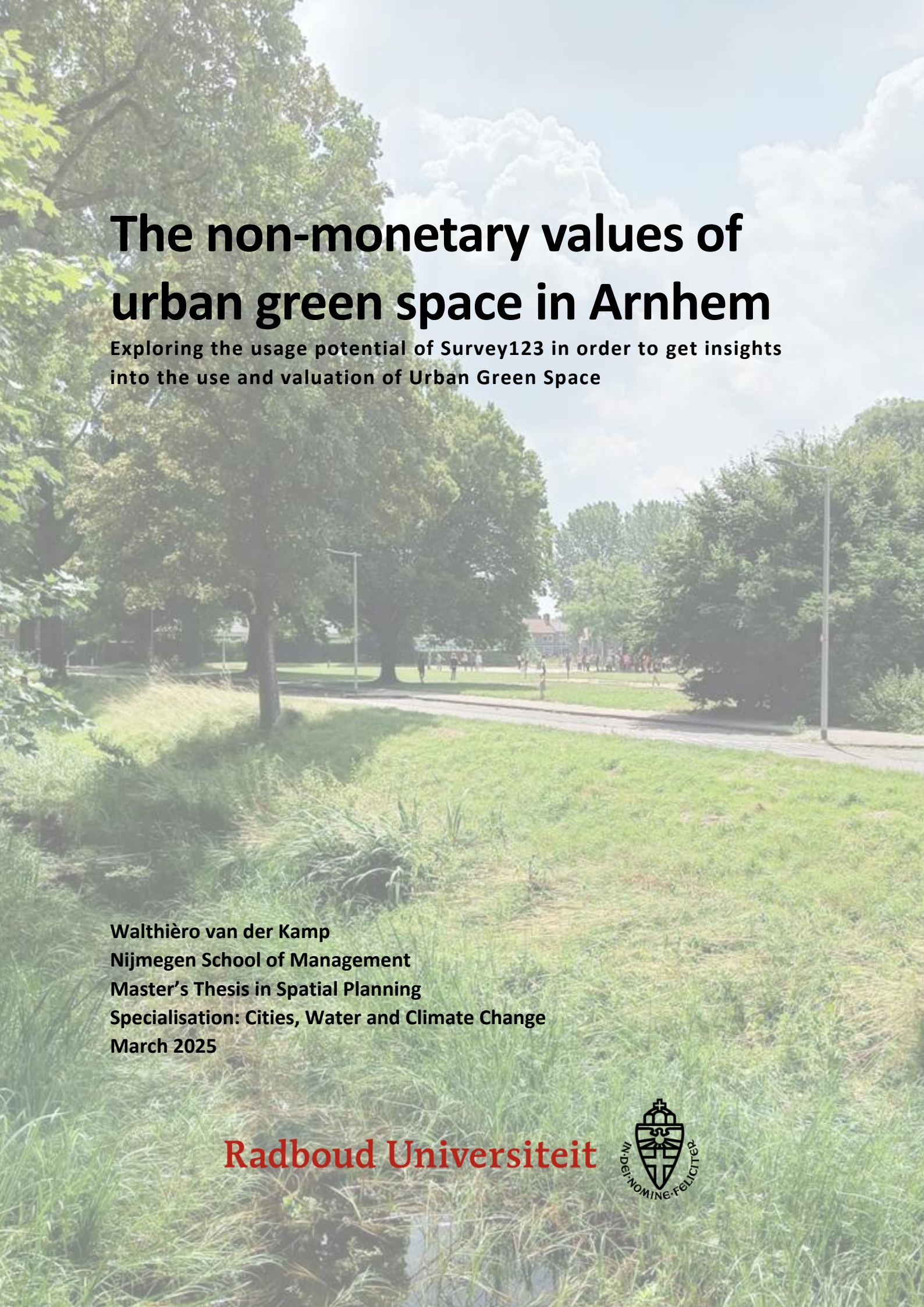

The non-monetary values of urban green space in Arnhem

Exploring the usage potential of Survey123 in order to get insights into the use and valuation of Urban Green Space

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Nijmegen School of Management
Master's Thesis in Spatial Planning
Specialisation: Cities, Water and Climate Change
March 2025

Radboud Universiteit

Colophon

Title: The non-monetary values of urban green space in Arnhem: Exploring the use of Survey123 in order to get insights into the use and valuation of Urban Green Space in Arnhem

Study programme and specialization:
Master Spatial Planning:
Cities, Water & Climate Change
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Date:
27th March, 2025
Bern, Switzerland

Word count:

30.418 (Excluding summary, preface, reference list, etc.)

Illustration front page: Walthièro van der Kamp.

Abstract

Due to urbanisation and population-growth in the Netherlands, cities are more and more looking towards densification as a strategy to grow the housing stock, meaning that space in urban environments becomes scarcer and more contested. As urban green spaces tend to represent little to no monetary value, the added value of green spaces towards the community can easily be overlooked in cost-benefit analyses. This research has created a deeper understanding of the use and valuation – thus the non-monetary values – of urban green spaces. Applied to the case of Arnhem, inhabitants of Malburgen, Klarendal and de Geitenkamp have been questioned regarding their use of different green spaces, using the new PGIS-survey tool Survey123. In Arnhem, green spaces are most often used for exercise, to experience nature and to find inspiration or peace, and most often valued for their proximity to one's home, its aesthetics and the natural feeling it provides. On top of that, this research has highlighted the importance of a diverse green space portfolio for cities. This can be illustrated by the fact that this research has been able to prove that scattered green spaces (<5ha) are used and valued significantly different than larger green spaces. Furthermore, this research has further explored the utilization potential of Survey123 in an academic (PGIS) context. We have been able to show that Survey123 is a promising tool in this regard, but currently lacks user-friendliness, which upholds or even heightens the digital- and cognitive barriers that PGIS-Surveys can present. In order for Survey123 to be part of a method which strengthens broad representation in participatory UGS research, enhancements in regard of user-friendliness and accessibility are required.

Key Terms: Urban green space (UGS); Non-monetary values of UGS; PGIS in Survey research; Representation in low-SES neighbourhoods.

Preface

Hereby, I present my thesis on *the non-monetary values of urban green spaces in Arnhem*. As I hand in this thesis, I also complete my master Spatial Planning, therefore my studies in general. The end of an era, as this also officially brings an end to my activities in the Netherlands, for now in any case.

The process of writing this thesis has not been straightforward, among other things, the process of finding the precise focus of my thesis, an intensive data-collection and a relocation to Switzerland has resulted in a slight delay, to say the least. Therefore, I specifically want to thank my supervisor, Linda Carton, for her guidance in this process. During the whole process she has been able to give direction to my thoughts and objectives in this process, which has helped me enormously in actually finishing this thesis. I also want to thank my partner, Sara, for her help and support in this process. Besides her academic knowledge and expertise, her presence and kind words have always been able to boost my morale, for which I am very grateful.

Finally, I want to thank all the respondents in Arnhem who took the time to fill in my survey.

I hope you will enjoy reading this thesis!

Yours, sincerely,

Walthièro van der Kamp

Bern, March 2025

Contents

1. Introduction

1.1 Research Problem statement

The positive benefits of green spaces in cities are broadly acknowledged in academia. Urban green spaces (UGS) are being unmistakably important in biodiversity conservation and can be key tools to reduce the Urban Heat Island effect (Semeraro et al., 2021). Besides the ecological and thermal benefits, public green spaces also have significant societal benefits. Parks, or other urban green spaces, are for instance spaces to meet each other, to find peace and calmness or to exercise (Nilon et al., 2017).

Due to current urbanization trends, worldwide and in the Netherlands, space in cities becomes more and more scarce and contested. This is also the case in the city of Arnhem, where a housing shortage provides a complex challenge. Densification in urban areas cannot be overlooked as part of the solution, meaning that urban green spaces also stand under pressure in Arnhem (König, 2023). In cost-benefit analyses green spaces often perish, as alternative planning outcomes, such as commercial or residential functions, generally represent more economical value than green spaces, which values are more often non-monetary, harder to quantify in a data analysis (Pietrzyk-Kaszyńska et al., 2017). Therefore, in order to conserve the existing, or create new green space in cities, methods to map out these non-monetary values are necessary. If planners gain better insight in how often UGS is used, for what purpose, and how these green spaces are valued by its residents, this might lead to more thorough consideration of densifying in the city at the expense of an existing green space. In order to gain insight into the uses and valuation of green spaces by residents, we will explore the applicability of a new instrument to collect data from residents who are living in Arnhem, and to map and visualize the use of UGS as perceived by the residents.

As we will explore the use of a new GIS tool, we have started with a literature review of methods in participation and GIS. Participatory Geo Information Systems (PGIS)[1] has been identified as a method with a lot of potential to collect and process data 'bottom-up', and therefore better cater to societal needs (Schuurman, 2009). However, the use of PGIS does not come without its problems. Public participation is a very noble aspiration but often lacks sufficient representation. In much PGIS research an overrepresentation of white, male, higher educated and people above 50 in age is present, while societal minorities are almost always underrepresented (Elwood, 2010). One can assume that people with different backgrounds may have different usages of, and preferences regarding urban green space. Ensuring sufficient representation in participatory research is of crucial importance in order to create a correct oversight of the non-monetary values of urban green space and contribute to the planning process in an accurate and just manner.

This research will therefore seek to create a participatory method to map the non-monetary values of urban green spaces, while ensuring a proper representation in the participatory process. Previous research has shown the potential of mapping survey tools such as Maptionnaire (Rall et al., 2019). This research will use a mappable survey tool created by Esri, named Survey123. Survey123 has not yet been used broadly in an academic context, therefore a lot is still to learn regarding the utilization of Survey123 in an academic context. Besides getting deeper insight into the dynamics of UGS use and valuation, this research will also explore the potential of Survey123 in PGIS research.

[1] PGIS (Participatory Geo Information Systems) and PPGIS (Public-Participatory Geo Information Systems) are both used in academia and can be seen as interchangeable concepts to a certain extent. This research will use the term PGIS, in line with the work of Rambaldi (2006).

1.2 Research Scope

Aim of the research

This research focusses on achieving two main goals. Firstly, we aim to create as complete a picture as possible of the non-monetary values of green space, specifically regarding the case of Arnhem. This research seeks to uncover how urban green spaces in Arnhem are used and valued by a broad and representative group of citizens.

Furthermore, this research will broaden the knowledge regarding the use of Survey123 in an academic PGIS context. As this tool currently lacks a wide application in this regard, this research seeks to uncover the potential as well as the deficiencies regarding the use of Survey123 in an academic context.

Case selection

This research is conducted in the city of Arnhem. We selected Arnhem as city because this city aims to invest more in greening the city, and at the same time there are places appointed for densification in existing green areas. Such a densification project was for instance planned in the neighbourhood Malburgen, a neighbourhood with a large share of low-income residents, at the time we designed this research.

Another potential city was Nijmegen, a pragmatic choice because of its proximity. When searching a research topic and place for studying the use of green, in the city of Nijmegen we encountered a local initiative started by largely high-income groups, while in Arnhem, Malburgen, we found an initiative that resisted the densification of the Veerpolderstraat in Malburgen, a neighbourhood known as 'low-SES'[2] (König, 2023). Because one of the aims of our research is to improve the representativeness of under-represented groups, we wanted to select neighbourhoods that are usually underrepresented in research, and thus we opted to select Arnhem as city of choice, and the neighbourhood Malburgen in particular.

In order to increase the spatial spread of this research, we selected three neighbourhoods in Arnhem, distributed over the city, all housing relatively lower income groups, and containing multi-floor apartment buildings and houses without a private garden. This will be further explained in chapter 3, methodology.

[2] Low social-economic status

1.2.1 Research questions

In order to be able to fulfil the aim of this research in a sufficient manner, this research will answer the following question:

> *"What are the perceived non-monetary values of urban green space in Arnhem, as mapped by residents using Survey123, a new mapping & survey instrument in ArcGIS that is enabling new ways of conducting PGIS research?"*

Sub questions

As a guiding tool to answer the main research question in a sufficient and complete manner, the following set of sub questions have been formulated:

(I) **How are green spaces in Arnhem used?**
- a. *Which green spaces are visited by the most people?*
- b. *How often are green spaces visited?*
- c. *For which functions are green spaces used?*

(II) **How are green spaces in Arnhem valued?**
- a. *How are green spaces rated? Which green spaces stand out, positively as well as negatively?*
- b. *For what qualities are green spaces valued?*

(III) **To what extent has Survey123 proven to be a usable and user-friendly tool to get good representation in PGIS research?**
- a. *What are the potential downfalls, and other considerations regarding the usage of this PGIS tool in UGS research?*
- b. *Is Survey123 an usable and fitting tool for an academic researcher?*
- c. *Is Survey123 user-friendly and accessible enough to conduct research on a group of respondents with varying technological and intellectual abilities?*

Core concepts in research question

This research revolves around the usage of PGIS as a representative research method, and the applicability in Urban (public) Green Space planning. The core concepts in this research are: **PGIS, Survey123, Multiple-location-PGIS Survey, Representation, non-monetary values, (public) urban green space, functions of green space, qualities of green space.**

PGIS: combines the usage of GIS (Geographic Information Systems) with participatory planning methods. The main goal of PGIS is to apply GIS in such a way the interest of every citizen is sufficiently represented (Abbot et al., 1998).

Survey123: A survey-tool created by Esri, the operators of ArcGIS. This survey-tool allows users to integrate maps into a survey, respondents are subsequently able to draw spatial data into these maps. This research uses Survey123 as the sole tool to yield data and explores the applicability of this tool for academic purposes.

Multiple-location-PGIS Survey: A type of survey in which respondents are able to map multiple points, and answer questions regarding each separate point, in one single survey. For this research such a survey has been created using Survey123, similar surveys can also be created using different software-tools such as Maptionnaire, used by Rall et al. (2019).

Representation: The degree in which the complete variety of stakeholders is included in the process. As different members of society have different experiences, interest, values and challenges in life,

mis- or nonrepresentation in research or policy processes would therefore lead to underexposure of certain aspects of the research object (Elwood, 2009).

Non-monetary values: The allocation of values to a certain object of service without the use of economic imperatives. For instance, sentimental or spiritual values of a certain place (Pietrzyk-Kaszyńska et al., 2017).

(Public) Urban green space: A collective term for all concentrations of vegetation in urban areas, which varies from forests and natures reserves that fall within the delineation of the urban area, to public parks and gardens, to verges and private gardens (Swanwick et al., 2003).

Functions of green space: Refers to the utilization of the respective green space. This includes the activities take place in the green space, as well as the general reasoning why people are in a specific green space. Exercising or meeting friends are examples of functions of green space (Palliwoda & Priess, 2021).

Qualities of green space: The inherent benefits of a green space. This refers to the extent in which a green space is valued, as well as the specific aspects of green space which are valued. Silence and peace, or biodiversity are examples of qualities of green space (Tandarić, Ives et al. 2020).

1.3 Societal Relevance

The Netherlands is a country facing multiple big political challenges regarding land use, housing, and nature. As land is a very scarce 'product', not all desired plans are able to be implemented. To further illustrate this; according to the provincial administration of Gelderland, where Arnhem is situated, 1.8 times the surface area of the province is necessary to be able to implement all the proposed plans (König, 2023). Therefore, the decision when ether to implement a certain plan requires a thorough justification. (Urban) Green space generally does not represent much economic value, especially in comparison to a scenario in which the same plot of land would be used for commercial or housing purposes. The intrinsic value of urban green space is often commonly acknowledged but harder to express in measurable values (Pietrzyk-Kaszyńska et al., 2017). The development of methods in which non-monetary values of planning projects can be displayed in a comprehensive, yet thorough manner would therefore benefit the planning process, because it may enhance the visibility of the 'added value' of having UGS in the city, as counterargument when considering densification on the expense of green. By answering the research questions, this research will create insights into the non-monetary values of urban green space and contribute to the improvement of broad participation in PGIS.

Besides the general contribution to the enhancement of planning processes, by offering tools to make the non-monetary values of UGS better visible, this research can also offer practical insights into the specific case of Arnhem. This research could highlight other valuable urban green spaces which are currently still under the radar, especially in and around the neighbourhoods Malburgen, de Geitenkamp and Klarendal. Better insights into the non-monetary values of green spaces in Arnhem can prevent a future scenario in which unexpected opposition against a densification plan of the municipality of Arnhem arises.

On top of that, this research will focus on increasing representation in participatory digital planning methods. The emergence of PGIS can be traced back to the desire to represent the interest of as much stakeholders as possible, as GIS on itself is a tool that fits better on top-down planning, upholding existing power structures and the marginalization of certain groups in society (Schuurman, 2009). If one adopts the viewpoint that the most desirable policy outcome is one that benefits the largest part of the community as possible, being able to get insights into the use, preferences, and appreciation of as much different community member as possible is vital. By exploring the utilization potential of multiple-location GIS surveys via Survey123, this research will contribute to the enhancement of participatory GIS methods in research and policy making, leading to a better and more extensive utilization of these methods.

1.4 Scientific Relevance

Although this research will not be the first to use participatory GIS methods to measure non-monetary, societal values of Urban Green Space (Ives et al., 2017; Korpilo et al., 2023; Pietrzyk-Kaszyńska et al., 2017), this topic of research is far from saturated. As mentioned by Tandarić (2020), research regarding Cultural Ecosystem Services had lagged behind research on other types of ecosystem services, even in an urban context. As this research regards the use and valuation of urban green spaces, it will contribute to the academic knowledge in this topic. Besides its contributions towards the knowledge of the functions of green space (Koh et al., 2022; Palliwoda & Priess, 2021; Pietrzyk-Kaszyńska et al., 2017; Rall et al., 2019), and the qualities of green space (Sanesi & Chiarello, 2006; Ives et al., 2007; Misiune et al., 2021). This research will also test specific relations, in which previous researchers have not been able to draw conclusive remarks.

Previous research has not been able to create coherent conclusions regarding the influence of size to the use and valuation of urban green spaces. Schipperlijn, Stigsdotter, et al., have discovered a pull effect of larger green spaces over green spacer smaller than five hectares (ha) (2010), while Peschardt et al. suggest this relation to be exactly opposite (2012). Although most researcher seem to agree that smaller and larger green space are used inherently different, regarding the realms of use and travel patters no conformity has been reached. Therefore, this research will test specifically when ether the use, valuation and travel patterns of small urban green spaces are significantly different to larger urban green spaces.

A second relation this research will test is the influence of accessibility to private gardens on green space usage. The research problem regarding this relation is not perse that researchers have drawn completely different conclusions regarding this relation, but rather the fact that the relationship that most researchers discover is fairly counterintuitive. Multiple research papers have suggested that people without direct access to a private garden, do not visit (public) urban green spaces more often (Schipperlijn, Stigsdotter et al., 2010; Barbosa, Tratalos et al., 2007, Misune et al., 2021). As one would expect that people without access to a private garden would rely more on public green space in order to benefit from the qualities and functions of green space, this research aims to create a better understanding of this relationship.

Furthermore, methodologically, PGIS is an academic field which keeps developing. No previous research on UGS planning has been found that used the Survey123 software. This research will not only delve further into the general considerations and challenges regarding the utilization of PGIS in academic research, but it will also explore the utilization of a new survey tool. Therefore, this research will also help future researchers in a quite practical sense, by exploring the opportunities of Survey123, describing how it can be implemented and serving as example of how it can be used in research, what results it can yield, and the user-friendliness for respondent and researcher.

In developing a survey with GIS, this research applies Participatory Action Research, a broad methodological field of knowledge regarding the constraints and ethical implications of PGIS. The insights of Participatory Action Research and PGIS will be used while creating a comprehensive approach to visualize the non-monetary values of Urban Green Space. This approach forms a desirable addition to existing literature using PGIS in the context of UGS planning, as respondents are not only viable data ‘sources’. By giving the respondents as much freedom as possible in choosing which (green) locations they want to highlight, they do not only deliver data, but also shape the research focus, as only green spaces which are highlighted by the respondents are subject of this research.

Lastly, this research puts an emphasis on correct community representation in the data collection. In many cases of participatory research, an overrepresentation of white people, males, higher educated people, and people with an above-average age is projected (Brown, 2012). If misrepresentation is successfully avoided, it would not only benefit the PGIS approach in general, but it could also possibly identify issues that have been underexposed because of mis- or underrepresentation. This research will also explore the possibilities to include children in PGIS research, which is still under reserve. Including children in participatory research can be quite challenging, however if conducted successfully it would open up a new perspective, and possibly different insights into societal values of urban green space.

1.5 Reading guide

This paragraph forms the last part of chapter 1 of this thesis. In this chapter the problem statement of this research, as well as the research questions, the core concepts, the scientific- and societal relevance of this research are presented. Chapter 2 provides the theoretical framework necessary for this research, as well as the conceptual model. In chapter 3 the used methods are presented, with specific focus on Survey123, and the survey created via this software. Chapter 4 focusses on the first two sub-questions of this research, as this chapter presents the outcomes of the analyses using the yielded data from the Multiple-Location PGIS survey. Chapter 5 solely focusses on the last sub-question of this research, in which the applicability of Survey123 in an academic context will be discussed. Chapter 6 provides the final answer to the main research question as well as the discussion, in which the process of this research, as well as the relevance of the outcomes will be discussed.

2. Literature Review & Theoretical Framework

This chapter provides the necessary theoretical elaboration and discussion regarding the key concepts of this research; (P)GIS and the non-monetary values of urban green space. Using key literature, relevant case studies and recent debates regarding these topics, a clear theoretical foundation can be formed.

2.1 Urban green space

The creation and expansion of cities has great impact on the local natural environment; existing natural (green) space is replaced by urban (grey) space, dislocating or removing natural habitats. However, this does not mean that cities are inherently un-natural. Throughout every city flora and fauna can be found; via deliberate ways such as public parks or private gardens, but also non-deliberate habitats such weeds, insects, birds, and other animals that inhabit cities. Even so, cities play a large role in biodiversity networks (van Haaster-De Winter et al., 2022).

Urban green space (UGS) refers to a contiguous area of natural space within an urban area. Urban green space can be as big as a nature reserve, for instance Nairobi National Park in Kenya, or as small as a curb garden or verge (Byrne & Wolch, 2009). Urban green space does therefore not exclusively refer to the colour green, a field of purple tulips is considered green space, while a bike path that has been painted green for traffic management reasons is not classified as green space. In various papers, the term '*blue space'* has been added consistently when addressing UGS, in order to explicitly include bodies of water. For the sake of readability this research consistently uses the term Urban green space, in which the inclusion of blue space is implied.

2.1.1 Usage and valuation of urban green Space

Insight into the usage and valuation of greenspace is of contingent value in order to be able to measure the non-monetary values of green space. Because of this, the patterns of UGS usage and valuation have been well researched by various scholars. These findings will be presented in this paragraph.

For the sake of maintaining overview, this paragraph will be divided into four elements: Demographics, spatial factors, green space services and green space functions. The latter two elements require a clear distinction, as they can be mixed up easily. UGS qualities refer to the inherent benefits these places offer, for instance; space, quietness, clean air, or aesthetics, closely related to the concept of Cultural Ecosystem Services, as elaborated by Tandarić (2020). The concept of UGS functions refers to the purposes for which green spaces are used, this includes for instance, sports and social activities.

Demographics

A common subdivision in research regarding the use of UGS is the distinction between people who use green space predominantly for nature-oriented uses, and people who tend to use green space for social uses (Phillips et al., 2021). Although this distinction is not completely comprehensive, as these categories are not excludable, they help to better understand the dynamics of UGS usage. The differentiation between nature-oriented usage and social usage is not only of importance regarding the demographics of green space users, but also crucial for understanding the differences in UGS preferences and valuation.

Another important consideration regarding UGS usage is accessibility. The frequency of visits and usage dynamics does not only depend on inherent motivation but are often subject to external factors. The synergy between people and their surroundings are of major influence on UGS data. For instance, as discussed by Richardson and Mitchell (2010), safety issues can be a constraining factor

for woman to visit a green space at night, or even in general. Moreover, the quality and quantity of green spaces differs from place to place. If a certain neighbourhood has poor green space accessibility, demographic groups that are overrepresented in this neighbourhood will most likely be visiting green space less. This can lead to disparities in UGS data among different demographics, which are not inherent but solely situational, as pointed out by Wüstemann et al. (2017). Therefore, data should be treated with prudence and always be considered in its context. When accessibility considerations are disregarded, claims regarding the role of age, race, gender, or other characteristics in green space cannot be made accurately.

The relationship between age and visiting frequency shows varying associations. Older people generally lean towards a more nature-oriented use of UGS, while younger people tend to visit UGS predominantly for its social functions (Phillips et al., 2021). Schipperlijn et al. have found a positive relation between age and visit frequency for men (until the age of 80), while this relation was not found regarding woman (Schipperijn, Stigsdotter, et al., 2010). Sanesi and Chiarello assigned an age between 25 and 44 as a predicting factor for a higher visiting frequency (Sanesi & Chiarello, 2006). Having children is a factor increasing UGS visiting frequency (Phillips et al., 2021). Having children being an increasing factor in UGS visit frequency could explain the earlier mentioned predicting value of the age group 25 – 44, as most parents are in this group. This correlation could also explain the fact that the relation between visit frequency and age is not linear for woman, while it is for men; woman generally spend more time with their children than men, therefore having children might have a higher impact on UGS visit frequency for woman.

People who visit UGS more often, value the ecosystem services of these spaces higher than people who visit UGS less. Both groups mention the same push and pull factors of urban green spaces. This effect can be explained both ways; people who are more often in contact with (urban) nature have a better understanding of its values and benefits, and people who find nature inherently more important, for various reasons, are more likely to visit UGS more often (Misiune et al., 2021). This could be a possible explanation for the fact that people who do not have a private garden, do not visit UGS more often (Schipperijn, Stigsdotter, et al., 2010), as there could be a correlation between having a garden and having a particular interest in natural spaces. However, this relation is most likely more complex, as having an own garden is often not something one can choose freely. Accessibility to a private garden is strongly linked to one's housing situation, and therefore in many cases linked to one's socio-economic status. The relation between access to private gardens and green space use has further been explored by Barbosa et al., they have as well uncovered differentiating patterns in the usage and accessibility to green space across people from different socio-economic groups. To a certain extent, private gardens can be an alternative to public urban green space, however they are not completely interchangeable. As they, as well as Misune et al., have found a positive correlation between public green space usage and access to a private garden (Barbosa, Tratalos et al. 2007).

Research regarding ethnicity, socioeconomics and green space visit numbers focusses often on the realm of accessibility. In many cases, neighbourhoods in which ethnic minorities are overrepresented and have lower income statistics, have worse UGS accessibility. However, the degree in which this inequity exists differs vastly between cases, in Western Europe this disparity is usually less than in the United States for instance (Liu et al., 2021; Roe et al., 2016; Wüstemann et al., 2017). In Berlin, despite an unequal distribution of green space, most sub-districts are above the threshold-value of 6m2 UGS per inhabitant. However, people form an immigrant-background still tend to use UGS less than people from a German background. This disparity could be explained by the fact that the

respective green spaces did not connect well to the stated preferences of respondents with an immigrant background (Kabisch & Haase, 2014).

Spatial factors

The relation between proximity of a green space and its usage has been tested by Schipperijn and Ekholm et al. in Denmark (2010). Their research shows a to be expected relation between frequency of use and distance; if distance increases, frequency of use decreases, which is in line with statements in other research (Schipperijn, Ekholm, et al., 2010). According to Sanesi and Chiarello (2006) people living in the city centre are more likely to use urban green space than people living in the outskirts of the city. Inner city green space is more often used for social functions, while green space on the outer skirts of city is more used for nature-based uses (Phillips et al., 2021).

However, people do not necessarily use the green space nearest to their home. The degree to which people do not prefer the nearest green space depends on the area size of the green space, the distance of the green space and (reduced) mobility dependencies, such as: old age, young children and poor health (Schipperijn, Stigsdotter, et al., 2010). Building upon that, Schipperlijn et al. uncovered a 'pull-effect' of 5ha; meaning that a green space needs to be at least 5ha larger in order to be given preference to a smaller green space. This effect decreases if the larger green space is more than six hundred meters further than the nearest green space (Schipperijn, Stigsdotter, et al., 2010).

People tend to use smaller green spaces inherently differently than larger green spaces. Although smaller green spaces are also used as a place for social activities and 'rest and restitution', just as larger green spaces, for other purposes smaller green spaces are used less (Peschardt, Schipperijn et al. 2012). Larger green spaces are more often used for walking and exercising than smaller green spaces (Rey Gozalo, Barrigón Morillas et al. 2019).

Peschardt et al, concluded that people travelled further to smaller green spaces. However, this can most likely be explained by the fact that a lot of these smaller spaces are located in the city centre, which means that people have most likely not travelled solely to the specific green space but were in the area for different purposes as well. Although larger and smaller green spaces are rated for different qualities, in the bigger picture has size not been identified as a determining factor regarding how green space is rated (Rey Gozalo, Barrigón Morillas et al. 2019).

Another phenomenon regarding the relation between distance and visit frequency is the compensation theory. This theory states that people use green space close to home more often, but for shorter visits, while visits to green space further away are usually longer, creating a balance in total time spent per green space (Grahn & Stigsdotter, 2003). This variance in distance-decay function regarding size and other UGS characteristics is likewise pointed out in other research (Łaszkiewicz et al., 2022; Peschardt, Schipperijn et al. 2012).

This brings up the question to which extent, and for what reasons size is a determining factor in the number of visitors a green space receives? The Structure Diversity Index, as introduced by Massoni et al. (2018), expresses the number of different biotic, abiotic and man-made elements per green space. This provides an opportunity to test the relation between multiple UGS characteristics. Their research points out that size is not a great determinant for the structural diversity of a green space. Although some correlation exists (Figure 2.1), green space of similar sizes can have large disparities regarding structural diversity. The structural diversity index can be used to differentiate via

quantifiable methods between more 'natural' green spaces from green spaces with a lot of man-made structural elements.

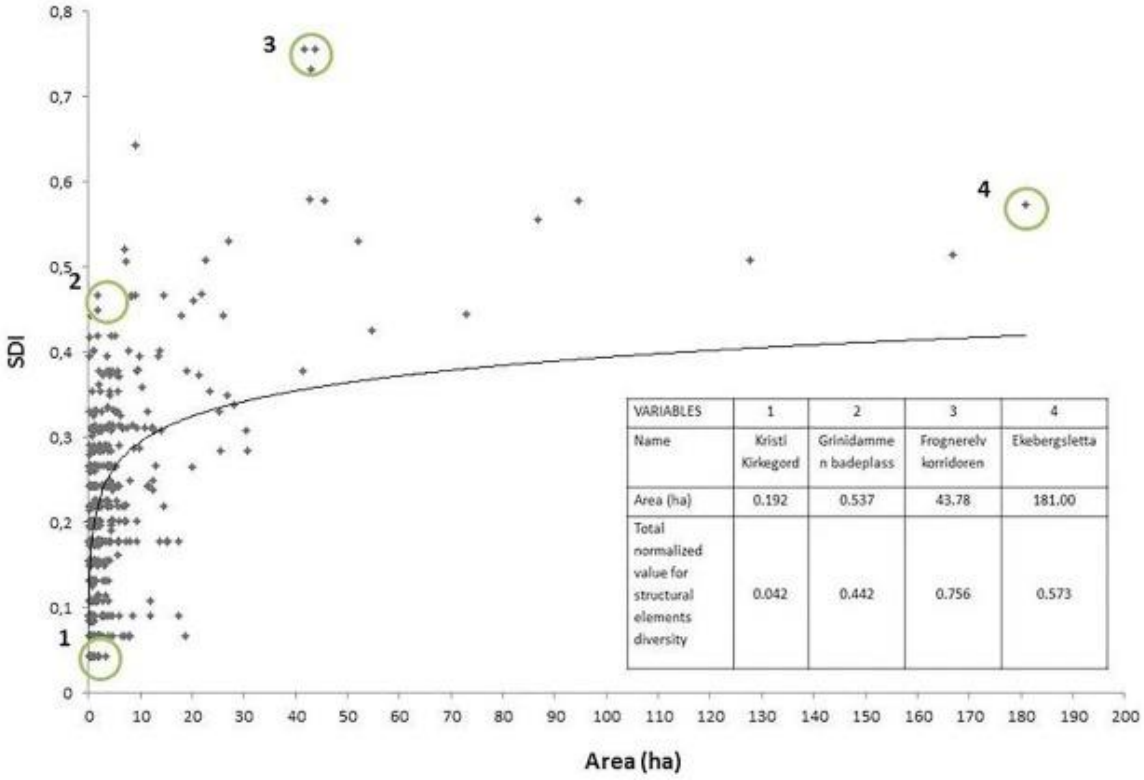


Figure 2.1 Structural diversity (Y-axis) in relation to UGS size (x-axis) (Massoni et al., 2018)

When including the perceived importance of each structural element (RIS, relative importance score), size is a determining factor for green space preference, as larger UGS's tend to have more elements with a higher RIS-score, especially man-made elements. Regarding solely biotic elements, small (<0.5ha) UGS's score similar to medium sized (<10ha) green spaces (Massoni et al., 2018). Therefore, small green space can be of excellent value regarding the 'natural' qualities of UGS, while larger green spaces, which have more space for abiotic and man-made elements are of crucial value for the recreational qualities of UGS (Massoni et al., 2018). Meaning that a successful urban green space strategy would include a large diversity in types and sizes of green space.

