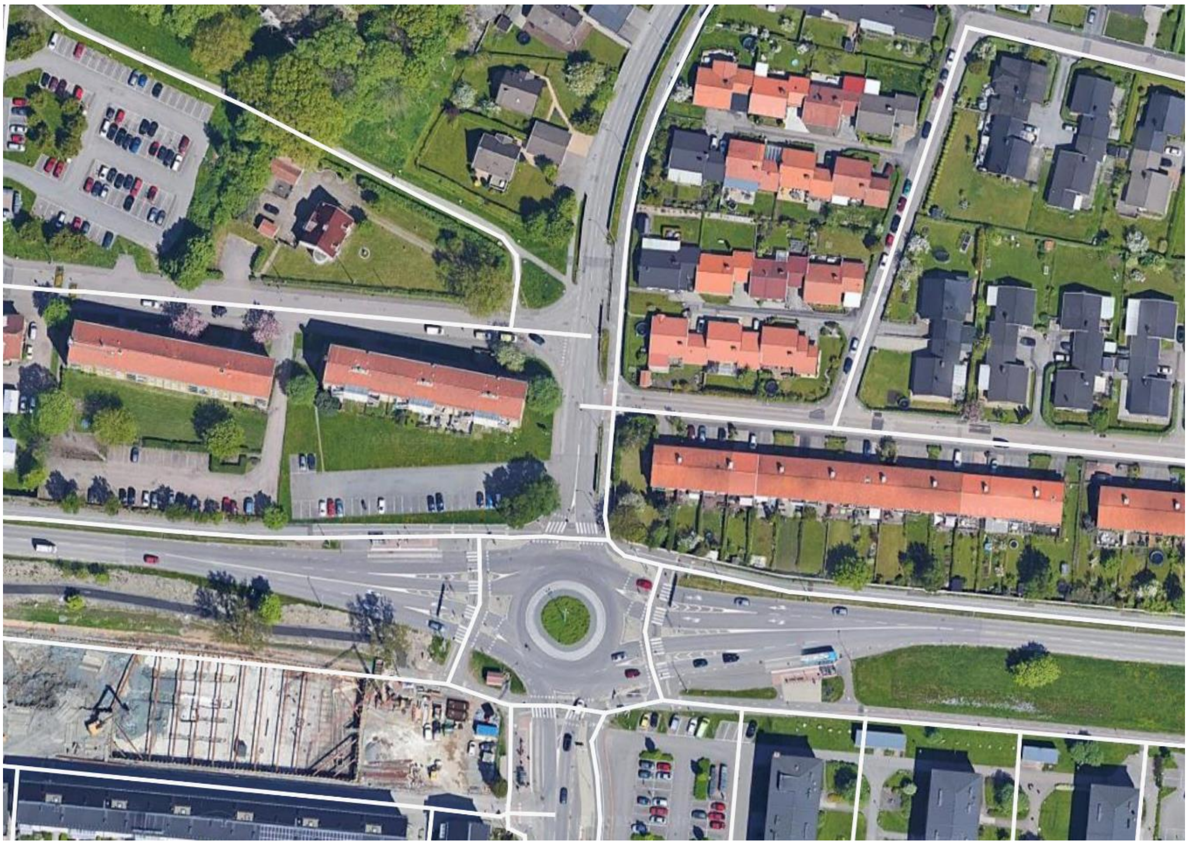


Figure 9. Exemplifying image of network errors: Connection over roadway missing.

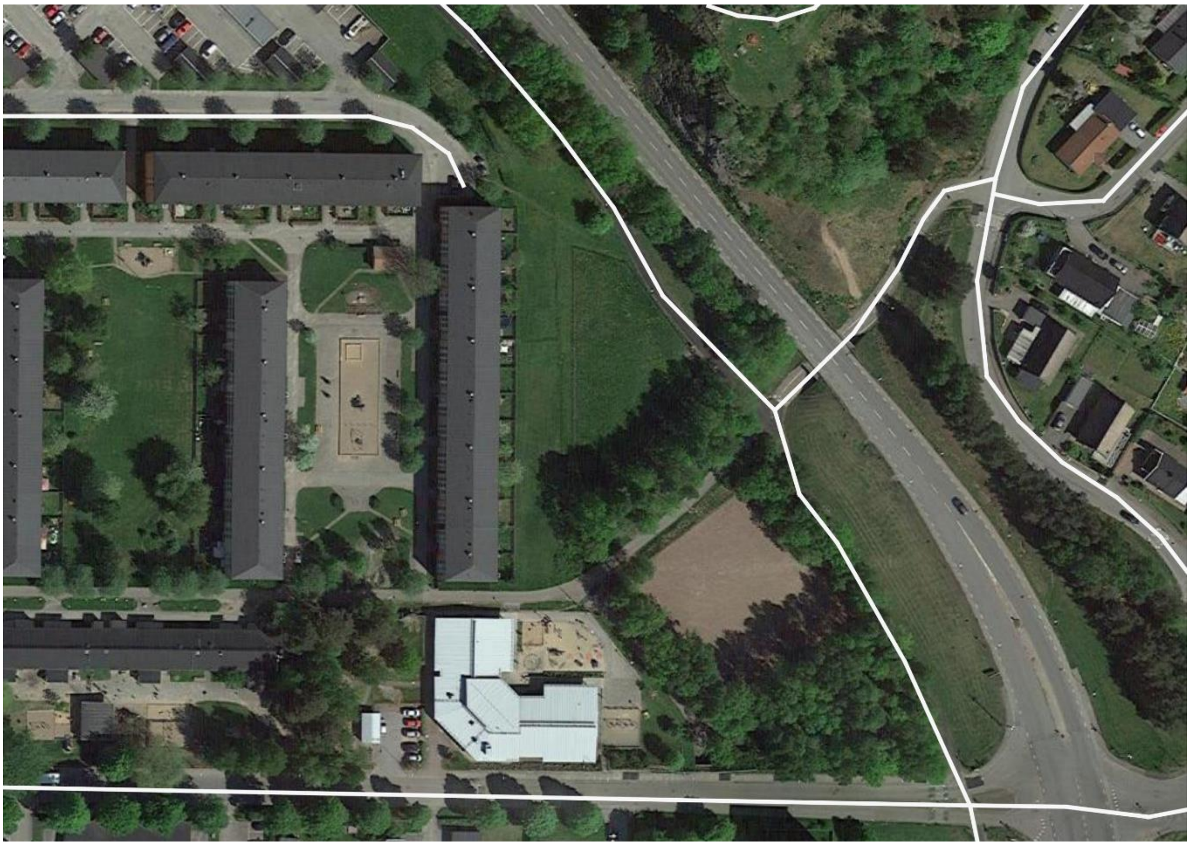


Figure 10. Exemplifying image of network errors: Pedestrian road missing within the network dataset.

Traffic noise data – Environmental Administration

This dataset consisted of a shapefile containing polygons that covers all areas with a noise level above 55 dB(A). The polygon covers substantial parts of the study area. In the central parts of the city there are almost no larger uninterrupted areas with noise levels below this value, which will be an important factor in the chapters to come. The volume is calculated as a LAeq24h value, which means that the values represents the average noise level during a 24-hour day, adapted to human hearing. The reference height (the height for which the value is calculated at) is 2 meters above ground level and the noise level is calculated in relation to the traffic volumes of 2014. This could pose an actuality problem with the data. But since the traffic volumes in Gothenburg in general only have increased by 3 % during the period 2014-2018, the data seems to represent the current situation adequately enough to be used in this thesis (Göteborgs Stad, 2019).

Address points – City Planning Authority

This dataset consisted of address points of all street addresses in Gothenburg. Using the residential area layers described above, the points were clipped so they only contained the address points within the residential areas of interest and also divided according to open space availability.

2018 population statistics within 2nd level sub-borough areas [basområden] – City Hall

This dataset consisted of a statistical sheet of the number of inhabitants within all 2nd level sub-borough areas in Gothenburg. The 2nd level sub-borough areas are the smallest administrative areas with statistical information provided by the municipality of Gothenburg. Typically, they only cover a few blocks in urban parts of the city and the division strives to create as homogenous areas as possible in terms of building structure and demographical variables. They are 1 207 in total, covering the entire municipality. The sheet was transformed in to CSV-format and imported into QGIS. Then, it was joined with a shapefile of all 2nd level sub-borough areas, assigning the population values to spatial areas.

4.1.2 GIS analysis method

Urban green spaces' potential social utility classification workflow

The classification of green space polygons started in the same way for all three utilities. The workflows are illustrated in figure 11 and 12 below. First, all polygons with the sociotopic values indicating each utility were extracted from the sociotopic maps. Then, the area coverage size criterion was applied, deleting all polygons below the threshold values. The polygons within the physical activity and social interaction utility classes were then dissolved and all remaining holes were deleted. Then, the polygons were turned into single parts for further processing in the accessibility analysis.

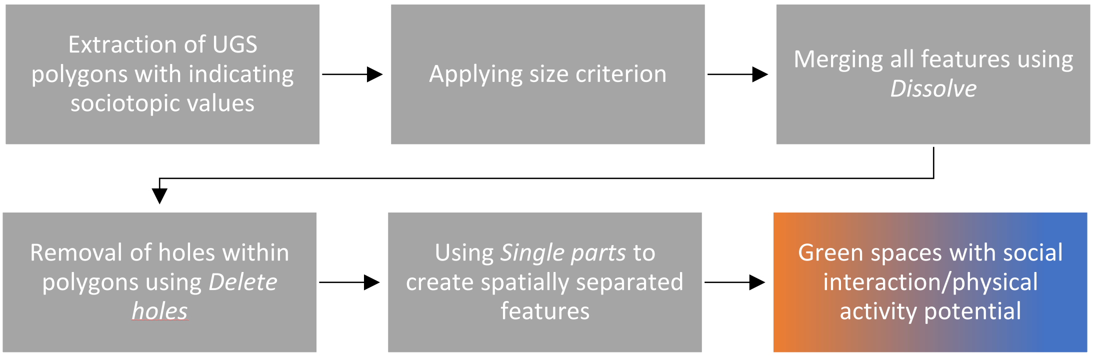


Figure 11. Illustration of the urban green spaces' potential social utility classification workflow – social interaction and physical activity.

The mental recovery polygons had to be processed further. First, all of the polygons containing disqualifying sociotopic values were removed. But since the literature indicated that they could coexist with mental recovery values if the green space were large enough, all removed areas larger than 5 hectares were added back to the data. Then, the polygons were also dissolved, and all remaining holes were deleted. Then, the polygons were differentiated from the traffic noise data. This step chipped away many of the green spaces within the study area, some were even completely disqualified, leaving only the green space surfaces with a $L_{Aeq,\,24h}$ value below 55. In some green spaces however, isolated smaller "islands" of quiet location remained. If these islands were smaller than 0,25 hectares, they were also removed. This lower size limit was also selected based on that it is the lower limit for urban green space size within the Urban Atlas urban green space data, provided by the European Environmental Agency (Poelman, 2018). The remaining polygons were then turned into singe parts and were then also ready to be used within the accessibility analysis.

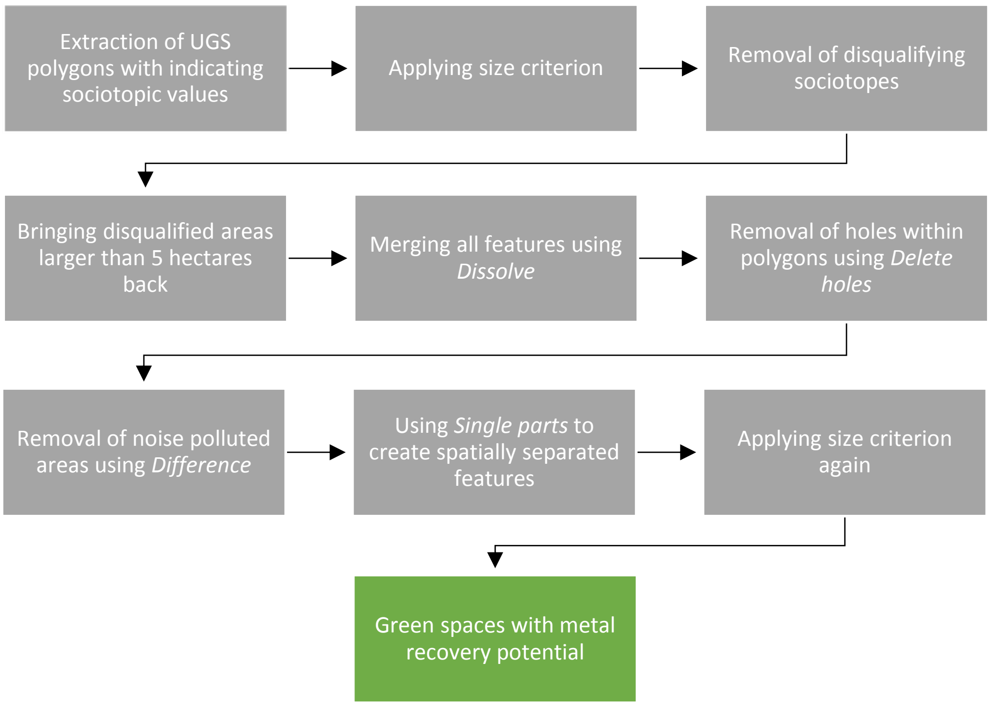


Figure 12. Illustration of the urban green spaces' potential social utility classification workflow – mental recovery.

Accessibility analysis workflow

With the green spaces classified according to their potential to provide the outlined social utilities, the next step was to analyze the pedestrian network accessibility from residential areas. The workflow is illustrated in figure 13 below. The first step in this calculation process was to prepare valid starting and target points for the network algorithm. The actual calculation was performed in the opposite direction, meaning that the green spaces were the starting feature and the residential aZreas were the target feature. As previously stated, green space boundaries proximate to the pedestrian road network were to be used as access points. To generate these, all green space polygons for each social utility type were transformed into line using the tool *Polygons to lines*. Then the lines were turned into lines of periodic points using the tool *Points along geometry*. The point interval was set to 15 meters, which would ensure that the distance between points wound not obscure the data significantly, while not making the further data calculation process too demanding and time consuming. The next step was to connect the address points to the network. This was done with the GRASS tool *v.net.connect*, which created lines from the closest part of the network to the coordinates of the points. The maximum distance for connection were set to 50 meters. This was judged to be a well-balanced distance that made sure that as address points were connected correctly. A larger distance would risk connecting points in places where they shouldn't be connected. Now, all data were ready for the network analysis. The network algorithm used in this method was the *v.net.iso*, which is a GRASS tool that divides a network into segments based on a cost parameter calculated from a starting layer within the network. As starting layer, the points along the boundary of the green spaces were selected. The tool allowed a maximum distance tolerance for the starting point in relation to the network, which was set to 10 meters. This means that the algorithm only acknowledged the green space boundary points within 10 meters of the network polylines as starting points. The cost interval in which the network was set to be divided in were set to 100 meters distance, up to 1 kilometer. The tool was then executed, putting out a network with information on how many hundreds of meters (or over 1 kilometer) there were to the closest green space with a particular social utility potential. To join this information with the address points, a spatial join was performed, connecting the distance attribute from the network algorithm output to the address points. Using the tool *Rasterize*, the points were turned into a raster image with a 50-meter resolution, displaying the average 100-meter distance for all residential address points within each cell. This procedure was repeated for all the social utility classes.

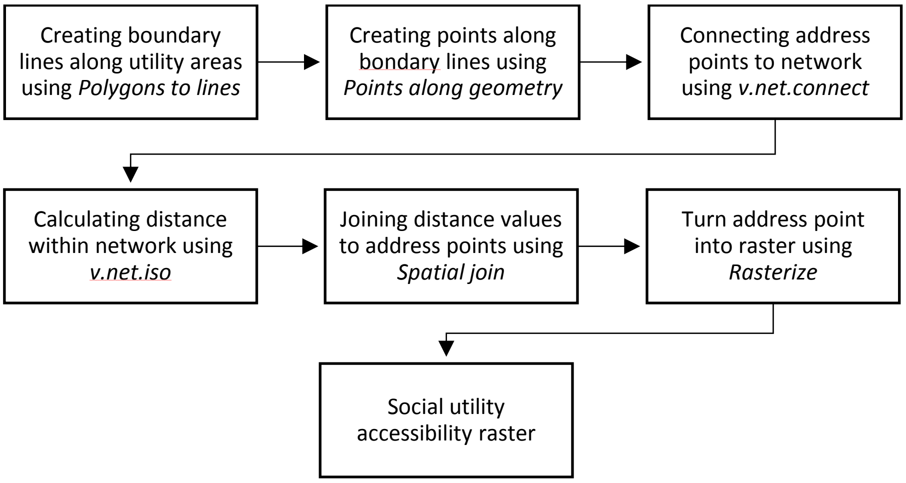


Figure 13. Illustration of the accessibility analysis workflow.