Structural diversity is not inherently a useful predictor for recreational opportunity, as preferences and uses of green space are highly heterogeneous. For some people a green space with low structural diversity is preferred, for instance when seeking quietness and peace, while other recreational uses, certain sports for instance, require specific elements (Massoni et al., 2018).

Green Space qualities

Sanesi and Chiarello (2006), have analysed usage and perception of green space in Bari. This research has pointed out that the improvement of climate conditions and environment is most frequently named as the most important quality of green space (46%). However, outcomes varied largely among different demographics, for instance; woman recognised the importance of green space for children a lot more than men, and young people tend to recognise the importance of green space for their social life more often than older respondents (Sanesi & Chiarello, 2006).

Regulating services of UGS, such as noise reduction and air quality improvement are deemed as the most valued urban ecosystem service. Other qualities mentioned are, relaxing observing nature and

the ability to move around (Misiune et al., 2021). In general, green environments are valued more positive than 'grey' environments. The proximity of blue environments (water) has an even stronger positive effect (Ives et al., 2017). The importance of water for UGS visitors has also been stressed by respondents in another research (Koh et al., 2022). In terms of Cultural Ecosystem Services, recreation has been valued as most important, aesthetics, social opportunities and nature experience were also deemed as important (Rall et al., 2019).

The *quality of space* (aesthetics, size, biodiversity etc.), is the most crucial variable regarding the degree to which a green space is valued. Natural elements and the ability to participate in activities are equally mentioned but subordinated to quality of space. Regarding natural elements, the presence of water was especially considered important. Man-made elemens, accessibility, *non-material connection* (sentimental values, history, spirituality etc.) and non-visual senses were also mentioned as important non-monetary green space values (Rall et al., 2019).

Green Space functions

Recreation, nature experience, exercise and social activities are identified as the most important function of green space in numerous papers (Koh et al., 2022; Palliwoda & Priess, 2021; Pietrzyk-Kaszyńska et al., 2017; Rall et al., 2019). Structural elements are decisive elements regarding how green space is used. For instance, seating possibilities and sports facilities benefit social and cultural interaction significantly in a green space, whereas higher numbers of vegetation have a negative relationship with social interaction, and a positive relation with the experience of nature (Palliwoda & Priess, 2021).

Differences in uses of green space among different social groups are also acknowledged in other research. Besides age and gender, one's cultural background can also affect the attitude towards, and the use and customs (Kabisch & Haase, 2014). For instance, park visitors with a Turkish background valued opportunities of UGS for group activities and social gatherings more than visitors with a Dutch background (Peters et al., 2010). However, the interactions that people have with their surroundings are complex and heterogeneous. Therefore, making claims for an entire population or social group is not possible, and one is only able to expose trends and tendencies among certain groups.

In line with research regarding the values of UGS, in which age is a crucial factor in how green space is valued, age is also a strong predictive variable for which aspects are considered important. Older UGS visitors tend to identify natural elements as most important structural elements in green space and have specified walking and enjoying the landscape as most important activity. Younger people valued the size, maintenance and park design as the most important elements of a green space. And consider social- and sports activities as most important activities in UGS (Palliwoda & Priess, 2021).

However, respondents also think about what is desirable for the whole community, as play facilities for children were considered the most essential recreational facility in green space by respondents, while a substantial portion of respondents did not have children of young age (Sanesi & Chiarello, 2006). Furthermore, people often state the importance of biodiversity as a UGS function, which certainly also adds to the nature experience, regulating services, and in some cases to the aesthetical value of a green space, but is also for a great part a green space function that benefits a more broader cause (Koh et al., 2022).

2.1.2 PGIS and urban green space planning

As this research aims to delve into the use and valuation of urban green spaces by using a specific method – a Multiple-location-PGIS survey – it could be valuable to look into other cases in which quantitative Participatory GIS methods have been utilized in the context of urban green space. A lot of research has been conducted regarding urban green space, while using participatory GIS tools to measure appreciation and more specific non-monetary values (Bijker & Sijtsma, 2017; Ives et al., 2017; Koh et al., 2022; Korpilo et al., 2023; Pietrzyk-Kaszyńska et al., 2017), the current use of green space (Bijker & Sijtsma, 2017; Brown et al., 2014; Poplin, 2012; Rall et al., 2019), and to improve the usability of PGIS as policy tool (Bartling et al., 2019; Brown, 2012; Brown & Kyttä, 2014; Johnson & Sieber, 2012; Koh et al., 2022; Korpilo et al., 2023).

Usability of PGIS methods in UGS studies

Greg Brown (2012) has reviewed over fifteen studies using participatory mapping methods in order to examine whether it has improved the quality of decision making in environmental planning. He discusses the role of sampling in PGIS, who participates in PGIS studies? Respondents in these studies project an overrepresentation of white people, males, higher educated people and people with an above-average age. On top of that, participants are more likely to be familiar and/or committed with the planning area, which often results in a certain bias towards the area, not always corresponding with the views of the general public. Non-participation of certain demographics, resulting in an overrepresentation of other groups, is a reoccurring problem in participatory policy methods. Although the usage of participatory GIS methods does not seem to be the magical solution towards this problem, it is able to attract a higher quantity of respondents than other forms of participatory planning. Therefore, PGIS methods can be seen as a promising tool in participative research (Brown, 2012).

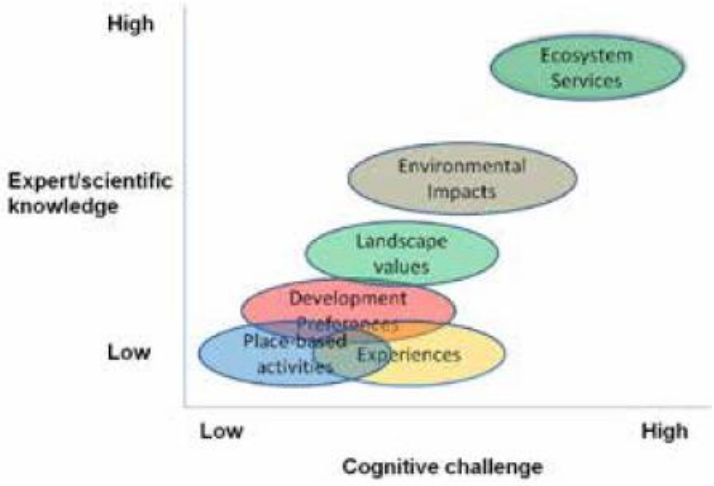


Figure 2.1 Cognitive and knowledge requirements to identify PGIS attributes (Brown, 2012)

Further on, Brown discussed the degree in which different spatial attributes were suitable for the broader public to assess (Figure 2.4). The allocation of experiences, activities and development preferences are quite easy to identify for the broader public, while using Participatory GIS methods to identify environmental impacts or ecosystems services would be more of a challenge for respondents. One could argue that spatial attributes that do not require expert knowledge and/or much cognitive challenge to identify are more suitable for this type of research, as there is a lesser threshold for people to participate, making it easier to collect representative data (Ibid.). In a different paper by Brown, four top research priorities in PGIS were identified: (I) understanding and increasing participation rates, (II) identifying and controlling threats to spatial data quality, (III)

improving the “PP” or public participation in PGIS, and (IV) evaluating the effectiveness of PGIS (Brown & Kyttä, 2014).

Ives et al. (2017) have identified three research gaps regarding the use of PGIS specifically in urban green space planning; (I) the applicability of previous PGIS studies regarding urban green space, (II) the challenges one should overcome to better apply PGIS in green space planning practice (III) and what can the statistical relationships tell us about green space characteristics (Ives et al., 2017, p. 33)? By the means of four case studies in Australia, they have aimed to create guidance for practitioners applying Participatory GIS methods. They state that participatory mapping can be an useful tool, as it has key advantages regarding community engagement in comparison to other participatory approaches, as it is more spatially applicable than public surveys, more participatory than town hall meeting of leaflets, and more representative than planning forums (Ives et al., 2017, p. 41). However, the quantitative nature of this tool can also underrepresent certain groups and sentiments, as discussed in previous paragraphs. In addition to previously discussed representation issues, Ives et al. have discussed some other challenges regarding the interpretation of publicly yielded geographic data. The spatial arrangement of landscape features and residency of respondents can influence data strongly, leading to incorrect conclusion regarding the relation between distance and value. They also suggest longitudinal research into valuation of Green Space, as almost all research does not include a time component, while seasonality and other time dependent variables could affect this possibly (Ibid.).

Application of Participatory GIS methods in survey research

The concept of *Cultural Ecosystem Service* (CES) is used quite a lot in research regarding the societal value of urban green space. However, the concept has been used in a broader sense, mixing up the term *service* and *benefit*. Therefore, a redefinition of CES has been proposed (Tandarić et al., 2020). Illustrated in figure 2.3.

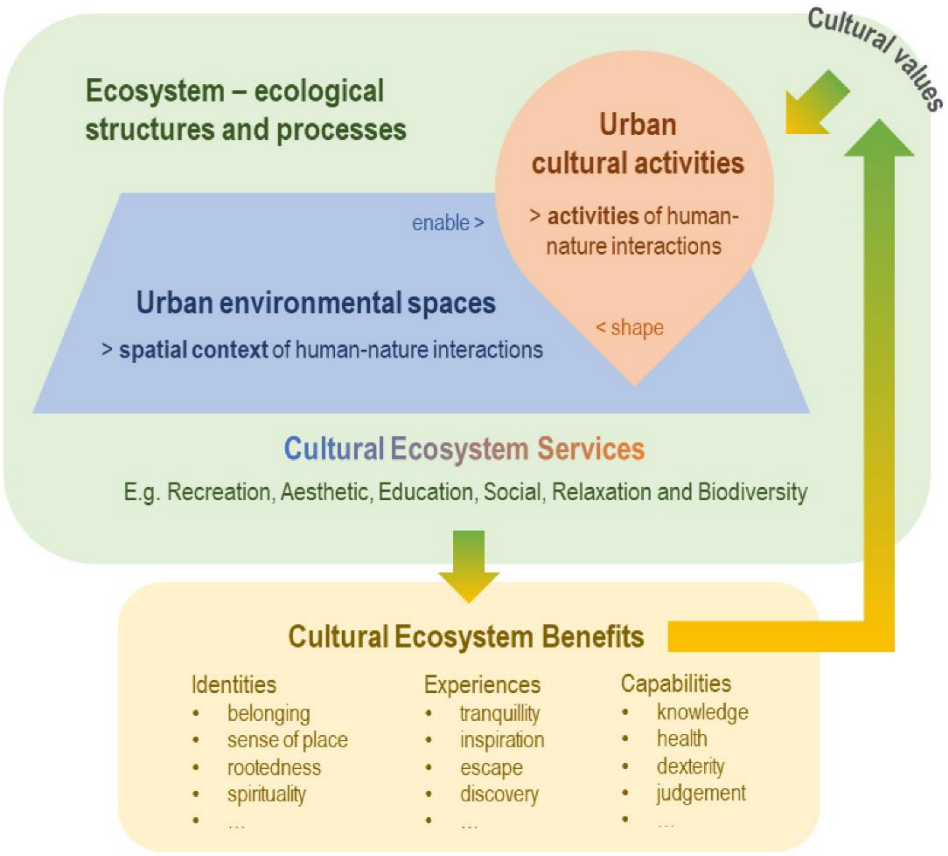


Figure 2.2 Cultural Ecosystem Benefits illustrated (Tandarić et al., 2020)

To evaluate when ether this broader definition is operatable, Koh et al. have used a Multiple-location-mapping tool to evaluate the new CES definition in a case study in Singapore (2022). Through twenty questions via the Map-Me software, respondents were asked to highlight significant locations, and their respective attributes. The redefined CES conceptual framework has been valued as useful, Koh et al. therefore advise policy makers to use this new framework in UGS planning. This framework highlights the distinction between *services* and *benefits* – which this research has translated to *functions* and *qualities* – at the same time the interconnectivity between both concepts is also stressed via this framework. These authors have succeeded to create a framework in which the benefits and services of urban green spaces are yielded using a multiple-location-PGIS survey, which could be of great value for future researcher seeking to set up a comparable study. Therefore, the CES definition and conceptual framework, as developed by Tandarić et al. (2020) and Koh et al. (2022) has been used as basis for our conceptual framework, see section 2.3.

Rall et al. (2019) have examined the added value of PGIS for urban green infrastructure planning. Their research aims to create more insight in the cultural ecosystem services of urban green space, and to explore the added value Participatory mapping methods have in acquiring these insights, comparing to more traditional methods. By the means of an online survey tool, maptionnaire.com, respondents were asked to point out a maximum of ten meaningful green spaces and answer multiple questions about this location. The results of this research show that PGIS is a valuable addition to current assessment methods in three separate ways (Rall et al., 2019):

(I) *More just and comprehensive assessments*: current methods are dependent on expert knowledge and therefor overlook certain aspects.

(II) *Better understanding of (cultural) ecosystem services:* Due to the quantity, nature and spatial level of detail, a better understanding of the complementarity and synergy of ecosystem services can be acquired. On top of that PGIS research is better able to assess more 'subjective' cultural services such as spirituality.

(III) *Identification of imbalances in quality and accessibility of ecosystem services*: PGIS research is able to provide more detailed information about which ecosystem services is lacking in which area.

Instead of merely focussing on green spaces in one's vicinity, Bijker and Sijtsma (2017) have looked into the use and appreciation of green space of urban residents without any spatial delimitation. As relative distances have decreased over time, and more people travel internationally than ever before. The researchers used a Multiple-location-PGIS tool to examine the influence of proximity to the use and appreciation of green space, as mostly studies only focus on 'local' green space or 'nature-based' tourism, this research tries to create an integrated perspective. By using the survey tool *Hotspotmonitor*, respondents were able to point out natural locations that were attractive, valuable of important to the respondent, and were subsequently asked to answer a set of questions regarding these locations. The research has pointed out that urban dwellers have a 'portfolio of natural places', distinguishing between local, regional, national and world places. A standardized version of this portfolio can be found in figure 2.4.

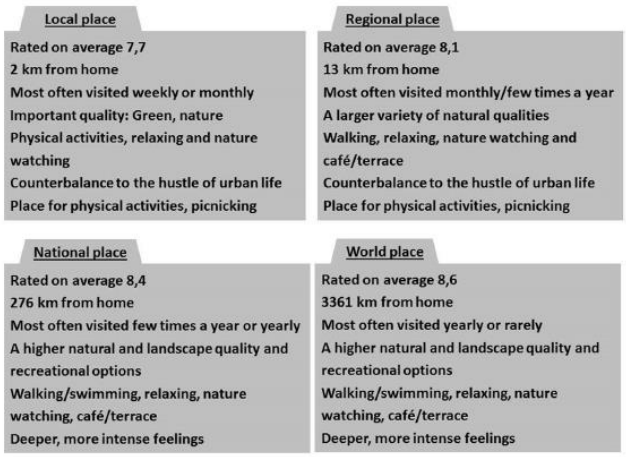


Figure 2.3 Portfolio of natural places (Bijker & Sijtsma, 2017)

2.2 Public Participation in GIS

The craft of map making can be dated back to ancient times, via various methods humans have attempted to create visual representations of the known world. As technology and knowledge has developed over time, maps have become increasingly accurate, detailed and widespread. The emergence of digital technology in the 1950s and 60s is a key moment in this development, as it became possible to digitalize maps, thus geographical information. A new dimension in cartography, Geographic Information Systems (GIS), has been born (Goodchild, 2009). As maps were digitalized, information represented by maps is no longer static, and can be edited at any moment by multiple people. GIS has followed a parallel path as the general technological development; as (personal)computers were able to handle more and more data, maps were able to represent more geographical information, and via the internet of things, geographical information could be shared through the whole world (Goodchild, 2009). Such a revolution in cartography has many consequences and implications, from which various debates and critiques have emerged, fundamental and pragmatical. Critical GIS refers to the critiques of academics on the narrowness of GIS, and the emphasis to broaden its functionality and democratization (Schuurman, 2009).

Regarding spatial planning, GIS can be more suitable for, and could therefore reinforce, top-down decision-making (Abbot et al., 1998). The critiques within critical GIS, mainly expressed by human geographers and other social scientist, did pique the interest and received recognition of GIS researchers, resulting in collaborative work between these fields. These collaborations laid the groundwork for the emergence of other types of GIS research, such as Feminist GIS, and Participatory GIS. As a result of the critiques on GIS, especially regarding the inaccessibility and power implications, the involvement of citizens in GIS became an increasingly popular topic. By creating methods to involve the general public in the collection and analysis of spatial data, GIS research can be able to empower groups that are normally excluded from the policy process (Schuurman, 2009). Especially since the 1990s, via several books, articles, and conferences the concept of Participatory GIS (PGIS) has been shaped (Craig et al., 2002).

PGIS stems from the viewpoint that desirable political outcomes are the result of input from as many stakeholders as possible (Radil & Anderson, 2019). And can be seen as an attempt to utilise GIS in a way that caters to the needs of people and communities affected by a certain project (Abbot et al., 1998). On top of that, PGIS seeks to break down the technical and knowledge barriers of GIS, meaning that a larger group of people can utilize geographical information. PGIS can be utilized for various practices, collaborative governance, activism or research for example. It can also help to incorporate more qualitative and/or noncartographic values into GIS (Elwood, 2009).

Key to PGIS is the role of the community in the planning process. The concept of community refers to a group of people that share common experiences and perspectives. In many cases these relationships are place-based, living in the same neighbourhood or region for instance. However, communities can also be based on social relationships, by having the same profession, hobby, or family ties for example (Craig et al., 2002). Community-based action is a phenomenon that can be found in many different cultures and societies, however the degree in which communities are organized and formalized can differ vastly (Ibid.). The degree to which community members are invited to participate in a policy process can differ vastly. Sherry Arnstein (1969) used the metaphor of a ladder to illustrate the differences in public participation (Figure 2.5), better quality and quantity of public participations results in a higher place on this ladder. PGIS is able to help communities to progress to higher on this ladder (Craig et al., 2002).

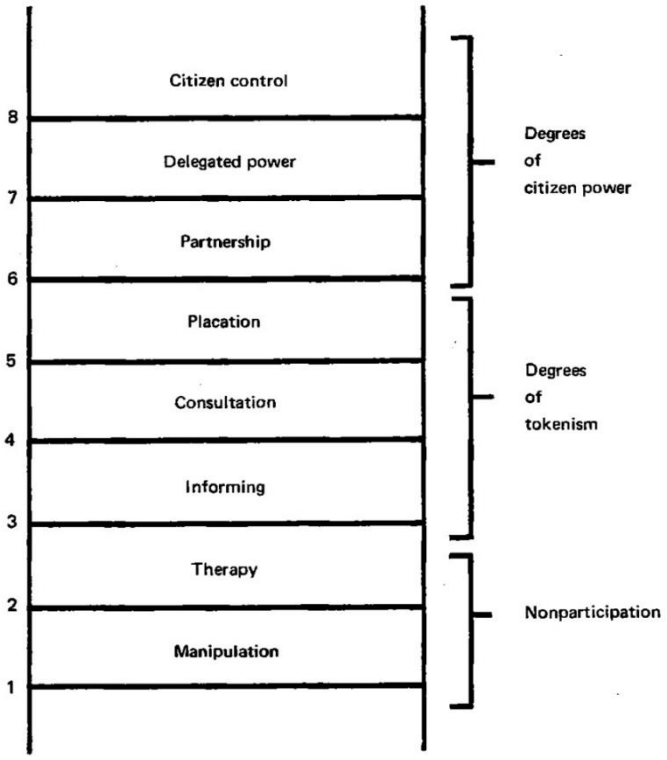


Figure 2.5 Citizen Participation Ladder (Arnstein, 1969)

Besides fundamental arguments regarding empowerment, in planning, community organizations and public participation can be of great value to get a grip on local issues, and to create support for projects. More recently, especially since the introduction of smartphones and other devices able to use GPS and mobile internet; crowdsourcing spatial data has become more feasible. This phenomenon is called Volunteered geographic information (VGI). VGI can work two ways; citizens are able to use geographic data for their own interest, while citizens can also be the provider of geographic data (Senaratne et al., 2016).

VGI is also viable to use in an academic context and is very much interconnected with PGIS. Bluntly, VGI is more interested in the yielded information, whereas PGIS is more concerned with the participatory process. VGI methods can be distinguished between *volunteered* crowdsourcing, in which participants actively and willingly provide information, and *opportunistic* crowdsourcing, in which citizens provide information in a passive way (Verplanke et al., 2016). For instance; if someone uses Google Maps while driving in order to take the quickest route, they also provide Google Maps with information regarding the flow of traffic on the respective roads, this real-time data is subsequently used to optimize the determination of the fastest route for other app-users. This process is in essence consensual, via the terms of service, however often not actively known by the users of the service.

2.2.1 Representation and crowdsourcing in PGIS

As mentioned, developments in (P)GIS follow relatively the same track as the general technological development. Especially the introduction of the smartphone, and broad availability to (mobile) internet have had enormous effects on the manner in which, and the amount of (geographic) information and data people are exposed to. This revolution on the Internet as a platform, was often referred to as *'Web 2.0'.* During this development of Web 2.0, Haklay et al. discussed the implications for GIS and mapping (2008). In this period, platforms such as OpenStreetMap, in which map data is crowdsourced and completely free of use, emerged. In their paper, it is argued that because of the change in information provision, in which users are *prosumers*, the role of the traditional information providers shifts more to a facilitation and verification. As professional standards in mapping are still important for numerous reasons, the perfect balance between digital, participatory techniques and traditional methods should be found (Haklay et al., 2008). These same tendencies were noticed by Elwood (2010). Elwood claims that these changing roles, and the vague distinction between providers and consumers of data have significant societal impact. Besides the potential of PGIS to make spatial data more accessible, more use of data input from citizens could also result in a digital divide, in which there is an overrepresentation of data from higher income and/or more popular regions, disadvantaging people form marginalized regions even more. Accumulation of data can even become a power tool, leading to *knowledge politics* regarding geographical information (Elwood, 2010).

Building upon this notion, Radil and Anderson (2019) argue for a more radical, 'post-political' view towards PGIS. They state that, although the main aim of PGIS is to enhance the possibilities for marginalized people to influence policy processes and therefore reduce the 'gaps' in society. However, via these methods one is still operating within the existing power structures that have created these societal inequalities (Radil & Anderson, 2019). To illustrate this argument the authors have used a project in Bronzeville, Chicago as an example. In this project PGIS is used to get community engagement in restoring a lakefront area. The fact that low-income minority populations — overrepresented in Bronzeville — are historically excluded from quality urban green spaces, is named as one of motives of this initiative. However, Bronzeville is a gentrifying neighbourhood, therefore one could argue that participating citizens are, by the means of 'empowerment' and 're-connecting', possibly contributing to their own future displacement. Radil and Anderson acknowledge the often good intentions of PGIS, but question the effectivity of these intentions as long as they operate within the status-quo:

''Even as PGIS aims to disrupt the status-quo by enrolling new voices into existing political-economic power relations, there is often failure to recognize the ways in which such power relations

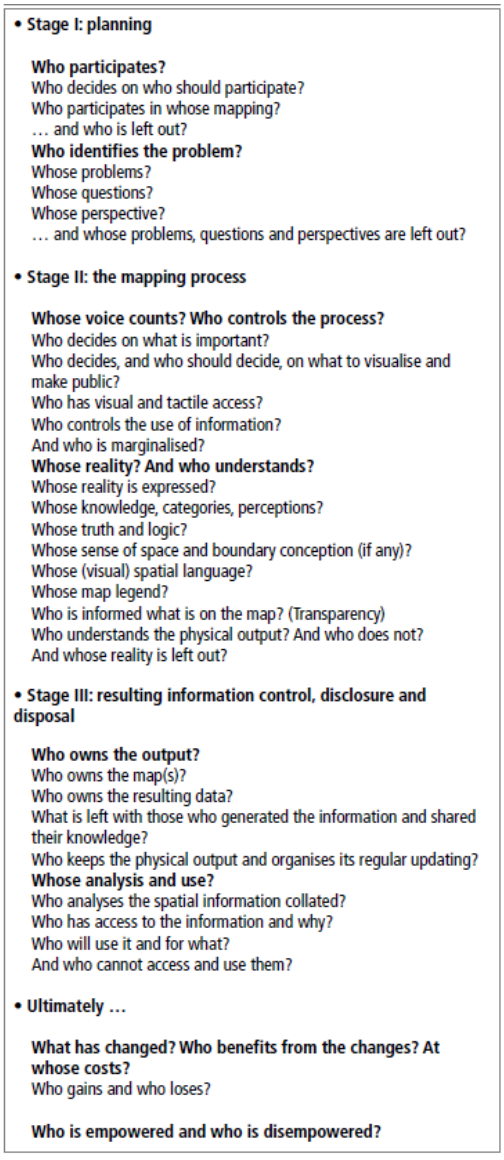


Figure 2.6 The 'Who?' and 'Whose?' Questions (Rambaldi et al., 2006)

might strike at the core of how capitalist political-economic systems function.''(Radil & Anderson, 2019, p. 198)

Abbot et al. (1998) describe a comparable challenge, GIS can turn local knowledge into widely available, public knowledge. Meaning GIS can work *for* the community but also *against* the community, as the geographical data can be subject to power misuse. Building upon this, Rambaldi et al. (2006) have ought to create a guide towards good practice and PGIS ethics, in which the 'Who?' and 'Whose?' questions (Figure 2.5) are the building blocks to *good practice.* Although many considerations are mainly applicable to situations in which the researcher comes from a different cultural background as the research subjects, considering these questions can be essential to be able to conduct PGIS research in an ethical manner.

2.3 Conceptual Model

In this paragraph the conceptual models of this research are presented. Due to the fact that this research entails two main goals, this research has also created two models that further illustrate this research.

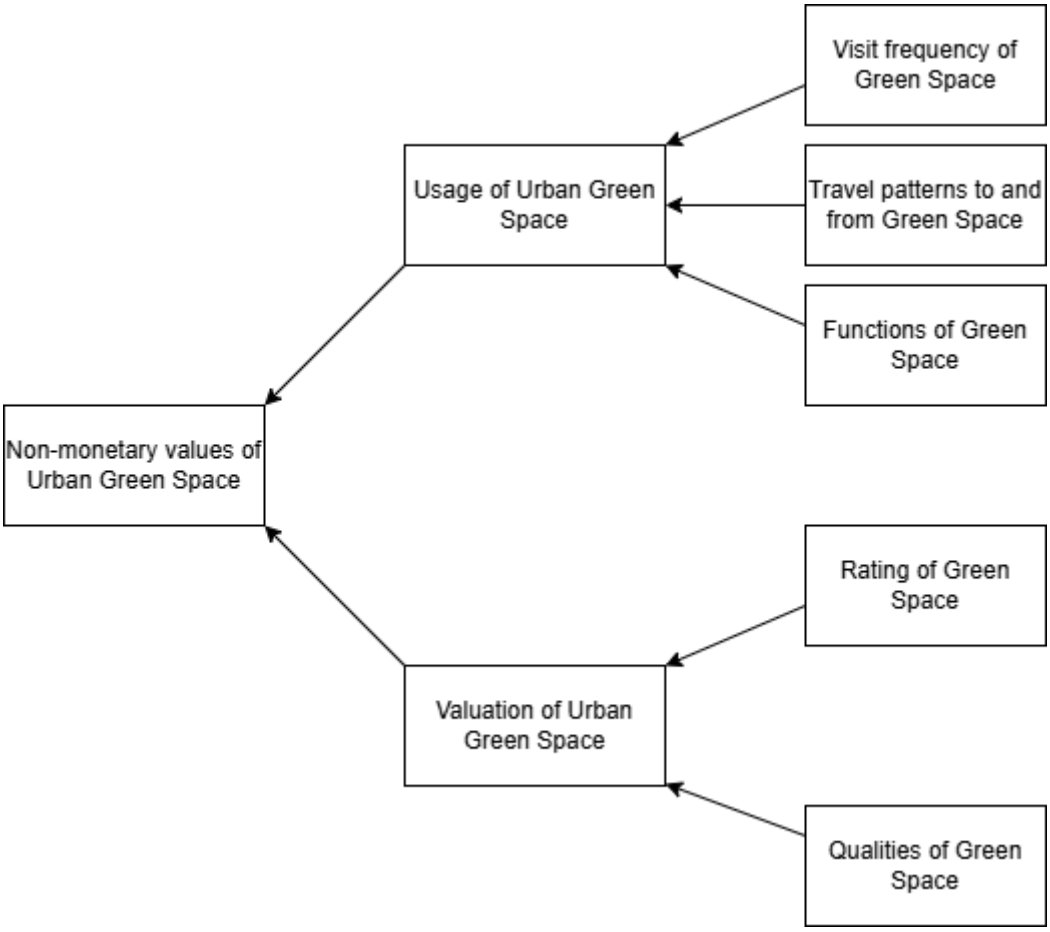


Figure 2.7 Conceptual model of the non-monetary values of UGS

The first model visualised in figure 2.7 represents how non-monetary values of Urban green space are yielded. This research splits the non-monetary values up into two main categories: the usage of urban green space and the valuation of urban green space, inspired by the framework created by Tandarić et al (2020) and Koh et al (2022) (Figure 2.3).

The usage of urban green space consists of three realms: The visit frequency of green space, as discussed by Grahn and Stigsdotter (2003). The travel patterns, and the influence of distance on green space usage, as discussed by, among others, Peschardt et al. (2012), and Łaszkiewicz et al. (2022). And lastly the functions of green spaces as discussed in, among others (Koh et al., 2022; Palliwoda & Priess, 2021; Pietrzyk-Kaszyńska et al., 2017; Rall et al., 2019).

The valuation of green space can be subdivided into two main categories: The first category regards how green spaces are valued, which is pretty straightforward, and discussed in many previous studies, under which Misiune et al., (2021). The second category regards the qualities of green space. This entails the valuable characteristics of a green location, connected to the concept of cultural ecosystem services, as discussed by Tandarić et al. (2020). The concept of green space qualities is further discussed and applied by Ives et al. (2017), Koh et al. (2022) and Rall et al. (2019).

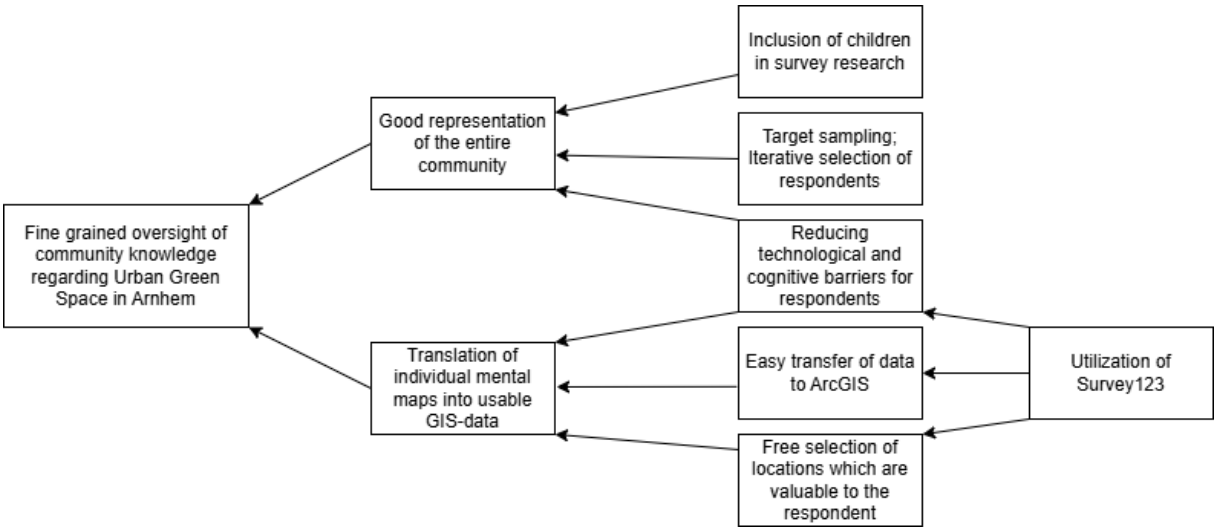


Figure 2.4 Conceptual model of the usage of Survey123 in representative PGIS research

The second conceptual model visualizes the research goal to further explore the usability of Survey123, in order to get a fine grained and representative image of the non-monetary values of green spaces, which is encapsuled in the fourth research question of this research. A fine-grained oversight of the non-monetary values of green space can be achieved by getting both a good representation of respondents, as well as being able to convert these implicit mental maps into usable data.

The goal of participatory research and governance is to involve as much (different) stakeholders as possible, otherwise the added value of participation would be negligible relative to expert knowledge (Radil & Anderson, 2019). Therefore, the researcher should find solutions to be able to reach a as diverse group of respondents as possible. Regarding this research, ways have been found to include children in the research, which are a vital factor in green space usage (Sanesi & Chiarello, 2006). Via the iterative process in which addresses were either targeted or purposely skipped, it was possible to give specific regard to targeting certain demographics which are valuable to this research. In this case houses without a private garden.

Reducing the technological and cognitive barriers to be able to participate in (PGIS) researcher, enhances the general representation of a research, as less people are not able to take part due to insufficient abilities (Brown, 2012). The technological and/or cognitive barriers of PGIS Surveys can also be of influence regarding the ability to convert individual mental maps into usable GIS-data. The (in)ability of respondents to be able to correctly convert their thoughts and opinions into answers that fit the survey has a major impact on the degree in which the data correctly represents the community knowledge (Rall et al. 2019). As people have a very personal portfolio of places they visit and value, they are not able to reflect on each green space in their vicinity but carry a lot of knowledge regarding the places that are valuable to them (Bijker & Sijtsma, 2017). Therefore, a free selection of locations to map and ask questions about, contributes to a creating a fine grained oversight of the community knowledge regarding UGS. Lastly, this research will examine the degree to which Survey123 is able to create data which can be sufficiently used by the researcher to be able to conduct analyses and create maps representing the non-monetary values of green spaces.

3. Methodology

3.1 Research Design

In this chapter, the methods of research will be elaborated. The design of this research will be fitted according to the main research question: *"What are the perceived non-monetary values of urban green space in Arnhem, as mapped by residents using Survey123, a new mapping & survey instrument in ArcGIS that is enabling new ways of conducting PGIS research?".*

The main goal of this research is to contribute to the enhancement of PGIS methods that can be applied to urban green space planning projects. The utilization of community knowledge is the main foundation of this research. The design of this research is therefore not only focused on analyzing current practice, taking action by participating in the process is vital part of this research. Therefore, this research can best be described as 'Participatory action research'. In participatory action research the participants are to a certain extent co-researchers, their input is of core value for the research process (Kindon et al., 2007). The usage of Participatory GIS can be seen as a prime example of participatory action research, as the (geographic) analysis is primarily based on data gathered by the local community.

This research consists of two large components; (I) a literature study in which the ethical considerations and implications of PGIS will be analyzed and discussed, in particular in the context of urban green space planning, and (II) Participatory Action Research in which the recommendations of the literature study are incorporated and applied on the case of Arnhem via a PGIS survey. The first research component consists of one phase, while the second research component has been divided into two phases, as the assessment of the maps can only take place if the data collection and the map making process has been finished.

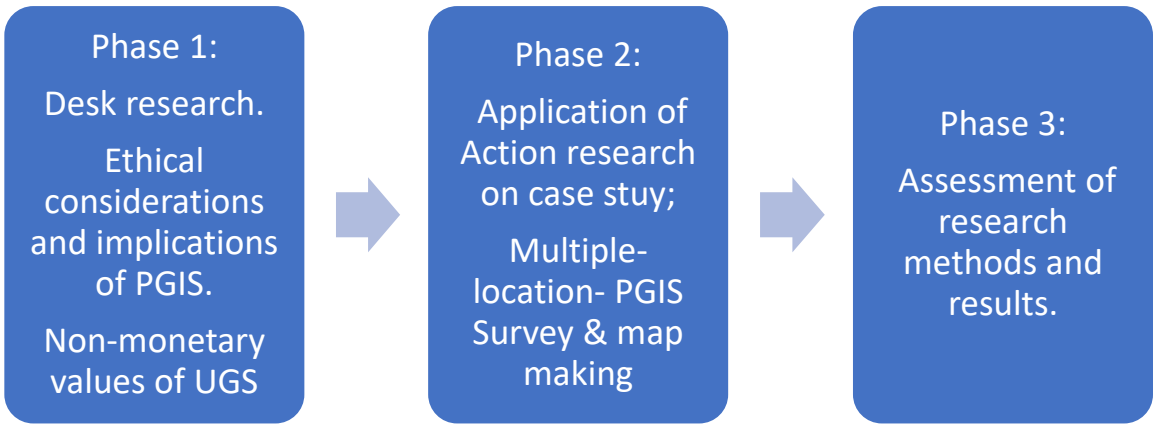


Figure 3.1 Phases of research

In the first phase, an extensive assessment of existing literature regarding the topic of PGIS, and its ethical implications will be conducted, resulting in an oversight of the current shortcomings of participatory mapping methods in UGS planning. In the second research phase, the multiple-location-PGIS survey will be conducted; resulting in the creation of multiple maps and other data projections. In the third phase, in order to evaluate the successfulness of the chosen approach, the results of the survey and especially the created maps will be discussed and assessed.

Phase one

To be able to answer the sub questions, an extensive overview of literature regarding UGS planning and PGIS ethics needs to be acquired. This includes fundamental works regarding (critical) GIS, participatory planning approaches and community representation, for instance (Abbot et al., 1998; Elwood, 2010), but also needs to include more recent work delving into contemporary debates and practical implication regarding PGIS and UGC planning, in which the work of Radil & Anderson (2019) is a good example. On top of that, in order for this research to build further upon the existing knowledge regarding the non-monetary values of UGS, a strong theoretical foundation of this field needs to be acquired.

Phase two

In the second phase of the research, the emphasis has been laid on the creation and application of a PGIS survey. The survey is an appropriate tool to acquire a larger number of data, which can be statistically tested. Meaning that this method of data gathering connects well to the quantitative nature of GIS (van Thiel, 2014). The survey has been created using ArcGIS's software Survey123. Survey123 is a web-based tool, which allows users to include geodata in their survey, which can immediately be used to analyse using ArcGIS Pro. Survey123 offers distinct options regarding the type of questions and answers. Using the Survey 123 tool of ArcGIS Pro, the input of respondents regarding the preferences, appreciation and usage of green space can be directly linked to a geographical location. This phase will follow a comparable research setup to the work of Rall et al. (2019), which uses the software 'Maptionnaire' instead of Survey123, however both systems can be utilized for the same purposes. In combination with non-geographic question, regarding one's personal situation, age, gender, education etc., the degree in which these findings are representative for the whole community can be tested.

During the survey, respondents will be asked to locate as much green space locations in and around their neighbourhoods as they want. Questions regarding the use, value, appreciation and future preferences of these locations will be asked. Resulting in a comprehensive amount of data regarding the Green Space use and appreciation of the inhabitants of Arnhem. Respondents are deliberately asked about their general green space use, and not only about their own neighbourhood or direct surroundings. As the influence of spatial factors, such as distance, can be analysed more thoroughly this way. The results of the data collection will be incorporated into multiple maps, visualizing how green space is used, what (cultural) ecosystem services are provided, how these green spaces are valued etc.

In the second phase of this research, two hypotheses will be additionally tested. Chapter 2 provides us with two striking standouts regarding urban green space experiences, the contradictory role of smaller green spaces in the urban environment, in which different research papers provided different outcomes (Schipperijn, Stigsdotter et al., 2010, Rey Gonzalo, Barrigón Morillas et al., 2019), and the influence of accessibility to a private garden has on the usage of (public) urban green space, in which people without accessibility to private gardens seem to use urban green space less, while one would expect this relation to be the other way around (Barbosa, Tratalos et al. 2007). Therefore, two hypotheses have been formulated in order to test these relationships on a deeper level:

H0: Scattered green is not used and experienced differently than larger urban green spaces.

H1: Scattered green is used and experienced differently than larger urban green spaces.

And.

H0: People without a private garden do not use and valuate UGS differently than people with a private garden.

H1: People without a private garden use and valuate UGS differently than people with a private garden.

These two hypotheses are not directly subject to one of the three sub-questions but rather connect to all of them, and therefore the main research question, as it tackles the usage as well as the valuation of green spaces, and further explores to which extent Survey123 can deliver data usable for hard statistical analysis.

Phase three

The third phase of the research, simultaneously the fourth sub-question is primarily focussed on assessing the created maps, and the research method in general. Especially the usage of Survey123 in this context will be of vast importance, as this is a relatively new method in the academic context. The usability of the results Survey123 has provided is not the only factor that will be assessed, the entirety of the process from the creation of the survey, data gathering as well as the transfer of data will be discussed.

3.2 Data collection

3.2.1 Study Area & Target sampling

This research has been conducted in the Dutch city of Arnhem, with particular focus on the Malburgen neighbourhood. In order to put the findings from Malburgen in a broader context, and to benefit the reliability of this research, two other neighbourhoods have included in this research: de Geitenkamp and Klarendal. The exact research area has been tracked during the process of distributing survey invites, illustrated in figure 3.2. Ultimately the selection of neighbourhoods has been made on the basis of certain statistics (Average income, house prices, demographics), as well as other, non-quantitative factors such as type of housing (Size and quantity of private garden) and its relative location to the other neighbourhoods. Resulting in a target study area which predominantly consists of terraced- and high-density housing, in lower income neighbourhoods, spread throughout the city of Arnhem.

Important notion to this process is the fact that initially only Malburgen-Oost Noord[3] and de Geitenkamp were selected. Before distributing the survey, a miscalculation has been made regarding the number of available invites. This meant that more addresses could be targeted than initially accounted for, leading to the inclusion of (parts of) Malburgen-West, Malburgen-Oost Zuid and Klarendal. The search for respondents has been an iterative process, during the distribution of invites certain streets were deliberately included or excluded to ensure a more fitting representation of the goals of this research. For instance, in Malburgen-Oost Noord nearly every house has a private garden. Therefore, in order to be able to make reliable claims regarding the influence of having a private garden on UGS valuation or visit frequency, more addresses without private gardens needed to be selected. Resulting in the choice to include the flats of Immerloo II, part of Malburgen-Oost Zuid. Respondents were approached via a flyer in their mailbox, composing of a small elaboration of the research and a QR-code/link to the survey (figure 3.3).

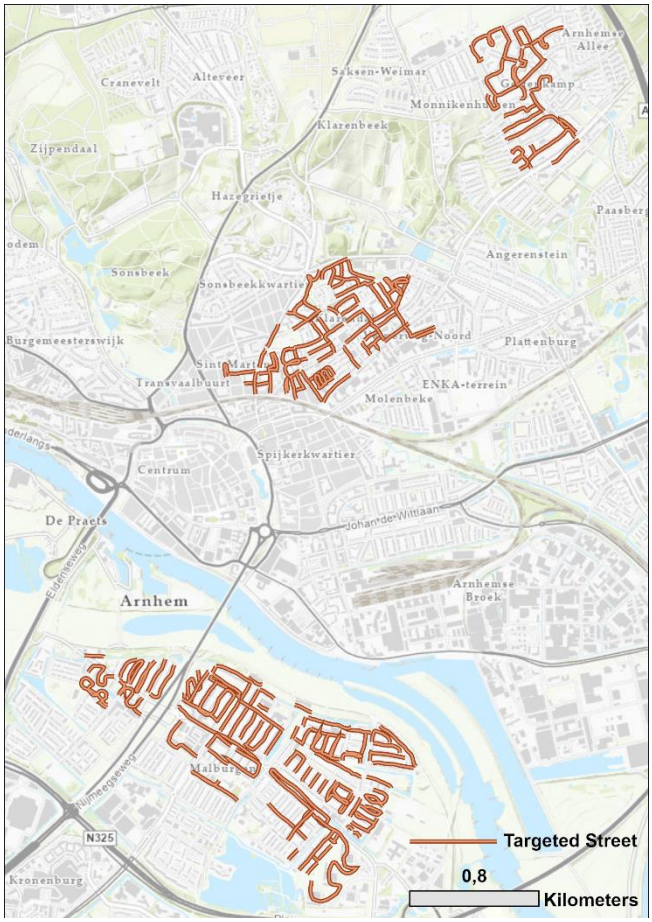


Figure 3.2 Streets targeted in this research

[3] Malburgen-Oost Noord and Malburgen-Oost Zuid are two different districts. As their names are quite similar, this can lead to confusion.

Figure 3.3 The invite respondents received in their mailbox

The choice to approach respondents via their mailbox was made in order to ensure the geographical delineation of the study area – assuming the survey has been completed by the resident of the targeted house – and to accommodate respondents, by giving them the opportunity to fill out the survey in their own time, in their own pace. On top of that, this process has benefited the iterative nature of selecting addresses, as the invites have been distributed in person, the choice whether to include a certain street or not could be made could be made during distribution. In total approximately six thousand invites have been distributed in six days between the 8th and 18th of July 2023. Addresses which clearly did not have a residential function, and mailboxes which stated that unaddressed mail was unwelcomed were skipped.

3.2.2 Questionnaire

In order to be able to create a solid questionnaire, three important steps need to be fulfilled (van Thiel, 2014, p. 77):

- Choose the right variables and operationalize these.
- Carefully formulate the questionnaire items.
- Put the items in an order that makes sense, with a clear layout.

The selection and operationalization of variables are derived from the theoretical framework. This chapter has provided various insights into how PGIS research can best be utilized, and which topics regarding UGS usage and preferences need further research. In essence, this questionnaire consists of two types of questions: questions regarding the use and appreciation of green space and questions regarding one's personal situation. In which the latter is mainly of importance in order to put these answers in perspective, making claims about the sampling and, and to be able to reflect on the representativeness of the research.

Effective formulation of survey questions is of key importance for the validity of the research, as it ensures that every respondent correctly comprehends the question. Van Thiel has mentioned a couple of criteria to which survey questions should adhere (2014, pp. 78,79):

- Unambiguous formulation: it should be clear to everyone right away what is meant with the question.
- No leading questions or statements that can steer respondents towards a certain direction.

- As less variation in answer categories as possible; to prevent confusion, discouragement or annoyance.
- Answer categories should be exhaustive, and mutually exclusive.

This research aims to be as compact as possible, without overgeneralizing answer categories, so that less people will quit midway, as this research stems from the viewpoint that a more compact manageable survey will lead to less non-response. At the same time enough data needs to be gathered in order to execute fine-grained research.

Furthermore, a questionnaire should aways have an introductory paragraph at the beginning of the survey, in which the aim of the study, certain instructions for the survey and privacy implications are elaborated (van Thiel, 2014). In this case, each section of the survey also has an introductory section, including specific instructions - especially for the mapping questions - and a small elaboration why certain questions are asked, for instance regarding certain personal information that is used as a control variable.

3.2.3 Survey questions

This paragraph will present the exact questions used in the survey of this research. As the study-area is in the Netherlands, the survey has been conducted in Dutch. In order for this paragraph to be as readable as possible, the questions are therefore translated into English. The survey questions are presented using the following structure:

1. Personal characteristics of respondent: Housing questions and control variables
2. Mapping important green spaces
3. Mapping important green spaces of children
4. Evaluation of Survey

Figure 3.4 Screenshot of the survey

Important notion is that in the actual order of questions is slightly different to how it is presented in this chapter. In this chapter, to enhance readability, the questions are presented in the most logical and coherent sequence, while in the actual survey questions of different subsections were mixed. This choice has been made to let respondents start with the 'fun' mapping part of survey as early as possible, in order to prevent respondents being overwhelmed directly by the number of questions regarding their persona and living situation, this way we believe we have lowered the non-response of the survey.

Personal characteristics of respondent

The first section contains questions regarding one's demographical data; Age, gender, educational level etc., and one's living situation; Zip-code, private garden and kids. This section consists of eight questions, four of which are centred towards the demographics, two regarding the housing situation, and two regarding children.

1. **How do you identify yourself? (Gender)** Respondents were asked to state if they identified as female, male or neither of these two options. This question is mainly asked as a control variable, in order to test when ether in this research respondents were equally

distributed regarding gender. As well as to be able to test differences in UGS use and valuation between male and female respondents.[4]

2. **What is your age?** Respondents were asked to fill in their age in years. As well as gender, this question mainly acts as a control variable.
3. **Do you have an immigrant background?** Respondents were asked to state if they had an immigrant background, this means that either they, or one of their parents were not born in the Netherlands. As people of minority ethnicities are often underrepresented in (participative) research, and this research seeks to find out to which extent Survey123 can be a usable tool to get good representation in PGIS research, it is valuable to know to which extent people from immigration backgrounds are included in this research.
4. **What is your highest obtained degree?** Respondents were asked to state their highest finished education-level. In order to get good representation in research, it is of vast importance to be able to research respondents from all socio-economic backgrounds. As questions regarding one's wealth or salary are deemed too private by a lot of people, question regarding this parameter can possibly lead to higher non-response. In order to still test the representation of different socio-economic groups, this question regarding education-level was included.
5. **What is your Zip-code?** Respondents were asked to fill in their (PC6) Zip-code. Information regarding the location of residence of the respondents can be of great value, as this makes it possible to make claims regarding the geographical distribution of respondents, as well as perform tests regarding the travel distance to green spaces, which previous research has shown to be a topic in need of further research (Łaszkiewicz et al., 2022) (Peschardt, Schipperijn et al. 2012). The zip-code (PC6) is a fitting way to receive somewhat precise data regarding where someone lives, thus being able to conduct spatial analysis, while still preserving the anonymous nature of the survey.
6. **Do you have a private garden yourself?** As previous research has shown contradicting, or in any case remarkable outcomes regarding the influence of accessibility to private gardens and public green space usage (Misune et al, 2021, Schipperlijn, Stigsdotter, et al., 2010). Therefore, this research seeks to get insights into how people without accessibility to private gardens experience green space in comparison to people with access to a private garden. Resulting in this question, which respondents are only able to answer with yes or no. As stated in chapter 2, the relationship between having a private garden and visiting UGS has been analysed before (Schipperijn, Stigsdotter, et al., 2010),
7. **Do you have children living at home?** This research seeks to get insights into the experience of urban green space by children, however as interviewing children involves practical as well as ethical challenges and considerations, we have chosen to ask adults to fill out questions on behalf of their children. As not all respondents are parents, we have firstly asked if they have children living at home. If so, new questions pop up regarding their children. If not, these questions do not pop-up.
8. **[If applicable] Which age-categories do your children allocat?** This question only pops up if people have answered question 7 with yes. People were asked to select one or more age-categories in which they have children. These categories are: 0-3yo, 4-8yo, 9-12yo and 13+. As one would expect vast differences between children of different ages in how they use and valuate green spaces, differentiation between these age categories is important.

[4] The group of respondents who did not identify as either male or female was most likely to be too small to be able to compare the results to the groups of male and female respondents.

Mapping important green spaces.

The second part of the survey forms the main body of the survey, in this part respondents are asked to select a green location on the map, and answer questions regarding this location. This section is a so called 'repeat', this means that by pressing the + button, people can repeat this part as often as they want. Each question therefore refers solely to the respective mapped location, respondents can therefore answer the same question multiple times and give different answers, as each 'repeat' is processed as a different data-point.

9. **Draw a green location on the map which is important to you.** Respondents are asked to use the mapping tool; the following questions are all regarding this mapped location. In previous research, similar types of mapping questions have been used (Koh et al., 2022; Rall et al., 2019). As discussed by Brown (2012), mapping own experiences, values, activities and preferences requires a relatively low expert knowledge and is a low cognitive challenge. Respondents are asked to map places that are 'important' to them. Therefore, respondents are able decide for themselves what they deem to be important, which prevents possible misunderstandings a more direct question would create.
10. **How often do you visit this location?** This question regards the visits frequency of the respective green space. The frequency to which a green space is visited is a telling factor to how green spaces are used, locations visited daily have a different role in one's life as a location only visited a couple of times per year, but can be deemed equally as important (Schipperijn, Ekholm, et al., 2010). Respondents were asked to select one of the five options; Daily, a couple of times per week, - month, -year or seldom visits. These options are comparable, but more compact to the questionnaire Koh et al. used (2022).
11. **For which reasons do you visit this location?** In this question respondents are asked to name the functions of their mapped location. Respondents could select one or multiple functions of their mapped location. The selection of these functions are formulated in order to create a broad spectrum of functions which include all functions previously identified as important functions of green space, based on multiple different papers which discuss the functions of green spaces (Koh et al., 2022; Palliwoda & Priess, 2021; Pietrzyk-Kaszyńska et al., 2017; Rall et al., 2019).
12. **What do you value regarding this location**? In this question respondents are asked to name the qualities of this green space. This question has been created with a similar strategy and considerations as question 11, again on the basis of various research papers (Misune et al., 2021, Sanesi and Chiarello 2006, Rall et al., 2019, Koh et al., 2022).
13. **I rate this location…**: Respondents were asked to rate their mapped location on a Likert-scale from 1-7. In which one means the location is very bad, and 7 means the location is very good. This question provided insight into how green spaces are rated. This is not only in itself a valuable piece of information, but it also provides more context to other outcomes of this research, as previously used by Koh et al. (2022).
14. **For which activity do you use this location the most**? This is an open question, which therefore allows the researcher to test if certain functions of qualities of green space are overlooked in question 11 and 12. As well as opening up the possibility to get more in-detail insights into specific locations, as respondents can leave more detailed answers regarding how they use this location. Respondents are free to leave this question blank.
15. **Is there something missing in this location? What could better this location?** Besides getting more insight into the detailed characteristics of the respective green space, this question is is included to better understand the dynamics of UGS valuation, improvement suggestions can be very telling regarding what is deemed important by citizens (Rall et al.,

2019). On top of that, offering respondents the option to state their dissatisfaction regarding a location will let them feel more 'heard', and therefore satisfied with the survey, possibly lowering non-response.

[If applicable] Mapping important green spaces of children

The third section contains questions regarding children's use of UGS. This section only pops up if respondents have stated previously that they have children living at home. This section is nearly the same as the second section, also containing a mapping question and the same question regarding this location. However, the answer options are modified in order to better fit the values and uses of children, based on research conducted by Kantar Public on behalf of Jantje Beton, a Dutch NGO focussed on outside playing opportunities for children (Kaal, 2022).

Evaluation of Survey

The last section of this survey includes three questions, which are all centred towards the nature of the survey. As quantitative PGIS methods, especially the usage of Survey123, are still new to the big public. On top of that, as previously discussed, various ethical and practical consideration regarding the use of PGIS in (quantitative) research are prominent (Rambaldi et al., 2006, Brown, 2012).

16. **Statement: It was easy for me to find my locations on the map.** As discussed by Brown (2012), Participatory GIS methods can form cognitive as well as technological barriers for respondents. This question seeks to find out how easy it was for respondents to use the mapping tool of Survey123. Respondents answer this question via a 7-step Likert scale, in which 1 means they completely disagree with the statement, and 7 means they totally agree with the statement.
17. **Statement: It is a good idea to use these types of maps more often in future questionnaires:** This question seeks to find out when ether respondents are satisfied with the concept of PGIS questionnaires. If the answer to question 16 and 17 vastly differ, this could mean that the problems people have with mapping questions are broader than solely the technological or cognitive challenge these questions form. Equal to question 16, respondents answer this question via a 7-step Likert scale, in which 1 means they completely disagree with the statement, and 7 means they totally agree with the statement.
18. **Would you like to make a final comment regarding this questionnaire, or regarding the research in general?** In this question, respondents are given the opportunity to give a final remark about anything they want. This is an open question and offers the opportunity to respondents to reflect on the survey and state their opinion. Besides giving the researcher more detailed insights regarding what respondents actually think regarding the survey, this question also offers the respondents the opportunity to release any thought they want to share with the researcher but have not been able to before. This can result in possible interesting insights and point of views, previously missed by the researcher when creating the survey.

3.3 Validity & Reliability

Regarding the validity of this research, the degree in which the research methods accurately measure the factors it claims to measure, it is of vast importance that the survey questions are formulated in a clear way, especially regarding the construct validity of the research. In this research, the survey questions are focussed upon non-monetary values, the exact definition and perception of these values can differ from person to person. Especially regarding values such as spirituality of cultural significance, perceptions will most likely differ from person to person. Therefore, questions should be asked in a clear manner, and enough response options have been provided in order to be able to discover certain nuances between values. However, an overload of response options could also work counter wise, as respondents possibly get overwhelmed. On top of that, besides being able to categorize a place – which is necessary for the quantitative nature of this research – respondents should be able to leave an optional comment about this place, as these nuances can help to place the research results better in context, an fill possible gaps in the answer options. The aim of this research is not only to receive insights into the non-monetary values of green space, but also to explore the utilization of Survey123 in academic participatory survey research. The survey used in this research is therefore not only a tool to get results, but also a vital part of the research in itself. Together with the fact that representativeness is one of the key components of this research, extensive emphasis has been given to this research's methods. This benefits the content validity of this research.

The earlier emphasis on representation will also benefit the reliability of the research. Of course, perfect representation in quantitative research is close to impossible, however this strong emphasis will in any case enhance the reliability of this research. The significant effort of into viable representation will most likely force us to approach respondents via multiple methods, on different moment in different settings. In the case of UGC appreciation and utilization, time and weather components can play a significant factor (Ives et al., 2017). A possible factor that could harm the reliability of this research is selection bias. Respondents decide themselves which locations they map, and therefore include in this research. This can lead to a situation in which respondents only map locations they like to visit, and skip locations they rate lower. Respondents are not specifically asked to map location which they like, but rather which locations are important to them, however this could still exclude locations respondents to do visit, for varying reasons. When analysing and discussion the outcomes of the study, one should therefore keep in mind that the data may be misleading regarding dissatisfaction of green spaces.

4. Analysis

In this chapter the main findings of this research will be presented. This entails direct results from the survey, as well as tests and deeper analyses of the data. This chapter is subdivided into seven paragraphs.

4.1 Survey response: This paragraph mainly discusses the characteristics of the respondents of this survey, which demographics are overrepresented? Which are underrepresented? Where do respondents live? Which places have low response rates?

4.2 Parks and Green spaces in Arnhem: This paragraph mainly identifies which places have been mapped. Where do respondents go to the most? Which spaces stand out? What places do people go less to?

4.3 Frequency and travel patterns of green space visits: This paragraph discusses the factors of frequency and distance in relation to the respective green spaces. Which green spaces are more often visited? For which spaces people are willing to travel further?

4.4 Functions of urban green space: This paragraph focusses on the utilization of green spaces. For what purposes are green spaces used? How are different green spaces used differently?

4.5 Valuation of green space: This paragraph discusses the rating of green spaces, and for which reasons these spaces are valued. Which green spaces are rated best? Which are rated worst? For which qualities are these green spaces rated?

4.6 Hypotheses testing; Private gardens and scattered green: In this chapter, the hypotheses presented in chapter 3 are tested. This means that this paragraph will mainly focus on finding out the influence of (in)accessibility to private gardens on the experience of green space, and when ether scattered green spaces are experienced differently than larger green spaces.

4.7 Conclusion: The final remarks regarding this chapter will be presented in this paragraph.

4.1 Survey response: Typifying residents of three neighbourhoods

In a time span of 35 days (06-07-23 until 09-08-23), the survey has yielded 197 respondents, resulting in 497 mapped locations. Fifty-two locations are child specific locations, the remaining 445 locations are 'regular' locations (Figure 4.1).

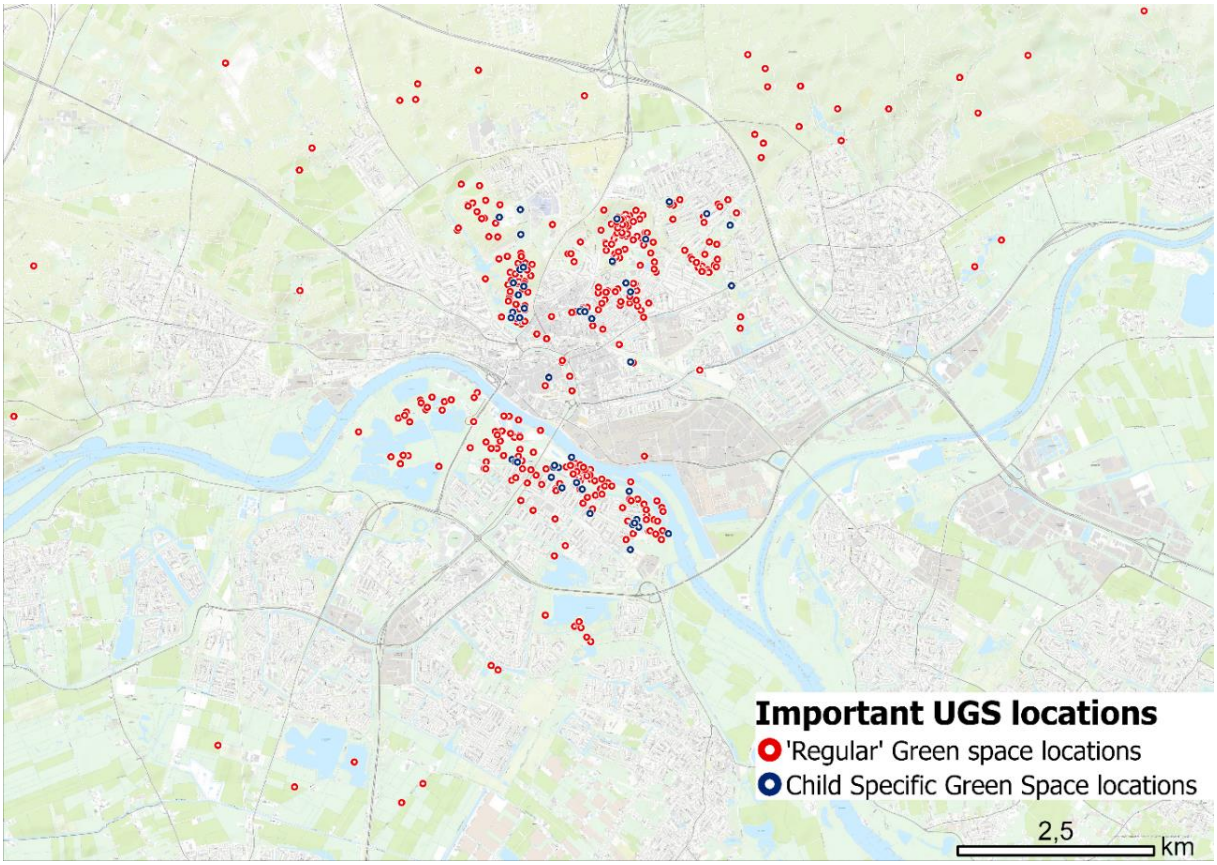


Figure 4.1 Mapped locations in and around Arnhem (above)

A considerable number of mapped green spaces is clustered in two 'belts'; a belt south of the river Rhine, and one north of the city centre (figure 4.1). A majority of the points are mapped inside the urban area of Arnhem. Outside of the urban area of Arnhem, most points are mapped either in the Hoge Veluwe nature reserve, or westwards around Schaarsbergen and Papendal. Deeper analysis of the geographical spread of mapped location will be presented further in paragraph 4.2.

People without a migration background and higher educated people are overrepresented in this dataset, as well as female respondents. Exact data regarding the dispersion of private gardens is not available. However, apartment housing and upstairs apartments (*bovenwoningen*), take up 29,74% of the housing in the study area. As these two types of housing generally cover most of the housing without a garden, one can presume that respondents without a private garden are not underrepresented in this research. An oversight of the background characteristics of this surveys' respondents, and the general characteristics of the study area, is presented in Table 1.1. The latter has been retrieved using the Enrich-tool of ArcGIS and includes all addresses within 300m of the streets captured during the data collection.

Category	Group	Percentage	Mean of study area
Gender	Male	42.64%	
	Female	53.81%	
	Non-conforming/no answer	3.55%	
Age	≤29	11.17%	15.81%*
	30-44	24.37%	35.50%*
	45-64	46.19%	32.14%*
	≥65	15.74%	16.24%*
	No answer	2.23%	
Education	Lower Education	4.56%	39.26%
	Medium Education	23.35%	31.83%
	High education	68.00%	28.89%
	Other/no answer	3.05%	
Ethnicity	Migration background	9.14%	43.20%
	No migration background	87.82%	56.80%
	No answer	3.05%	
Housing situation	Private Garden	63.45%	
	No Private Garden	36.55%	

Table 4.1 Demographic statistics of dataset
**Age of the Head of household*

As well as higher educated- and residents without a migration background, residents aged between 45 and 65 years are vastly overrepresented in this research, while residents under the age of forty-five are underrepresented. It seems that the technological challenge that PGIS surveys can provide have not resulted in the exclusion of elderly respondents, as the age group above 65 years is represented virtually fitting. However, as mentioned, the same cannot be said regarding education level, in which the discrepancy could potentially be explained by the technological or cognitive challenge this survey has provided.

4.1.1 Residence of respondents

Out of the 190 respondents who managed to fill in a valid zip code, seventy-seven reside in Malburgen, eighty-eight in Klarendal and twenty-four in de Geitenkamp. The exact number of addresses targeted in each district has not been counted during the distribution process, as this would be too time consuming. However, during the distribution process, in order to maintain oversight and to make sure no street was targeted twice, every street targeted has been drawn in another Survey123 file. By using the 'enrich' tool in ArcGIS, an estimate of the number of households targeted in each district, and therefore an estimated response rate, could be calculated (Table 4.2). This estimate is based on the assumption that each district had a same proportion of households that were unable to reach (NEE/NEE sticker, inaccessible postal box etc.). Table 4.2 shows us that the response rate in Klarendal and de Geitenkamp is comparable, while Malburgen falls short in comparison to the other districts.