In order to incorporate the effect of private domestic gardens, one additional operation had to be added. The adjusted workflow is illustrated in figure 14 below. First, the polygons covering residential areas with very good space availability were merged into a single feature. Then, it was differentiated with the noise data so that only parts of the polygons with a LAeq24h value below 55 remained. As with the mental recovery green space polygons, this procedure left smaller "island" of quiet areas in many locations. These were also removed if they were small enough but with a lower size threshold of 1000 m^2, which seemed adequate for most gardens after testing different values. The resulting polygon now contained all residential areas with potential mental recovery abilities, in total 37 % of all residential areas derived from the sociotopic maps. The address points were however often located right next to the street, were the noise value often transcend 55 LAeq24h, while the gardens on the opposite side of the houses often had a noise value below 55. In order to incorporate these address points also, a buffer of 10 meters were created around the polygon from the previous step. A second version of the address point containing mental recovery distance data was then created in which all address points with very good space availability that fell within this new buffer were classified as having access (within 100 meters) to potential mental recovery through their gardens. These points were then rasterized in the same manner as described above.

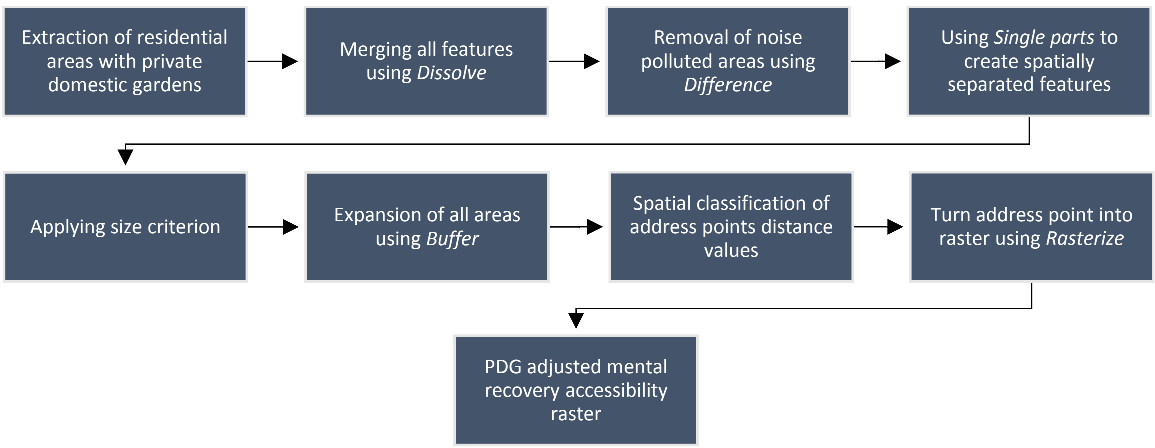


Figure 14. Illustration of the accessibility analysis workflow for mental recovery, adjusted for private domestic gardens (PDG).

This type of network analysis approach is one of the simpler available within the QGIS software, which has several shortcomings. It cannot calculate which green space that is the closest for a particular point, nor can it calculate how much of a particular resource that are within a certain distance. Tools calculating the distance from all points to all points within two layers are capable of doing this. But given the very large amount of access point and the number of address points within the study area (combined up to 90 000), it would have taken a very long time to perform those types of algorithms for all the social utilities.

The maps these procedures produced made it possible to evaluate how the walking accessibility was spatially differentiated in different areas in Gothenburg. In order to concretize these results, an additional method procedure was added, which analyzed how the accessibility was distributed over the population within the study area. This was done in the following manner: First, the number of address points (with distance attributes to the closest green space utility) within each 2^{nd} level sub-borough areas were calculated. Then, the inhabitant number was divided by the number of address points within each area. In this way, the average number of inhabitants on each address point within all 2^{nd} level sub-borough areas were derived. This value was then spatially joined with all address points within the study area, which then could be used to compare approximately how many people that have each type of green space utility within a certain distance. The result from this procedure were arranged in diagrams, which can be seen in the result chapter.

4.2 Validity and reliability

One central aspect with the methodological approach deployed in this thesis is that it is to some extent a new methodological technique. To evaluate spatial patterns of accessibility to potential urban green space utilities, classified using sociotopes and other relevant data has not been done before. The evaluation of this methodological framework is therefore addressed in the analysis chapter, as it is mainly related to the thesis aim. This discussion will therefore only address aspects in the actual method process described in this chapter.

According to Harris & Jarvis (2011, p. 8) a challenge of quantitative analysis is to "separate the noise from the signal". By this the authors mean that all data analysis processes are influenced by errors that could potentially hamper the result, leading to faulty assumptions. These errors cannot be avoided within these types of method processes. Therefore, the authors state that is important to acknowledge that no such process can be one hundred percent definitive. These errors can be related to two main concepts regarding problematization of method designs; validity and reliability. Validity is considered one of the most crucial aspects within scientific research. The criterion can be formulated as if a study investigates what it is intended to investigate. (Bryman, 2012, pp. 47–48 & 170–171). A crucial issue for this study relatable to this is the quality of the pedestrian street network. Is it accessibility to green space utilities that is measured, or is the result more related to network errors within the network dataset? In general, OpenStreetMap quality are population density dependent, since there generally are more people adding and editing information in densely populated areas. This might effect data validity when studying areas with spatially heterogenic population density, such as Gothenburg (Le Texier et al., 2018). There are numerous other weaknesses like this within the geographical data that could compromise the method results at specific locations. However, this thesis does not aim to analyze accessibility to green space utilities at such a level of detail, but to reveal general spatial pattern on a municipal level. And when arguing for such patterns with examples from specific locations in latter chapters, the underlying data has been examined in more detail in order to avoid such analysis errors.

The criteria of reliability refers to the level of confidence that measurements and data analyses have within a study (Bryman, 2012, pp. 46 & 168–170). In an effort to ensure as high reliability as possible, the data used within this study has been closely examined across all of the study area and across relevant sub-areas (the city boroughs) in order to detect potential errors that could compromise the confident level of the GIS analysis. This process also did identify several errors within the applied data, which has been acknowledged and described earlier in this chapter. While these errors were corrected for the most part, it was not possible to do so for all data, as it would have taken a very long time to do so across the entire dataset. The most important one is the previously discussed pedestrian road network. However, while not perfect, it still was the most accurate one available for this thesis, and by acknowledging these weaknesses it was judged to be acceptable for the main scope of this thesis. The GIS analysis process has also been documented in a high level of detail in order to ensure that method considerations could be traced and evaluated in retrospect, both for the author, but also for the readers.

5 Results

In this chapter, the main result of the thesis method process will be presented. It is divided into two main sections, each designated to one of the thesis research questions, which will be answered here. In the first section, the result from the urban green space utility analysis will be presented. Here, the main spatial pattern of each utility will be presented, along with relevant descriptive statistical information. In the second section, the result of the urban green space utility accessibility analysis will be presented. The general level of accessibility to the three types of social utilities will be highlighted, along with the general spatial patterns of different levels of accessibility for each respective utility. How this accessibility is distributed over the population living within the study area will also be presented for each utility. Illustrating maps will also be presented throughout the chapter, but only for the entire study area. For more zoomed-in maps, see the appendix chapter.

5.1 Potential social utilities within urban green space in Gothenburg

As an initial remark, it could be stated that the classification framework managed to incorporate several of the important factors important for social utility provision from urban green spaces, although to a varying extent. However, it should already here be noted that there are additional factors that also are important for the designated social utilities that the framework did not manage to incorporate due to time restrictions and lack of empirical data. The two main ones were sense of security and park facilities, which has been showed to be important features, both for the creation of social utilities but also for interaction frequencies in general. The effect of the green space area shape was not acknowledged either, much due to the division of sociotopic areas which made some of the suggested methods invalid.

The final potential social utility areas identified within urban green spaces generally had varying spatial distribution across space depending on the type of utility and is illustrated in figure 15.

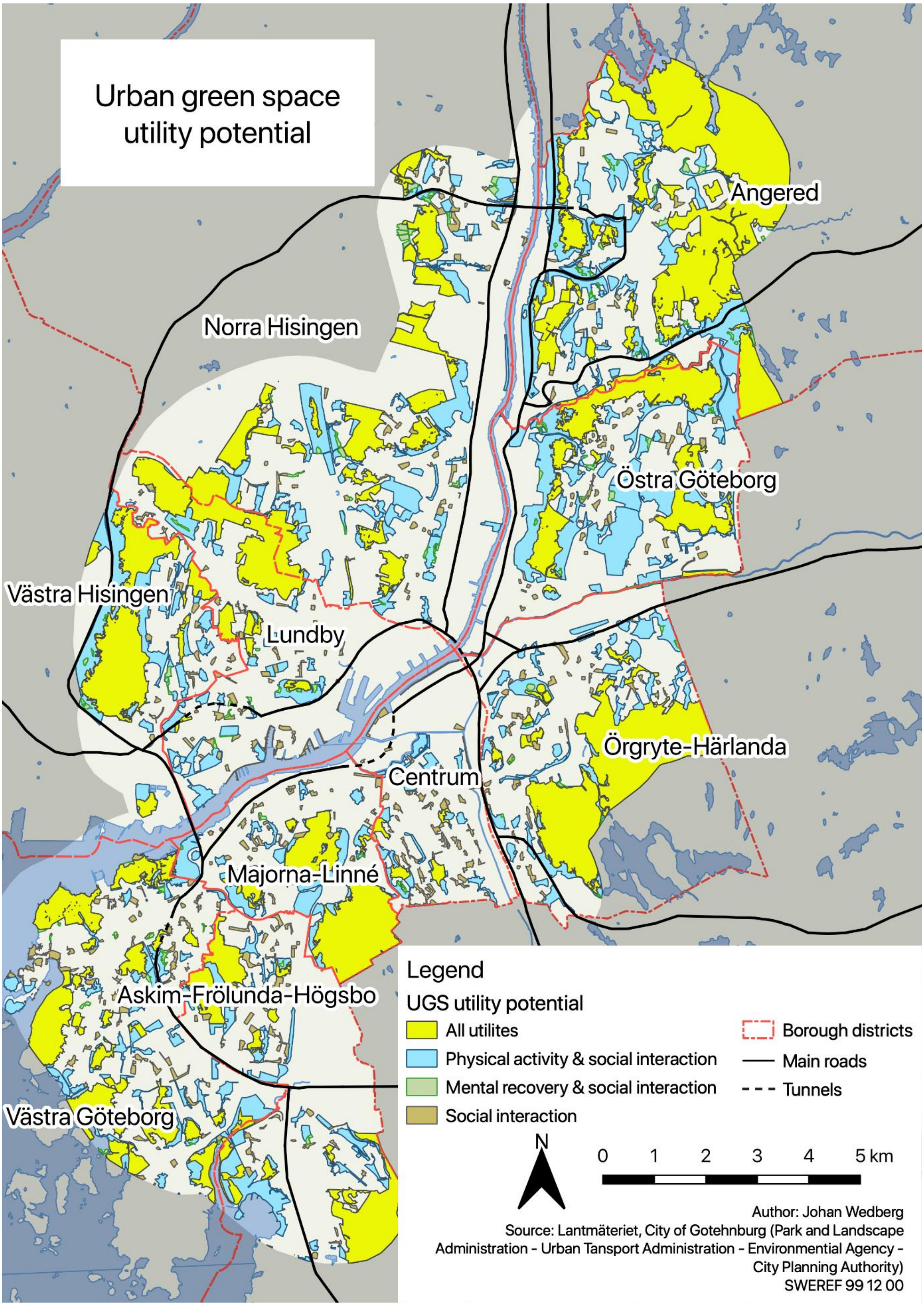


Figure 15. Combined map of social utilities within the urban green spaces within the green space extent zone.

Social interaction

The most common utility was social interaction. In total, there were 753 coherent areas that met the prerequisites for this form of utility with an average green space size of 10 hectares, covering a total area of 7 239 hectares which is 99 % of the total green space area investigated.

Physical activity

The second most common form of utility were physical activity. It only consisted of 396 coherent areas with an average green space size of 17 hectares, but still covering an area of 6 784 hectares (93 % of the total green space area). The reason for the fall in the number of areas, but not in the total areal extent is that the only difference between these two types of utilities is the area size prerequisites. Lots of small green space with social interaction potential were disqualified due to their small size, but together they did not make up that many hectares. This also means that if an area qualified for the physical activity utility, it also qualified for the social interaction utility and is why almost no exclusive social interaction areas can be observed in figure 11; almost all are incorporated within the physical activity areas.

Mental recovery

The least common green space utility was mental recovery, which only consisted of 220 coherent areas, covering 4 224 hectares in total, 58 % of the total green space area and with an average green space size of 39 hectares (before the removal of noise compromised areas). For this utility, a major drop was observed for both the number of areas, but also in the total amount of land coverage. The reduced amount of mental recovery areas is particularly noticeable in the central parts of the city, where are areas that completely lacks these types of environments. The reduction in number of areas as well as land coverage has several explanations. One concerns the sociotopic prerequisites, which is much narrower for this utility than it is for the two others. It is both based on only two types of values (however very common ones) and also have disqualifying sociotopic values, which the other utility forms have not. This aspect mainly affects the number of areas qualifying for mental recovery. The land coverage on the other hand was mainly decimated by the traffic noise prerequisite. Although only completely disqualifying around 40-50 areas, the analysis found that 1 272 hectares of urban green space potential for mental recovery were compromised by too high traffic noise values. This effect is illustrated in figure 16 below and in figure 19 in the next section of this chapter. It should further be noted that 98 % of all metal recovery areas also met the prerequisites for physical activity and therefore also the ones for social interaction. This is the reason why there are almost no exclusive mental recovery areas in figure 15; they are all incorporated within the all utilities polygons. The additional 2 % only meet the prerequisites of social interaction.

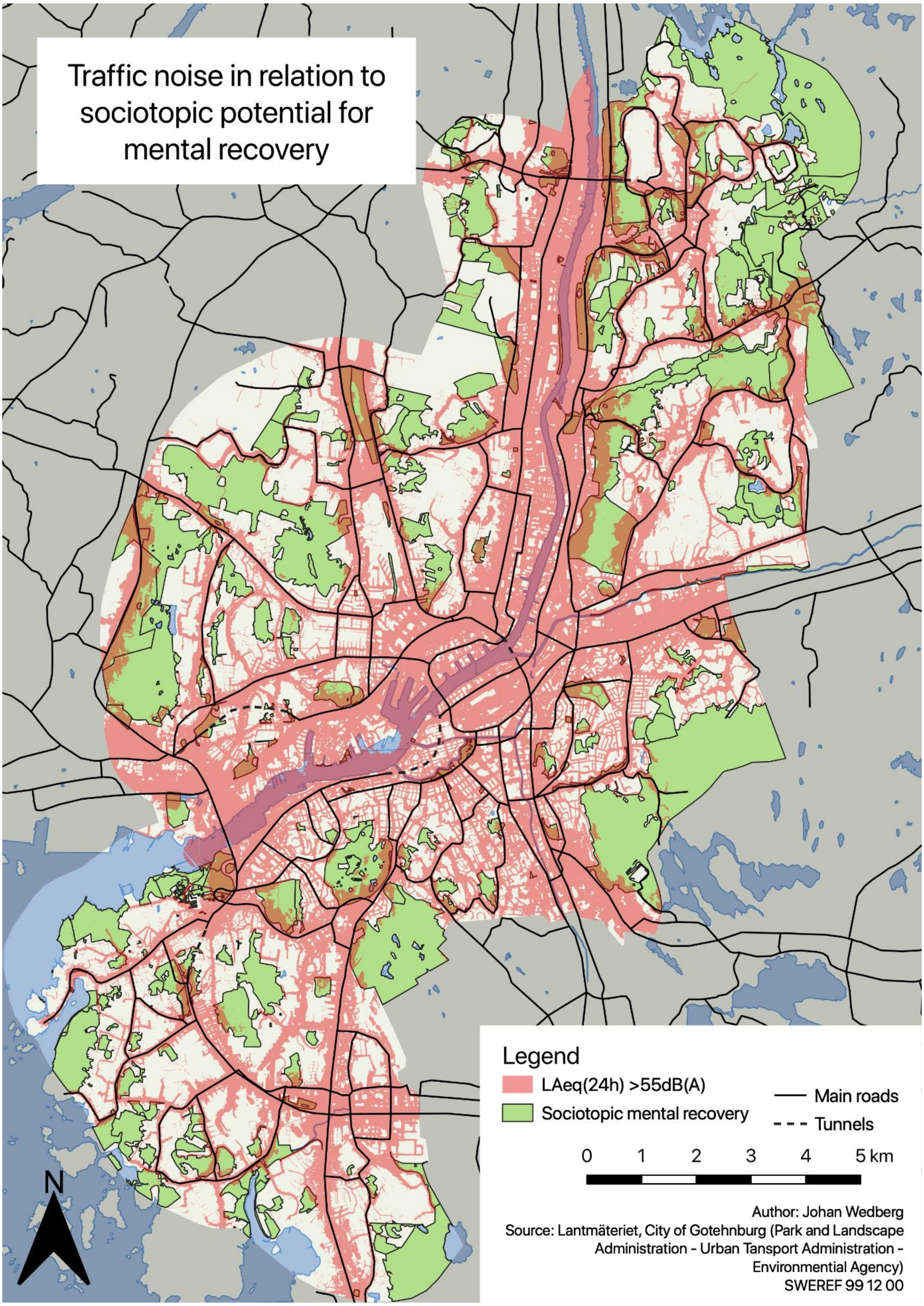


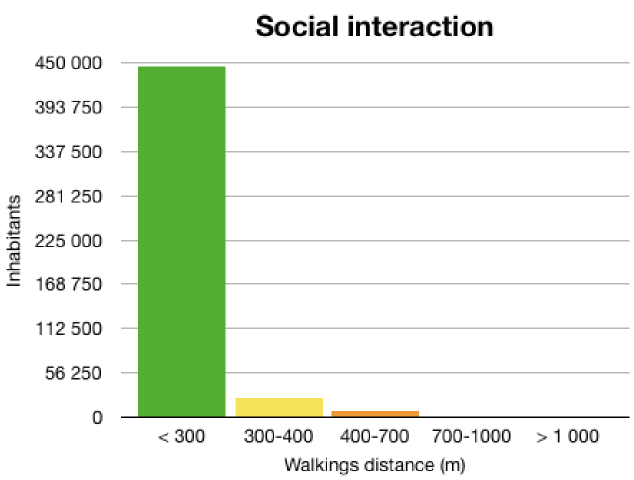
Figure 16. Map of traffic noise pollution in relation to areas with sociotopic potential for mental recovery.