District	Respondents	Est. Targeted Households	Est. Response Rate
Malburgen	77	2740	2.81%
Klarendal	88	2391	3.69%
Geitenkamp	24	868	3.62%
Total	197	6000	3.28%

Table 4.2 Respondents and response rate per Neighbourhood

Figure 4.3 shows the spread of respondent in Arnhem. This figure also shows that respondents are most clustered together in Klarendal in the northern- and northeastern parts of the neighbourhood, around the Vijverlaan, in the Geitenkamp most respondents live in the southwestern corner of the neighbourhood. In Malburgen a lot of respondents reside in the northern part between the Veerpolderstraat and the Graslaan, as well as in the northeastern part of Malburgen, around the Fanny Blankers-Koenstraat. The areas in Klarendal and de Geitenkamp consist mainly of smaller terraced housing built in the 1920s and 30s, which usually come with only a small private garden or none at all. The area between the Veerpolderstraat and the Graslaan consists of terraced housing, and small apartment blocks, built around the 1950s and 60s. The area around the Fanny Blankers-Koen consists of larger Vinex-style terraced housing, built after two thousand, which in general all have some degree of private garden (Figure 4.2).

Figure 4.2 Impression of four locations in which a relatively large number of respondents reside (Klarendal top left, Geitenkamp top right, bottom left Veerpolderstraat (Malburgen), bottom right Fanny Blankers-Koenstraat (Malburgen))

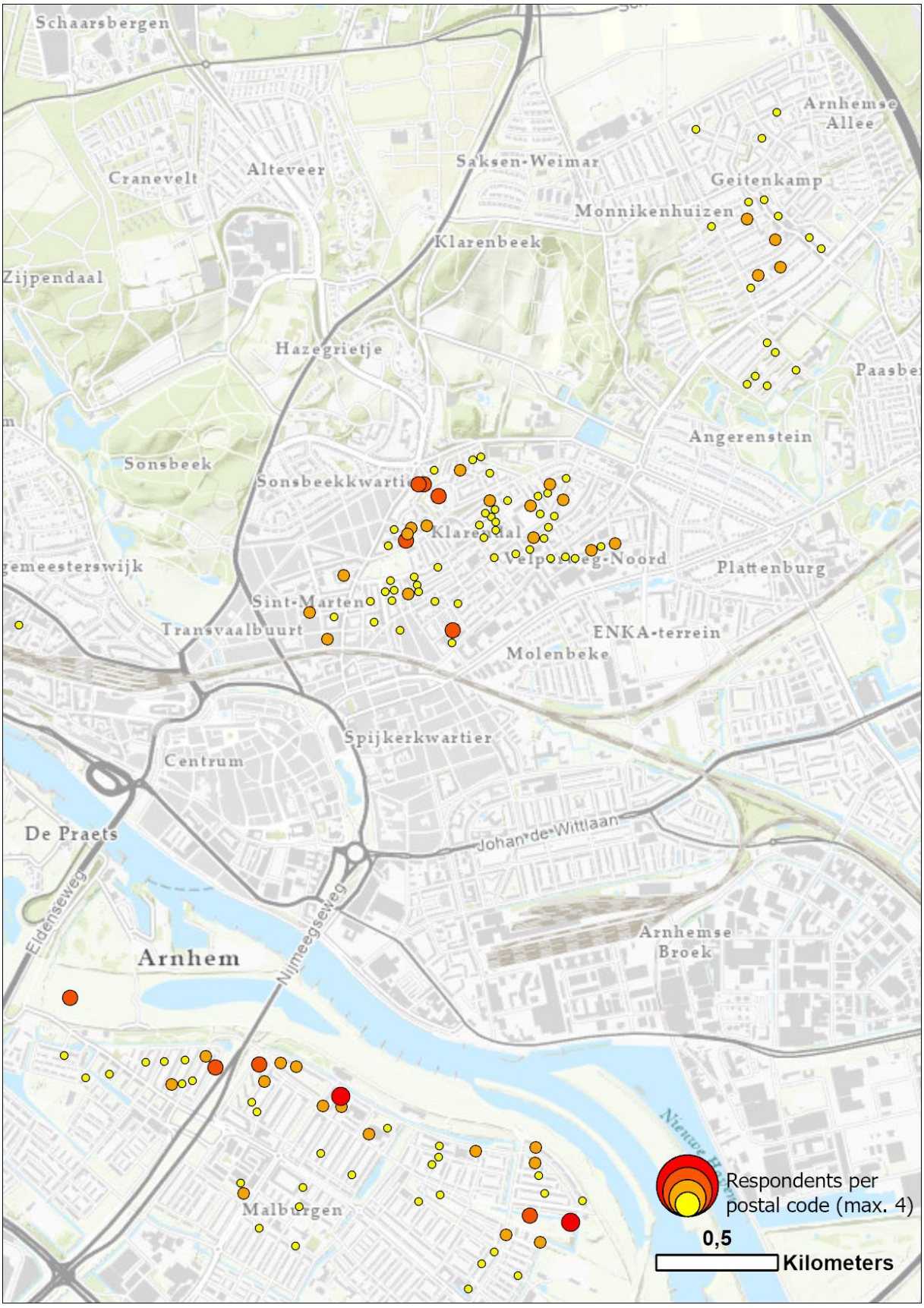


Figure 4.3 Spread of respondents per zip-code.

Insufficient representation

Besides focussing on where the most respondents are clustered, the question in which areas non-response is more prevalent is perhaps even more interesting. Most striking is the face that not a single respondent residing in one of the Immerloo II flats has been registered, despite the fact that all addresses in Immerloo II have been targeted. Immerloo II is deemed as one of the poorest and deprived neighbourhoods in the Netherlands, the neighbourhood consists solely of small flats in large buildings pictured in figure 4.4. As none of the residents have access to a private garden, but do live next to two large urban green spaces (Eimersweide and Immerlooplas), residents of these flats could have provided very useful and interesting insights to this research, as their living situation, as well as their demographical characteristics differ vastly from most of this surveys' respondents.

Besides the abstinence of respondents from Immerloo II, the residence of respondents seems to be spread somewhat equally across the study area. As the flats of Immerloo II count for at least five hundred targeted households, this would also explain the lower response rate for Malburgen in comparison to the other two neighbourhoods.

Figure 4.4 The flats of Immerloo II

Concluding remarks about representativeness of the residents in the survey

The response of this survey can be interpreted in two ways. Considering the fact that the barrier to not comply with the research is very low, respondents were not approached personally, rather solely via an invite in their postal box, our survey has managed to achieve a respectable response rate of around 3.3%. One of the goals of this survey was to include a large number of respondents without accessibility to a private garden, as the data suggest that the number respondents without a private garden is higher than the average of the neighbourhood, we can conclude that this goal has been achieved. On top of that, we notice that we do in fact include people with a migration background and/or a lower education, although their number is small and their percentage is only 9.14% and 4.56 % of respondents, while the neighbourhoods average is a way bigger portion of the population. We conclude that it is possible with this tool and method to reach out to people that are usually hard to include in research, the people with a lower education grade and the elderly, although the method still is not a panacea.

4.2 Parks and green spaces used in Arnhem

In order to be able to make claims regarding the use of urban green space, these spaces need to be identified. By isolating all green spaces in which five or more locations were mapped, a total of sixteen green spaces could be identified (table 4.3). Three of these green spaces include more than fifty mapped locations: Park Klarenbeek, Park Sonsbeek and the Uiterwaard Groene Rivier. The 'Big three' in Arnhem are all large green spaces located close to both the city centre as one or two of the targeted neighbourhoods. Smaller green spaces that stand out are Stadswallen Malburgen-Oost (29 mapped points), Veerpolderstraat (18 points) and Onder de Linden (15 points) (figure 4.6). Two green spaces are outside of the Arnhem's urban Area, Hoge Veluwe and Schaarsbergen. Out of the green spaces inside of the urban area, only Sonsbeek, Zypendaal and de Braamberg are not (partially) inside, or bordering one of the three neighbourhoods subject to this research (Malburgen, Klarendal & de Geitenkamp) (figure 4.5). The respective green spaces are of various sizes and characteristics. Ranging from Onder de Linden, a neighbourhood playing field of approximately four hectares, to the green spaces in the Rhine floodplain which, although located within the urban area of Arnhem, consists of unspoilt nature, and has a combined area of more than 350 hectares.

Green space	Points mapped
Uiterwaard Groene Rivier	71
Park Klarenbeek	64
Park Sonsbeek	61
Hoge Veluwe	33
Stadswallen Malburgen Oost	29
Meinerswijk	24
Park Angerenstein	23
Veerpolderstraat	18
Onder de Linden	15
Park Zypendaal	15
Malburgse Bandijk west	10
Park Burgemeester Bloemersweg	10
Park Immerloo	8
Landgoed Schaarbergen zuid	6
De Braamberg	6
Groen Weide	5

Table 4.3 All green spaces which include five or more mapped locations

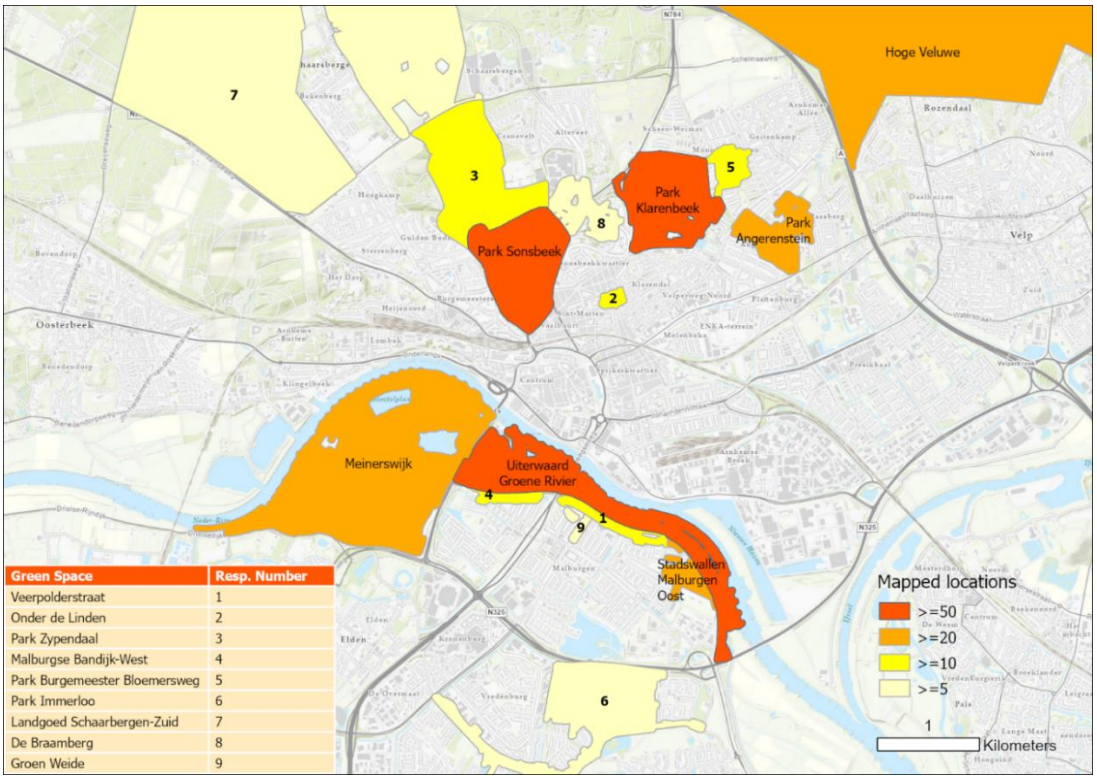


Figure 4.5 Green spaces in Arnhem in which five or more points were mapped.

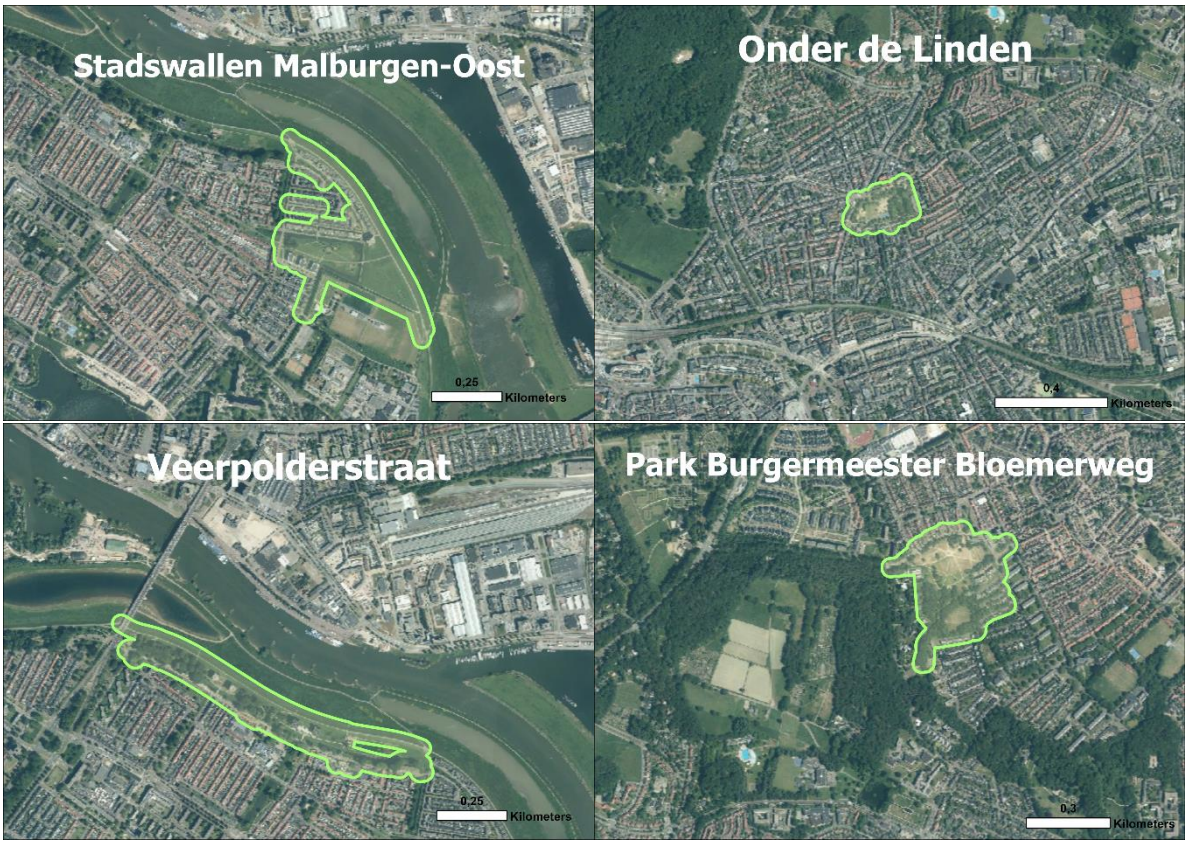


Figure 4.6 Satellite images of several smaller greenspaces

Clustering

Using ArcGIS' Density Based Clustering (DBC) tool, five main data clusters could be identified (Figure 4.7), in which three clusters clearly represent a large park (Sonsbeek, Klarenbeek and Angerenstein), and two clusters are a bundle of multiple green spaces in a neighbourhood (Klarendal and Malburgen).

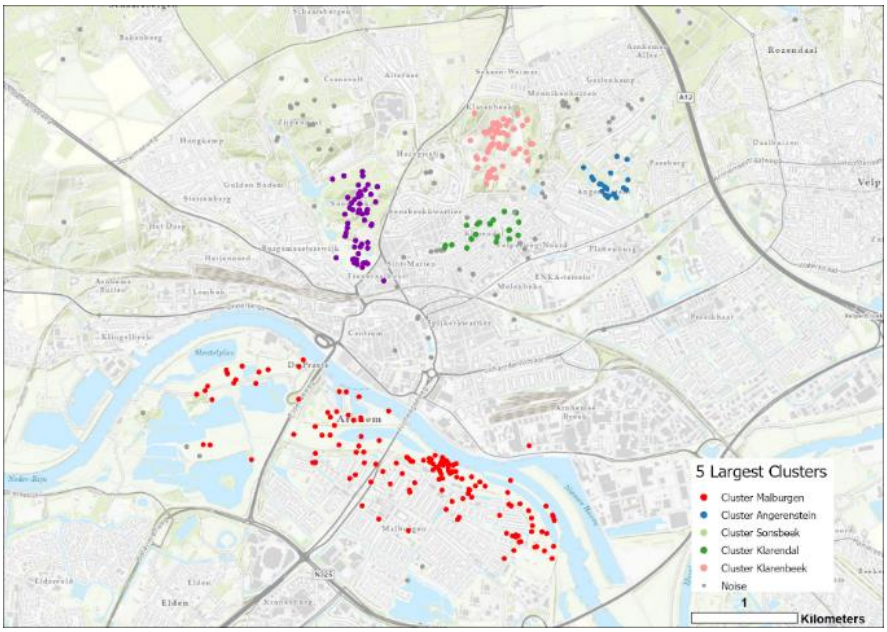


Figure 4.7 Density Based Clustering of UGS locations (Left: ≥15 features per cluster, Right ≥5 features per cluster)

Use of UGS by children

As mentioned before, an option to map locations specifically for children has been built in the survey. Respondents were given the option to map locations which were important to their children, or they would go to with their children. A total of fifty-two locations have been mapped, by forty unique respondents (figure 4.8). Considering this number of respondents, it can be hard to draw conclusive findings on the basis of this dataset. However, this map does paint a different picture than figure 4.1, consisting of all mapped points in the complete dataset. Besides a lot of points being clustered in park Sonsbeek and south of the river Rhine. Other locations within Klarendal and Malburgen, in which mapped locations are clumped arise, these locations are the petting zoo *"Onder de Linden"* and multiple playgrounds. In general, de child specific locations seem to be more often smaller greenspaces within neighbourhoods, suitable to play close to home, instead of larger green spaces further away from home (with the exception of park Sonsbeek).

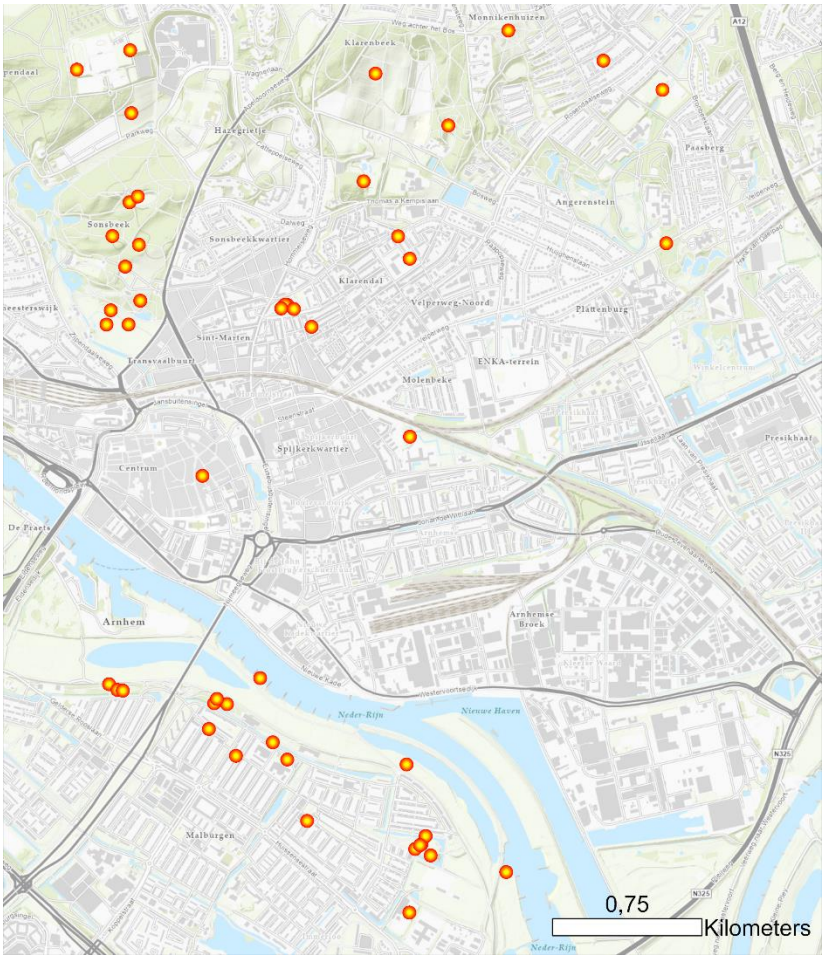


Figure 4.8 Locations valuable to the children of respondents

Concluding remarks about parks and green spaces used in Arnhem.

Our research has shown that an extensive number of mapped points are clustered in a few green spaces, the three green spaces that immediately stand out are Sonsbeek, Klarenbeek and the Uiterwaard, each receiving more than sixty mapped points. Also, in smaller green spaces a relatively high number of points were mapped, for instance in Stadswallen Malburgen-Oost and Onder de Linden. In comparison to the whole dataset, locations which were especially valuable to children were more often smaller green spaces within neighbourhoods with less natural characteristics.

4.3 Frequency and travel patterns of UGS visits

In this paragraph all results discussing and illustrating the dynamics of visit frequency are discussed. Different green spaces are used in different ways; therefore, it is of great significance to look deeper into how often greens spaces are used, and the influence of distance in this manner.

	Uiterwaard		Sonsbeek		Klarenbeek		Scattergreen		Complete Dataset	
Visit Frequency	Amount	Share	Amount	Share	Amount	Share	Amount	Share	Amount	Share
Daily	20	29%	1	2%	14	23%	24	21%	88	18%
A couple of times per week	24	35%	9	17%	22	36%	19	17%	113	23%
A couple of times per month	17	25%	15	29%	15	25%	25	22%	136	27%
A couple of times per year	4	6%	14	27%	5	8%	19	17%	77	15%
(Almost) never	0	0%	0	0%	0	0%	1	1%	4	1%

Table 4.4 Visit Frequency Across the dataset

Table 4.4 shows the distribution of visit frequency in the whole dataset, the 'Big Three' green spaces and the collection of scattered green. The colours in this table, are meant to be read horizontally and visualize how a location scores relative to the other green spaces, and the general dataset. A dark green colour represents an above-average percentage, a dark red colour represents a below-average percentage. The colour yellow indicates that the share of mapped points in around average.

Generally, respondents visit their mapped greenspace at least a couple of times per month, as these three categories count for 68% of the dataset. However, vast differences can be found between green spaces. In both the Uiterwaard and Klarenbeek, the share of mapped locations which are visited only a couple of times per year or less is far lower than in other Sonsbeek, while Sonsbeek is visited daily by almost no one. The collective of scatter green does not point a significantly different picture than the complete dataset.

Visit Factor

In order to provide oversight and keep the maps as clean as possible, the names of each green space are not mentioned in every map made in this paragraph. Figure 4.5 provides an oversight of all relevant green spaces (with names) and all mapped points in this dataset, which can be used as a reference tool.

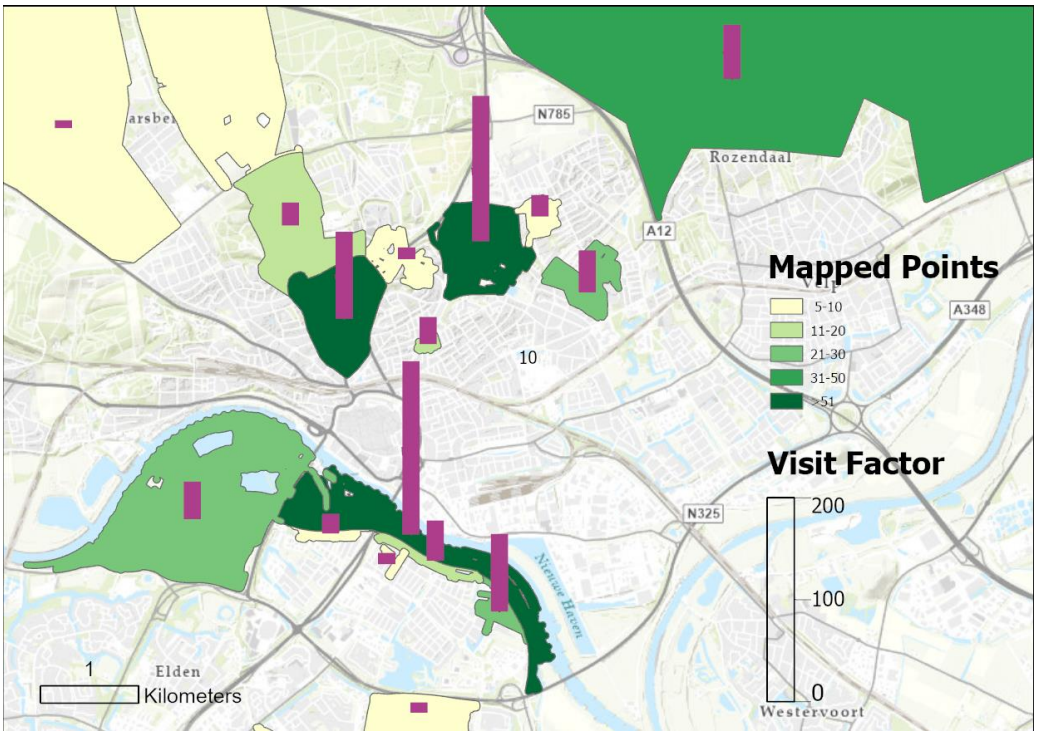


*Figure 4.9 All greenspace with more than five mapped points and its visit factor (Mapped points * Visit score)*

Figure 4.9 illustrates an oversight of all relevant green spaces and its '*Visit factor'.* Respondents were asked to provide per green space how often they visit each green space (daily; multiple times per week; - per month; - per year; almost never), each answer has been awarded a score (Daily = 5; Almost never = 1). For each green space the mean visit score has been multiplied by the number of locations mapped, resulting in a 'Visit factor'. This factor in itself does not mean much; however, it does provide insights in what way green spaces are used. Meinerswijk and the Hoge Veluwe are for instance green spaces in which a lot of points are mapped, but do not have a high visit factor. Meaning that these locations are visited by a lot of different people, but not that often, while for instance the Stadswallen Malburgen-Oost and Park Burgermeester Bloemerswijk have a relatively high visit factor for the number of mapped locations, which implies that this park is not necessary for the big public, but everyone that does come to this place visit this place quite often. Figure 4.8 also shows an interesting difference between the 'Big 3', Sonsbeek, Klarenbeek and the Uiterwaard. In which the Uiterwaard, and to a lesser extent Klarenbeek, have a much higher Visit factor than park Sonsbeek. The Uiterwaard and Klarenbeek can best describe as natural spaces within the city, which are more often used for activities such as walking and experiencing nature. Sonsbeek on the other hand can best be describes as a classic urban park, perfect for social activities and playing sports. Figure 4.9 could suggest that locations with these functions tend to be visited less often, while more natural spaces are more often visited. Perhaps these locations are visited more routine-wise, for instance by walking the dog, or as part of one's running route.

Weekly visits

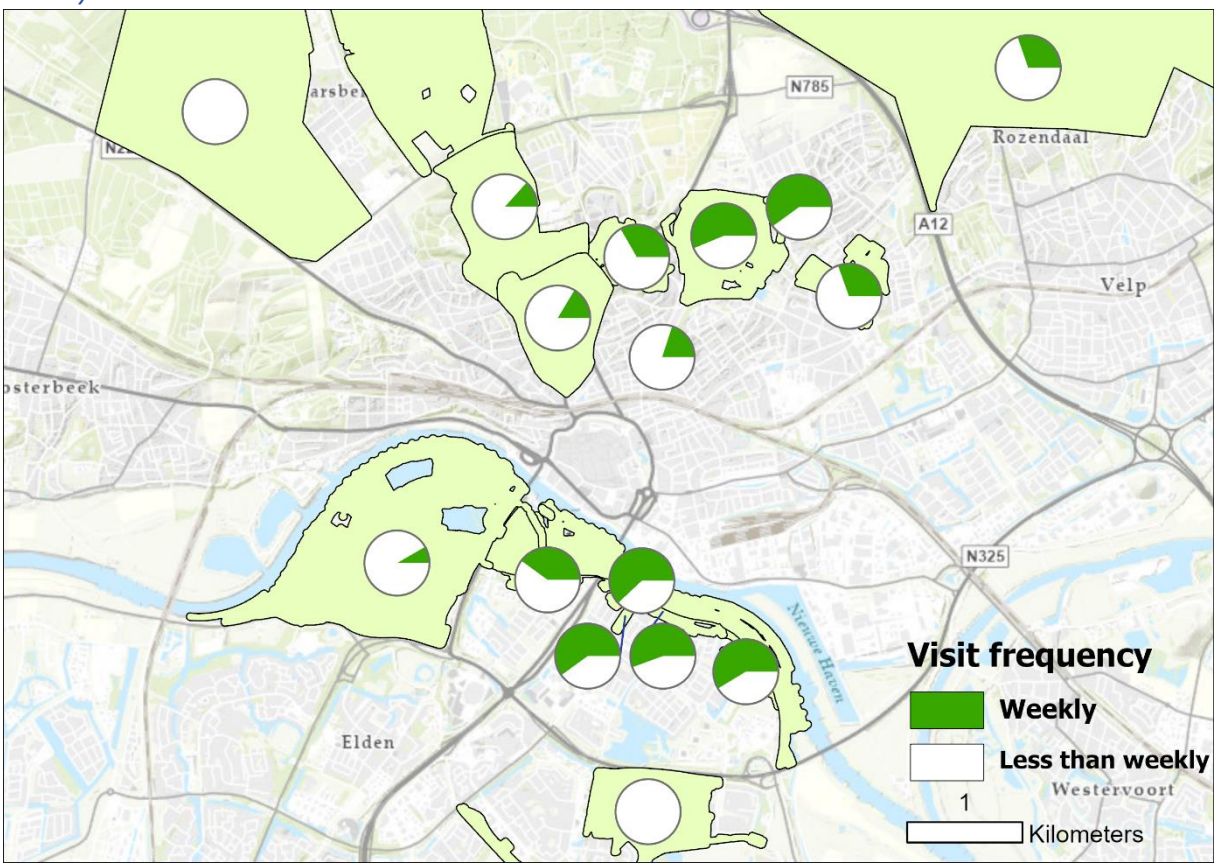


Figure 4.10 Visit frequency of each green space

Smaller green spaces close to one's residence are more often visited than larger green spaces far away. Also, green spaces which are more used for a social function (Onder de Linden, Sonsbeek) are visited less frequent, while more natural green spaces (still close to home) such as the Uiterwaard and Klarenbeek are visited quite often (Figure 4.10). These green spaces are most likely often used for more day-to-day functions such as exercise and walking the dog, while green spaces which are not visited that often could be more used for activities not done on a daily basis, such as picnicking.

Space efficiency

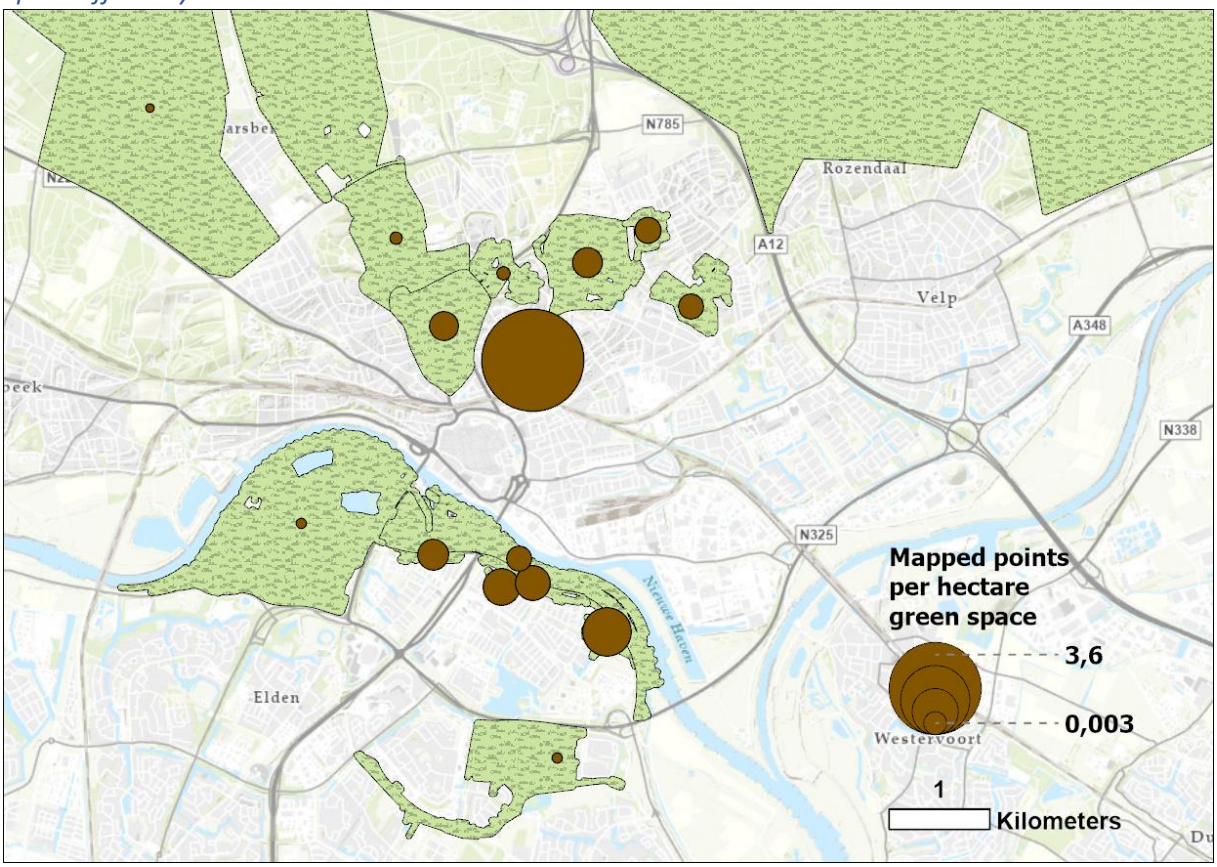


Figure 4.11 Mapped points per hectare of green space

Figure 4.11 shows the number of mapped location relative for the size of the green space. It shows a to be expected in which smaller greenspace is more 'space-efficient' than larger green spaces. Especially Onder de Linden, a small petting zoo and park in Klarendal, stands out in this perimeter. Although this map does not contain the most surprising outcome, it highlights the importance of smaller greenspace within a neighbourhood. As one could assume the general acknowledgment of the importance of being in green spaces for a human being withing policy makers and the general public, this figure shows the effectiveness of small urban green spaces into making green space accessible for people.