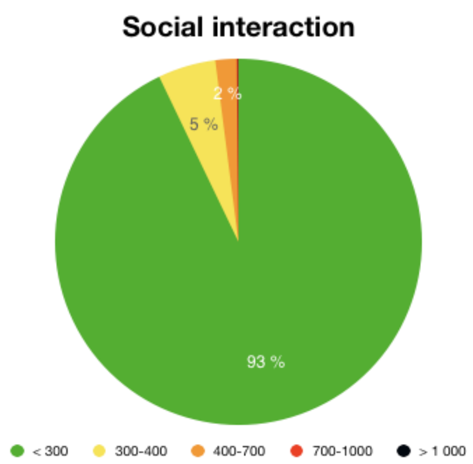
5.2 Urban green space social utility accessibility in Gothenburg

In this section, the result from the accessibility analysis is presented. It starts with outlining the results from the accessibility analysis of Gothenburg – then continues with results concerning the measurement in general. The accessibility distributions follow the same patterns as in the previous result section. In addition, the result from the analysis of the accessibility distribution within the population will also be presented for each utility.

Social interaction accessibility

Being the most common and well distributed form of utility, the accessibility to this resource were also the highest of all three forms of utilities. Very few of the analyzed residential areas had longer than 300 meters to the closest green space with social interaction potential, which also can be seen in figure 17. There does not appear to be any differences between the central parts of the study area and the more peripheral ones, apart from the fact that the areas are in general smaller. This relatively adequate distribution of adequate accessibility is also present within the population statistics. An overwhelming majority of the population within the study area appears to have green spaces with social interaction potential within walking distance that is suitable from a weekday perspective, see the diagrams below. Only 2 % have longer than 400 meters and almost no inhabitants appear to have longer than 700 meters. The small number that do (764 people) appear to mainly derive from network errors within the analysis. In conclusion, the accessibility to green spaces with social interaction potential seems to be adequate for large majority of the population and no real problematic areas or spatial patterns can be identified based on the utility and accessibility frameworks of this thesis.





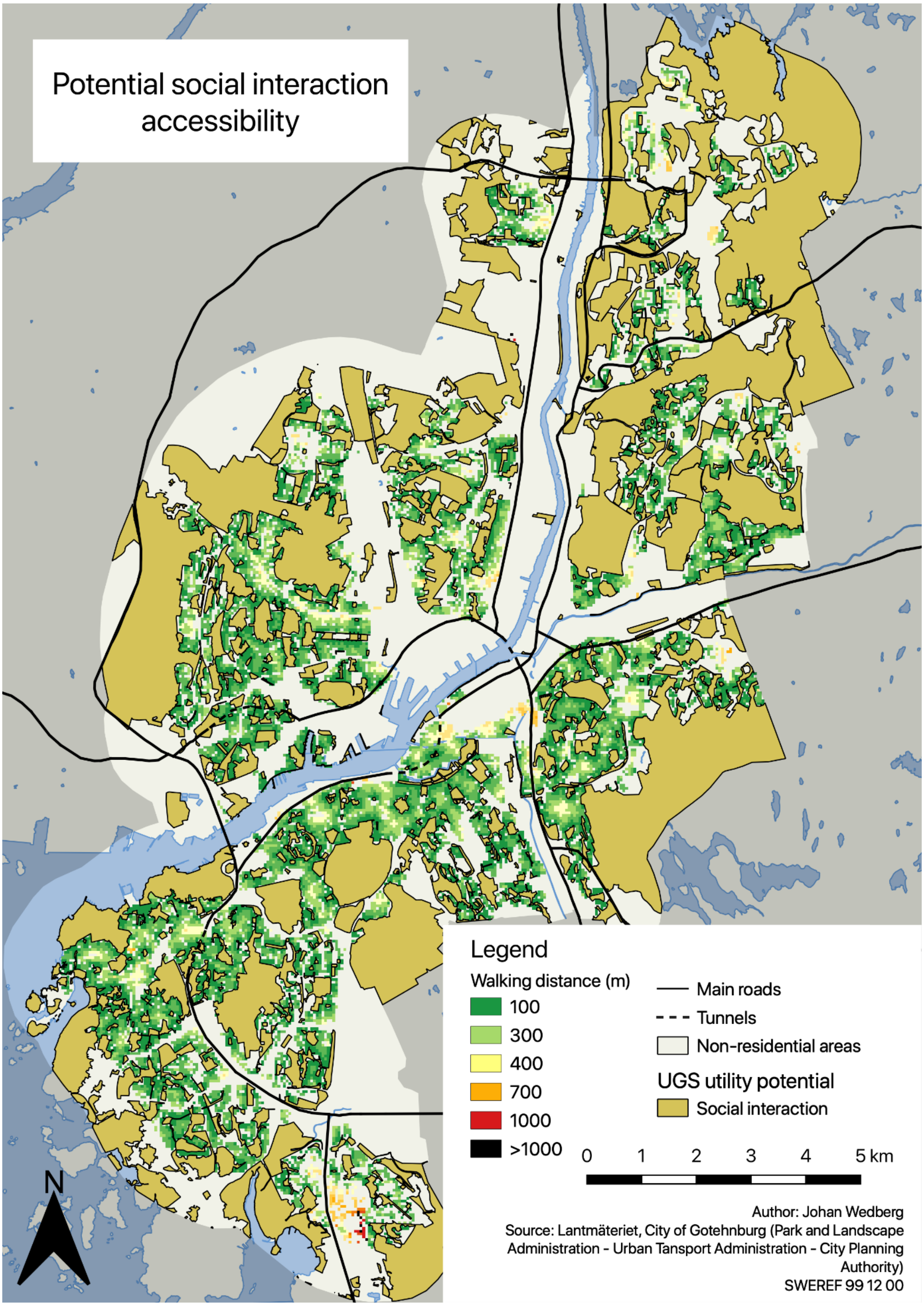


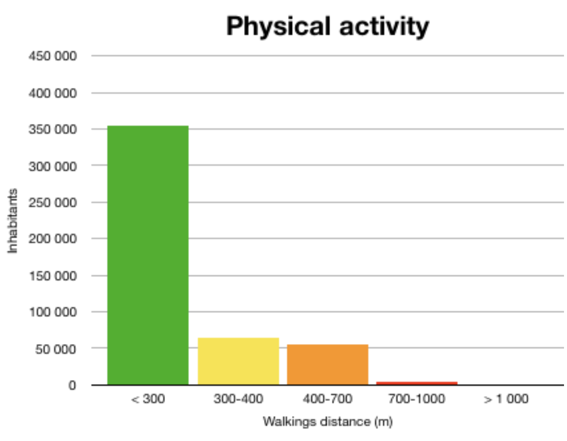
Figure 17. Map of residential walking accessibility to green spaces with social interaction potential.

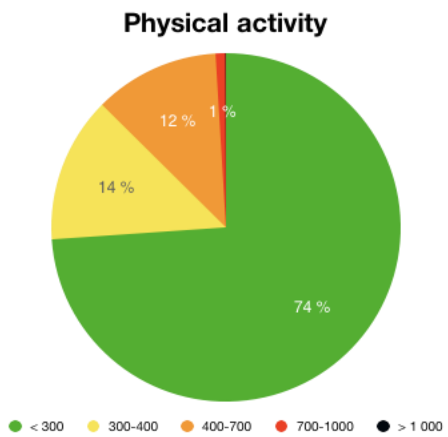
Physical activity accessibility

The accessibility to green spaces with physical activity promotion potential is more hampered for residents within the study area than it is for social interaction, see figure 18. More areas present distances of 400 meters or longer to their closest green space with physical activity promotion potential. For this utility, a spatial pattern also starts to become visible. Several central areas distinguish themselves with more red-orange values, particularly close to the Göta river. In comparison with figure 17, the main reason for this appear to be a shortage of urban green spaces larger than 2 hectares in general in these areas. In terms of accessibility dimensions, it is a proximity, or land use issue. However, mobility hampering factors related to the walking network do start to emerge for this utility in a few locations. Here, the pedestrian road network lacks important links that could reduce the walking distance substantially. One such identified location is Västra Bergsjön, see figure 19 in appendix 9.2.

The reduction of accessibility in relation to the utility social interaction can also be seen in the population statistics, see the diagrams below. A larger share of the population appears to have further to this type of potential utility than the previous one. However, it still appears to be a large majority that have an adequate walking accessibility to their closest green space with physical activity promotion potential and a very small share of people appears to have further than 700 meters.

In conclusion, the level of accessibility is for a majority adequate from a weekday perspective, but problematic areas and spatial patterns can be described within the study area.





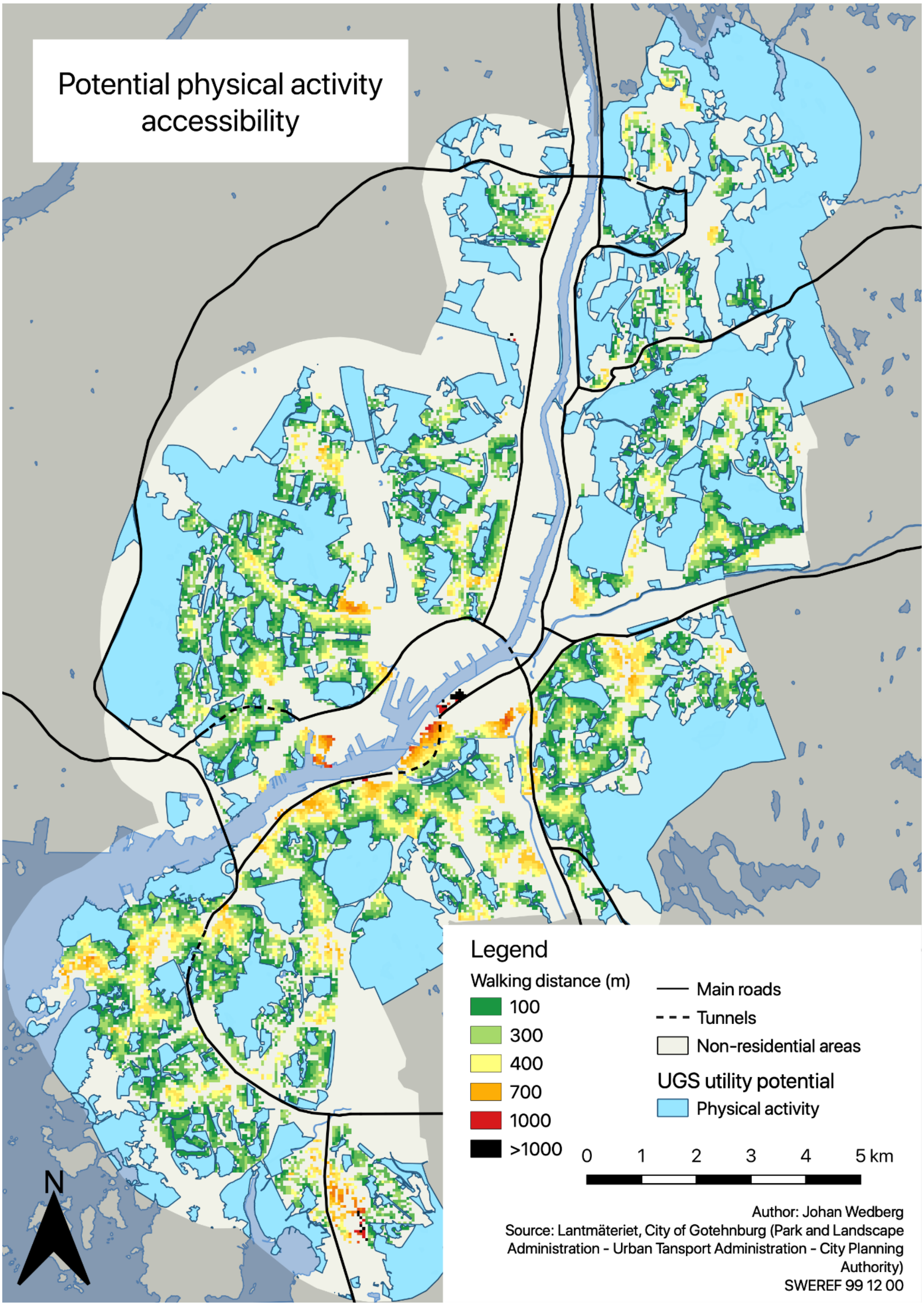


Figure 18. Map of residential walking accessibility to green spaces with physical activity promotion potential.

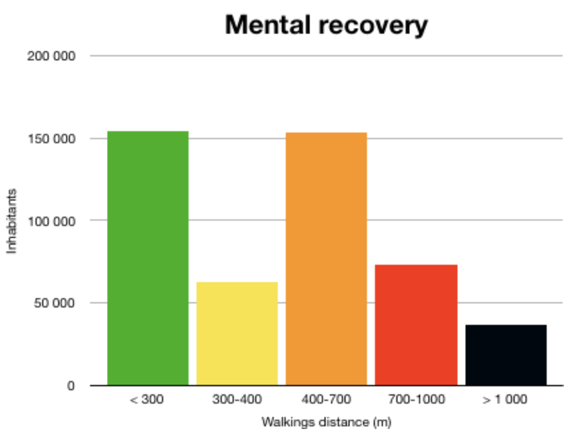
Mental recovery accessibility

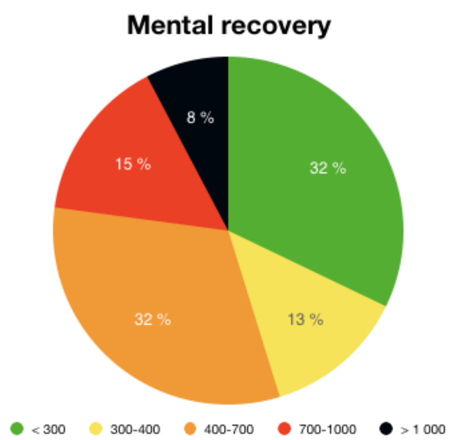
As an initial statement, the accessibility to green spaces with mental recovery potential is clearly different from the two other forms of utilities, see figure 19. Both in terms of accessibility levels in general, with a substantial share of the residential areas having a walking distances above 400 meters to the closest green space with mental recovery potential all over the city. But also in terms of spatial patterns with several consistent areas where the walking distance is longer than 1 kilometer. The central parts of Gothenburg seem to be the most problematic area in this matter, which is where the largest consistent > 1km area can be found. A substantial part of the city core also lacks residential areas with an adequate walking distance all together. But there are also several other patches of residential areas where the walking distance to the closest green space with mental recovery potential is over 1 kilometer.

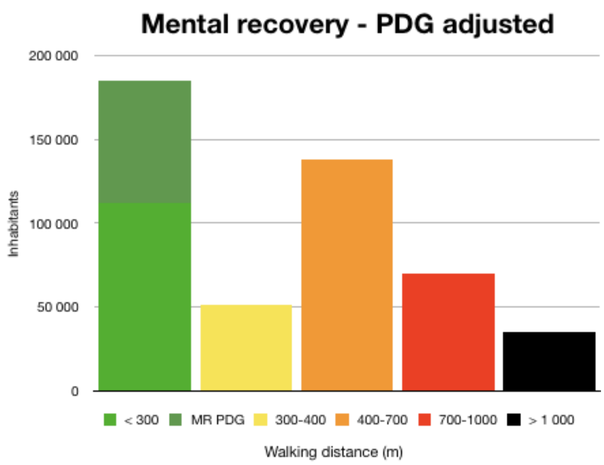
From an accessibility perspective, explanatory factors can be found within both of the proximity and mobility dimensions, which stands in contrast with the physical activity utility, which mainly appears to be limited by proximity related factors. In many of the worst affected areas there is a shortage of sociotopic mental recovery areas in general. But at the same time, these are also areas that often are exposed to traffic noise at a level unsuitable for mental recovery. This is something that appear to affect residential areas in general along major roads, where adequate walking distance to green spaces with mental recovery potential seems to be rare. The fact that traffic noise "eats away" substantial parts of green spaces that could have had mental recovery potential is also hampering mental recovery accessibility in residential areas that otherwise has a very short distance to these green spaces. In order to reach the mental recovery parts of the green spaces, one must first travel a non-neglectable distance into the area. Examples of such areas are Sanna, Högsbohöjd, Grimmered, Eriksberg and Olskroken, see appendix 9.2. In addition, with a larger amount of areas with limited accessibility to this form of green space utility, mobility hampering factors related to the walking network is also much more common for this utility than they are for the physical activity utility. Most of them are found in the vicinity of larger traffic routes. Apart from Västra Bergsjön, additional areas can now be found in Kallebäck, Gårdstensberget, Gamlestaden, see appendix 9.2.