4.3.1 Travel distance and green space usage

In the survey, in order to ensure privacy, respondents were not asked to provide their exact address, only their zip-code (PC6). In urban areas, this can give a fair estimation of the location of the respondents' residence. Figure 4.12 shows the relation between the mapped locations in the top 3 Green spaces, and the residence of the respective respondent. The start point of each arrow represents the mapped UGS location, the end point of the arrow the respondent's residence.

Figure 4.13 shows heatmaps of the mapped locations, subdivided by the neighbourhood of residence. As visible on these maps, most respondents live quite close to their mapped locations. Most mapped locations south of the Rhine are mapped by respondents who also reside south of the river, while inhabitants of de Geitenkamp and Klarendal select predominantly locations north of the Rhine River.

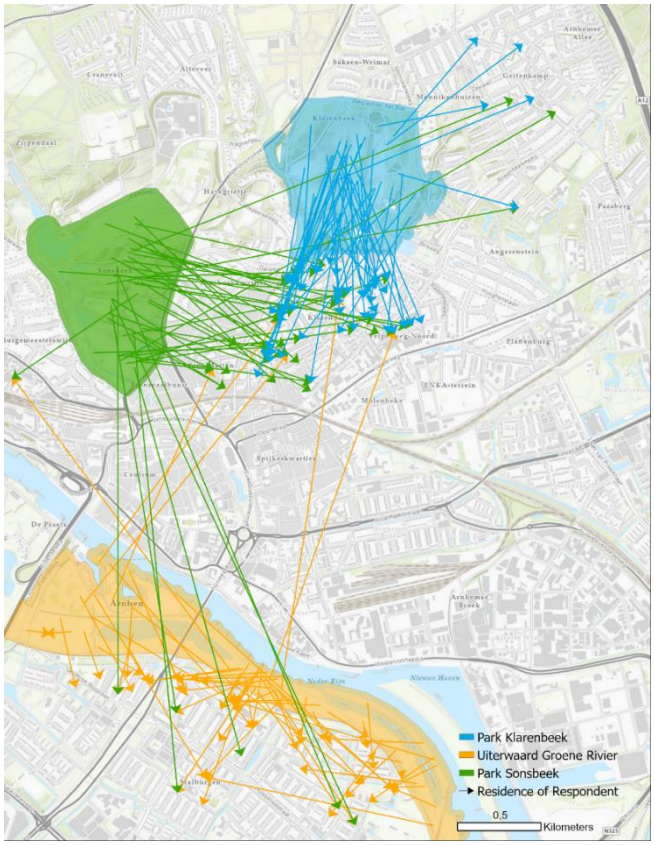


Figure 4.12 Relation between mapped locations and residence of respondent

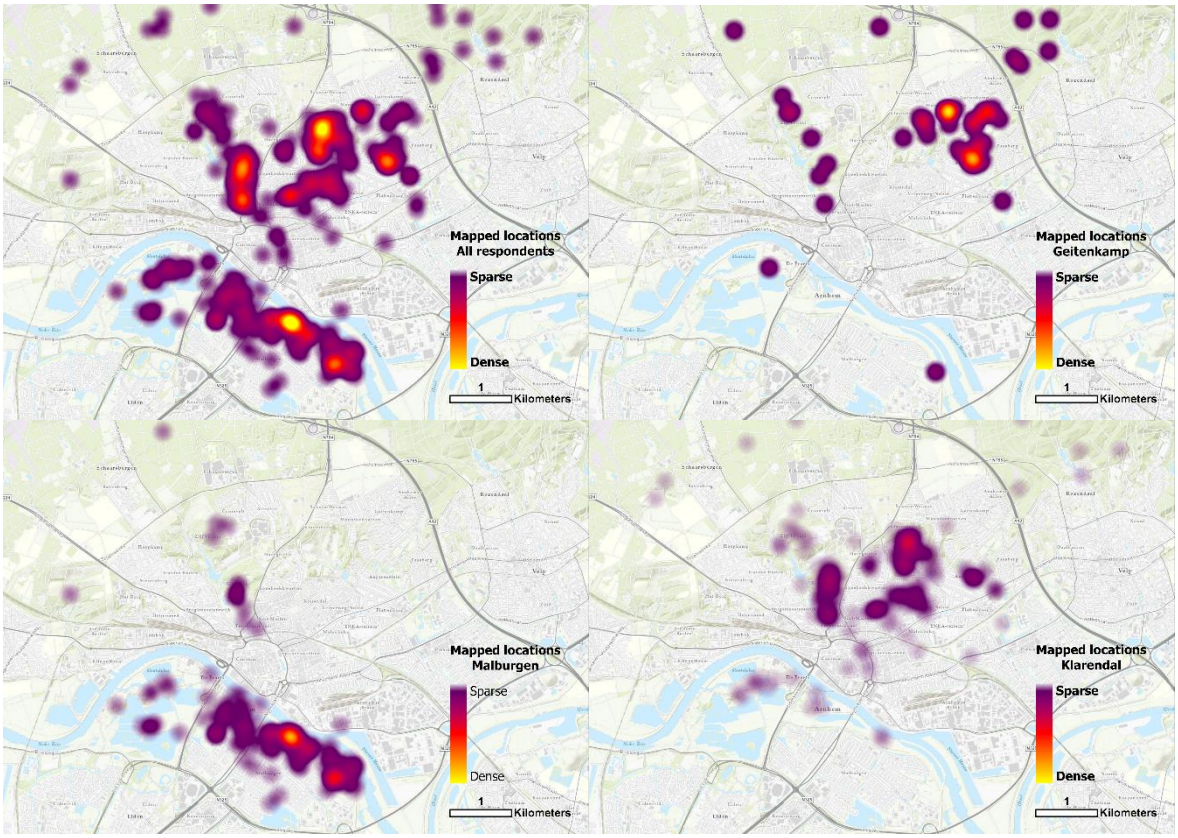


Figure 4.13 Heatmaps of mapped locations of respondents residing in the respective neighbourhoods

The distance between mapped location and residence does not follow a standard distribution. For the complete dataset the Mean distance between mapped locations and residence is 1444,87 meters, while the Median is 785,88m. This is largely due to the outliers, UGC locations mapped outside of Arnhem, mostly in the Hoge Veluwe. In the case of the Uiterwaard ($\bar{x}$=670,98; $\tilde{x}$=450,50), park Sonsbeek ($\bar{x}$=1420,8=64; $\tilde{x}$=1156,67) and park Klarenbeek ($\bar{x}$=831,22; $\tilde{x}$=811,03) this difference still exist, however notably less. In these cases, the distribution does also not follow a standard distribution but is also not as linear as in the complete dataset.

Figure 4.12-14, as well as the descriptive statistics suggest a further pull effect for park Sonsbeek than for the other two green spaces. This can partially be explained by its relative location to the study area, as park Sonsbeek is not situated in, or directly next to one of the neighbourhoods studied. This is the case for the Uiterwaard and park Klarenbeek. On the other hand, Park Sonsbeek is, out of these three parks, the only one to attract respondents form all three neighbourhoods, while Klarenbeek has not been mapped by any respondent from Malburgen, and the Uiterwaard lacks mapped locations form Geitenkamp residents. This adds to the suggestion that people are willing to travel further to Park Sonsbeek than to the other two parks.

Other green spaces that attract respondents relatively far away are the Hoge Veluwe ($\bar{x}$ = 5165,25m), Zypendaal ($\bar{x}$ = 2481,33m) and Meinerswijk ($\bar{x}$ = 2119,06m). These green spaces are all located at the outskirts of the Study Area and are relatively larger in size, but also attract respondents from various districts, while green spaces with a much lower mean distance, such as Onder de Linden ($\bar{x}$ = 158,72m) and Veerpolderstraat ($\bar{x}$ = 317,03) are located within a neighbourhood, and have only attracted respondents from the respective neighbourhood. Figure 4.14 shows the average distance between the respondent's residence and the respective green space, in which the same relationship between size, location and travel distance can also be seen.

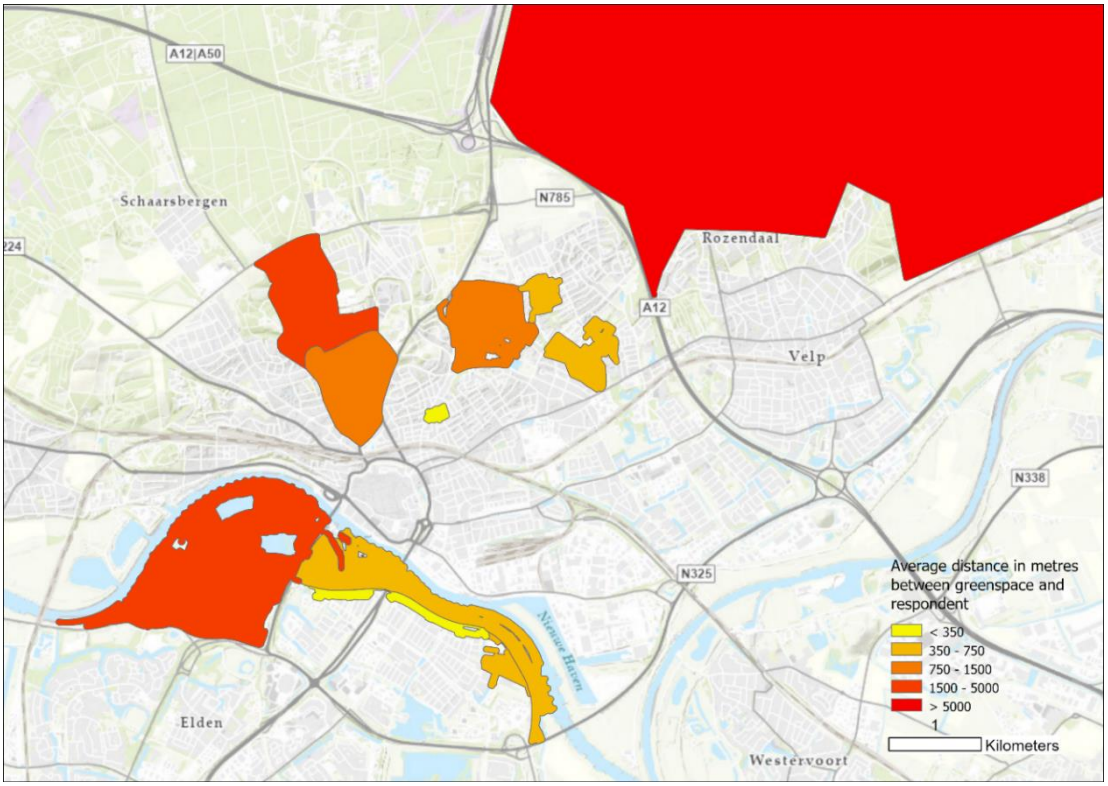


Figure 4.14 Average distance between residence of respondent and the green space they have mapped.

Concluding remarks regarding the frequency and travel dynamics of UGS visits

This paragraph has shown vast disparities between certain green spaces regarding how often they are visited, and by which people. Larger, more natural, green spaces are less often visited than smaller *in-neighbourhood* green spaces. However, as people are willing to travel further to these larger green spaces, these green spaces have larger catchment area, and are therefore still able to attract visitors, which is proven by the fact that green spaces which are visited weekly or more often by almost no one, such as Meinerswijk and Sonsbeek, still received a high number of mapped points, meaning that these spaced are deemed as valuable to a considerable number of the respondents.

4.4 Functions of urban green space

This paragraph focusses on the reasoning of respondents to visit a certain green space. For which purpose are green spaces used? And for what reasons are these spaces rated? Firstly, the survey results will be presented. Afterwards, maps will be presented including further analyses and illustrations of the findings.

In general, the USG functions which are most often mentioned are Exercise, Nature experience and finding Inspiration or peace, while the cultural and/or spiritual function of green spaces or using green space as a place to eat food were mentioned far less (Table 4.5). Especially exercise is mentioned a lot, almost 70% of each mapped location mentions this as a function, this number is even around 80% in the Uiterwaard and Klarenbeek.

	Uiterwaard		Sonsbeek		Klarenbeek		Scattergreen		Complete Dataset	
Function	Amount	Share	Amount	Share	Amount	Share	Amount	Share	Amount	Share
Excercise	56	82%	31	60%	48	79%	57	50%	296	67%
Nature experience	48	71%	28	54%	39	64%	38	33%	223	50%
Inspiration, Peace	32	47%	18	35%	34	56%	19	17%	162	36%
Social Activities	16	24%	22	42%	6	10%	17	15%	84	19%
Cooling effect	17	25%	6	12%	16	26%	14	12%	78	18%
Part of Route	11	16%	0	0%	4	7%	23	20%	57	13%
Food (Picnick, BBQ…)	8	12%	10	19%	2	3%	10	9%	41	9%
Cultural/Spritiual	3	4%	8	15%	6	10%	3	3%	31	7%
Other	2	3%	2	4%	2	3%	15	13%	34	8%

Table 4.5 UGS functions across the dataset (the colour-use is explained in the paragraph following figure 4.4)

This shows some interesting distinctions between the green spaces in Arnhem. Scattered green spaces are used for way less functions than the larger green spaces, except for ‘Part of Route’ all functions are mentioned less than average in scattered green spaces. The Uiterwaard and Klarenbeek show quite a similar pattern, as more rough and natural green spaces they are more used for functions such as experience nature, finding peace and cooling off. On the other hand, is Sonsbeek, which could be described best as a more ‘classic’ urban park with a lot of man-made elements, is more used for social activities, picnicking and cultural functions.

Exercise

In 67% of all mapped nodes, exercise had been mentioned as a function of the respective location. As visible in figure 4.16, exercise is mentioned regarding at least 50% of mapped locations in each green space, except for Groene Weide and Schaarsbergen. The largest proportion of nodes with exercise as a UGS function (>75%) can be found across the Rhine flood banks, the Hoge Veluwe and Park Klarenbeek. All larger locations with more rural characteristics in comparison to the other green spaces. De Hoge Velue is evidently located outside of the city of Arnhem, however, likewise park Klarenbeek and the two greenspaces at the Rhine outer banks can best be described as natural places inside of an urban area, which are not created for human recreation perse.

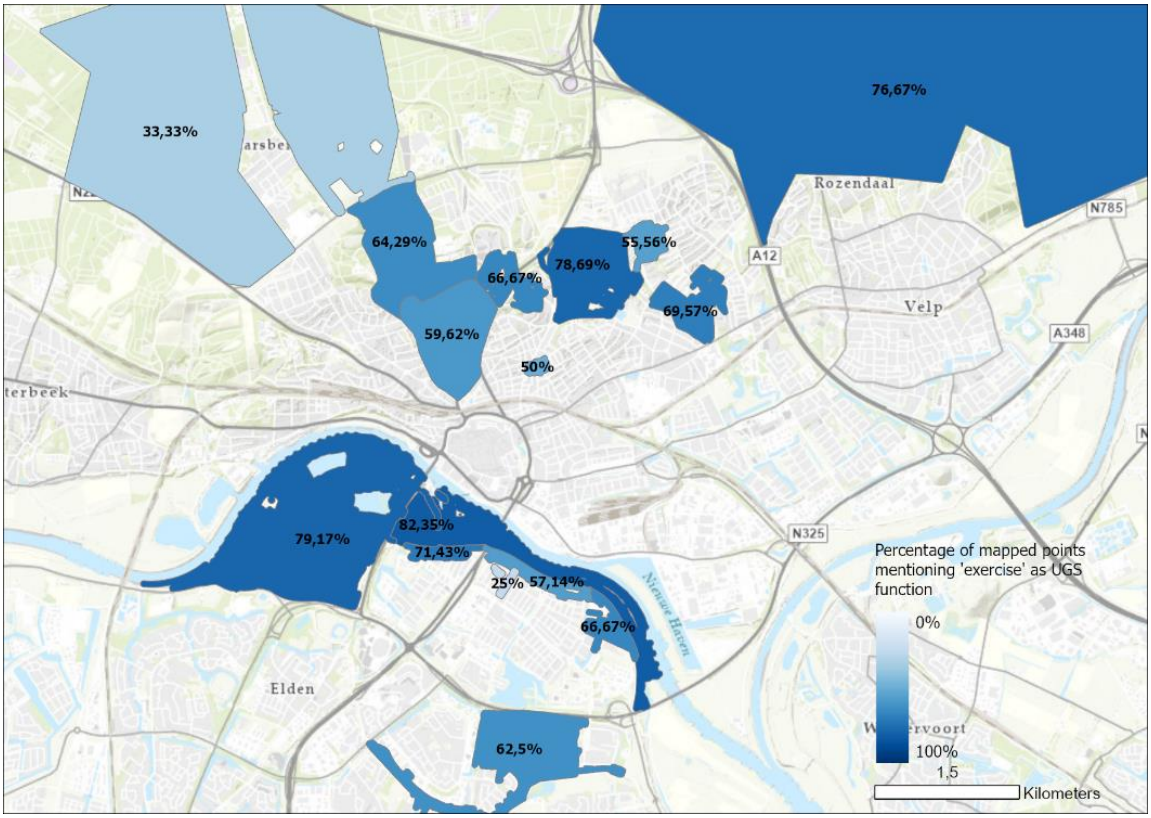


Figure 4.16 Percentage of mapped points mentioning 'exercise' as UGS function

Green spaces in which this concentration of mapped nodes is lower, are smaller green spaces, purposefully built into a neighbourhood such as de Groene Weide and Onder de Linde. These greenspaces are presumably too small to do activities that require much space such as running or team sports. An interesting outlier in this trend is park Sonsbeek, which is used less than average for exercise purposes (59,62%), while being a relatively large greenspace with natural characteristics. However, by taking a closer look at the data, it becomes clear that in Sonsbeek a relatively large number of nodes are mapped without stating any form of function of quality. Therefore, reducing the concentration of all functions and qualities in Sonsbeek. When only including nodes in which at least one function has been mentioned, Sonsbeek is not an outlier in this regard.

Based on the previous findings, one would assume that qualities such as enough space and natural feeling are the most often mentioned as important UGS qualities in relation to exercise (Table 4.5). Aesthetics and closeness to home are mentioned more often in locations which also mention the function exercise, which is in line with the general dataset. Except “Close to home” all UGS qualities

are mentioned slightly more often in combination with exercise than in the complete dataset, with no substantial outliers.

UGS Quality	%Exc	%All*	UGS Quality	%Exc	%All*
Aesthetics	**80.41%**	76.68%	**Proximity of Water**	**32,43%**	30.83%
Close to home	**75,34%**	76.94%	**Silence, Peace**	**32,09%**	29.22%
Being in nature	**62,84%**	57.10%	**Shade, Cooling effect**	**31,08%**	28.42%
Enough Space	**42,90%**	39.68%	**Enough Facilities**	**19,93%**	20.38%
Biodiversity	**37,16%**	33.78%	**Nice people**	**13,18%**	14.21%

Table 4.6 UGS qualities mentioned together with the function 'Exercise' relative to the complete dataset.
**not counting the seventy-two mapped locations which did not mention a single UGS quality and function.*

Locations in which exercise is mentioned as a function therefore do not derive from the general dataset in terms of UGS qualities mentioned. Part of this can be explained by the fact that multiple functions and qualities can be mentioned regarding one unique location. Therefore, one can not a draw direct expressed relation between the two. A greenspace can be a good fit to exercise, while being rated for its proximity of water, without this quality enhancing this specific function of the green space.

Other functions

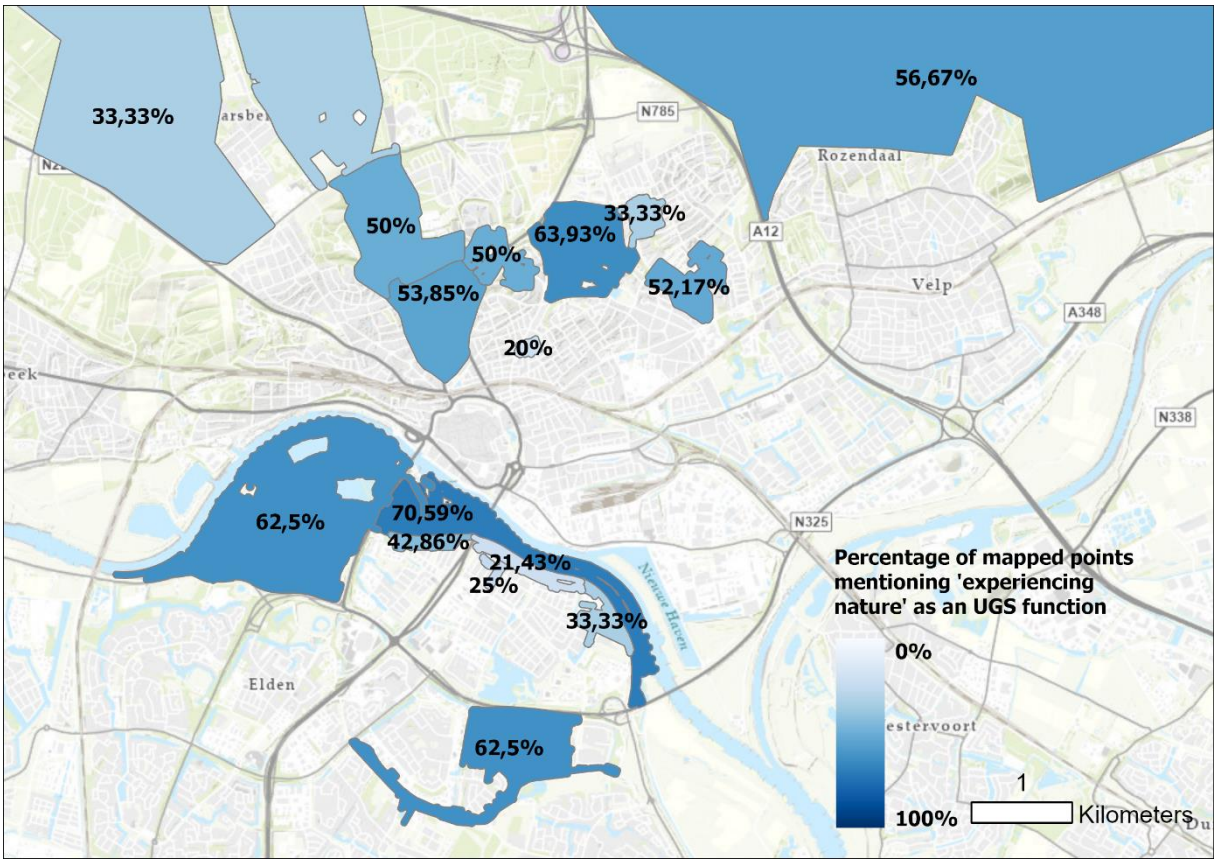


Figure 4.17 Percentage of mapped points mentioning 'Experiencing nature'.

Figure 4.17 shows a similar map to figure 4.16, in this case the function 'experiencing nature' has been mapped for each green space. This map shows some to be expected results, for instance the small green spaces such as Groene Weide and Onder de Linde scoring quite low in this perimeter. Striking however are the relatively low scores of some larger, more 'natural' green spaces such as the Hoge Veluwe and Schaarsbergen. Part of the explanation lays within the respondents, who often have only mentioned one function, which could be done deliberately, or respondents could not have

been aware of the fact that it was possible to mention multiple functions. Especially Schaarsbergen has not received a large number of mapped points, therefore a couple of respondents who forgot to, or were unable to correctly fill in the functions can have a large impact on the outcome of this map.

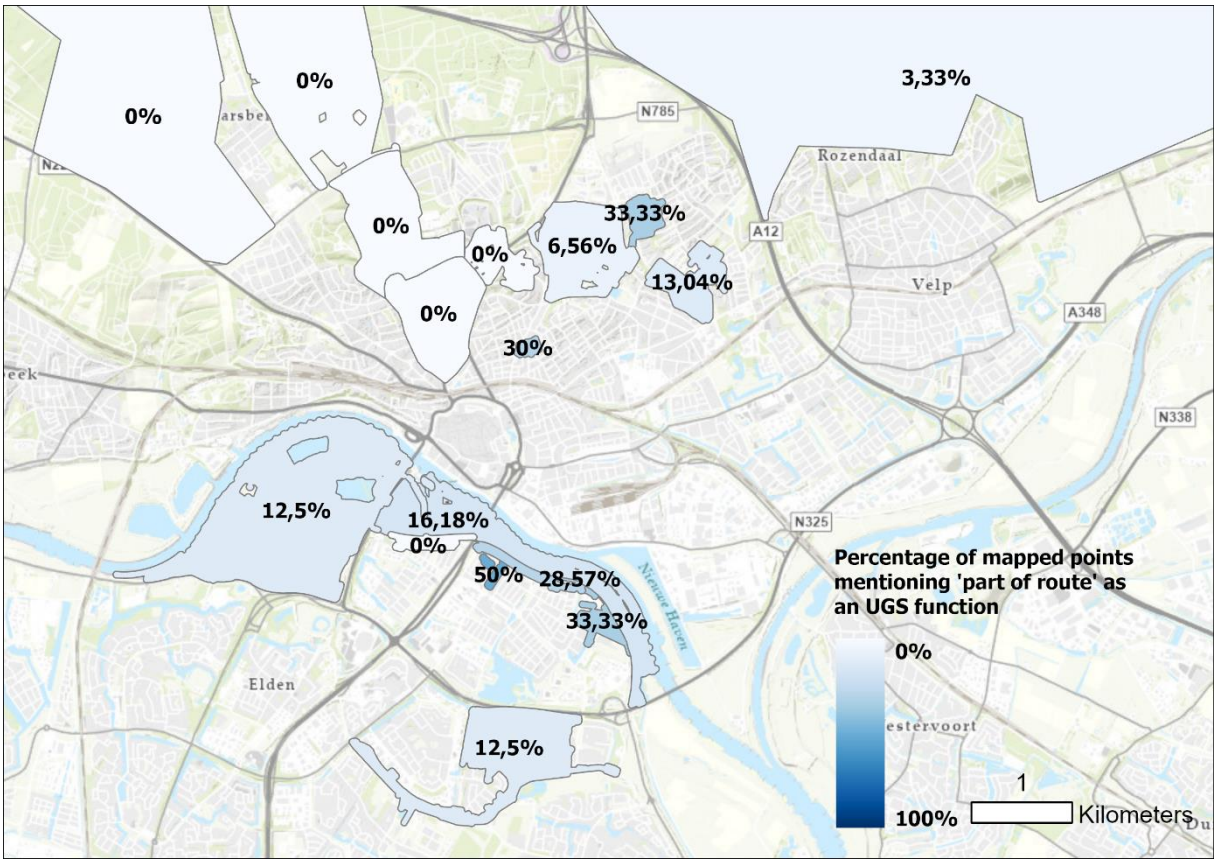


Figure 4.18 Percentage of mapped points mentioning 'part of route' as an UGS function.

A significant different picture is painted in figure 4.18, in which the proportion of mapped points mentioning ‘part of route’ as an UGS function is visualized. Besides the fact that this function is mentioned a lot less than the two previous functions, it also highlights other green spaces. Instead of the big green spaces containing a lot of mapped points, such as the Uiterwaard and Klarenbeek, smaller green spaces such as Park Burgermeester Bloemerweg and de Groene Weide score relatively high in this parameter. All (large) green spaces in the northwest of Arnhem (Sonsbeek etc.), lacked any mapped point mentioning the green space being a part of their route as a function. Geography is most likely a factor in this outcome, all respondents live east or south of these green spaces, while the urban area of Arnhem stops northwest of these locations.

Figure 4.18 highlights how functions of green spaces which are different of nature are relevant in different types of green spaces; going to a certain green space to exercise, or to experience nature is a premeditated act most often. When a green space is a location within one’s route, the green space in itself is most likely not visited deliberately. However, the fact that these green spaces are still mentioned in this survey, illustrates the fact that these locations are still relevant to the respondents, also when not visited in a premeditated manner.

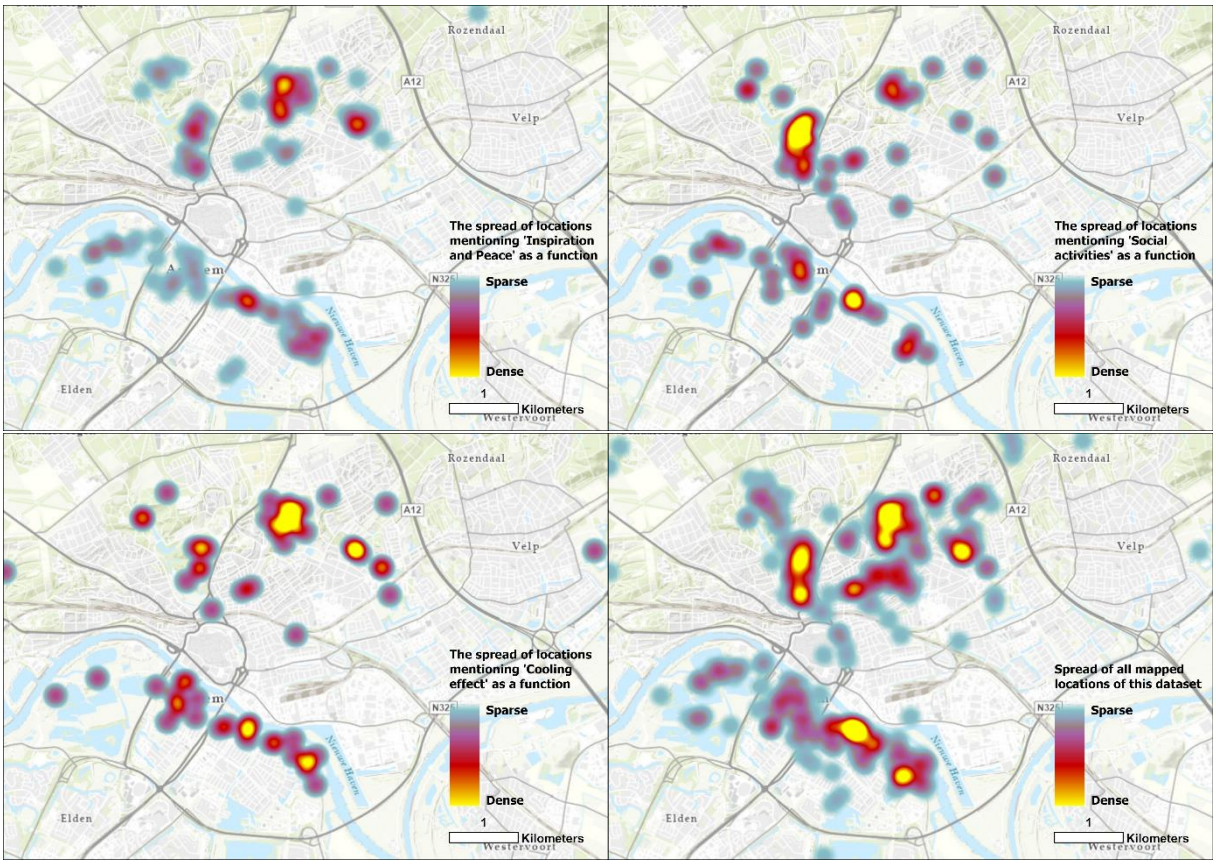


Figure 4.19 Heatmaps of mapped locations (clockwise) mentioning as UGS function: a. 'Inspiration & Peace' b. 'Social activities' c. 'Cooling effect' d. The complete dataset

Figure 4.19 shows the spread of the mapped locations of various UGS functions using heat maps. On the surface these maps show a relatively similar pattern, which identifies the Uiterwaard, Sonsbeek and Klarenbeek as hotspots. Therefore, most valuable is what differentiates these maps. The function cooling effect (Figure 4.19[c]) shows the strongest clustering of points in the large green spaces, people tend to choose big urban green spaces to cool off. Especially Klarenbeek, a park with a large density of trees, jumps out as a hotspot for escaping the heat. The two functions shown above in figure 4.19, 'Inspiration and peace'[a] and 'Social activities'[b], show a more evenly spread across Arnhem. Meaning that also smaller greenspaces, inside of neighbourhoods, are used more often for these functions. Remarkable regarding social activities is the fact that a higher density of points in and around the city centre of Arnhem can be observed, as well as the fact that the highest density of points is location in park Sonsbeek, which directly borders Arnhem's city centre. This suggests that green spaces within a close vicinity of the city centre are more often used for social purposes. This could be explained by the means of geography – these parks are located in a central location with good accessibility -, or because of factors such as the proximity of certain services (shops, public toilets, etc.).

Concluding remarks of functions of green space

Green spaces are most often used for exercise, experiencing nature and finding inspiration or peace, especially the first two functions are mentioned far more than other functions. Both functions are more often mentioned in the same green spaces, larger more natural green spaces. A remarkably high percentage of mapped points the Uiterwaard and park Klarenbeek mention exercise and experiencing nature as important functions of this green space. Parks with less natural elements,

such as Sonsbeek, as well as smaller green spaces and locations close to the city centre, are more often used for social functions.

4.5 Rating and valuable characteristics of green spaces

This paragraph focusses on two main questions; how are green spaces in Arnhem valued? And for which attributes are these spaces valued. In the same manner as previous paragraphs, the general and per-cluster results are first presented. Next, by the means of maps, interesting insights and visualizations are presented thereafter.

4.5.1 Rating of green spaces

	Uiterwaard		Sonsbeek		Klarenbeek		Scattergreen		Complete Dataset	
Rating	Amount	Share	Amount	Share	Amount	Share	Amount	Share	Amount	Share
1 - Very Bad	0	0%	0	0%	0	0%	1	1%	2	0%
2 - Bad	0	0%	0	0%	0	0%	6	5%	7	1%
3 - Could be better	8	12%	0	0%	1	2%	10	9%	27	5%
4 - Neutral	0	0%	0	0%	1	2%	5	4%	13	3%
5 - Sufficient	9	13%	2	4%	3	5%	17	15%	59	12%
6 - Good	27	40%	22	42%	19	31%	33	29%	173	35%
7 - Very Good	19	28%	15	29%	30	49%	15	13%	133	27%

Table 4.7 Rating of green space across the dataset (the colour-use is explained in the paragraph following figure 4.4)

During the survey, respondents were asked to rate each mapped location on a Likert-scale from one to seven. Across the whole dataset respondents tend to give relatively high ratings to their mapped locations, as the mean rating of all mapped location is 5.83 out of 7. Less than 10% of all mapped locations received a score of 4 (neutral) or lower, meaning that more than 90% of mapped locations are deemed at least as sufficient. Of course, selection bias plays a significant role in this matter, as respondents only mapped a couple of locations which are meaningful to them, one can assume they would not select locations they rate poorly as quickly as locations they enjoy. Table 4.7 shows also shows that scattered greenspaces are more often rated poorly, and less often rated highly than the larger green spaces. This is in line with previous findings in paragraph 4.2.

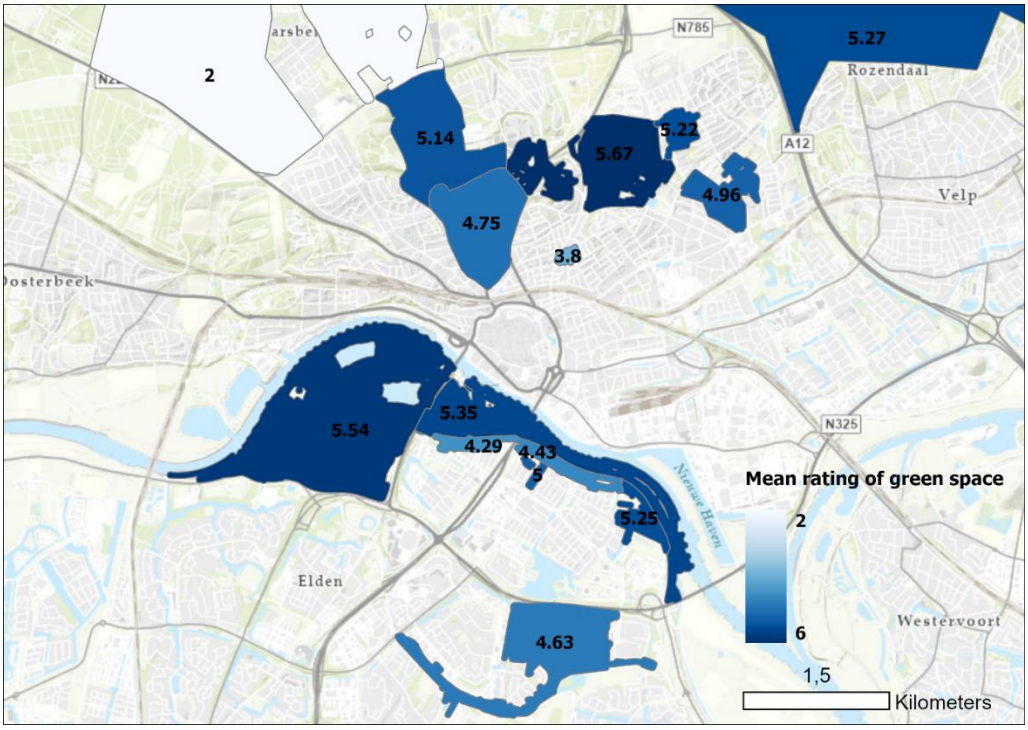


Figure 4.20 Mean rating of each green space

Figure 4.20 shows us the mean rating of each green space. This map provides us with a couple of interesting insights. The green spaces with the highest scores are Klarenbeek, Meinerswijk, two

‘natural’ spaces on the edge of the city. Locations without a lot of facilities or opportunities for activities but still rated very highly. It seems that locations in the neighbourhoods which are more often used for functions such as social activities or picknicking, are rated lower. This could be due to the fact that these location have to comply to more expectations, for instance having enough public toilets, benches or bins, while the appreciation of more ‘raw’ nature is more unconditional, as it is (to a certain extent) not human made, or made for the purpose to conform to the needs of humans. A large outlier in this map is Schaarsbergen, which has a mean rating of two, this is due to the fact that Schaarsbergen did not have many mapped points to begin with, a regarding a lot of its’ mapped points the rating question was left blank. As these null values were filtered out, only two mapped points remained, resulting in a very odd mean rating. It is therefore unlikely that this green space is rated this badly by a broader audience.

4.5.2 Valuable characteristics of UGS

In the survey, respondents were asked to highlight one or more values of green space for each mapped location. Across the whole dataset, 'Close to home' and 'Aesthetics' are mentioned most often (64%), as these are the only two values mentioned in more than half of the cases. A clear third is the value 'Nature experience', which is mentioned almost 50% of the time.

	Uiterwaard		Sonsbeek		Klarenbeek		Scattergreen		Complete Dataset	
Value	Amount	Share	Amount	Share	Amount	Share	Amount	Share	Amount	Share
Close to home	52	76%	27	52%	48	79%	71	62%	287	64%
Aesthetics	56	82%	37	71%	49	80%	51	45%	286	64%
Nature Experience	44	65%	23	44%	44	72%	33	29%	213	48%
Enough space	27	40%	18	35%	25	41%	19	17%	148	33%
Biodiversity	33	49%	13	25%	18	30%	24	21%	126	28%
Proximity of Water	45	66%	15	29%	5	8%	16	14%	115	26%
Silence, Peace	14	21%	3	6%	27	44%	15	13%	109	24%
Shade, cooling effect	7	10%	11	21%	26	43%	22	19%	106	24%
Enough Facilities	5	7%	18	35%	8	13%	23	20%	76	17%
Nice people	3	4%	17	33%	6	10%	17	15%	53	12%
Other	1	1%	2	4%	1	2%	7	6%	20	4%

Table 4.8 UGS values across the dataset (the colour-use is explained in the paragraph following figure 4.4)

Table 4.8 creates some interesting insights. A large distinction exists between the highlighted green spaces, in line with the functions of green space, a lot of resemblance can be identified between Klarenbeek and the Uiterwaard, while Sonsbeek paints a different picture, the same goes for the scattered green spaces. Park Klarenbeek is remarkably often valued for its Silence, peace and shade, the Uiterwaard for its proximity of water and Sonsbeek for the presence of nice people. Compared to the general dataset and the large green spaces, scattered green is valued rarely for its natural experience, aesthetics and space.

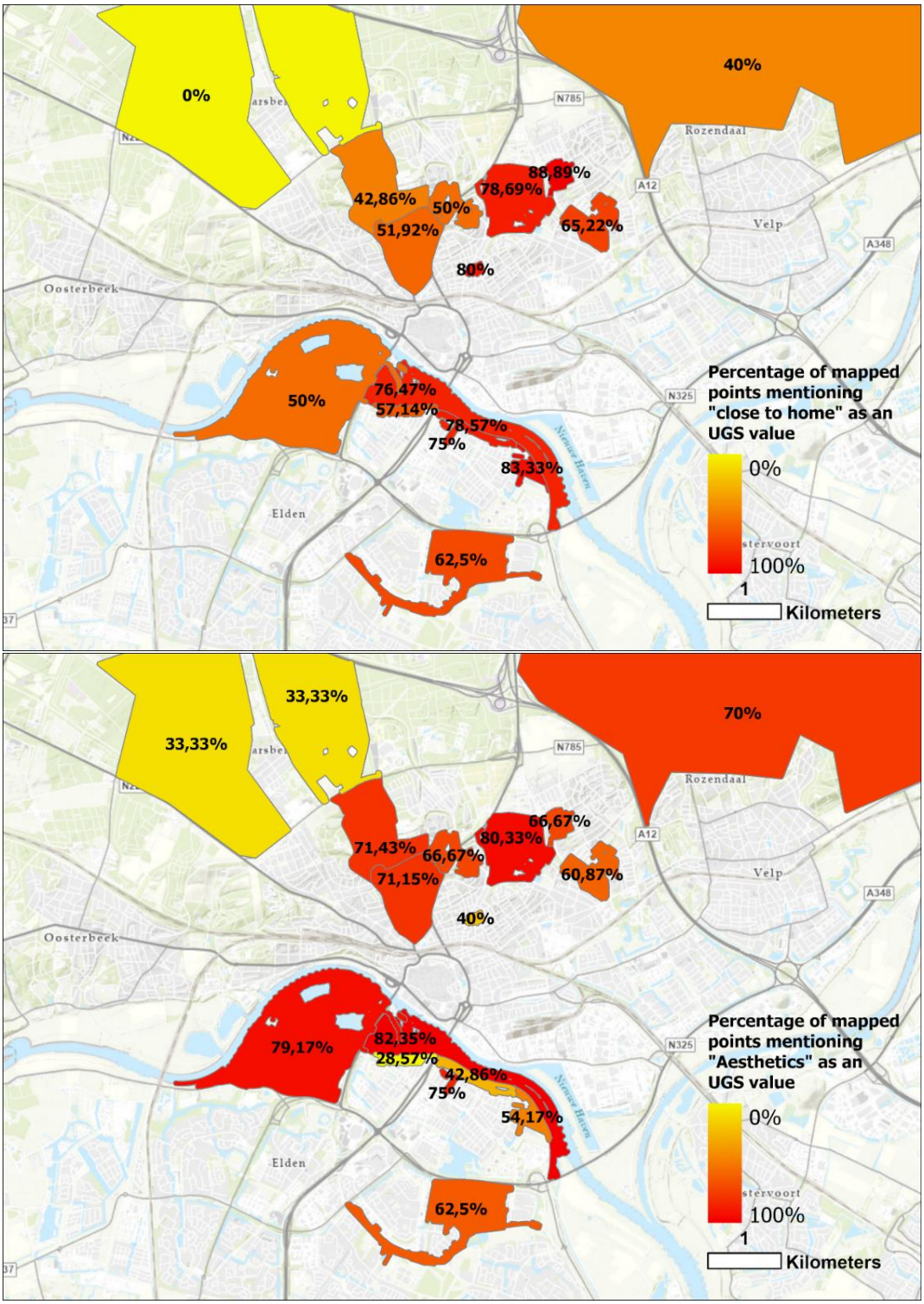


Figure 4.21 Percentage of points mentioning "close to home" as an UGS value
Figure 4.22 Percentage of points mentioning "Aesthetics" as an UGS value.

Figures 4.21 and 4.22 illustrate the percentage of mapped points per green space mentioning the proximity to one's home (25) and aesthetical values of the location (26). As mentioned before these two are the values most often mentioned in the whole dataset, both coming in at 64% of all mapped locations mentioning at least one of these values. However, for both values vast differences exist between green spaces. Proximity to one's home is never mentioned regarding park Schaarsbergen for instance, while it is mentioned in almost 90% of mapped locations in Burgermeister

Bloemerstraat. Of course, this has to do a lot with the fact that this research has only been conducted in certain neighbourhoods, Schaarsbergen is not located close to any of the neighbourhoods, therefore it makes sense that this green space is not rated highly for its proximity to one's home. However, regarding the Veluwe still 40% of the mapped location mention the proximity to their home as a value, while also no respondent lives in a close proximity to this green space. Suggesting relative distance also plays a role in this value, as the Veluwe is a natural area known and visited by people across the entirety of the Netherlands, living in Arnhem (Noord) means you live relatively close to this green space, which is deemed as valuable, even if there are other green spaces more close by.

Larger, more natural green spaces tend to be more often valued for its Aesthetical value than smaller green spaces with more man-made elements. Locations such as the Uiterwaard, Meinerswijk and Klarenbeek score remarkably high in this regard, while Malburgse Bandijk-West, Veerpolderstraat and Onder de Linden are valued for its aesthetical value in only 40% or less of the cases. A large similarity can be observed between figure 4.23 and figure 4.17, in which the percentage of points mentioning Natural experiences. This further implies a correlation between the natural character of urban green spaces and these spaces being rated for its aesthetical value.

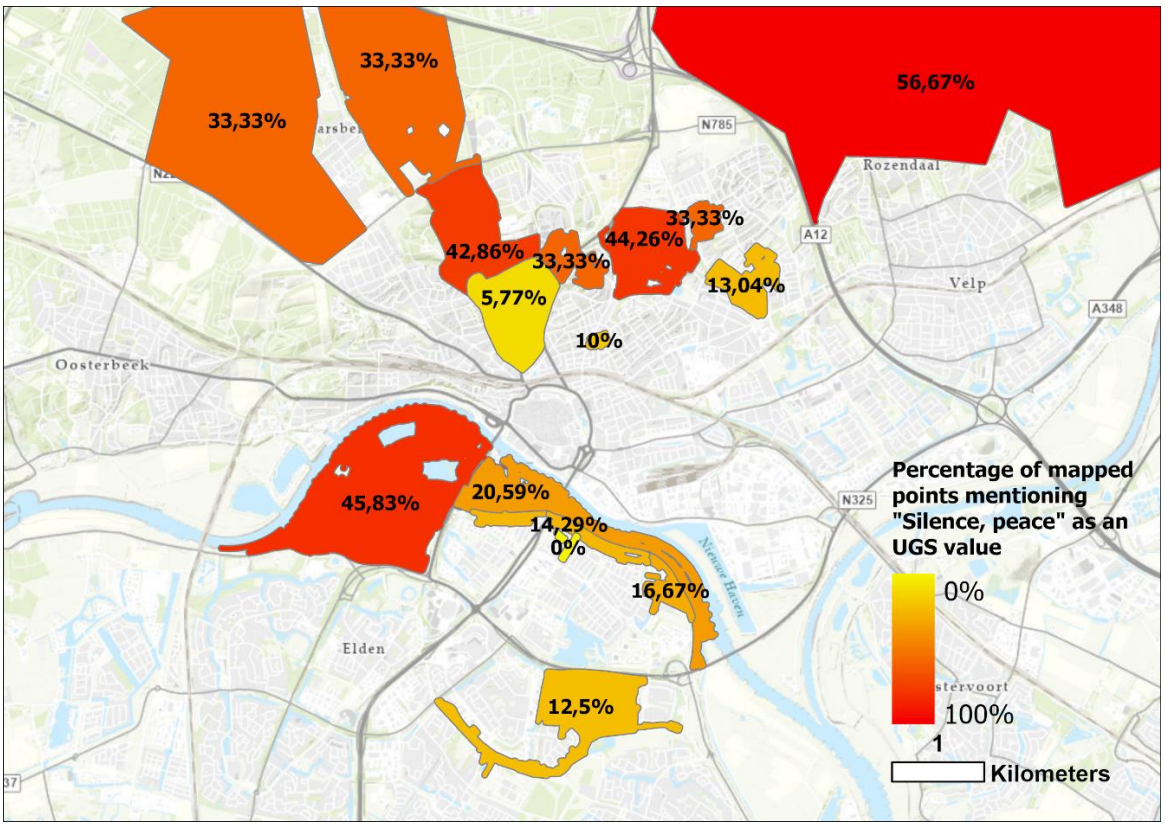


Figure 4.23 Percentage of points mentioning "Silence, peace" as an UGS value.

Figure 4.23, in which the percentage of mapped points per green space mentioning silence and peace as a value are visualized, paints a vastly different picture in comparison to the previous maps. Apart from the fact that the percentages are a lot lower than regarding the other two values, different green spaces are highlighted in this map and interesting differentiations can be observed. For example, in Sonsbeek only 5,77% of the points mapped mention silence and peace, while these percentages are a lot higher in de Braamberg and Zypendael, which border Sonsbeek. Simultaneously a large gap can be observed between the Uiterwaard and Meinerswijk, which are also bordering green spaces. Based on figure 4.23 one could conclude that green spaces more dislocated from the

urban area of Arnhem are more valued for its silence and peace, as the Veluwe and Meinerswijk score the highest in this regard, while smaller greenspaces inside of neighbourhoods such as Groene Weide and Onder de Linden score a lot lower.

Concluding remarks of the rating and valuable characteristics of green spaces

In general, green spaces in this research are rated relatively high (5.83/7), which most likely is at least partly due to selection bias as respondents were asked to map placed that were valuable to them. Across Arnhem, green spaces with more natural characteristics and less man-made elements, are rated higher than the classic *urban park*.

This distinction between larger parks with more natural characteristics, and urban parks with more made-made elements, which has also been described in paragraph 4.4, is albeit to a lesser extent, also noticeable regarding the valuable characteristics of these urban green spaces. Except for the values of 'Nice people' and 'Enough facilities', most values are more often mentioned in parks such as Klarenbeek and the Uiterwaard in comparison to Sonsbeek and smaller green spaces as Onder de Linden or Park Burgermeester Bloemersweg.

4.6 Hypotheses testing

In this paragraph, the two hypotheses presented in chapter 3 will be tested via statistical analyses. Besides the visualizations of geographical data presented in paragraph 4.1 – 4.4, this research will be able to make definite claims regarding certain aspects of the use and valuation of green space in Arnhem.

First, we will test whether green spaces are experienced differently by people without access to a private garden, in comparison to people with access to a private garden. This will be tasted by the means of three survey items: frequency of use, rating of green space and travel distance to respective green space. Together, these three characterises tackle a broad spectrum regarding green space usage. If a certain group of people visits green space more often, rates these visits higher and travels further to these spaces, than another group of people, one would be able to say these groups experience green space differently.

Next, the same variables will be used to test whether small green spaces, *scattered green,* is used differently than larger green spaces. As well as regarding private gardens, these variables will be tested via the 'Independent Samples Test' in SPSS. This tool allows the researcher to put in the relevant properties of two datasets, and conduct statistical testing, without needing to transfer the complete dataset to SPSS. As the data of this research is captured in ArcGIS using a survey software produced by Esri for ArcGIS, and certain aspect of this dataset make it very difficult to transfer the data to other software (further elaboration of this will be presented in chapter 5), the Independent Samples Test provides a perfect opportunity for us to conduct statistical analysis.

4.6.1 The influence of (in)accessibility to a private garden to UGS use and valuation

In the survey, respondents were asked if they had access to a private garden attached to their home. Out of the 448 *regular* mapped points (this excludes the child specific points), 291 were mapped by respondents with a private garden, and 154 by respondents without. Respondents of the latter group may however have access to a balcony or some other form of private outside space. The survey question solely focussed on private green spaces. As discussed in chapter 2, previous research has been unable to make striking claims regarding the influence of having a private garden to green space use, while one could assume that people without a private garden would rely more on public (green) space for certain needs and activities. This sub-paragraph therefore seeks to test the hypotheses:

H0: People without a private garden do not use and valuate UGS differently than people with a private garden.

H1: People without a private garden use and valuate UGS differently than people with a private garden.

Frequency of visiting UGS

Regarding each mapped point, respondents were asked to mention how often they visit the respective green space. Each category of visit frequency received a corresponding score, in which daily visits got a score of 5 and seldom visits received a score of 1. By using the 'Explore Statistics' function in ArcGIS, we have been able to gather the mean frequency score of the two groups of respondents, as well as the standard deviation.

All points mapped by respondents with a private garden had an average visit frequency score of 3.549, while locations visited by respondents without a garden had a visit score of 3.508, resulting in

a mean difference of -0,041. Both means therefore fall somewhat in between the options *'A couple of times per month'* and '*A couple of times per week'.*

As the p-value is 0,697 (we use the row 'Equal variances not assumed' as the Hartley test for equal variance suggest that the variances are not equal (p-value > 0.05)), as well as the fact that the Standard error of the mean difference is higher than the mean difference itself (0,105 versus 0,041), meaning that the variance is to the extent that we are not able to claim that the mean difference is no coincidence.

Therefore, we are able to conclude that the difference in means is not statistically significant, meaning that this research is, with an error margin of 5%, unable to conclude that either people with- or without a private garden visit urban green spaces more than the other. This is further supported by the fact that (Table 4.9).

Summary Data

	N	Mean	Std. Deviation	Std. Error Mean
No Garden	154,000	3,508	1,069	,086
Private Garden	291,000	3,549	1,036	,061

Independent Samples Test

	Mean Difference	Std. Error Difference	t	df	Sig. (2-tailed)
Equal variances assumed	-,041	,104	-,393	443,000	,694
Equal variances not assumed	-,041	,105	-,390	303,430	,697

Hartley test for equal variance: F = 1.064, Sig. = 0.3241

Table 4.9 Frequency of visit. Respondents with a private garden vs. without

Rating UGS

Respondents were asked to rate each location they mapped on a Likert scale from 1 (very bad) to 7 (very good). Equal to table 4.9, all mapped points were subdivided on the basis of the respondent having access to a private garden or not. The analysis shows that locations mapped by people with access to a private garden are rated on average slightly higher (mean difference of -0,049), however this gap is not at all statistically significant, as the p-value of 0,696 (equal variances not assumed) is way above 0,05, the threshold value used for the 95% confidence interval. This is further supported by the fact that the Std. error of the mean difference is higher than the mean difference. Therefore, with an error margin of 5%, this research is also unable to conclude that people with or without a private garden rate green spaces in Arnhem differently (table 4.10).

Summary Data

	N	Mean	Std. Deviation	Std. Error Mean
No Garden	154,000	5,839	1,247	,100
Private Garden	291,000	5,888	1,272	,075

Independent Samples Test

	Mean Difference	Std. Error Difference	t	df	Sig. (2-tailed)
Equal variances assumed	-,049	,126	-,389	443,000	,697
Equal variances not assumed	-,049	,125	-,392	317,144	,696

Hartley test for equal variance: F = 1.040, Sig. = 0.3952

Table 4.10 Rating of green spaces. Respondents with private garden versus without

Distance travelled to UGS

Table 4.11 shows the Independent Samples Test of travel distance to green space. For each mapped point the distance in metres is calculated between the mapped points and the location of residence[5]. This analysis shows that locations mapped by respondents without a private garden were on average 1303 metres away from the residence of the respondents, while people with a private garden travelled on average 222,5 metres further to their green space (mean difference -222,51). This is in line with the assumption that people without a private garden would more often used green space close to their home more often, as an alternative to a private garden. However, this would also imply that people without a private garden would use public green spaces more often, which this research does not show.

As the p value is 0,249 (equal variances assumed, as p-value Hartley test is < 0,05), this test is not able to conclude that difference is travel distance is statistically significant. On top of that, the 95% confidence intervals provide that the actual mean difference could also be above 0, as the upper limit is 155,493, meaning that this test is unable to exclude the possibility of people without a garden travelling further to green spaces that people with access to a private garden. Therefore, this research is, with an error margin of 5%, unable to claim a discrepancy regarding travel distance to green space between people with or without a private garden.

[5] By approximation. The geometrical centre of each PC6 zip-code was used as point of measurement.

Summary Data

	N	Mean	Std. Deviation	Std. Error Mean
No Garden	151,000	1302,710	1677,780	136,536
Private Garden	291,000	1525,220	2038,240	119,484

Independent Samples Test

	Mean Difference	Std. Error Difference	t	df	Sig. (2-tailed)
Equal variances assumed	-222,510	192,862	-1,154	440,000	,249
Equal variances not assumed	-222,510	181,434	-1,226	358,857	,221

Hartley test for equal variance: F = 1.476, Sig. = 0.0039

95.0% Confidence Intervals for Difference

	Lower Limit	Upper Limit
Asymptotic (equal variance)	-600,513	155,493
Asymptotic (unequal variance)	-578,115	133,095
Exact (equal variance)	-601,555	156,535
Exact (unequal variance)	-579,318	134,298

Table 4.11 Distance in metres between residence and mapped location. Respondents with private garden versus without

Concluding: Rejecting the H1 hypothesis for private gardens

On the basis of these tests, this research is unable to claim that people without a private garden use green spaces more or less, rate green spaces higher or lower or have different travel habits to their green space in comparison to respondents which have access to a private garden. Therefore, in this case H0 cannot be rejected in favour of H1, meaning that people without a private garden do not use and valuate UGS differently than people with a private garden.

4.6.2 Testing the hypothesis about use of scattered green in the neighbourhoods

Besides large parks and urban green spaces in Arnhem, smaller strips of green spaces are also utilized a lot. However, as these green spaces are often only relevant for people living in a close vicinity to the respective green space, they gather not as many results in this research, as respondents are spread across three neighbourhoods in Arnhem. All mapped points inside of the urban area of Arnhem which do not overlap with a greenspace largen than 5ha are bundled together as 'Scattered Green'. This makes it possible to compare the results of larger green spaces to (very) small green spaces without needing to rely on the opinions of just one or two respondents. In order to clarify this, figure 4.15 provides an oversight of all scattered green points in and around Klarendal. This map illustrates how most of these points are mapped in very small green spaces, sometimes not even identifiable from satellite images. Besides regarding Onder de Linden, located in the centre of this map, almost no points are clustered together. Each individual strip of scattered green therefore does not entail a large value for the city of Arnhem and this research, however all these smaller strips collectively form a significant part of the dataset. Therefore, scattered green has a great significance in this research.

Figure 4.15 Scattered green in and around Klarendal. Each green spot represents a mapped point in a green space <5ha.

As discussed in chapter 2.1, the relationship between the size of green spaces and its usage and has provided striking results, which are not always concordant (Łaszkiewicz et al., 2022) (Peschardt, Schipperijn et al. 2012). Therefore, this research tests the following hypotheses:

H0: *Scattered green is not used and experienced differently than larger urban green spaces.*

H1: *Scattered green is used and experienced differently than larger urban green spaces.*

In order to test these hypotheses, all mapped locations categorized as scattered green (114 in total), were bundled and tested against all mapped points which are located in the six green spaces with more than 20 mapped locations (Figure 4.5), as this includes 275 mapped points all in urban green

spaces larger than 5HA. This ensures no overlap between the two bundles of data, making independents sample testing possible.

Rating of scattered green

As mentioned previously, respondents were asked to rate each mapped point on a Likert scale from 1 to 7. In order to examine the distinction between scattered green and larger green spaces, disparities between how these two typed of green spaces are rated, are analysed. The mean rating of scattered green space's location is 5.184, while mapped points inside of the larger green spaces are rated 6.119 on average, resulting in a mean difference of 0,935. The Independent Samples Test shows that this is a disparity of statistical significance, as the p-value is 0,0, which is further supported by the fact that standard error of the mean difference is way closer to 0 than the mean difference, as well as the 95% confidence interval suggesting that mean difference will be negative in any, as the upper and lower limit are both far under 0 (Table 4.12). Therefore, on the basis of this research one is able to assume, with an error margin of 5%, that in Arnhem scattered green is rated significantly lower than larger green spaces.

Summary Data

	N	Mean	Std. Deviation	Std. Error Mean
Scattered Green	114,000	5,184	1,544	,145
UGS >20 mapped points	275,000	6,119	1,069	,064

Independent Samples Test

	Mean Difference	Std. Error Difference	t	df	Sig. (2-tailed)
Equal variances assumed	-,935	,137	-6,839	387,000	,000
Equal variances not assumed	-,935	,158	-5,903	159,784	,000

Hartley test for equal variance: F = 2.086, Sig. = 0.0000

95.0% Confidence Intervals for Difference

	Lower Limit	Upper Limit
Asymptotic (equal variance)	-1,203	-,667
Asymptotic (unequal variance)	-1,245	-,624
Exact (equal variance)	-1,203	-,666
Exact (unequal variance)	-1,247	-,622

Table 4.12 Rating of Scattered Green versus green spaces with more than twenty mapped locations

Frequency of visits

Table 4.13 shows us the Independent Samples Test of the visit frequency of green spaces. The mean visit score both scattered green locations as locations in larger green spaces are around 3.5 which lies exactly between a visit frequency of a couple of times per month (3) and a couple of times per week (4). The data shows that locations within larger green spaces are slightly more often visited (mean difference of -0,059). With a p-value of 0,611(equal variances assumed as Hartley test provided a p < 0,05), which is far above 0,05 the independent samples test provides that, with 95% confidence, we can conclude that the mean difference is not statistically significant. Therefore, this research does not highlight distinctive visit frequency patterns between scattered green spaces and larger greens spaces.

Summary Data

	N	Mean	Std. Deviation	Std. Error Mean
Scattered Green	114,000	3,523	1,144	,107
UGS >20 mapped points	275,000	3,582	,992	,060

Independent Samples Test

	Mean Difference	Std. Error Difference	t	df	Sig. (2-tailed)
Equal variances assumed	-,059	,116	-,509	387,000	,611
Equal variances not assumed	-,059	,123	-,480	186,858	,632

Hartley test for equal variance: F = 1.331, Sig. = 0.0308

Table 4.13 Frequency of visits scattered Green versus green spaces with more than twenty mapped locations.

Travel distance to scattered green.

In order to test the variable of travel distance, a different sub selection is used than in the previous tests. As the mean travel distance is highly influence by outliers, a choice has been made to only include scattered green spaces which are within, or in the direct vicinity of one of the three targeted neighbourhoods. Simultaneously, the sub selection of mapped points in larger green spaces has also been reduced to only include points in the '*Big 3'* Klarenbeek, Sonsbeek and the Uiterwaard, as these three green spaces are also all location in, or next to one of the targeted neighbourhoods. On average respondents lived 329 metres away from their mapped scattered green space location, while the mean distance between mapped points inside of larger green spaces and the residence of the respondent is 936 metres (Table 4.14). A mean difference of -606,368, together with a Std. Error of the mean difference of 187,344 suggest that this difference may be statistically significant, which is confirmed by the p-value of 0,001 (equal variances assumed), as well as supported by the fact that the upper and lower limit of the 95% confidence interval is below 0, meaning that on is able to conclude with 95% confidence that the exact mean difference between travel distance to scattered green and larger green spaces is somewhere in between -239 and -973 metres. Therefore, the Independent Samples Test shows that this difference is, with an error margin of 5%, statistically significant.

Summary Data

	N	Mean	Std. Deviation	Std. Error Mean
Scattered Green	89,000	329,136	502,757	53,292
UGS >50 mapped points	174,000	935,504	1728,960	131,072

Independent Samples Test

	Mean Difference	Std. Error Difference	t	df	Sig. (2-tailed)
Equal variances assumed	-606,368	187,344	-3,237	261,000	,001
Equal variances not assumed	-606,368	141,492	-4,286	222,948	,000

Hartley test for equal variance: F = 11.826, Sig. = 0.0000

95.0% Confidence Intervals for Difference

	Lower Limit	Upper Limit
Asymptotic (equal variance)	-973,556	-239,180
Asymptotic (unequal variance)	-883,687	-329,049
Exact (equal variance)	-975,267	-237,469
Exact (unequal variance)	-885,201	-327,535

Table 4.14 Distance in metres between residence and mapped location. Scattered green versus larger green spaces.

Concluding: Accepting the H1 hypothesis on using scattered green

Scattered green is rated significantly lower than larger green spaces, and people travel on average further to visit larger green spaces. However, no differences can be found between the visit frequency of scattered green spaces in comparison to mapped locations in larger green spaces. Therefore, evidence exists to reject H0 in favour of H1, nonetheless the outcomes of previous analyses have not provided a consistent image, which leaves opportunities for further research open.