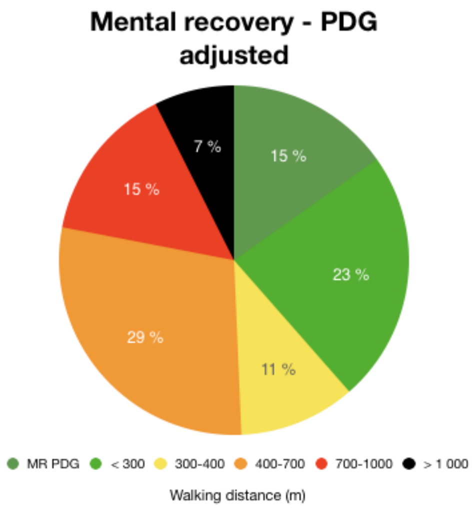
This spatial distribution of accessibility is also reflected in the population statistics. In contrast to the other forms of utilities, were a broad majority had access to both of them, only a third of the population within the study area appear to have adequate accessibility to green spaces with mental recovery potential, see diagram below. Just as many people have green spaces with mental recovery potential on a walking distance of 400-700 meters. A substantial part of the population now also have further than 1 kilometer from their home to their nearest green space with mental recovery potential.

When the effects of private domestic gardens (PDG) on access to potential mental recovery utilities are incorporated, the effect is quite dramatic from a spatial perspective. As can be seen in figure 20, a large share of areas within the study area now have good access to mental recovery environments from a weekday perspective. The effect is most noticeable in the more peripheral parts of the study area, with almost no effect in the central parts. However, when the impact on population statistics is examined, the effect is much more modest than it appears to be in the spatial distribution. Only around 15 % of the population appear to live on addresses that have access to private domestic gardens that are exempted from traffic noise levels above 55 dB and the group that have adequate accessibility to mental recovery environments only grew by 6 percentage point to 38 % What also should be noted is that 9 % of these 15 %, a majority, comes from the group that already had less than 300 meters to their closest green space with mental recovery potential. By comparison, only 1 % of those 15 % comes from the group that has more than 700 meters to their closest green space with mental recovery potential. This means that those that have access to mental recovery environments through private domestic gardens generally already also have an adequate level of accessibility to green spaces with mental recovery potential.









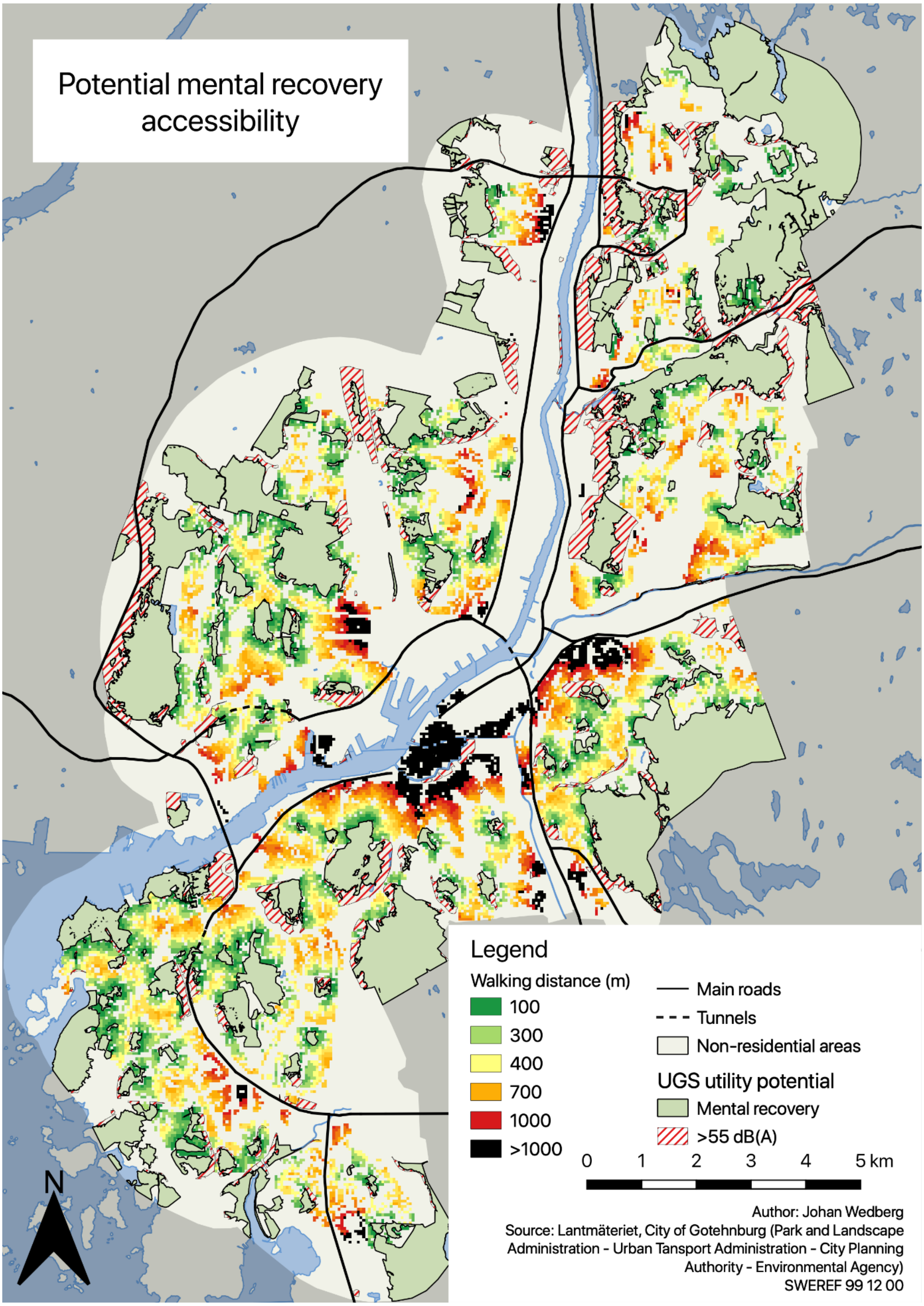


Figure 19. Map of residential walking accessibility to green spaces with mental recovery potential.

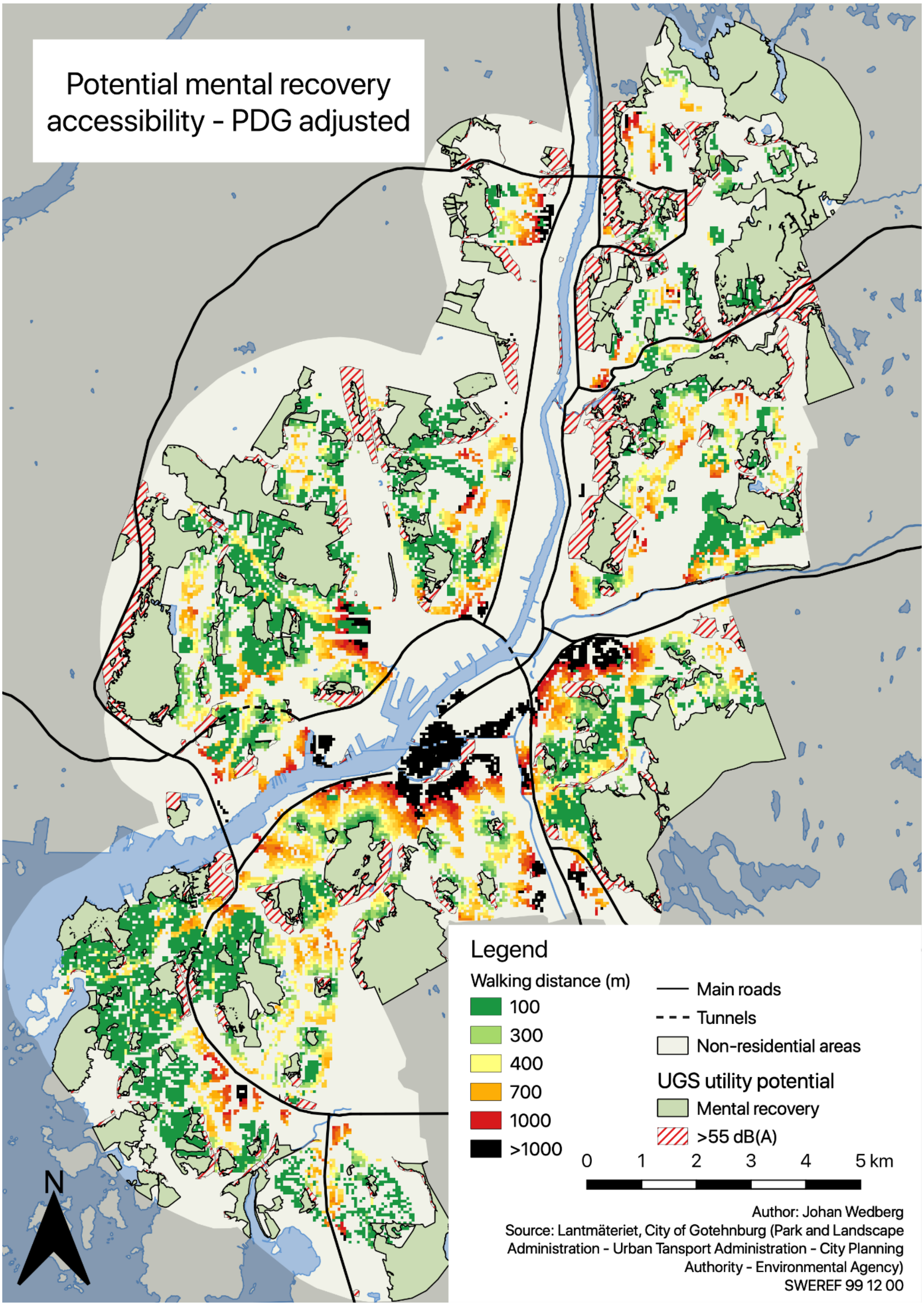


Figure 20. Map of residential walking accessibility to green spaces with mental recovery potential, adjusted for access to mental recovery private domestic gardens.

6 Analysis

In this chapter, the main findings from the result chapter will be analyzed and used to critically evaluate the methodological framework that has been developed within this thesis. This chapter is divided into two main sections. In the first, the results from the case study area are analyzed for general utility patterns, both within green spaces in general but also in relation to their spatial distribution in Gothenburg. Then, the different parts of the methodological framework are critically evaluated based on the method results. The section then ends with an analytical discussion on the potential for applying the framework within other urban contexts in other locations. Based on this first section, the second section ends the chapter with a discussion on what these analyses can tell about the general urban green space social utility accessibility situation in Gothenburg.

6.1 Methodological framework analysis

Firstly, it can be concluded that urban green space is definitely not a uniform category. In order to get a deeper understanding of its relative importance for the potential recreational benefits for urban inhabitants, they have to be analyzed beyond the dimension of just homogenous green spaces of different sizes. The methodological framework developed for this thesis offer a way to do this. In this section this will be analyzed and discussed.

6.1.1 The three-level hierarchical pyramid of social utilities

One main aspect with the utility classification framework is that the utilities can be arranged in a sort of hierarchical pyramid, based on how hard they are to achieve within a green space, see figure 21 for an illustration. The higher up a utility is, the rarer that type of utility is within urban green spaces. The classification is also arranged in such a manner that if an urban green space qualifies for a value at the upper part of this pyramid, it qualifies for the lower ones as well.

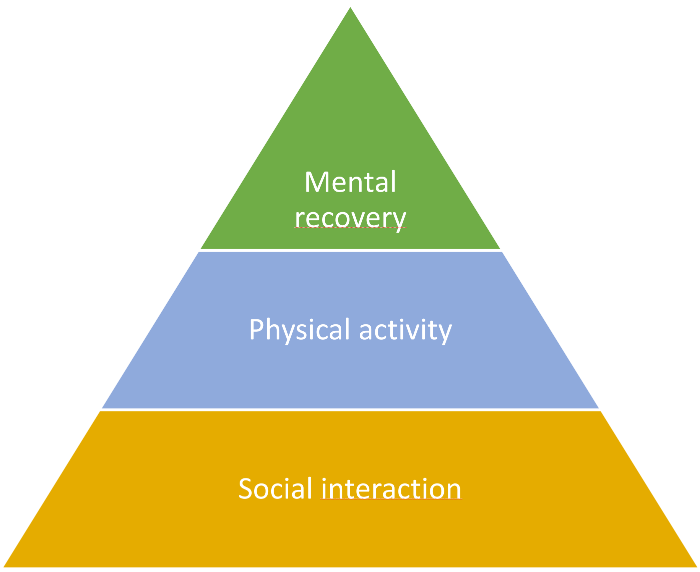


Figure 21. Illustration of the three-level hierarchical pyramid of social utilities.

At the bottom sits the social interaction utility, whose only prerequisite is the presence of human activities from broader population spectrum. Given that sociotopic values are based on realized human activities, it is not surprising that almost all green spaces above the lower size limit of 0,25 hectares qualifies for this type of utility. In the middle sits the physical activity utility, which is based on the same sociotopic values as the social interaction utility, but with a higher minimum size limit. At the top sits the mental recovery utility, which is the utility that has the toughest criteria to achieve. Not only is the indicating sociotopic values much fewer, but it also has disqualifying sociotopic values, something that the other utilities have not. The size attribute is initially lower than it is for stimulation of physical activity though, but when the size requirements for coexisting outdoor social activities are applied, most green spaces with mental recovery potential below 2 hectares of size disappear in Gothenburg. The traffic noise has a big impact on this matter as well, as most of the green spaces that were completely stripped of their mental recovery potential were smaller in size, further strengthen the notion that smaller green areas are more sensitive to noise pollution (Boverket, 2007). In addition, there are almost no green spaces with the sociotopic value *Natural experience* smaller than 2 hectares, which also could be expected, given the finding that wooded areas smaller than this often are not considered worth visiting (Harrison et al., 1995). This is also reflected in the average size value for green spaces with mental recovery potential, which is much larger than the ones for the other forms of utilities. As probably noticed by now, the literature's emphasis on the importance of size for general urban green space qualities is also present within this thesis methodological framework and is consequently reflected within the result of this thesis (see Arnberger & Eder, 2015; Coombes et al., 2010; Grahn & Stigsdotter, 2010; Le Texier et al., 2018; Schipperijn et al., 2013; Wood et al., 2017). As can be seen in figure 11, almost all larger green spaces within the study area has patches of areas which meets the criteria for all forms of utilities. In combination with the previous scientific finding that larger green areas often can house multiple utility values (Arnberger & Eder, 2015), this supports the notion that from a public health perspective, much can be gained by simply striving towards larger urban green spaces. Especially within more dense urban environments, where large green environments often are a particular prerequisite for the more sensitive social utility features due to larger visitation pressure and noise pollution.

In conclusion, almost all urban green spaces have the potential to stimulate social interaction and thereby an increased sense of community and place identity. These green spaces can then be enhanced with additional features that raises the social utility level, first to stimulation of physical activity by making it large enough, and then by making it silent enough and providing serene or natural environments (probably by making it even larger), raising it further to the level of mental recovery. It is however important to acknowledge that "physical activity" in this aspect is more oriented around a general increase in physical exercise, rather than a high-intensity type of activity like football or cardio running, however still not excluding such activities. This means that harnessing the mental recovery utility is often also associated with physical activity. All in all, the pattern indicates that if you as a resident have an adequate walking distance (under 300 meters) to your closest green space with mental recovery potential, you most likely have the other forms of utilities within adequate walking distance as well.

An interesting reflection on this hierarchical pyramid is that it appears as the more desirable a utility generally is, the rarer that form of utility is within urban green spaces. As is explained by numerous scholars, the ability for social interaction is not an unimportant quality for people, but among the three main social utilities described in this thesis, it appears to be the least important one. Both in terms of general green space appreciation and motives for outdoor recreation in general (Grahn & Stigsdotter, 2010; Sandell & Fredman, 2014; Skärbäck et al., 2014). The second most important utility for people can be argued to be physical activity, which also is one of the most important motives for outdoor recreation, especially on weekdays (Sandell & Fredman, 2014). The most important utility seems to be mental recovery. Not only because the ability to relax in natural environments also is one of the most important motives for outdoor recreation (Chiesura, 2004; Sandell & Fredman, 2014), but also because values important for mental recovery like serenity are some of the most sought after qualities for outdoor environments (Grahn & Stigsdotter, 2010).

The incorporation of private domestic gardens as a potential resource for the most sought-after social utility (green mental recovery environments) might counteract the relative rarity of this utility, at least for residents living in residential buildings with such resources (see Dennis & James, 2017). But as the result of this thesis revealed, the number of people that gain access from such a resource appear to be relatively few in relation to the land surface that these residential areas occupy. These are also often areas that have a relatively short distance to their closest green space with mental recovery potential. In addition, if one assumes that private domestic gardens are more associated with more affluent socioeconomic groups, it can further be argued that this type of green space resource does not primarily provide mental recovery utilities to the socioeconomic groups that benefits the most from green space utilities in general (see Leslie et al., 2010). Furthermore, if one assumes that these types of residential arrangements (detached and row houses) are associated with a higher car dependency, one can also argue that these types of green mental recovery environments are associated with more car traffic, and therefore more noise pollution, within a city. This can in turn have a negative influence on the mental recovery potential in public accessible urban green spaces as well as in other private domestic gardens. All in all, this indicates that private domestic gardens are inefficient as a resource for mental recovery utilities on a municipal level of scale.