4.7 Conclusion

The survey of this research has yielded 197 respondents who collectively mapped 497 mapped locations. Despite underrepresentation of people with a migration background as well as lower educated people, the survey has been able to reach a relatively broad spectrum of respondents. The biggest hiatus regarding representation is the abstinence of respondents from Immerloo II, a neighbourhood solely consisting of large blocks of flats, housing relatively many people of demographics underrepresented in this research.

Geographically, a large part of the 497 mapped points is located in either of two belts, one south of the Rhine river overlaying greenspaces such as Meinerswijk, the Uiterwaard and Stadswallen Malburgen-Oost, and one belt Northeast of the city centre of Arnhem, from Sonsbeek eastwards via Klarenbeek to Angerenstein.

A total of sixteen green spaces could be identified which have yielded five or more mapped locations, three of them yielded more than sixty, which are the Uiterwaard, Park Klarenbeek and Park Sonsbeek. These three parks are all large green spaces located next to either of the three neighbourhoods. Besides these three large urban green spaces, other smaller green spaces which have yielded a relatively substantial number of mapped points are Angerenstein, Onder de Linden and Stadswallen Malburgen-Oost.

The data shows a large distinction between more 'natural' parks such as Meinerswijk and Klarenbeek, and 'classic' man-made urban parks such as Sonsbeek and Onder de Linden. *Natural* parks are generally visited more often, rated higher, and have accumulated a higher quantity of functions and values than the *classic* green spaces. Besides the quantity of functions, *natural* urban green spaces are also used and valued for distinct functions and qualities than more *classic* urban green spaces. The latter tends to be more used for social activities and valued for its proximity to home and its' facilities, while *natural* urban green spaces are more used to exercise and experience nature and are more valued for its aesthetics and peace. Of course, this distinction is not black and white, but a general trend is very noticeable.

This research has not been able to find evidence which suggests that people without access to a private garden use and experience urban green space in any different way, they do not rate their mapped green spaces differently, do not visit their mapped locations more of less often and do also not travel further or less further to their mapped locations in comparison to respondents with access to a private garden. However, this research has been able to claim significant differences in how scattered green spaces are used and experienced in comparison to larger green spaces. Mapped locations in green space smaller than 5ha tend to be rated lower and are located significantly closer to the residence of the respective respondent. Despite the relation between size of green space and visit frequency not being statistically significant, enough evidence exists to claim on the basis of this research, which scattered green spaces are used and experienced differently than larger green spaces.

5. Usability of Survey123 in participatory research

This chapter discusses and reviews of the used method of data collection, Survey123, and therefore seeks to answer the sub-question of this research: *"To what extent has Survey123 proven to a usable and user-friendly tool to get good representation in PGIS research?"* As the title of this chapter suggest, the main topic of discussion in this chapter is the utilization of Survey123. Besides the utilization of this software, other factors of data gathering, such as the survey questions, approaching respondents and the delineation of the research area will be discussed in this chapter.

This chapter is divided into two main paragraphs, the first paragraph focusses on the experience of the researcher, starting from the moment of survey creation, along the distribution phase, up until the analysis of the gathered data. The second paragraph of this chapter mainly focusses on the user experience of the respondents, and which implications this has had for the research in general.

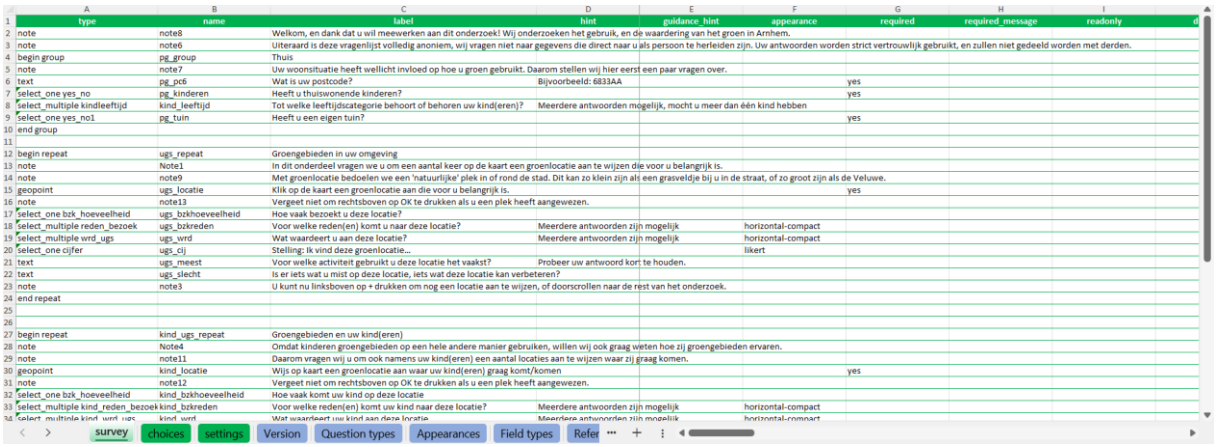
5.1 Survey123 for the researcher

Survey 123 is an online questionnaire tool created by Esri, the mother company of ArcGIS, in order to be able to include geographical data into an online survey in an easier manner. As Survey123 uses the same software as ArcGIS, it ensures an easy transfer of raw data to ArcGIS, which should be directly usable for analysis.

Survey123 is not exclusively nor particularly created for an academic purpose, it is also utilized in corporate or public service environments. For instance, a plumber who needs to map all the faulty drains in a certain area could use a simple Survey123 questionnaire, consisting of one box to map a location, and one textbox to specify any remarks. Another example: during the distribution process of survey invites regarding this research, another simple Survey123 questionnaire has been used to map all streets which were already finished, which helped making sure no house received two nor zero survey invites per accident.

5.1.1 Opportunities provided by Survey123

Creating a survey with Survey123 can be done via two methods; ArcGIS online provides a web-tool in which a basic questionnaire can be made quite easily. For instance, when only one datapoint needs to be mapped, and a couple of simple questions need to be answered in regard to them. When a more comprehensive survey is needed, one needs to create a survey using *Survey123 Connect*, which is a software tool made by Esri in which one creates a survey is programmed in Microsoft Excel using codes and formulas. This allows you to create more complex questionnaires, in this case a questionnaire in which potentially multiple datapoints need to be mapped. Although this coding process requires some expertise, it is quite straightforward and user friendly. Especially in an academic context the cognitive challenge which is required to create a survey is not too big, making it therefore a suitable option for PGIS researchers to utilize.



	A	B	C	D	E	F	G	H	I
1	type	name	label	hint	guidance_hint	appearance	required	required_message	readonly
2	note	note8	Welkom, en dank dat u wil meewerken aan dit onderzoek! Wij onderzoeken het gebruik, en de waardering van het groen in Arnhem.						
3	note	note6	Uiteraard is deze vragenlijst volledig anoniem, wij vragen niet naar gegevens die direct naar u als persoon te herleiden zijn. Uw antwoorden worden strict vertrouwlijk gebruikt, en zullen niet gedeeld worden met derden.						
4	begin group	pg_group	Thuis						
5	note	note7	Uw woonsituatie heeft wellicht invloed op hoe u groen gebruikt. Daarom stellen wij hier eerst een paar vragen over.						
6	text	pg_pc6	Wat is uw postcode?	Bijvoorbeeld: 6833AA			yes		
7	select_one yes_no	pg_kinderen	Heeft u thuiswonende kinderen?				yes		
8	select_multiple kindleeftijd	kind_leeftijd	Tot welke leeftijdscategorie behoort of behoren uw kind(eren)?	Meerdere antwoorden mogelijk, mocht u meer dan één kind hebben					
9	select_one yes_no1	pg_tuin	Heeft u een eigen tuin?				yes		
10	end group								
11									
12	begin repeat	ugs_repeat	Groengebieden in uw omgeving						
13	note	Note1	In dit onderdeel vragen we u om een aantal keer op de kaart een groenlocatie aan te wijzen die voor u belangrijk is.						
14	note	note9	Met groenlocatie bedoelen we een 'natuurlijke' plek in of rond de stad. Dit kan zo klein zijn als een grasveldje bij u in de straat, of zo groot zijn als de Veluwe.						
15	geopoint	ugs_locatie	Klik op de kaart een groenlocatie aan die voor u belangrijk is.				yes		
16	note	note13	Vergeet niet om rechtsboven op OK te drukken als u een plek heeft aangewezen.						
17	select_one bzk_hoeveelheid	ugs_bzkhoeveelheid	Hoe vaak bezoekt u deze locatie?						
18	select_multiple reden_bezoek	ugs_bzkreden	Voor welke reden(en) komt u naar deze locatie?	Meerdere antwoorden zijn mogelijk		horizontal-compact			
19	select_multiple wrd_ugs	ugs_wrd	Wat waardeert u aan deze locatie?	Meerdere antwoorden zijn mogelijk		horizontal-compact			
20	select_one cijfer	ugs_cij	Stelling: Ik vind deze groenlocatie...			likert			
21	text	ugs_meest	Voor welke activiteit gebruikt u deze locatie het vaakst?	Probeer uw antwoord kort te houden.					
22	text	ugs_slecht	Is er iets wat u mist op deze locatie, iets wat deze locatie kan verbeteren?						
23	note	note3	U kunt nu linksboven op + drukken om nog een locatie aan te wijzen, of doorscrollen naar de rest van het onderzoek.						
24	end repeat								
25									
26									
27	begin repeat	kind_ugs_repeat	Groengebieden en uw kind(eren)						
28	note	Note4	Omdat kinderen groengebieden op een hele andere manier gebruiken, willen wij ook graag weten hoe zij groengebieden ervaren.						
29	note	note11	Daarom vragen wij u om ook namens uw kind(eren) een aantal locaties aan te wijzen waar zij graag komen.						
30	geopoint	kind_locatie	Wijs op kaart een groenlocatie aan waar uw kind(eren) graag komt/komen				yes		
31	note	note12	Vergeet niet om rechtsboven op OK te drukken als u een plek heeft aangewezen.						
32	select_one bzk_hoeveelheid	kind_bzkhoeveelheid	Hoe vaak komt uw kind op deze locatie						
33	select_multiple kind_reden_bezoek	kind_bzkreden	Voor welke reden(en) komt uw kind naar deze locatie?	Meerdere antwoorden zijn mogelijk		horizontal-compact			
34	select_multiple kind_wrd_ugs	kind_wrd	Wat waardeert uw kind aan deze locatie	Meerdere antwoorden zijn mogelijk		horizontal-compact			

survey | choices | settings | Version | Question types | Appearances | Field types | Refer

Figure 5.1 Screenshot of the tabs in Microsof Excel required to code a survey in Survey123

Survey123 provides a broad array of opportunities for the researcher to gather data. This research has solely collected pointdata, and respondents were only asked to answer relatively simple and straightforward questions. However, Survey123 offers more than that; besides pointdata it it also possible to let respondents draw lines or even polygons. On top of that, Survey123 also offers the possibility to let respondents take and upload pictures, scan a bar/QR-code, or upload a file to the survey.

An oversight of the gathered data is directly available on the portal of ArcGIS online, making it possible for the researcher to get insights into the results during the process of data gathering. Making it possible to make real-time adjustments when certain questions gather a lot of non-response or are often interpreted falsely. After the survey is closed, the data can be downloaded into shapefiles which are directly usable in ArcGIS Pro.

Other uses of Survey123

Using PGIS methods for the visualisation of green space usage does not exclusively mean the visualisation of quantitate data. Besides quantifiable questions, this survey also gave respondents the option to write own remarks regarding each green space. Most respondents only mapped one or two locations and skipped the optional open questions. However, some respondents took the time to map a bit more locations and provide personal remarks to each one of them.

The best example of this is Respondent X, a woman fifty-six of age, living in Klarendal without kids in an apartment without a private garden. Respondent X has mapped eight locations, one south of the river Rhine and seven north of it (Figure 5.2). Respondent X lives remarkably close to Onder de Linden and has mapped two locations; in the western part, close to the petting zoo, she goes to picknick and meet friends, while the eastern part is solely a place she walks by often. In Onder de Linden she would like the public toilet to be open for longer, and she finds it a shame that part of the green space has been sacrificed for electrical cabinets.

Figure 5.2 shows nicely how each green space has a slightly different function, in Zijpendael she plays cricket with her friends, while the Uiterwaard is a place to hike and drink a coffee. Places close by are used for social functions and to cool off in summer, while she goes a bit further away to experience nature and exercise. These things come together in park Klarenbeek and the Braamberg, in which it is possible to experience nature without having to travel far, which she rates highly.

Therefore, survey123 could also be utilized in qualitative research methods. As the software offers a broad spectrum of question types, it could also be used to conduct longer, more interview-like, questionnaires, in which respondents can map more locations, and provide more in-depth answers via text, photo, video or even audio files. Figure 5.2 shows only the beginning regarding the qualitative possibilities of utilizing Survey123 in green space research.

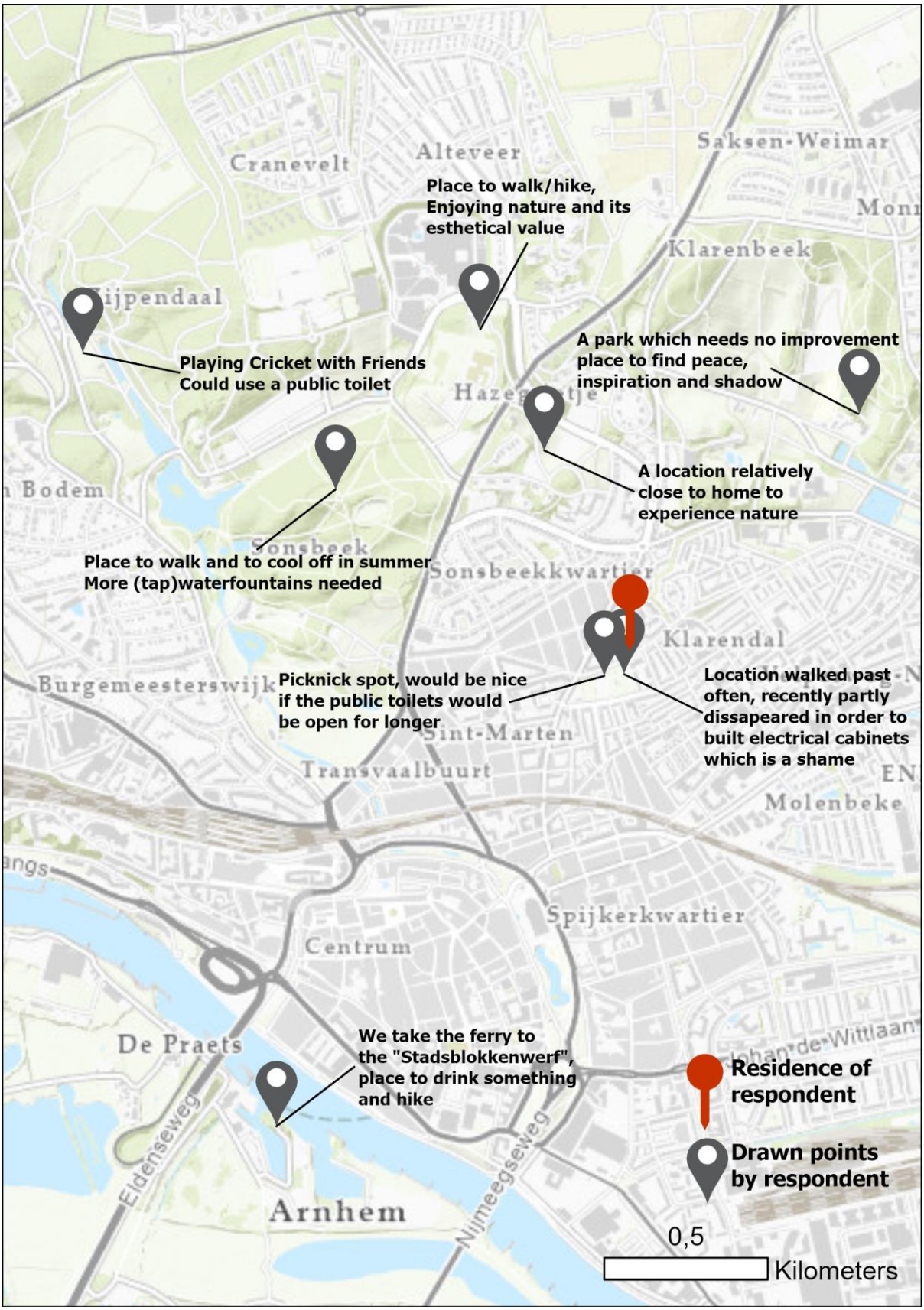


Figure 5.2 Portfolio of green spaces of Respondent X

5.1.2 Difficulties and considerations regarding Survey123

When creating a longer, more extensive, survey using Survey123 one should keep a couple of things in mind in order to prevent problems or unnecessary difficulties when analysing data. If one wants to create a survey in which multiple locations are mapped, so-called 'repeats' are required, which are loops within the survey that act as mini surveys in itself, resulting in separate data points, with their own attributes. Therefore, one should afterwards be able to join the separate datafiles back together, which is possible via the 'parentglobalID', which links each repeat back to its original survey. However, this means that no other properties of different repeats should be equal to each other, as these properties can afterwards not be differentiated when merged together. For instance, when the respondents is asked in the first part of the research, as well as in the 'repeat' to give a rating to two different things, and both question are coded using the label 'Rating', ArcGIS will have a hard time differentiating these different questions as different values, as they are allocated the same label.

As well as the challenge in creating a survey with multiple geodata points, a separate difficulty faced in this research was the problem regarding locating the residence of the respondents. In order to preserve anonymity, respondents were not asked to map exactly where they live, instead they were asked to fill in their zip-code. However, survey123 does not recognize a Dutch zip-code directly as a geographical location. Therefore, one should find a workaround in which a zip-code is directly converted to a geoshape or find a different solution to create insight in where a resident approximately lives, without invading their privacy. Because of this, the main part of the survey, without the repeats (the mapped greenspaces, which are in a different shapefile), did not included a geolocation directly recognizable for ArcGIS, therefore locating all shapefiles at the 0.00°, 0.00°coordinates. As this could not be altered later on, in this research it was necessary to create a different shapefile containing the locations of each zip-code in which all responses needed to be linked to by hand. A time-consuming process.

Another hitch in the process was a clear fault on the part of the researcher, however still something to definitely keep in mind. In the case of multiple-choice questions, Survey123 and therefore ArcGIS automatically recognizes these as non-numeric data. Multiple questions using a likert-scale or another form of numerical data had been created, however ArcGIS does only recognize this as text data, making any form of numerical analysis impossible without converting this data by hand, which has also been quite a time-consuming process.

A last challenge Survey123 provided relates to the way data is stored and the transfer opportunities of the data to other software. Because of certain aspects of the survey and its data storage, it has been hard to transfer (part of the) data to other data analysis-software, such as SPSS. Regarding questions that could receive more than one answer, for instance the question in which respondents were asked to provide one or multiple functions of their mapped location, each individual function was transferred to SPSS as a separate object. As the number of functions per mapped location differed, as well as the fact that not all respondents were required to fill out each question, streamlining the data in SPSS required quite some effort. In the end only simple analyses were possible to be conducted, such as testing mean differences using descriptive data provided by ArcGIS. If one is interested to utilize geographical data in such a way that in depth statistical analysis is also possible, one should set up the survey in such a way that data is easily transferable to SPSS. This aspect was not regarded in this research, as in the test phase of survey creation, only the transferability to ArcGIS was tested.

Concluding remarks

Survey123 offers a blank canvas with many opportunities for researchers to gather data fitting to their research goals. As well as gathering quantitative, numeral data, Survey123 can also be a fitting tool to gather other forms of response, more suitable for qualitative or mixed-methods research. However, as the software is such a blank canvas, creating a survey can be somewhat of a technical challenge that requires some expertise. During this research, a lot of mistakes or challenges were made which would be easily prevented if it were beforehand known or realised that these complications would come up. Therefore, when using Survey123 it is recommended to familiarise oneself very well with the potential challenges and hitches this survey provides. On top of that, as some hitches regarding the usability of the data came up after the data was downloaded, extensive testing of the usability of the data the survey provides, before launching the survey to the respondents is recommended.

5.2 Survey123 for the respondent

As discussed, by Brown (2012), one of the biggest challenges in PGIS research is the cognitive challenge provided by many PGIS methods. Transforming mental maps to usable data via digital, as well as analog methods, can be challenging for respondents, as it requires them to answer questions about somethings abstract concepts using geographical methods. This paragraph will reflect on the usability of Survey123 in this context, how user friendly has the software been for the respondents?

5.2.1 Positive remarks regarding Survey123 as a digital PGIS method

As the survey has yielded sufficient response, almost two hundred respondents who have collectively mapped close to five hundred locations, at least a significant group of respondents have been able to successfully complete the survey. Of course, no data is available regarding the number of failed- or aborted attempts, so one can only guess how many potential respondents have tried to fill out the survey.

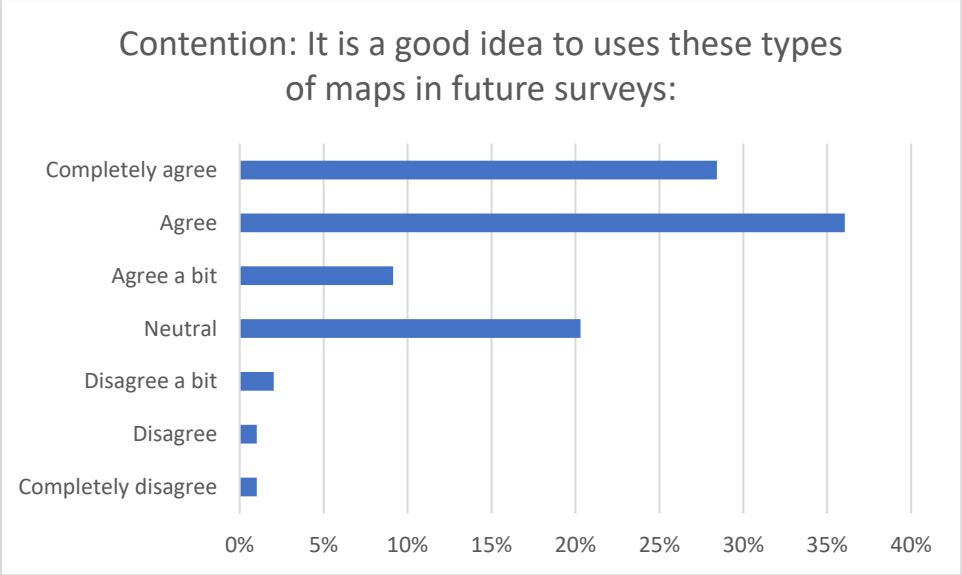


Figure 5.3 Distribution of response regarding the question whether it is a good idea to use PGIS in digital surveys.

A large part of the respondents who succeeded to complete the survey stated that they liked this way of participation. 73,61% of respondents at least agreed a bit with the statement that it is a good idea to use mapping-based questions in future questionnaires, while only 4,04% of the respondents responded negatively to this statement (Figure 5.3). At the end of the survey respondents were asked via an open question if they have any final remarks regarding the survey or the topic of research in general. A couple of respondents stated they were pleasantly surprised by the interactive nature of the survey.

"Surprising research… Great initiative"

On top of that 81,22% of the respondents stated it was a quick and straightforward process for them to find their locations on the map (figure 5.4). Therefore, it appears that the technological challenge for respondents to use these maps has not been too big. However, selection bias plays most probably a crucial role in this regard, as this research has only yielded responses from people who were able to successfully submit the survey. People who found the maps to be too daunting or were not able to map a location successfully and therefore aborted the survey, have obviously not been able to share their opinion via this survey.

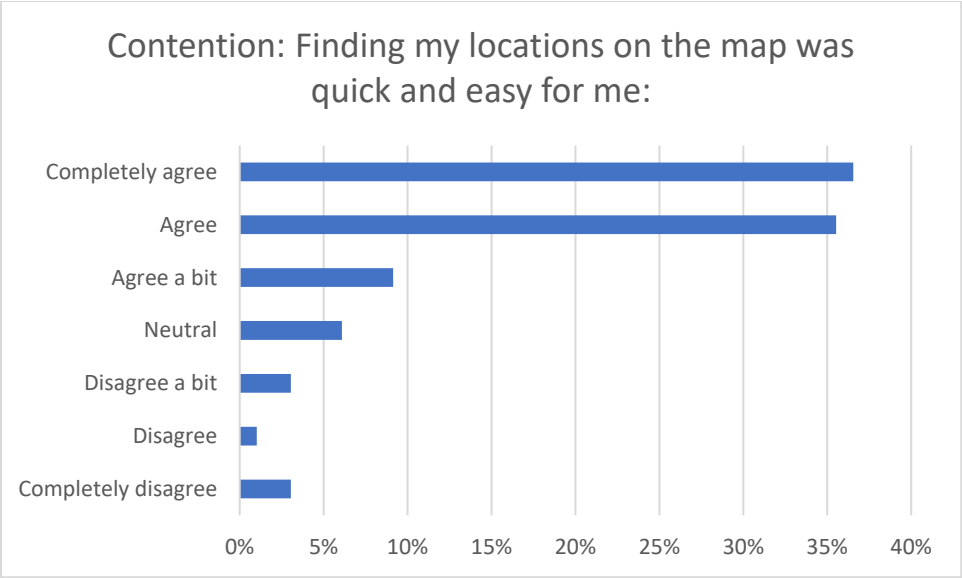


Figure 5.4 Distribution of response regarding the question whether respondents could easily find their locations on the map.

5.2.2 Challenges provided by Survey123 for the respondent

Besides positive remarks, the questionnaire – and therefore Survey123 – has also received criticism form respondents. Especially regarding technical factors, and the feedback Survey123 gives out once something goes wrong. The biggest issue regarding the usage of Survey123 draws back on the user experience for respondents. Besides the issue whether respondents are fundamentally able to complete the survey, the software has been too daunting in itself. As mentioned, no data on failed attempts is available, however a lot of questions were not answered, and multiple e-mails have been received of respondents not being able to map points or submit the survey.

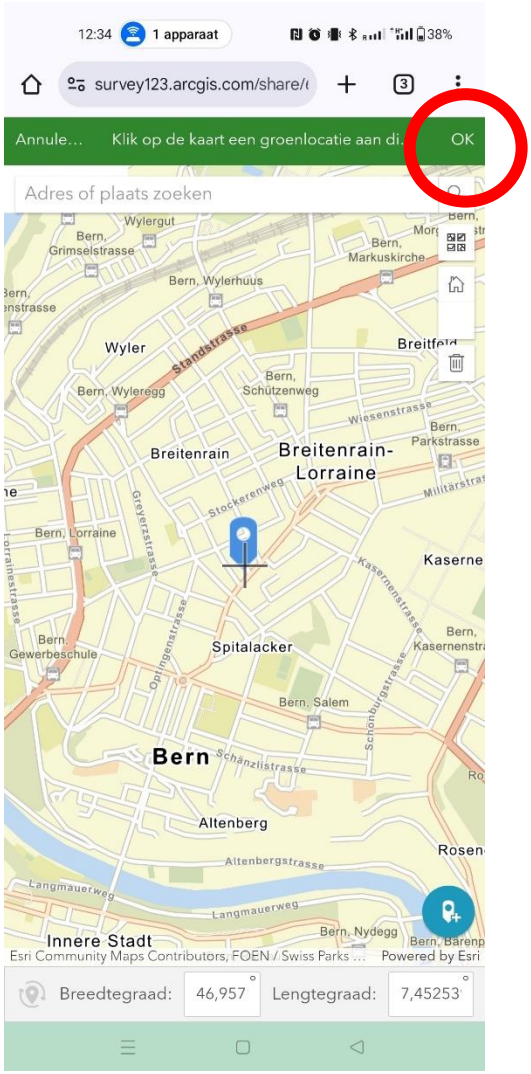


Figure 5.5 Screenshot of survey's mapping tool

These e-mails suggest a sizeable portion of respondents not successfully completing the survey, as it is very likely that a lot of respondents simply aborted the survey without sending an e-mail. These digital barriers could even be partly an explanation for the higher response of higher educated people, as they are maybe better adjusted to these types of surveys. However, this claim is of course hard to consolidate.

What stays is a problem with the software, when tested on family and friends, a lot of them also had a hard time successfully completing the survey. People who just got an invite in their letterbox will also quit a lot sooner when the experience using the software is not a user-friendly one. Typical problems were the needing to

save each mapped location, which was only possible by pressing a small button in the top right corner (figure 5.5), something not able to alter by the creator of the survey. This was often overseen by respondents, resulting in no mapped location, thus an error messaging when submitting the survey, or a location mapped at the coordinates 0.00°, 0.00°.

"… I really want to participate; however, I have not been able to safe locations whenever I zoom in and press "OK" in the green bar…." [E-mail received on 12-7-2023 13:14]

On top of that, respondent's device had allowed location sharing in order for the respondent to be able to use the maps, which some respondents have turned off. This had led to confusion by some respondents, as they did not understand the error message by Survey123. Some respondents even thought they had already allowed their location to be shared by participating in this research and filling in their zip-code.

"… filled in everything, no error pop-up. Just the app stating I have not shared my location… however I did that definitely, as I have shared my zip-code…" [E-mail received on 13-7-2023 13:32]

Another hitch regarded people had problems submitting in the survey. Survey123 was quite unclear when a respondent forgot to fill in a question. The respondent would only receive the pop-up that not everything has been filled in correctly, Survey123 did not state which question was missing. However, it was not possible to submit a survey when an obligatory question was not filled in.

"… At the end your survey does not submit, in any case, the button "send" does not give any response… "[E-mail received on 12-7-2023 21:20]:

To tackle this problem, a deliberate choice has been made to make as little questions as possible obligatory. This has resulted in less respondents not being able to submit the survey, however this has also resulted in a way larger non-response on questions, which lowers the reliability of the research.

Concluding remarks

The whole creation of the survey has been a constant trade-off between wanting to get enough usable data out of the respondent by correctly guiding them through the survey, without overflowing them with too much information and instructions making the entire process too daunting or unappealing. A more user-friendly interface, or in any case the possibility to be able to alter more of the interface of the survey to better suit the respondent could in future studies lower the non-response and null values in the dataset. Especially regarding the feedback Survey123 gives when something goes wrong (location sharing turned off, missing answers, etc.), there is a world to win. As it stands now, Survey123 shows exciting potential as an PGIS-tool, but lacks user-friendliness in order to be applied properly in research accommodating to every member of a community, as technological barriers are still too high for a significant share of respondents.

5.3 Conclusion

Survey123 provides a lot of potential to be utilized in Participatory GIS research, as it gives the researcher much freedom and many options regarding the creation of survey questions. One is easily able to include multiple datapoints per respondent, which are separately analysable, therefore Survey123 allows the researcher to get as much data as possible out of each respondent. This variety in data-gathering makes Survey123 even suitable to conduct qualitative research. However, this freedom also comes with a price, as the researcher is expected to manually create the survey via coding, the researcher should know very well what they are doing, as mistakes are made easily. In order to be sure, the data is maximally exhaustible, researchers should test the survey extensively. Going even as far as doing probe-analyses with made up data extracted from the survey could be wise, as some problems hitches with the data in this research only surfaced after downloading the data into ArcGIS or other software systems.

Unlike the data-technical aspects of the survey, in which extensive alterations were possible, regarding the interface of the survey little to no alterations were possible. As the standard interface of Survey123 has not been deemed as user-friendly by a lot of respondents, this has led to numerous problems. Allowing researchers to alter items such as the size and interface of certain buttons or the text of error pop-ups, the researcher would be able to create a better fitting user-experience for the respondent. In the case of this research, a lot of respondents had difficulties regarding the technical challenge of saving the mapped locations, turning on data-sharing on one's device and filling-in all the obligatory questions. As this research also points out that a large share of respondents stands positively towards participatory mapping questions in survey's and have not found the mapping in itself as to daunting. A more user-friendly interface, or in any case the possibility for the researcher to be able to alter the interface would allow the researcher to create an environment that suits the target-audience best, would allow PGIS research using Survey123 to reach its full potential.

6. Conclusion and discussion

In this chapter, a definitive answer will be formulated to the following main question of this research:

> *"What are the perceived non-monetary values of urban green space in Arnhem, as mapped by residents using Survey123, a new mapping & survey instrument in ArcGIS that is enabling new ways of conducting PGIS research?"*

The answer to the main research question will be crafted alongside the following sub-questions.

(I) How are green spaces in Arnhem used?
- *a. Which green spaces are visited by the most people?*
- *b. How often are green spaces visited?*
- *c. For which functions are green spaces used?*

(II) How are green spaces in Arnhem valued?
- *a. How are green spaces rated? Which green spaces stand out, positively as well as negatively?*
- *b. For what qualities are green spaces valued?*

(III) To what extent has Survey123 proven to be a usable and user-friendly tool to get good representation in PGIS research?
- *a. What are the potential downfalls, and other considerations regarding the usage of this PGIS tool in UGS research?*
- *b. Is Survey123 an usable and fitting tool for an academic researcher?*
- *c. Is Survey123 user-friendly and accessible enough to conduct research on a group of respondents with varying technological and intellectual abilities?*

Afterwards, the formulated answers, as well as the process of this research, will be discussed furthermore, leading to recommendations for further research.