6.1.2 Limitations of urban green space utility classification

Although the methodological framework and the results from its application in the case of Gothenburg can be underpinned with previous scientific findings in theory, one central aspect needs to be highlighted and discussed. The model is a quantified simplification of reality. The real world on the other hand is not arranged in a binary, three-utility framework, fashion. If this utility hierarchy is a realistic model of the real world's urban green spaces can therefore not be said with certainty and many aspects are important to acknowledge on this matter.

First of all, there are numerous variables that have been identified as important features for the different types of social utilities that the model does not incorporate. One of the more important ones is the feeling of safety, which not only is important for stimulation of physical activity and the mental recovery factors serenity, refuge and nature, but also for green space interaction in general (Grahn & Stigsdotter, 2010; Leslie et al., 2010). Another non-included factor is park facilities like walking/cycling routes, illumination, bicycle and car parking facilities and dog-related facilities, which are also entities that both further stimulates physical activity, and in turn green space interaction in general (Arnberger & Eder, 2015; Leslie et al., 2010; Schipperijn et al., 2010; Sugiyama et al., 2015). In addition, mental recovery from green space interaction can be described as a capacity restricted utility. One could argue that it would make the classification more robust if a better measure for usage intensity were used than the sociotopic values now used for this purpose. The main reason for not including these factors into the classification of urban green spaces is lack of data. There simply are no standardized records of green space park data covering these entities available that is suitable for social utility evaluation. This makes the sociotopic maps the only suitable available urban green space attribute data record.

An additional aspect not included within the framework is the shape of the green spaces. This means that areas with a stretched out and non-round form, but still covering a large green surface could have been assigned values that it actually lacks the prerequisites to house. An example could be made with a hypothetical green space that is just large enough to be classified as an area with potential for stimulation of physical activity. If this utility area were to be a long and narrow stretch, the theoretical basis highlighted in this thesis indicates that the area should not be assigned the same importance that areas with a similar size, but with a much more round-like shape (Le Texier et al., 2018). Given the fact that our hypothetical green space was close to the size threshold value, it should not be assigned potential for stimulation of physical activity in line with the utility framework. There are techniques for quantitatively addressing this by creating an index value based on an area's "roundness" (Le Texier et al., 2018). But when using green spaces that are divided based on sociotopes, this could produce misguiding values, since the areas often are divided with intra-area boundaries that makes the urban green spaces appear more non-round shaped and fragmentated than they actually are. The sociotopic division could potentially also affect the size attribute of green spaces. Sociotopic adapted techniques that can acknowledge sociotopic divided green spaces shapes credibly would therefore improve the methodological framework applied in this thesis.

Another aspect in relation to the model-real world dimension important to discuss is the sociotopic values that form the main basis for the social utility classification. These are themselves simplifications of reality. One could argue that there is a risk that original underlying empirical data (in this case the place inventories and public consultation within the sociotopic mapping process) lose explanatory power for each quantitative data transformation.

To avoid this, transparency in every data processing step is key. And this is a problematic matter within the sociotopic value generation process. It is hard to trace the original empirical data from its source to the utility classification of this thesis because there are no credible records on exactly how these procedures has been adapted and performed within the different boroughs of Gothenburg. It also makes it harder to critically evaluate the reason for the lack of sociotopic values within seemingly suitable green environments, as is shown in figure 8 in chapter 4. It also complicates the evaluation of the sociotopic values consistency in time, for examples during different times of the day or over the seasons. Another major issue with the sociotopic values in relation to the method results of this thesis is that the sociotopic classification is old, meaning that the utility classification could be based on obsolete values. Either because some green spaces simply do not exist anymore, or because they are not used in the same way as they were when the sociotopic classification were made.

All these aspects pose a credibility issue for the utility classification that is important to acknowledge and restricts the ability to use the method result of this thesis on a detailed spatial scale.

6.1.3 The accessibility analysis

The applied accessibility framework does seem to be able to give a comprehensive image of the accessibility situation to different forms of potential urban green space utilities. Generally speaking, the walking-based accessibility highlights the proximity dimension within this framework. It is suitable for the identification of potential problematic residential areas with lower level of accessibility. However, the method result revealed several weaknesses that hamper the usability of the framework. In order to avoid that the framework and its results leads to faulty assumptions on accessibility to potential urban green space utility resources, these needs to be clarified and discussed.

The first issue concerns the network used to calculate the walking distances. OpenStreetMap is one of the most high-resolution and reliable data sources for physical environmental features such as pedestrian road networks. Especially for informal features like smaller paths and shortcuts (Le Texier et al., 2018), which can be argued to be just as important as arranged roads for people's mobility patterns. However, the network has several issues when used for walking accessibility analyses. First of all, the connectivity issues do not seem to be a simple mistake, but rather an expression of how the network is systemically constructed. On roads where the pedestrian network feature lies outside of the roadway (often due to more pronounced sidewalks), connections over the roadways only exist at designated crosswalks and only if there is a network feature at the other side of the road that the connection can connect to. On most roads, this is good thing, because it can be hard to pass the street outside these locations. But sometimes, features for smaller sidewalks were missing in the network data and there were consequently no features that the crosswalk could connect to. This is also the underlying cause for the lack of a connection illustrated in figure 9. Together with earlier discussed weaknesses with OpenStreetMap data, this results in intra-model patterns with long detours beinng created that are not corresponding to reality. If the analysis would have been made from a weekend or holiday perspective, these types of errors would have been of lesser concern, since the tolerable walking distances are much longer then (Boman et al., 2014; Sandell & Fredman, 2014). This means that this type of errors would have been more easily absorbed, but within a weekday perspective, detours of just a couple hundred meters is critical for the network distance accuracy. All in all, analyzing accessibility within a weekday context requires a very high level of quality of the pedestrian road network and there might not be any available that fully meet the required standard. Thus, it is always important to acknowledge shortcomings of the deployed network when conducting walking accessibility analyses over shorter distances.

Another important aspect to highlight is that this type of accessibility analysis benefits from urban green space fragmentation. Fragmentated green space aerial coverage has more border distance in relation to its size, which also is spread over a larger area, compared to a coherent round-shaped green area. Because accessibility in this framework is calculated to the boundary line of green spaces, this means that the more non-round and divided a green area surface is, the more residential surface can be reached within a certain distance in relation to its own size. And since fragmentated green spaces actually are less valuable from a utility perspective (Le Texier et al., 2018), this is an issue. However, how much this issue actually affects the end result is unclear. The network analysis does not take topography into account either, which becomes an issue at locations with steep climbs. Because the distance is measured in meters, distances crossing such locations are valued as equally demanding to overcome as distances that runs along a flat surface. The ability to overcome steep obstacles by foot can also be argued to vary across population groups.

All these uncertainties mean that if weekday accessibility for a certain area is to be fully understood from all dimensions of accessibility (proximity and mobility), these aspects need to be examined in a relatively high level of detail to ensure that accessibility levels are not misguiding due to connection errors in the network, topography, green space formation, etc.

One must also consider the differentiated perspectives of accessibility, because this framework does not (and is not intended to) take these into consideration. As stated earlier, all green spaces with a certain utility are considered equally desirable for all inhabitants within the study area, no matter the other green space attributes or the route to these places. Because these are aspects that can vary substantially over population variables like age, gender, ethnicity, socioeconomic groups etc. (see section 2.2.3), it is important to bear in mind the specific preconditions for the group that are of interest. For children and the elderly for example, this would be to acknowledge their larger dependency on proximity for their accessibility to these features, regarding values over 300 meters as extra problematic. When focusing on accessibility on an individual level of scale, it is also important to acknowledge the individual accessibility component (see Geurs & van Wee, 2004) in order to take other mobility patterns into account. Because people can still experience values by passing areas, e.g. when travelling to work.

In conclusion, this accessibility framework is able to reveal larger spatial patterns of accessibility to different forms of urban green space utilities on a municipal level, but for analysis on a lower level of scale, one needs to verify the values through underlying data cross-referencing. This is also required in order to fully understand the proximity and mobility dimensions' influence of a certain level of accessibility in a certain location. Something that a place-based distance measure of accessibility cannot do directly (Geurs & van Wee, 2004). One measure that was thought to be incorporated into the framework to address this was a comparison between Euclidean distance and network distance to the closest green space utility area for all address points. This would have made it possible to evaluate the network efficiency. A large difference would indicate a mobility restricted level of accessibility, while a smaller one would indicate a proximity restricted one. But due to the limited time available for this type of thesis, this was unfortunately not possible to incorporate.

6.1.4 Generalizability of the methodological framework

Concerning the scientific contribution, it is important to ask how the methodology can be transferred to other context and areas as there are several limitations concerning this matter that could hamper the transferability. First of all, the framework is best suited to be applied to an urban context. The underlying reason for this is the sociotopic values that forms the basis for the utility classification. It could be argued that how green spaces are evaluated and perceived varies across the urban-rural gradient. This means that how the, for this thesis central, sociotopic value *Natural experience* is perceived by respondents in a sociotopic classification process can be completely different in a municipality like Dorotea in northern Sweden. It could also be problematic to transfer the framework to other cultural contexts. As is explained in section 2.2.3, how green spaces is perceived is something that varies with ethnicity and how people in Sweden value e.g. *Natural experience*, both in terms of characteristics and importance, can thus be different to other regions of the world. This would in turn affect the utility classification process. But beside these aspects, it could be argued that most of the framework is built on factors that are relatively generic in a wider urban context. Both the social interaction and physical activity utilities are based on general green space activities and park size and are underbuilt by scientific findings from different urban contexts. It could therefore be argued that if the regional sensitive aspects of the mental recovery utility are considered, there is a realistic potential to use this framework for urban green space utility potential analysis. It is however important to acknowledge that the thesis is written by an author that himself has a western oriented perspective on green space and outdoor recreation and it is necessary to be humble for the possibility that this might have affected the methodological framework and its results. It is therefore desirable to repeat this study in a different cultural context to verify its usability and generic status.

6.2 Implications for the city of Gothenburg

So, in the light of the results and what's have been discussed earlier in this chapter, what can be said about the urban green spaces with potential social utilities and the accessibility to their resources for residents in Gothenburg? Well, no social utility can be guaranteed within any green environment and no exact location can be given a precise value of accessibility to the different forms of social utility. Both due to the limitations of the methodological framework, but also because of group or individual perceptions on walking accessibility and green spaces in general that needs to be acknowledged. However, it can provide information of general patterns and fundamental underlying conditions that affect these entities. First of all, urban green space as a resource is well distributed all over the city of Gothenburg but the qualities of these areas seem to vary greatly across the urban landscape. This means that the prerequisites for recreational relations with green spaces from a public health perspective are not equal in different parts of the city despite this city's general green character. One major factor is that many areas are dominated by smaller green spaces, especially the central parts of the city, but also several more peripheral ones. This makes these parts of the city more vulnerable to a lack of accessibility to size demanding utilities. Because the weekday perspective entails such a limited adequate walking distance prerequisite, the areas dominated by smaller green spaces do not have to be that large for this factor to become problematic. And the result does indeed point to that the larger area a utility value generally is found within, the rarer they become in the urban landscape of Gothenburg, where areas with the most fragmentated green spaces are the worst affected from this deficiency. This suggests that the key aspect of this accessibility problem is a lack of proximity to the urban green space utility resources and that land use measures are the solution; designating more land to green environments. And for the most part, it probably is, especially for the utility physical activity, which seems to primarily require larger areas in some locations like Lindholmen and in areas along the south-central riverside. Because the acceptable walking distance is so short, in generally boils down to land use aspect of the proximity dimensions of accessibility when adopting a weekday perspective.

But for the mental recovery utility, the rarest utility within Gothenburg's urban areas, the situation is sometimes a little more complicated. Certainly, larger parks within the aforementioned worst affected areas could increase the probability for potential mental recovery environments. However, a lot of these areas are also heavily affected by traffic noise, meaning that there is a risk that land use measures could prove useless if the traffic noise issue is not addressed as well. This relates to mobility dimensions of accessibility on a larger level in which inhabitants' general mobility patterns are involved; Our car dependent increase in long-distance mobility accessibility has decreased our local proximity accessibility. It can be argued that similar patterns can be seen for numerous other resources like retail and public services. Thus, in order to achieve a better walking accessibility to urban features like green spaces with mental recovery potential, land use measures might need to be combined with restrictions in automobile accessibility within the urban environment. It could also be argued that a reduced noise level within the urban landscape might give rise to mental recovery sociotopes in existing green spaces as well. Noise reducing measures in relation to green spaces might also be an important measure. Concerning this aspect, it is interesting to highlight that the result maps also indicate that the formation of the physical environments within green space can be adapted to better withstand noise pollution. Because green spaces with open areas along their boundaries appear to be more affected by noise pupation than areas with wooded boundary areas. These are also very important aspects to consider for green space utility accessibility in general within future urban development projects in Gothenburg. Because many of the central areas that will be developed into dense urban environments in the coming decades, like Frihamnen, Backaplan, Ringön, Gullbergsvass and Södra älvstranden have a general shortage of larger green space land and are often heavily affected by traffic noise.

As an additional point concerning the mental recovery utility, it appears to be ultimately harder for the urban population that does not have access to silent private domestic gardens to reduce their stress levels, compared to inhabitants that do (see Dennis & James, 2017). Both because they don't have access to private domestic gardens, but also because this group seems to have a lack of accessibility to green spaces with mental recovery potential in general. In relation to the fact that people living in tenant housing also appear to be less satisfied with their neighborhoods in general (Skärbäck et al., 2014), these findings suggest that the access and quality of green spaces is particularly important to emphasize in today's urban development processes, where the urban areas are densified with more competition over urban land and new residential buildings are mostly in the form of apartment buildings.

As one might guess at this point, the mobility dimension of accessibility does not seem to be the main issue for a lack of accessibility to certain utilities from urban green spaces in Gothenburg. It is however important to acknowledge that a lack of pedestrian roads in many cases is the main cause for a low accessibility values, as has been exemplified in the result chapter. It is further important to stress that this conclusion only is applicable within the weekday context. If accessibility were to be analyzed within a weekend or a longer period of leave context, the mobility could very well become the limiting accessibility factor. In addition, the magnitude of the utilities is not analyzed within this thesis methodology. But it can be said that people within the areas dominated by small and fragmentated green areas probably has an inferior benefit of accessible utilities than people in areas dominated by larger green spaces.

In conclusion, how a lack of accessibility to a certain utility should be understood is a complex matter and it varies between different locations within the city. To solve such an issue requires a holistic perspective, both on the different dimensions of accessibility, but also on the prerequisites of different groups in society if accessibility is to be achieved in a socially sustainable manner. It is also interesting to discuss what implications the result from this thesis can have for urban areas in general, beyond the urban context of Gothenburg. General conclusions on this matter, along with this thesis's concluding remarks on urban green space utility accessibility analysis will be presented in the following conclusion chapter.

7 Conclusions

From this thesis's results and analysis, four main conclusions can be outlined, which are presented in this last chapter's first section below. The chapter then ends with a series of aspects on how this thesis's methodological framework could be improved in future research projects, along with several suggestions on what these research projects could focus on investigating further.

No. 1: Urban green space is not a homogenous entity

This study's theoretical framework, result and analysis has made one thing clearly evident. Green spaces are not homogenous surfaces in the urban landscape, and one cannot regard them as a universal resource that have the same meaning for all people in all locations. Instead, they can serve very different purposes for an urban population. From a public health perspective, these purposes can be better understood by considering the social utilities green spaces provide for interacting citizens. This is in turn dependent on the character and attributes of green spaces, which governs which type of utilities a green space has the potential to provide for interacting citizens. By using these attributes, it is therefore possible to divide green spaces in a city according to what types of social utilities they seem to be able to provide. This creates a more veridical perspective and utility-oriented understanding of urban green spaces within a city. This is an important contribution because certain types of green spaces can be argued to be more precious in urban environments. Both because they are more desirable for the urban population in general, but also because they efficiently can provide multiple utilities that can counteract some of the main public health issues in our modern societies today; diseases related to lack of physical activity and stress. The latter one can be argued to be particularly important within the urban context, because it is an issue that is generally more (however not exclusively) prominent in urban living environments. Ensuring presence of stress-reducing utilities within urban green spaces generally also appears to satisfy the prerequisites for other important social utilities.

No. 2: A keystone in understanding the social utility potential for urban inhabitants is the concept of accessibility.

However, in order to understand the potential for these positive effects, it is fundamental to acknowledge the utilities' availability in space and in relation to urban inhabitants' space-time prism. The concept of accessibility, with its proximity and mobility dimensions, offers a theoretical lens through which these aspects can be incorporated within a methodological analysis model. By doing this, different preconditions for accessibility to different utilities at different locations can be revealed.

No. 3: Analyzing accessibility to urban green space social utilities is a complicated and data demanding process.

However, to analyze accessibility to urban green space utilities quantitatively on a municipal level in order to reveal spatial patterns of accessibility is complicated for many reasons. First of all, a multifaced entity like accessibility is hard to analyze quantitatively. Because one must choose between theoretical solidity on one hand and operationalizability, interpretability and communicability on the other. When applied on such a multidimensional entity like green space utilities, the former appears to become exponentially more complicated, making the latter the only feasible alternative. Secondly, it is a data demanding process. It requires a large amount of information about user experience of urban green spaces within a designated study area at a detailed level that is rare. The sociotopic maps are in this context a unique data source that can meet these requirements. It also provides an opportunity to reveal important values missed by planners and policy makers. But even this does not cover all relevant attributes of green spaces, such as park facilities, etc. It is also important to acknowledge that unweighted accessibility analysis like this one becomes very influenced by the sociotopic classification, which in turn has some methodological shortcomings.

In addition, even though using the most detailed and comprehensive pedestrian street network available, the chance of measurement error due to network errors still persist. A problem that probably will amplify when analyzing areas with smaller population. Critical reflections and cross referencing against the underlying data is to some extent therefore necessary when the results from these types of frameworks are analyzed. All these aspects put large demands on the user of the results to be able to evaluate these from different perspectives. This limits the group of potential users to people with relatively high level of expert knowledge.

No. 4: Analyses of social utility accessibility can reveal important obstacles for the strive towards socially sustainable urban environments.

Despite these weaknesses, the methodological framework of this thesis managed to reveal comprehensive accessibility patterns thorough its application on the case of Gothenburg. Because of this, several generic accessibility patterns for green space utility potential in similar urban environments can be defined. Firstly, adequate proximity and mobility accessibility to green spaces with potential to provide sense of community and place identity through social interaction as well as stimulation of physical activity seems to be available to most inhabitants in such areas. However, when it comes to mental recovery, the most important utility derivable form green space, insufficient level of accessibility seems to be a general issue. The prerequisites for accessibility are not equal spatially, with denser part of the urban landscape being the most severely affected. One main reason for this appear to be a proximity issue; there is a lack of larger green space that can house this type of utility in denser urban areas. The worst affected are probably children and the elderly, since they rely more on proximity for their accessibility in general. A general policy strategy for counteracting this situation would be to support the development of larger, multi-purpose green spaces within urban environments. In the current trend of densification of many urban environments', this is of particular importance, as the increasing population density will further increase the number of users of urban green spaces, potentially hampering these environments stress reducing abilities. The other main reason for the shortage of urban green spaces with mental recovery potential appears to be a dependency of mobility modes associated with noise pollution. This indicates that the shortage of mental recovery environments is a larger problem in cities with a high car dependency and large volumes of freight traffic. In these types of cities, strategies for creating green space with mental recovery potential must combine land use measures with measures to counteract traffic noise pollution in order to be successful. To counteract the lack of accessibility by creating more residential areas with access to private domestic gardens is probably an inefficient strategy, since these areas' generally low population density sows the seeds for car dependency. This would further hamper the ability to create mental recovery environments on a municipal level, not just within urban green spaces, but also within private domestic gardens. Cities with lower car dependency on the other hand probably have better prerequisites in achieving mental recovery environments. However, they would most likely still require larger urban green spaces if one assumes that lower car dependency requires a higher urban density and thus a larger number of visitors in each green space within the city. This antagonistic relationship between large urban green spaces with mental recover potential and reduced car dependency through densification is one of many other important aspects to acknowledge within future urban development processes.

In conclusion, if this thesis's methodological framework's weaknesses are acknowledged, it can (and have) offer a unique opportunity to increase the knowledge of urban inhabitants' potential to receive social utilities from green space interaction. By revealing patterns and issues like the ones outlined above, a basis for more efficient urban green space policies and management within urban development processes and administrations can be created. An arguably important prerequisite for the socially sustainable cities of the future.

7.1 Future research

From this thesis result, analysis and conclusions, several factors can be identified that would be useful to investigate in future research projects. The main one would be to test the utility classification against empirical field measurement to see if the classification is accurate. Another comprehensive aspect is continued research on the urban green space utilities, both to investigate if there are more prerequisites of importance for the utility provision that needs to be acknowledged and how this could be done. But also if certain utilities can be created with other measures within other types of environments.

Furthermore, the methodological framework is suitable for continued research on relevant subgroups in society, like age, gender, socioeconomic status and ethnicity. This could be argued to be of particular importance since the perception of green spaces and accessibility are entities with strong individual and subgroup influences. Relatable to this, it would also be interesting to study how the accessibility levels to these utilities is differentiated across these groups in society. Furthermore, it would also be interesting to apply the framework in other time contexts, like within a weekend or longer leave perspective or different seasons. The accessibility analysis method could also be complemented and enhanced in future research on this subject.

To enable it to acknowledge dynamic and distance restricting barriers like elevations, road crossings, stairs, etc. would strengthen the analysis, however it would also increase the methodological preparation and method procedure substantially.

Finally, it would also be desirable to conduct the analysis on smaller areas, where the green spaces and the network can be much more adapted to reality through artisanal GIS data preparation. This would allow for adding of actual access points, green space utility area adaptation and more advanced accessibility measurement techniques. This is also what is needed if one would want climb down a step from the quantitative version of the world and adopt a more diverse perspective on these matters. However, it should be noted that there would still be almost an infinite number of complicating steps remaining before reaching a level equal to the endless multifaceted reality.

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9 Appendix

9.1 Map abbreviations

UGS: urban green space.

PDG: private domestic garden.

9.2 Detailed accessibility maps

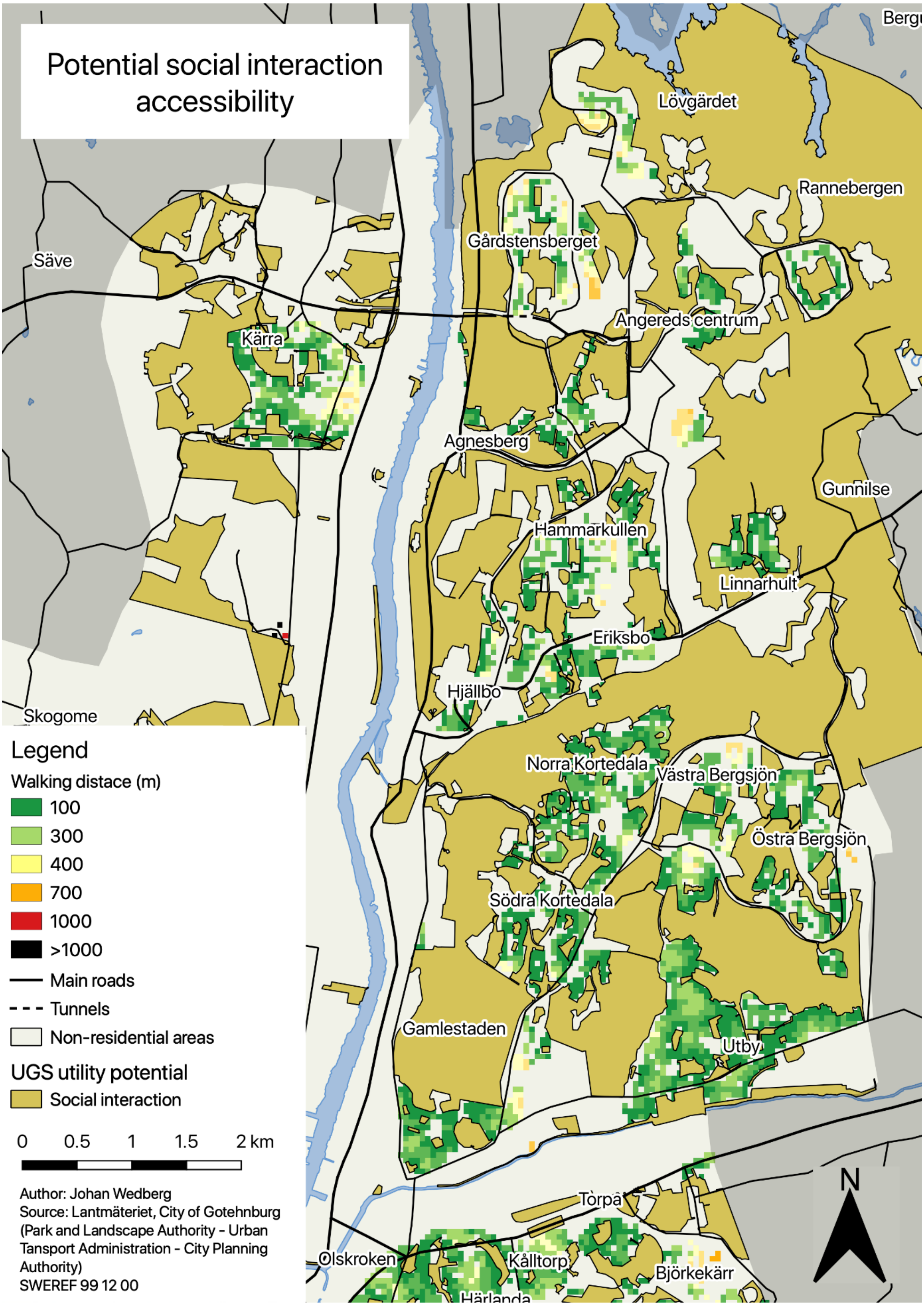

Figure 22. Map of residential walking accessibility to green spaces with social interaction potential - north

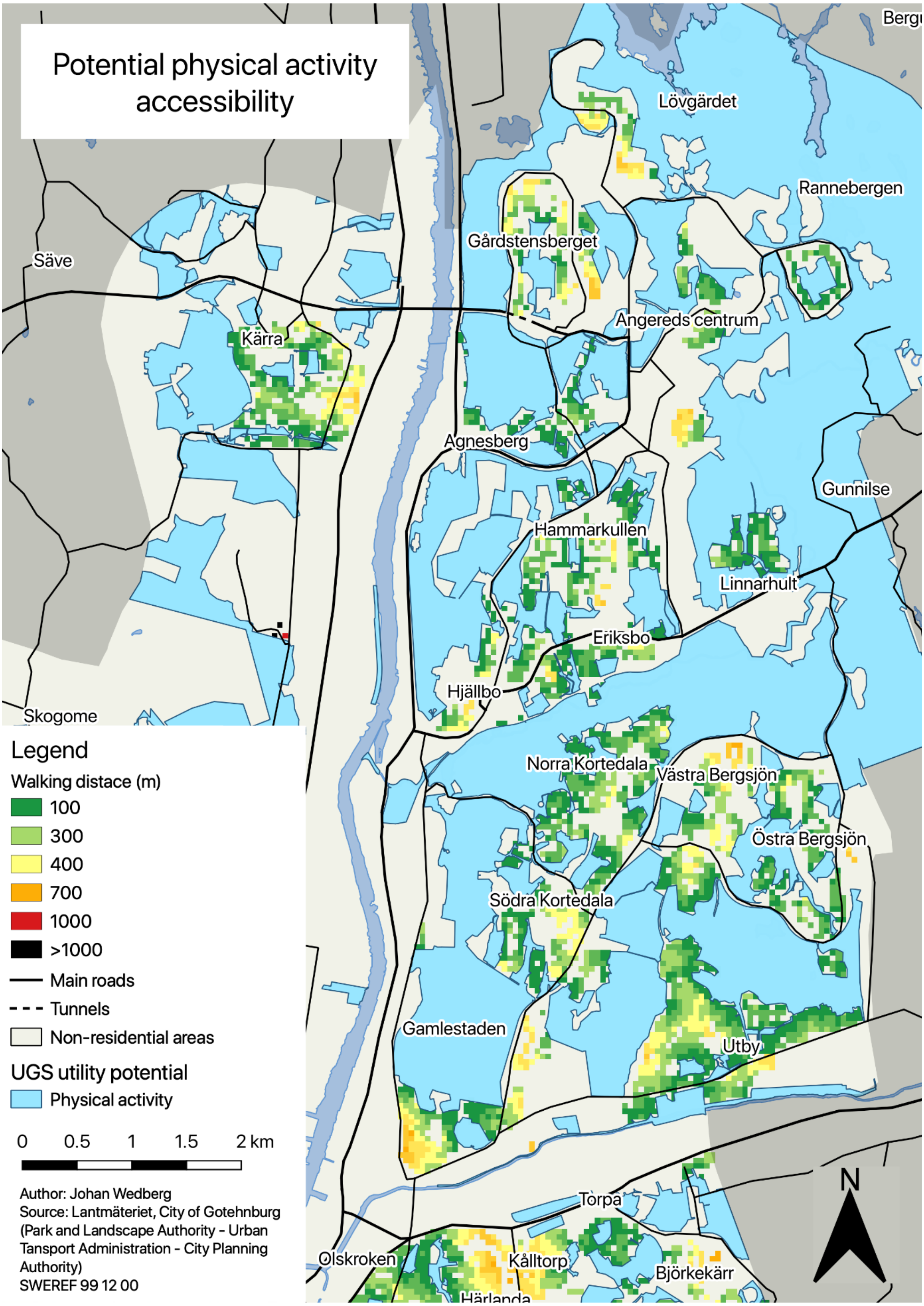

Figure 23. Map of residential walking accessibility to green spaces with physical activity promotion potential - north

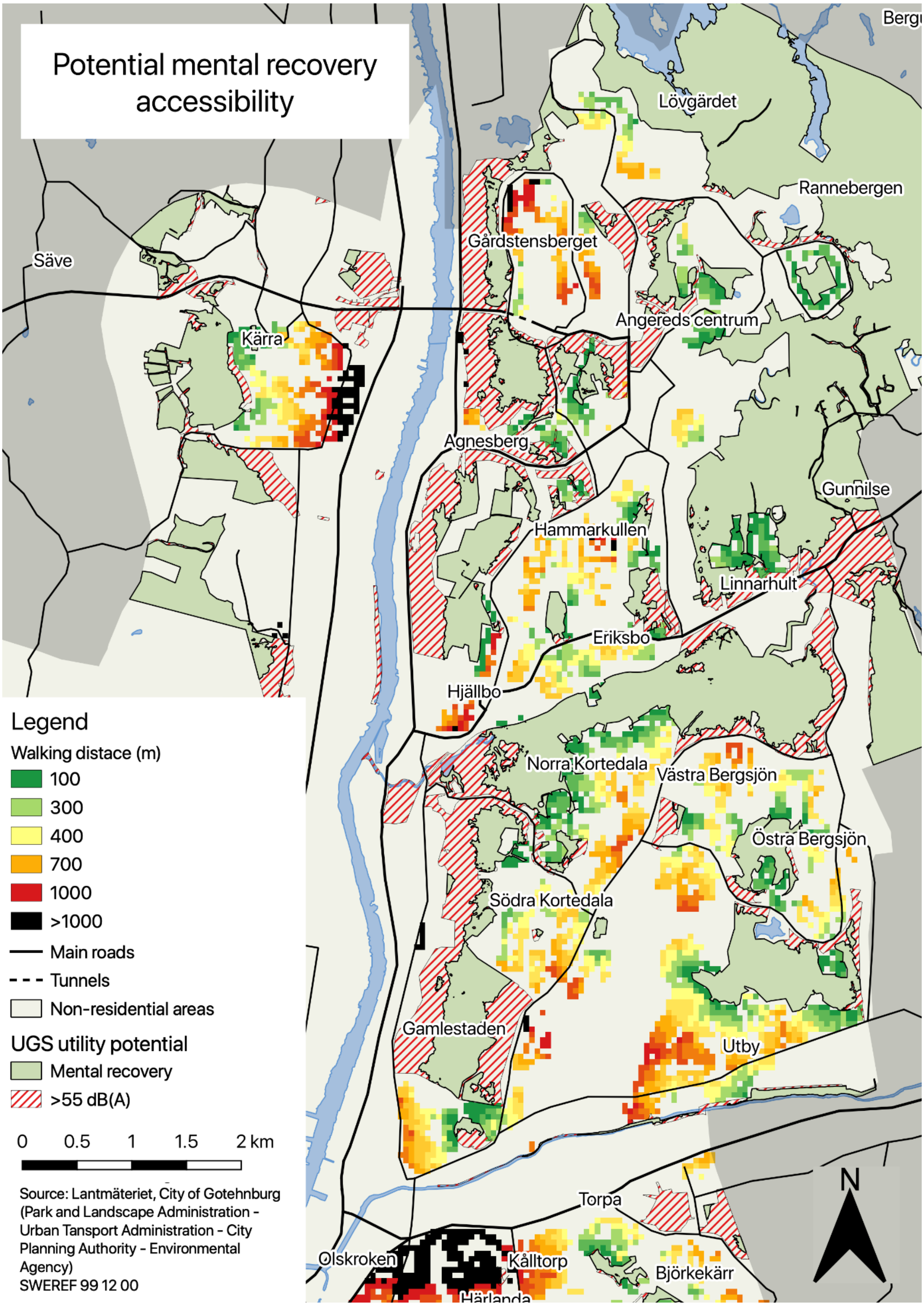

Figure 24. Map of residential walking accessibility to green spaces with mental recovery potential - north