6.1 Answering the research question

In this paragraph the three sub-questions of this research will be answered thoroughly. Afterwards, on the basis of these sub-questions, a final answer to the main research question will be formulated.

6.1.1 Usage of green space in Arnhem

The first research question of this research is the following: *How are green spaces in Arnhem used?*

In Arnhem three green spaces stand out regarding the number of mapped locations they have yielded, these are Park Sonsbeek, the Uiterwaard and park Klarenbeek. Besides these three large green spaces, other, smaller, green spaces that stand out are Stadswallen Malburgen-Oost, Onder de Linden, Veerpolderstraat and Park Burgermeester Bloemerweg (Figure 4.6). The Uiterwaard and Klarenbeek are more *natural* green spaces, meaning they have more rural characteristics and less man-made elements, while Sonsbeek is more of a classic *man-made* urban park, with more facilities such as benches or public toilets. Throughout the whole dataset, the distinction between 'natural' and 'made-made' green space, as previously elaborated by Massoni et al. (2018), is quite striking; natural green spaces are more often visited and used for distinct functions. Natural green spaces are more used for more daily functions such as exercise and finding peace. Man-made parks are more used for social activities.

The differentiation between inner-city green spaces and green spaces on the outskirts of the city, as described by Phillips et al. (2021), is difficult to test using the case of Arnhem, due to the distinctive geography of Arnhem. To illustrate this, the Uiterwaard, Klarenbeek and Sonsbeek (the 'big three') are all located in the city of Arnhem and at the same time these spaces are as well connected – sometimes via other green spaces – to rural area. Therefore, one could argue that these parks are inner-city green spaces, as well as green spaces at the outskirts of the city.

This research finds similar patterns to Schipperlijn et al. (2010) regarding travel distance and size of green spaces, in which people tend to travel further to larger green spaces (Figure 4.14), and regarding the compensation effect of size and visit frequency (Łaszkiewicz et al., 2022) (Figure 4.9 & 4.10). Smaller green spaces receive less unique visitors, but visitors who do visit smaller green spaces tend to come more often, resulting in a higher visit factor.[6]

Furthermore, has this research been able to proof that scattered green spaces (<5ha) are experienced significantly different than larger green spaces. Larger green spaces are rated higher, and people are travelling further to visit larger green spaces. However, people are not visiting larger green space more- or less often. The relationship between size and usage of urban green spaces has been tested before. Some outcomes of this research are in line with previous research the 'pull-effect' of green spaces larger than 5ha (Schipperlijn, Stigsdotter, et al., 2010). This has been confirmed by this research, as well as the fact that scattered green spaces are more used as stops alongside a route, relatively often used for social activities but less for other functions (Peschardt, Schipperijn et al., 2012) (Table 4.5).

One could expect people without access to private gardens to make more, or in any case different, use of urban green space than people who have access to a private garden. However, this research has not been able to uncover inherent differences in how green spaces are used between people with access to a private garden, and people who do not have access to a private garden. These findings are partly in line with previous research, as previous research has only found evidence that

[6] These specific findings relate to the general relation between size and visit frequency, not to the specific case of scattered green spaces, in which no significant difference in visit frequency could be found.

suggest green space is even more used by people with access to private gardens (Barbosa, Tratalos et al. 2007, Misiune, Julian et al. 2021).

6.1.2 Valuation of green space in Arnhem

The second research question of this research is the following: *"How are green spaces in Arnhem valued?"*

Green spaces in Arnhem are generally rated quite high (5.83 out of 7). However, one should keep in mind that selection bias plays a role in this part, as participants decided themselves which location they mapped, and which they did not map. It is therefore likely that participants predominantly mapped locations that they like visiting, instead of locations they avoid as they do not like to be there. Larger, natural green spaces such as Meinerswijk and Klarenbeek are rated the highest, while smaller in-neighbourhood green spaces such as Onder de Linden are rated generally lower (Figure 4.20). These findings are in line with previous studies, which have pointed out the positive relation between natural character of an urban green space and its rating (Ives et al., 2017).

A location being close to home and the aesthetical qualities of a location are most often mentioned as a quality of the green space, followed by nature experience and enough space for activities (Table 4.8). The possibility for activities, and the natural experiencing being often mentioned as important qualities of an urban green space has previously been highlighted in multiple studies (Rall et al., 2019, Misune et al., 2019). The proximity to one's home being one of the most important qualities of green space, has not been highlighted as much in other studies as this one has provided.

6.1.3 Usability of Survey123 in PGIS research

The third research question of this research is *"To what extent has Survey123 provided to be a usable and user-friendly tool to get good representation in PGIS research?"*

In comparison to other assessment methods, participatory mapping surveys have proven to be a valuable assessment method in gathering community information regarding urban green spaces. The utilization of participatory mapping tools in quantitative research ensures a more just and comprehensive assessment, it creates a better understanding of (cultural) ecosystem services and can provide more detailed pictures of spaces (Rall et al., 2019).

Although being acknowledged as a promising method to yield geographical knowledge from citizens, this method is not perfect yet. As well as issues regarding diversity and representation – a common theme in participatory research methods – not all aspects of UGS research are suitable for participatory research (Schuurman, 2009). Certain aspects of green spaces research are more difficult to approach via PGIS methods, as some topics require a larger cognitive challenge for respondents, for instance ecosystem services or environmental impacts (Brown, 2012). One should therefore seek to create a survey that is as accessible as possible, otherwise participatory mapping tools can even enlarge the lack of representation of certain demographics. Besides these barriers, the usage of digital participative mapping methods does not magically solve the issue of non-response in survey-based research. This means that, in order to get a fine grained a representative image, researchers still need to find ways to target social groups often underrepresented in (quantitative) research.

Although the goal of diverse representation has not been reached completely – as residents with a migration background, and lower-education levels are still underrepresented – this research has been able to get good response in low-SES neighbourhoods. On top of that, the iterative strategy has resulted in a strong representation of households without a garden, making it possible to test one of the hypotheses of this research in a good manner. However, despite including all buildings in this area, no respondents residing in Immerloo II have been reached, a neighbourhood solely made up of

high-rise flats, acknowledged as the most deprived neighbourhoods of Arnhem. Although we would argue that this research has set a significant step in the right direction regarding representation in (PGIS) survey research, this method is no panacea. Therefore, one should ask the question why underrepresentation is still a problem in this survey.

A relevant factor could be the digital literacy it required in order to successfully complete the survey. Digital (il)literacy is always a consideration when conducting quantitative research using digital methods (Elwood, 2009), as there are vast discrepancies regarding digital literacy amongst the Dutch population, which is not likely to decline in the coming years. Therefore, when using digital methods such as Survey123, it is of high importance to make these tools accessible, removing digital barriers as much as possible. In the current form, Survey123 has not proven to be a user-friendly tool for the broad population. Multiple hard-to-solve problems could pop-up during the process of filling in the survey, leaving a substantial part of the respondents not being able to submit their answers. As a dozen participants have complained via e-mail that they were not able to submit the survey, one can assume that the real number of people not being able to submit the survey is even a lot higher. Therefore, in order for Survey123 to be a PGIS-tool that yields good representation across a whole population, user-friendliness and error-feedback should be enhanced.

Besides the challenges for respondents regarding filling in the survey, using Survey123 for data gathering also provided challenges regarding the data analysis. Via *Survey123 Connect,* the software in which one can create a survey, the researcher has a lot of freedom regarding how the survey is set-up, and how data is stored. However, this freedom leaves a lot of room for error open. If one is not careful when setting-up the survey, numerical values could be stored as text-data, or shapefiles could end-up without a proper geolocation, meaning each datapoint is located at 0.00°, 0.00°. It is therefore highly recommended to test the survey, and yielded the data, extensively before distributing the survey.

6.1.4 Using new PGIS methods to learn about the use and evaluation of UGS

To conclude this paragraph, the main question of this research, *"What are the perceived non-monetary values of urban green space in Arnhem, as mapped by residents using Survey123, a new mapping & survey instrument in ArcGIS that is enabling new ways of conducting PGIS research?"* will be answered accordingly:

The questionnaire conducted using Survey123 has provided a large number of respondents and mapped locations. The data yielded from this survey has helped highlighting the most popular green spaces in Arnhem, the Uiterwaard, Park Klarenbeek and Park Sonsbeek, as well as a couple of smaller green spaces that mostly serve the neighbourhood they are located in, for instance Stadswallen Malburgen-Oost and Onder de Linden.

The data this Survey123 questionnaire has yielded, has offered the possibility to conduct spatial analysis by isolating mapped points not only based on the characteristics of the respective datapoints, but also on the basis of characteristics of the respondent. Highlighting for instance the fact that respondents tended to not cross the Rhine River in order to visit green spaces.

Using the data provided by the questionnaire, this research has been able to uncover key differences between 'natural' parks and 'man-made' parks. Natural parks are rated higher, visited more frequently and are used for more- and contrasting functions than man-made parks. Moreover, this research has proven that *scattered green space* are used and experienced elementally different than green spaced larger than 5ha. And that green spaces in Arnhem are most often used for exercise and

experiencing nature, and most often valued for its proximity to one's home and the aesthetic value of the location.

6.2 Discussion

6.2.1 Contribution to theory building

The data analysis of this research has uncovered a clear disparity between the use and valuation of urban green space consisting of more natural and untouched characteristics, and classic urban parks with a higher prevalence of structural elements. This research is not the first to differentiate between green spaces on the basis of '*naturalness'* and structural elements (Massoni et al., 2018; Ives et al., 2017). However, the case of Arnhem is an interesting case in this regard, as the distinctive geography of Arnhem has created a situation in which large *natural* green spaces – for instance the Uiterwaard and park Klarenbeek – are located in the hearth of the city, in close vicinity to the city centre, and stretch out to the border of the urban area. Most inhabitants of Arnhem live within close proximity to *natural*- as well as *less-natural* green spaces, and can freely choose between visiting either of these types of green spaces every day. In most cities, large *natural* green spaces are only found at the outskirts of the city, meaning that travel patterns and visit frequency are highly influenced by the factor of accessibility. The fact that the findings of this research regarding this distinction are in line with previous research suggest that the difference in valuation and usage between *natural*- and *less-natural* green space is much more inherent, and less circumstantial.

This research therefore forms a bridge between research which differentiates *natural* and *un-natural* green spaces (Massoni et al., 2018; Ives et al., 2017), and research regarding the influence of distance and inner-city geography on green space usage and valuation (Phillips et al., 2021; Schipperlijn et al., 2010). Previous research has shown that people are willing to travel further to larger green spaces, which this research also has proven. However, the naturalness of a green space could be a moderator variable in this regard, as natural green spaces tend to be quite large, and most small green spaces can best be categorized as man-made urban parks. As natural green spaces are valued inherently higher, and used for different purposes, the reason for people to travel further to a larger green space could be because of the naturalness of this space, in which the size of the specific green space is of less relevance. Therefore, this research opens up opportunities for future scholars to further delve into these relationships.

This research has proven that scattered green spaces (<5ha) are used and valued significantly different than larger green spaces. Besides the fact that this outcome is relevant in the general realm of UGS research, as they confirm or build further upon previous research (Schipperlijn, Stigsdotter et al., 2010; Peschardt, Schipperlijn et al., 2012), this research has explored a method to highlight the relevance of scattered green spaces in quantitative research. As individual scattered green spaces are only relevant in a highly local context, very little data regarding an individual scattered green space can be yielded. By creating a collective layer including all mapped points within scattered green spaces, we have been able to include these – often overlooked – green spaces in this research.

The findings within the second realm of this research, exploring the applicability of Survey123 as a participatory mapping tool, are more practical of nature. In regard of theory building, this research further illustrates the findings of Brown (2012), who discusses the cognitive barriers of participatory methods in UGS research. This research's survey has merely included topics which were deemed by Brown as suitable for a PGIS survey, and has concluded that these topics were indeed not too high of a cognitive challenge for the respondents. However, the survey did provide (a too large of) a technical barrier for many respondents. Considering the fact that digital technology is most likely to keep developing, technological barriers in these types of surveys will become an even bigger problem for those who are not able to keep up with these developments. Therefore, besides considerations

regarding the cognitive challenge PGIS surveys can provide for respondents, future research should also consider the technological challenges provided by PGIS survey. This research has given a prelude in this regard, describing multiple pitfalls within the survey. Future research could use this research as one of the building blocks in exploring the pathway to a participatory mapping survey accessible for as many respondents as possible.

6.2.2 Limitations of the research

Besides seeking to get deeper insight into the use and valuation of green spaces in Arnhem, this research has also explored the more elemental questions regarding the use of PGIS methods to get better representation in spatial quantitative research. In this case by applying Survey123 to create a PGIS survey that is accessible to a broad spectrum of respondents. The strength, as well as the weakness of this research can be traced back to the two-legged nature of this research.

One could argue the strength of this research is the fact that it tackled 'real life' issues regarding the use and valuation of green space, it has uncovered which green spaces are popular in Arnhem as well as weak spots in the greens structure of Arnhem, while at the same time it has helped exploring the usability of Survey123 in an academic context. However, as the scope of this research is limited due to it being a Master's Thesis, more remains to be uncovered about both of these domains.

We would argue that the truth lies in between these stances; insights into how to get good representation in participatory research can only be tested by actually doing research, conducting research by only repeating steps which have been previously done, do not bring the science of PGIS any further besides the case-specific outcomes of this research. At the same time, a narrower scope on the data analysis would enhance the outcomes of the data analysis, as we believe it is possible to extract a larger number of valuable outcomes out of this data. Or, by putting a more extensive focus on participatory GIS methods, for instance by reviewing the survey with respondents using qualitative methods or exploring ways to get more insight into the non-response, a more comprehensive research result could be presented.

As discussed in chapter 5, due to problems regarding respondents not being able to submit the survey, a deliberate choice has been made to make as few survey-questions as possible obligatory. Although this choice has most likely limited the number of general non-response, it has resulted in the fact that a lot of answers were left blank, which has made the data less useful.

Although a significant effort has been made to get good representation in this research, some demographics are still vastly underrepresented in this research, this includes people with lower education levels as well as people from migrant backgrounds. As discussed in chapter 2, this is a reoccurring problem in quantitative research in general, as well as in participatory(GIS) research methods, which harms the reliability of the research, as it is hard to make claims regarding the whole population when not all demographics are sufficiently included in this research.

6.2.3 Recommendations for future research

Via quantitative participatory GIS methods this research has uncovered general findings regarding the use and valuation of green space, as well as the applicability of Survey123 as a tool in academic PGIS research. In order to further examine the findings of this research, we would suggest a deeper dive into the distinction between *natural* and *man-made* green spaces. This could be conducted by using a broader scope, for instance by broadening the research area, including respondents from different cities, subdividing all relevant green spaces between natural and man-made, and conduction in-depth data-analysis between these two categories. Or using more detailed, qualitative methods, in which one focusses more on the 'personal portfolio of green spaces', as this could uncover more in detail insights into how certain green spaces are experienced differently than the other.

Furthermore, we would recommend a deeper review of the challenges and limitation of Survey123. Regarding this research the only information available for the researcher, were the reviews of respondents who actually managed to submit the survey and the few who took the time to send an

email. Most likely, the vast majority of people who have had difficulties filling out or submitting the survey have not taken the time to contact us. Therefore, a lot of valuable information regarding non-response to this research remains unknown. Exploring the possibility to be able to track the number of failed or aborted attempts to PGIS surveys would give valuable insights into the nature of non-response regarding Survey123 questionnaires, which provides building blocks for future research to get better representation. Besides tracking and delving deeper into failed or aborted attempts, mixed method research using qualitative methods to review the (quantitative) Survey123 survey could also provide valuable insights into the challenges and opportunities Survey123 has to offer in PGIS research. Lastly, staying at the topic of qualitative research, chapter 5 briefly discussed the potential Survey123 offers regarding its use in a qualitative context, as respondents are able to submit all types of answers, including photos, videos and audio files. Applying Survey123 in research of qualitative nature, further exploring the possibilities of this tool, could therefore also broaden the knowledge regarding the potential of this tool in an academic context.

6.2.4 Recommendations for future practice

Regarding the usage and valuation of green spaces in the case of Arnhem, a big distinction has been identified between 'natural' green spaces, with little to no man-made elements, and classical urban parks with a more man-made element. As these different spaces cater towards different users and usages, a strong and diverse urban green space framework would entail both of these types of green spaces. Classic urban parks can be found in almost every city in the Netherlands, however the quantity and quality of 'natural' urban green spaces such as in Arnhem cannot be taken for granted everywhere. Arnhem's geography and geology, built along the Rhine outerbanks, squashed between the Betuwe and the Veluwe, cater very much towards an UGS-portfolio which includes a lot of natural spaces. These preconditions are most often not present in other middle-sized cities in the Netherlands, for instance cities as Almere, Groningen or Eindhoven are not located in a geological environment as diverse as Arnhem. However, this does not mean that it is not possible to diversify the existing green space portfolio. By incorporating green spaces which predominantly cater towards the functions of exercise and natural experiences, one could enhance the usage and satisfaction of urban green spaces in their respective city.

Considering the case of Arnhem, this research has highlighted the importance of small – scattered – urban green spaces in the portfolio of green spaces. A relatively high number of mapped locations could be categorized as scattered green spaces. However, due to the fact that most of these individual locations are only relevant to the direct environment, most scattered green spaces have not yielded enough data to make sufficient claims regarding the non-monetary values of each specific scattered green space. Therefore in order for the municipality of Arnhem to get insight into the non-monetary values of individual small green spaces, for instance when considering sacrificing small green spaces for the purpose of densifying the housing stock of the city, the city should conduct more detailed and delineated research regarding one or more specific small green spaces. As previously mentioned, Arnhem's particular geography and geology has provided a strong supply of natural spaces within- and close to the city. Green spaces in Arnhem are in general rated very highly, especially the *natural* urban green spaces in Arnhem, such as Meinerswijk or Angerenstein are rated considerably high. This unique portfolio of natural urban spaces is something which Arnhem should cherish, as is enhances the liveability of the city.

In this research, the applicability of Survey123 in the academic context has been tested and discussed. However, this does not mean the outcomes are not valuable outside of the academic context. If the user-experience of Survey123 is enhanced, therefore lowering the technological and cognitive barriers for people filling in the survey, the software could also be useful to conduct a

(participative) study outside of the academic realm. The main problems respondents encountered while filling in the survey were regarding the user-interface of Survey123 leading to confusion, the mapping in itself has not led to major problems for the respondents, as people tend to be quite familiar with their direct environment. Survey123 could also be easily utilized by governmental institutions or other stakeholders to gather geographical community knowledge. One could for instance ask citizens to map dangerous traffic situations or sources of nuisance in their vicinity, or let citizens map preferred locations for new facilities such as public toilets or benches. Therefore, besides the problems regarding the user-friendliness of Survey123 – which are very much solvable – the utilization of Survey123 in a broader citizen-participation context offers a lot of potential.

Bibliography

Abbot, J., Chambers, R., Dunn, C., Harris, T., de Merode, E., Porter, G., Townsend, J., & Wei. (1998). Participatory GIS: opportunity or oxymoron? *PLA Notes*, *33*, 27–33.

Arnhem, G. (2022). *Groenkaart Arnhem*. https://data.overheid.nl/en/dataset/groenkaart-arnhem#panel-description

Barbosa, O., et al. (2007). "Who benefits from access to green space? A case study from Sheffield, UK." Landscape and Urban Planning 83(2): 187-195.

Bartling, M., Resch, B., Eitzinger, A., & Zurita-Arthos, L. (2019). A multi-national human–computer interaction evaluation of the public participatory GIS GeoCitizen. *GI_Forum*, *7*(1), 18–39. https://doi.org/10.1553/GISCIENCE2019_01_S19

Bell, S. (2009). Mental Maps. *International Encyclopedia of Human Geography*, 70–75. https://doi.org/10.1016/B978-008044910-4.00472-7

Bijker, R. A., & Sijtsma, F. J. (2017). A portfolio of natural places: Using a participatory GIS tool to compare the appreciation and use of green spaces inside and outside urban areas by urban residents. *Landscape and Urban Planning*, *158*, 155–165. https://doi.org/10.1016/J.LANDURBPLAN.2016.10.004

Brown, G. (2012). Public Participation GIS (PPGIS) for Regional and Environmental Planning: Reflections on a Decade of Empirical Research. *Journal of the Urban and Regional Information Systems Association*, *24*(2), 7–18.

Brown, G., & Kyttä, M. (2014). Key issues and research priorities for public participation GIS (PPGIS): A synthesis based on empirical research. *Applied Geography*, *46*, 122–136. https://doi.org/10.1016/J.APGEOG.2013.11.004

Brown, G., Schebella, M. F., & Weber, D. (2014). Using participatory GIS to measure physical activity and urban park benefits. *Landscape and Urban Planning*, *121*, 34–44. https://doi.org/10.1016/J.LANDURBPLAN.2013.09.006

Byrne, J., & Wolch, J. (2009). Urban Habitats/Nature. *International Encyclopedia of Human Geography*, 46–50. https://doi.org/10.1016/B978-008044910-4.01091-9

Craig, W. J., Harris, T. M., & Weiner, D. (2002). *Community Participation and Geographical Information Systems* (W. J. Craig, T. M. Harris, & D. Weiner, Eds.). CRC Press. https://doi.org/10.1201/9780203469484

Elwood, S. (2009). GIS, Public Participation. *International Encyclopedia of Human Geography*, 520–525. https://doi.org/10.1016/B978-008044910-4.00064-X

Elwood, S. (2010). Geographic information science: Emerging research on the societal implications of the geospatial web. *Progress in Human Geography*, *34*(3), 349–357. https://doi.org/10.1177/0309132509340711

Goodchild, M. F. (2009). GIS and Cartography. *International Encyclopedia of Human Geography*, 500–505. https://doi.org/10.1016/B978-008044910-4.00034-1

Grahn, P., & Stigsdotter, U. A. (2003). Landscape planning and stress. *Urban Forestry & Urban Greening*, *2*(1), 1–18. https://doi.org/10.1078/1618-8667-00019

Haklay, M., Singleton, A., & Parker, C. (2008). Web mapping 2.0: The neogeography of the GeoWeb. *Geography Compass*, *2*(6), 2011–2039. https://doi.org/10.1111/j.1749-8198.2008.00167.x

Harley, J. (1990). Cartography, Ethics and Social Theory. *Cartographica: The International Journal for Geographic Information and Geovisualization*, *27*(2), 1–23. https://doi.org/10.3138/C211-1512-0603-XJ14

Hunter, A. J., & Luck, G. W. (2015). Defining and measuring the social-ecological quality of urban greenspace: a semi-systematic review. *Urban Ecosystems*, *18*, 1139–1163. https://doi.org/10.1007/s11252-015-0456-6

Ives, C. D., Oke, C., Hehir, A., Gordon, A., Wang, Y., & Bekessy, S. A. (2017). Capturing residents' values for urban green space: Mapping, analysis and guidance for practice. *Landscape and Urban Planning*, *161*, 32–43. https://doi.org/10.1016/J.LANDURBPLAN.2016.12.010

Johnson, P. A., & Sieber, R. E. (2012). Increasing Access to and Use of Geospatial Data by Municipal Government and Citizens: The Process of "Geomatization" in Rural Québec. *Journal of the Urban and Regional Information Systems Association*, *24*(2), 57–64.

Kaal, M. (2022). *Onderzoek buitenspelen 2022*.

Kabisch, N., & Haase, D. (2014). Green justice or just green? Provision of urban green spaces in Berlin, Germany. *Landscape and Urban Planning*, *122*, 129–139. https://doi.org/10.1016/J.LANDURBPLAN.2013.11.016

Kindon, S., Pain, R., & Kesby, M. (2007). *Participatory Action Research Approaches and Methods*. Routledge.

Koh, Y. F., Loc, H. H., & Park, E. (2022). Towards a "City in Nature": Evaluating the Cultural Ecosystem Services Approach Using Online Public Participation GIS to Support Urban Green Space Management. *Sustainability (Switzerland)*, *14*(3), 1499. https://doi.org/10.3390/SU14031499/S1

König, E. (2023, April 3). In de strijd om ruimte botsen in Gelderland alle belangen en wereldbeelden. *NRC*, 10–11. https://www.nrc.nl/nieuws/2023/03/08/in-de-strijd-om-ruimte-botsen-in-gelderland-alle-belangen-en-wereldbeelden-a4158999

Korpilo, S., Nyberg, E., Vierikko, K., Nieminen, H., Arciniegas, G., & Raymond, C. M. (2023). Developing a Multi-sensory Public Participation GIS (MSPPGIS) method for integrating landscape values and soundscapes of urban green infrastructure. *Landscape and Urban Planning*, *230*, 104617. https://doi.org/10.1016/J.LANDURBPLAN.2022.104617

Łaszkiewicz, E., Heyman, A., Chen, X., Cimburova, Z., Nowell, M., & Barton, D. N. (2022). Valuing access to urban greenspace using non-linear distance decay in hedonic property pricing. *Ecosystem Services*, *53*, 101394. https://doi.org/10.1016/J.ECOSER.2021.101394

Liu, D., Kwan, M. P., & Kan, Z. (2021). Analysis of urban green space accessibility and distribution inequity in the City of Chicago. *Urban Forestry & Urban Greening*, *59*, 127029. https://doi.org/10.1016/J.UFUG.2021.127029

Massoni, E. S., Barton, D. N., Rusch, G. M., & Gundersen, V. (2018). Bigger, more diverse and better? Mapping structural diversity and its recreational value in urban green spaces. *Ecosystem Services*, *31*, 502–516. https://doi.org/10.1016/J.ECOSER.2018.02.013

Misiune, I., Julian, J. P., & Veteikis, D. (2021). Pull and push factors for use of urban green spaces and priorities for their ecosystem services: Case study of Vilnius, Lithuania. *Urban Forestry & Urban Greening*, *58*, 126899. https://doi.org/10.1016/J.UFUG.2020.126899

Nilon, C. H., Aronson, M. F. J., Cilliers, S. S., Dobbs, C., Frazee, L. J., Goddard, M. A., O'Neill, K. M., Roberts, D., Stander, E. K., Werner, P., Winter, M., & Yocom, K. P. (2017). Planning for the Future of Urban Biodiversity: A Global Review of City-Scale Initiatives. *BioScience*, *67*(4), 332–342. https://doi.org/10.1093/BIOSCI/BIX012

Palliwoda, J., & Priess, J. A. (2021). What do people value in urban green? Linking characteristics of urban green spaces to users' perceptions of nature benefits, disturbances, and disservices. *Ecology and Society, Published Online: Mar 23, 2021 | Doi:10.5751/ES-12204-260128*, *26*(1). https://doi.org/10.5751/ES-12204-260128

Peschardt, K. K., et al. (2012). "Use of Small Public Urban Green Spaces (SPUGS)." Urban Forestry & Urban Greening 11(3): 235-244.

Peters, K., Elands, B., & Buijs, A. (2010). Social interactions in urban parks: Stimulating social cohesion? *Urban Forestry & Urban Greening*, *9*(2), 93–100. https://doi.org/10.1016/j.ufug.2009.11.003

Phillips, A., Khan, A. Z., & Canters, F. (2021). Use-Related and Socio-Demographic Variations in Urban Green Space Preferences. *Sustainability 2021, Vol. 13, Page 3461*, *13*(6), 3461. https://doi.org/10.3390/SU13063461

Pietrzyk-Kaszyńska, A., Czepkiewicz, M., & Kronenberg, J. (2017). Eliciting non-monetary values of formal and informal urban green spaces using public participation GIS. *Landscape and Urban Planning*, *160*, 85–95. https://doi.org/10.1016/J.LANDURBPLAN.2016.12.012

Poplin, A. (2012). Web-based PPGIS for Wilhelmsburg, Germany: An Integration of Interactive GIS-based Maps with an Online Questionnaire. *Journal of the Urban and Regional Information Systems Association*, *24*(2), 75–88.

Radil, S. M., & Anderson, M. B. (2019). Rethinking PGIS: Participatory or (post)political GIS? *Progress in Human Geography*, *43*(2), 195–213. https://doi.org/10.1177/0309132517750774

Rall, E., Hansen, R., & Pauleit, S. (2019). The added value of public participation GIS (PPGIS) for urban green infrastructure planning. *Urban Forestry & Urban Greening*, *40*, 264–274. https://doi.org/10.1016/J.UFUG.2018.06.016

Rambaldi, G., Chambers, R., McCall, M. K., & ... [et al.], [Unknown]. (2006). Practical ethics for PGIS practitioners, facilitators, technology intermediaries and researchers. *PLA*, *54*, 106–113.

Rey Gozalo, G., et al. (2019). "Perceptions and use of urban green spaces on the basis of size." Urban Forestry & Urban Greening 46: 126470.

Richardson, E. A., & Mitchell, R. (2010). Gender differences in relationships between urban green space and health in the United Kingdom. *Social Science & Medicine*, *71*(3), 568–575. https://doi.org/10.1016/J.SOCSCIMED.2010.04.015

Roe, J., Aspinall, P. A., & Thompson, C. W. (2016). Understanding Relationships between Health, Ethnicity, Place and the Role of Urban Green Space in Deprived Urban Communities. *International Journal of Environmental Research and Public Health*, *13*(681). https://doi.org/10.3390/ijerph13070681

Sanesi, G., & Chiarello, F. (2006). Residents and urban green spaces: The case of Bari. *Urban Forestry & Urban Greening*, *4*(3–4), 125–134. https://doi.org/10.1016/j.ufug.2005.12.001

Schipperijn, J., Ekholm, O., Stigsdotter, U. K., Toftager, M., Bentsen, P., Kamper-Jørgensen, F., & Randrup, T. B. (2010). Factors influencing the use of green space: Results from a Danish national representative survey. *Landscape and Urban Planning*, *95*(3), 130–137. https://doi.org/10.1016/j.landurbplan.2009.12.010

Schipperijn, J., Stigsdotter, U. K., Randrup, T. B., & Troelsen, J. (2010). Influences on the use of urban green space – A case study in Odense, Denmark. *Urban Forestry & Urban Greening*, *9*(1), 25–32. https://doi.org/10.1016/J.UFUG.2009.09.002

Schuurman, N. (2009). Critical GIS. In R. Kitchin & N. Thrift (Eds.), *International Encyclopedia of Human Geography* (pp. 363–368).

Semeraro, T., Scarano, A., Buccolieri, R., Santino, A., & Aarrevaara, E. (2021). Planning of Urban Green Spaces: An Ecological Perspective on Human Benefits. *Land 2021, Vol. 10, Page 105*, *10*(2), 105. https://doi.org/10.3390/LAND10020105

Senaratne, H., Mobasheri, A., Ali, A. L., Capineri, C., & Haklay, M. (Muki). (2016). A review of volunteered geographic information quality assessment methods. *Https://Doi.Org/10.1080/13658816.2016.1189556*, *31*(1), 139–167. https://doi.org/10.1080/13658816.2016.1189556

Swanwick, C., Dunnett, N., & Woolley, H. (2003). Nature, Role and Value of Green Space in Towns and Cities: An Overview. *Built Environment (1978-)*, *29*(2), 94–106. http://www.jstor.org/stable/23288809

Tandarić, N., Ives, C. D., & Watkins, C. (2020). Can we plan for urban cultural ecosystem services? *Journal of Urban Ecology*, *6*(1). https://doi.org/10.1093/jue/juaa016

Thatcher, J., Bergmann, L., Ricker, B., Rose-Redwood, R., O'sullivan, D., Barnes, T. J., Barnesmoore, L. R., Beltz Imaoka, L., Burns, R., Cinnamon, J., Dalton, C. M., Davis, C., Dunn, S., Harvey, F., & Jung, J.-K. (2016). Revisiting critical GIS. *Environment and Planning A*, *48*(5), 815–824. https://doi.org/10.1177/0308518X15622208

van Haaster-De Winter, M. A., Dijkshoorn-Dekker, M. W. C., Mattijssen, T. J. M., & Polman, N. B. P. (2022). Enhancing Urban Biodiversity: A Theory of Planned Behavior Study of the Factors Influencing Real Estate Actors' Intention to Use Nature-Inclusive Design and Construction Concepts. *Land*, *11*(2). https://doi.org/10.3390/land11020199

van Thiel, S. (2014). Research Methods in Public Administration and Public Management: An introduction. In *Research Methods in Public Administration and Public Management: An Introduction*. Taylor and Francis. https://doi.org/10.4324/9780203078525/RESEARCH-METHODS-PUBLIC-ADMINISTRATION-PUBLIC-MANAGEMENT-SANDRA-VAN-THIEL

Verplanke, J., McCall, M. K., Uberhuaga, C., Rambaldi, G., & Haklay, M. (2016). A Shared Perspective for PGIS and VGI. *The Cartographic Journal*, *53*(4), 308–317. https://doi.org/10.1080/00087041.2016.1227552

Wüstemann, H., Kalisch, D., & Kolbe, J. (2017). Access to urban green space and environmental inequalities in Germany. *Landscape and Urban Planning*, *164*, 124–131. https://doi.org/10.1016/J.LANDURBPLAN.2017.04.002