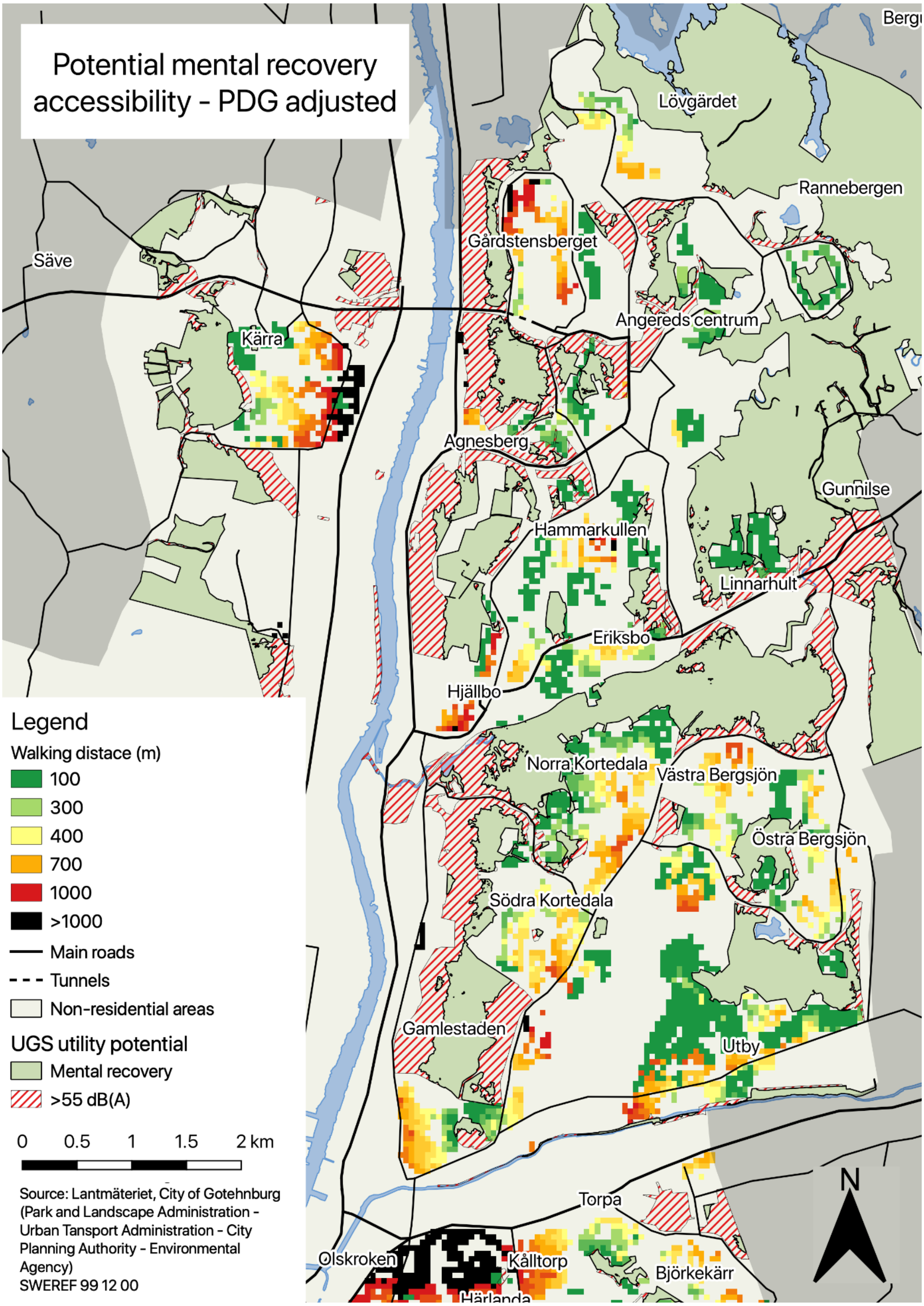

Figure 25. Map of residential walking accessibility to green spaces with mental recovery potential, adjusted for access to mental recovery private domestic gardens - nort

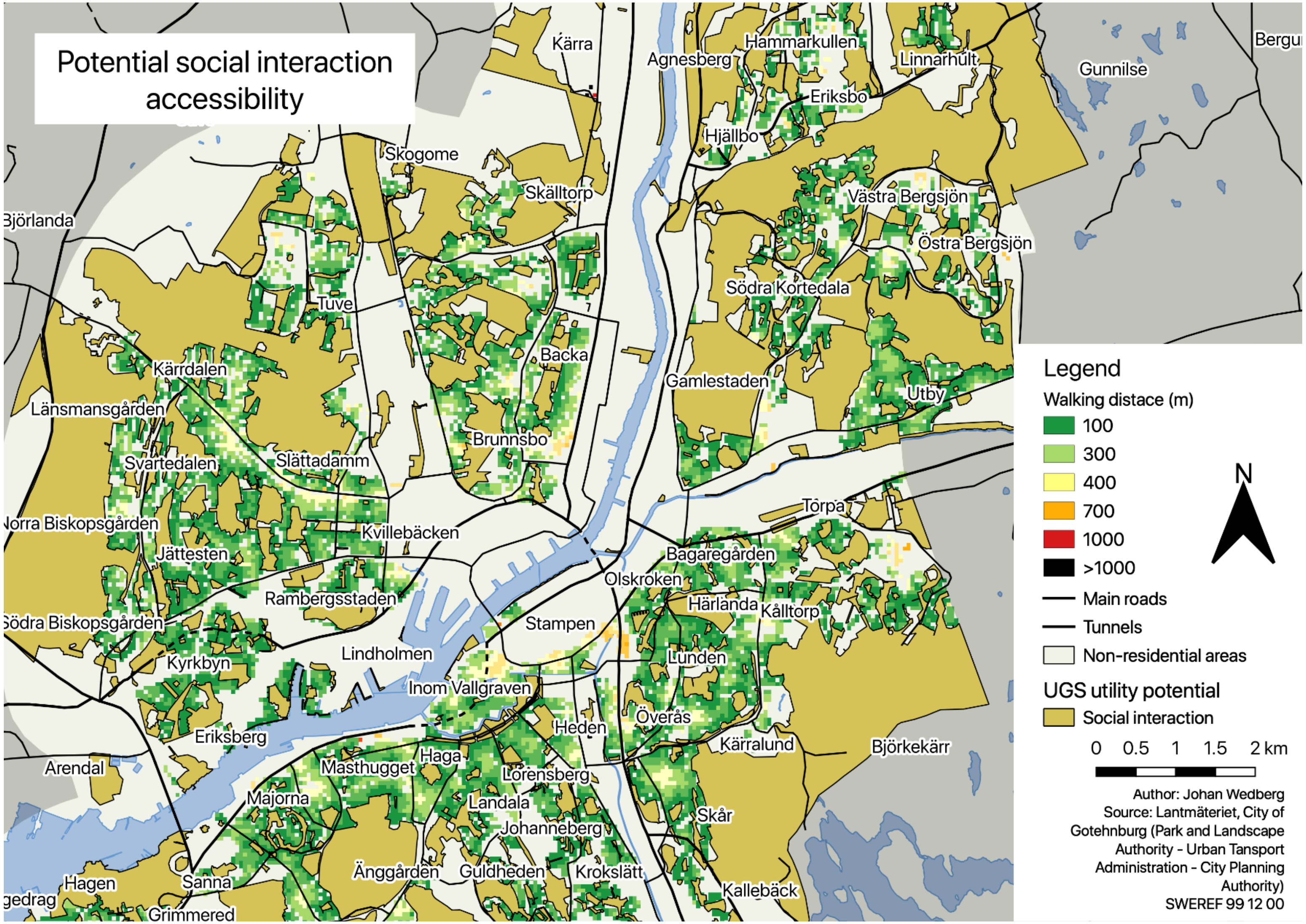

Figure 26. Map of residential walking accessibility to green spaces with social interaction potential - central

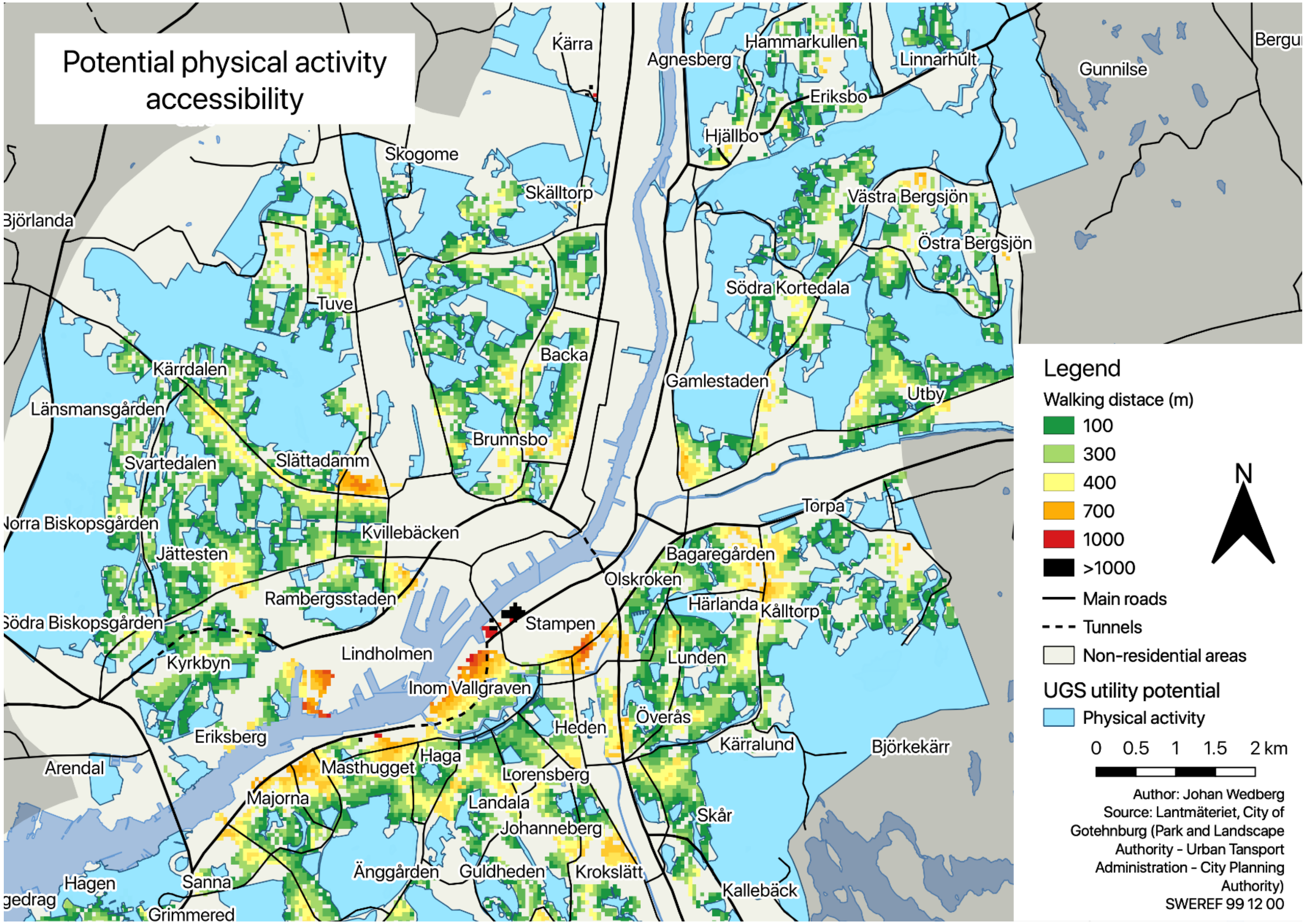

Figure 27. Map of residential walking accessibility to green spaces with physical activity promotion potential - central

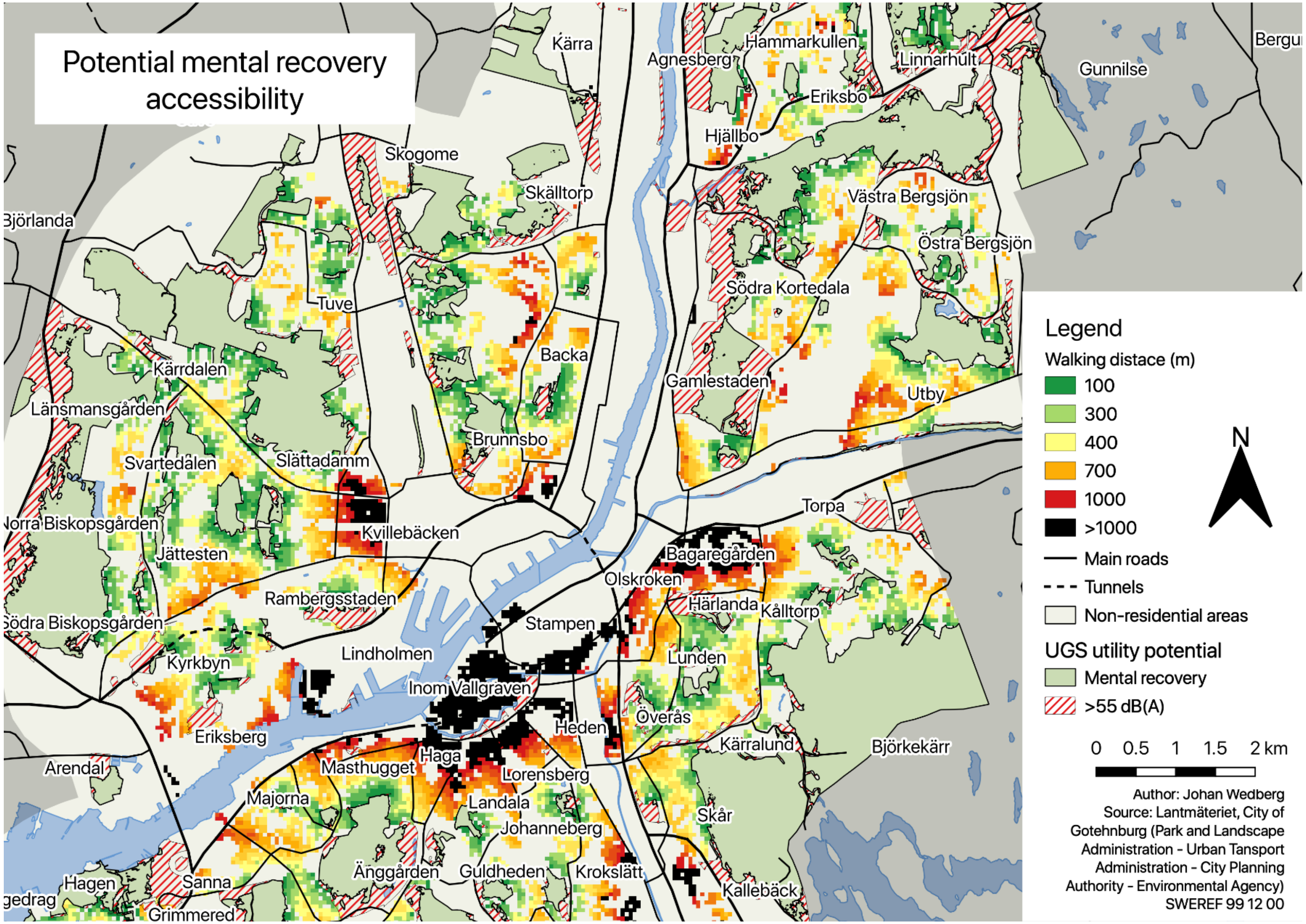

Figure 28. Map of residential walking accessibility to green spaces with mental recovery potential - central

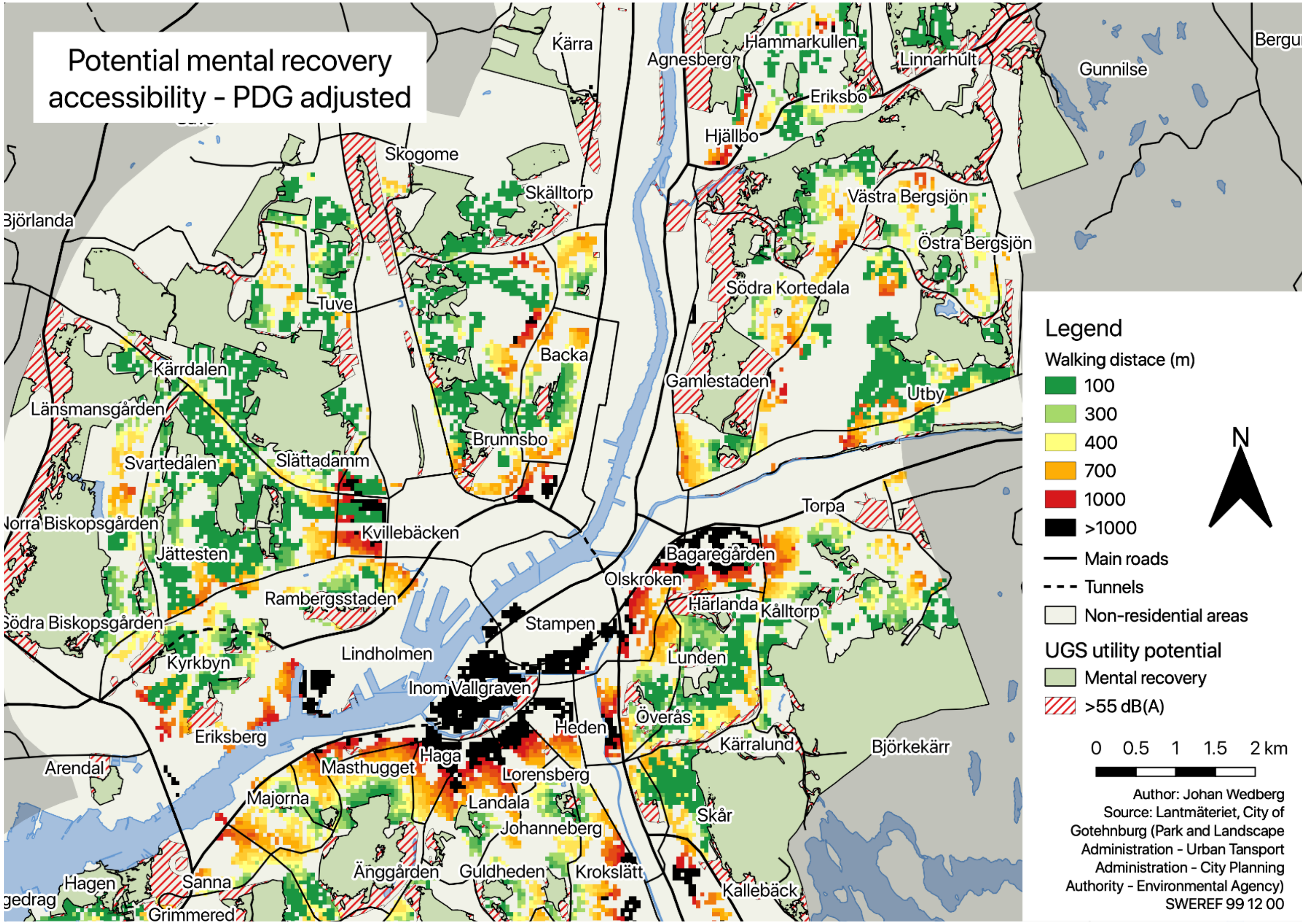

Figure 29. Map of residential walking accessibility to green spaces with mental recovery potential, adjusted for access to mental recovery private domestic gardens - central

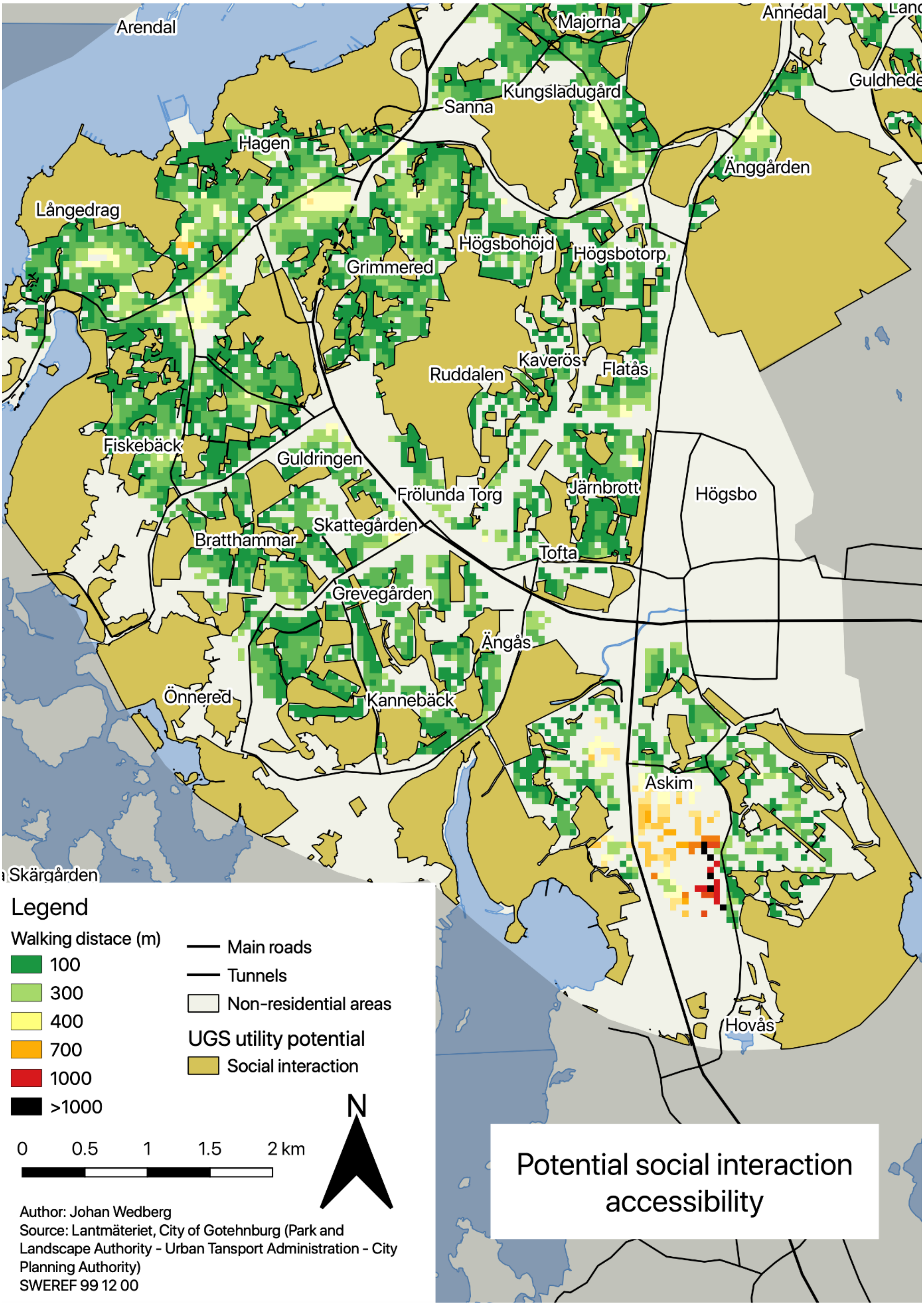

Figure 30. Map of residential walking accessibility to green spaces with social interaction potential - south

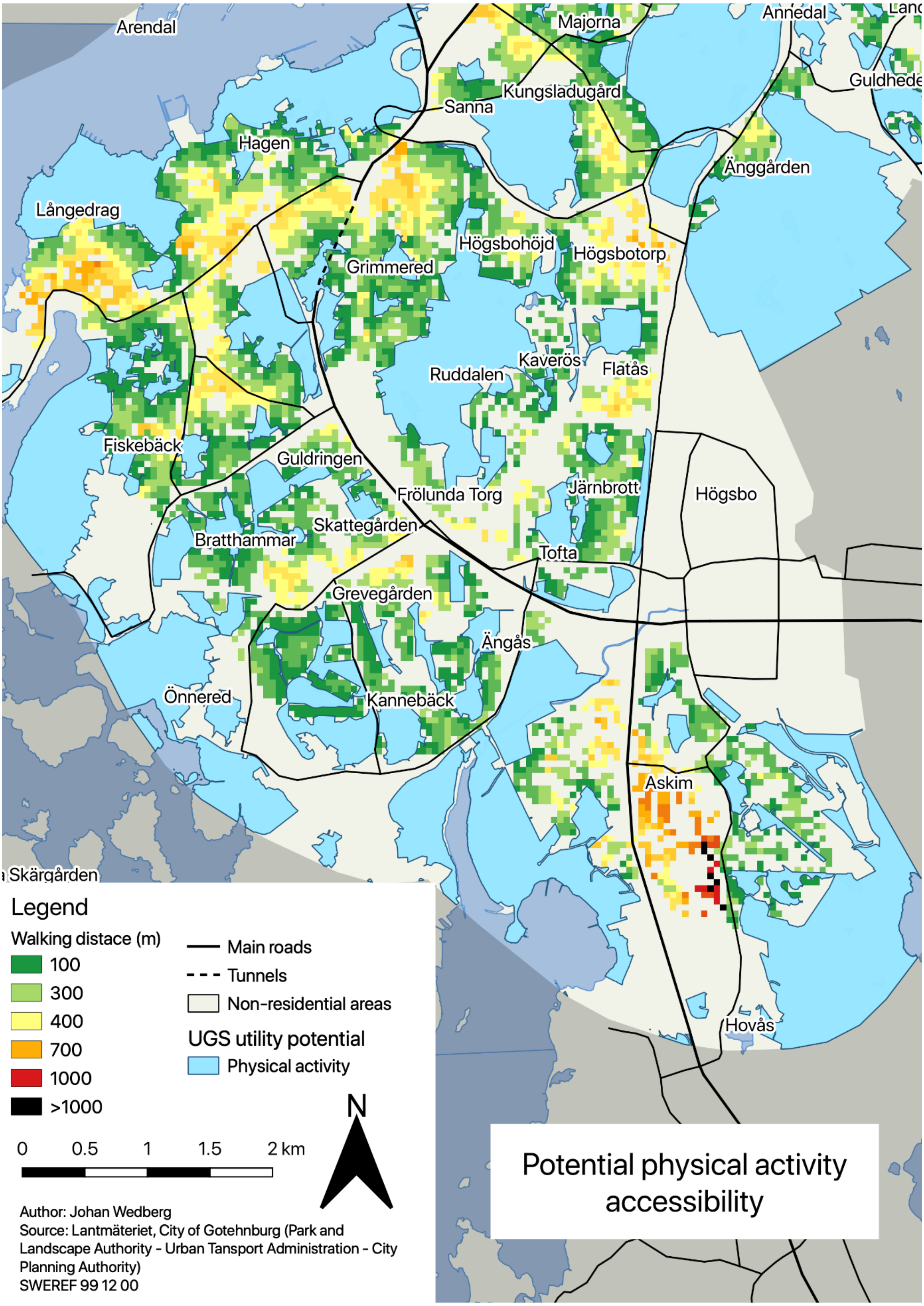

Figure 31. Map of residential walking accessibility to green spaces with physical activity promotion potential - south

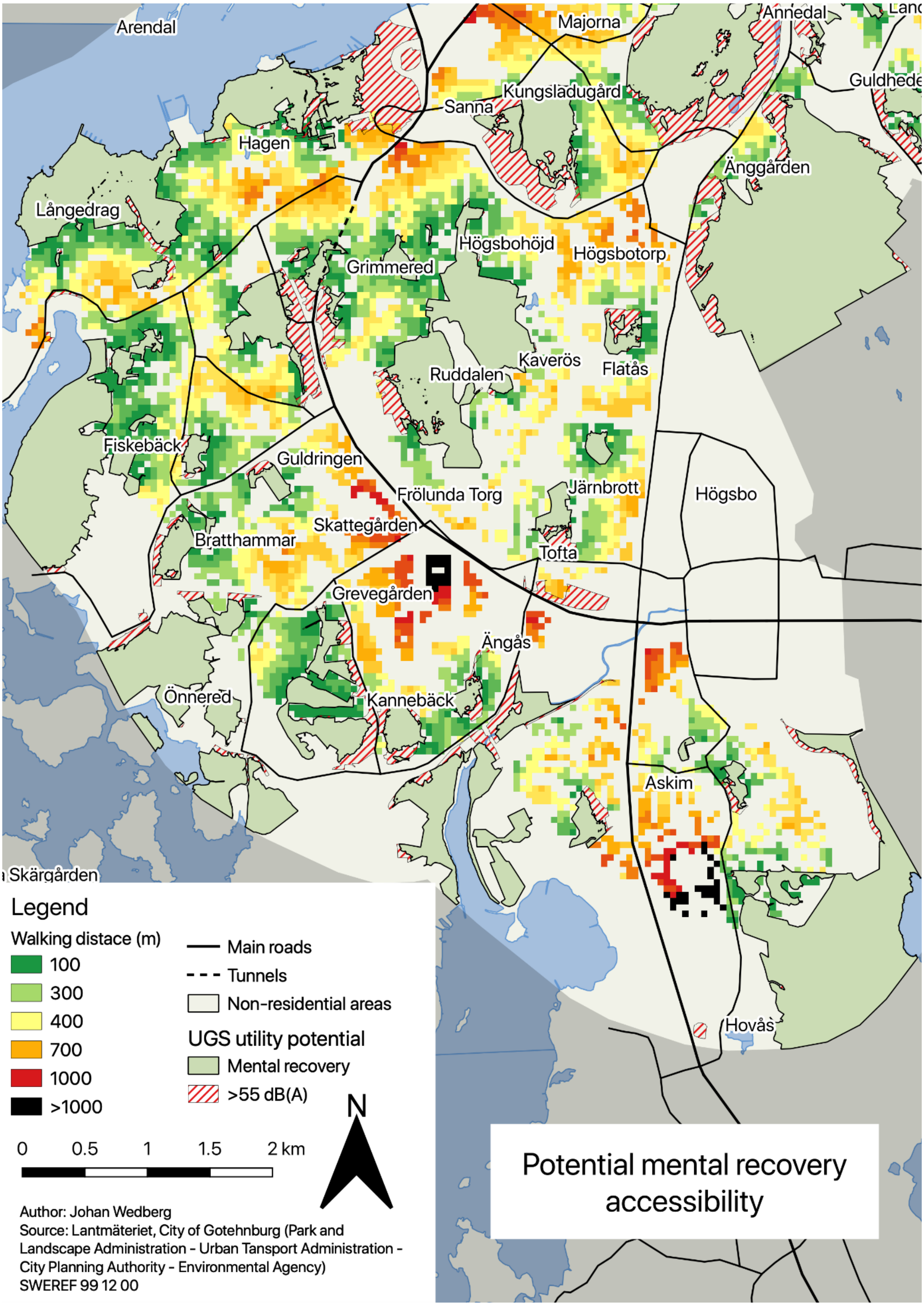

Figure 32. Map of residential walking accessibility to green spaces with mental recovery potential - south

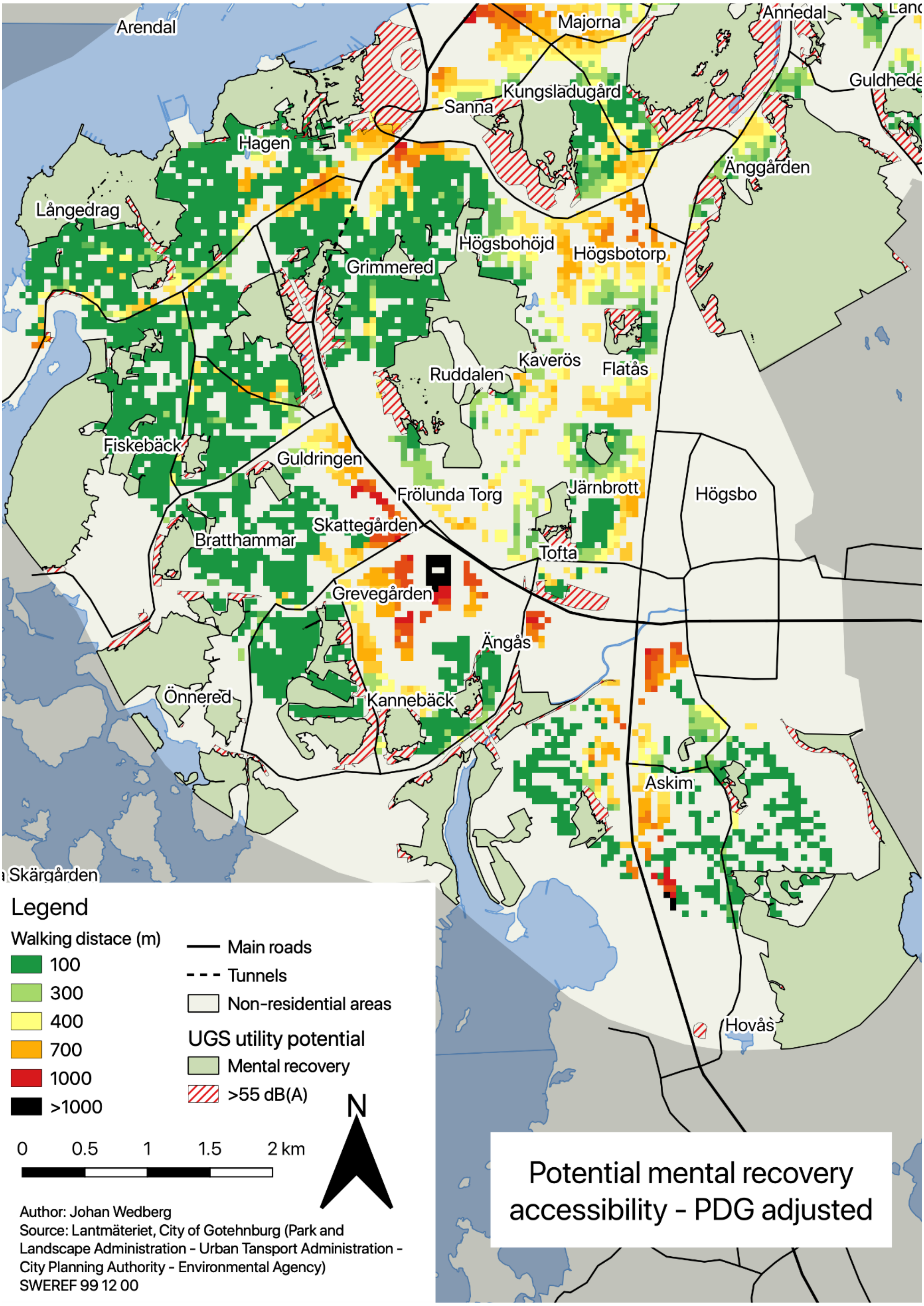

Figure 33. Map of residential walking accessibility to green spaces with mental recovery potential, adjusted for access to mental recovery private domestic gardens - south