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ENVIRONMENTAL JUSTICE AND DISTRIBUTION OF PUBLIC GREEN SPACES IN STORHAUG, STAVANGER

University of Stavanger
Masters in City and Regional Planning

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i Stavanger

Abstract

Environmental Justice (EJ) promoting fair treatment despite social differences is crucial when creating essential regulations or policies regarding the natural environment while ensuring equality amongst citizens regarding these rules. Greenery plays an essential role in keeping us happy; it can reduce our stress levels, benefit our respiratory systems, and hold prospects enticing us to move more physically. However low-income groups or minorities live within areas where they have only limited access to evergreen spaces, denying them these advantages provided by nature, unlike other wealthy or predominantly ethnic groups. This study aims to deduce the link between EJ and the distribution of green spaces in Storhaug district of Stavanger municipality in Norway. The study utilizes mixed methods such as surveyed residents and a Geographic Information System (GIS) analysis examining the factors influencing unequal spatial distributions indicating aspects of EJ, especially availability and accessibility.

After conducting an analysis based on resident questionnaire responses, the findings indicate that most individuals within Storhaug have easy access to public green space located near or within their neighbourhood - typically within about 300 meters of walking distance or no more than a five-minute journey on foot. However, in contrast to recommended standards suggested by most regulatory organizations such as the Norwegian Environmental Agency (NEA), and similar established figures in the scientific community who focus on this realm – most neighbourhoods aren't meeting enforced requirements when it comes to allocation of necessary quantities of green open space per person. Additionally, attention must be brought to environmental justice-related concerns if they’re not being thoroughly addressed during planning phases for these public sectors throughout Storhaug's land plots. Considering these discoveries thus far – it is strongly recommended to incorporate environmental justice values into future project proposals aimed towards expanding greenspace availability as it pertains to this locality which will ultimately benefit all people alike.

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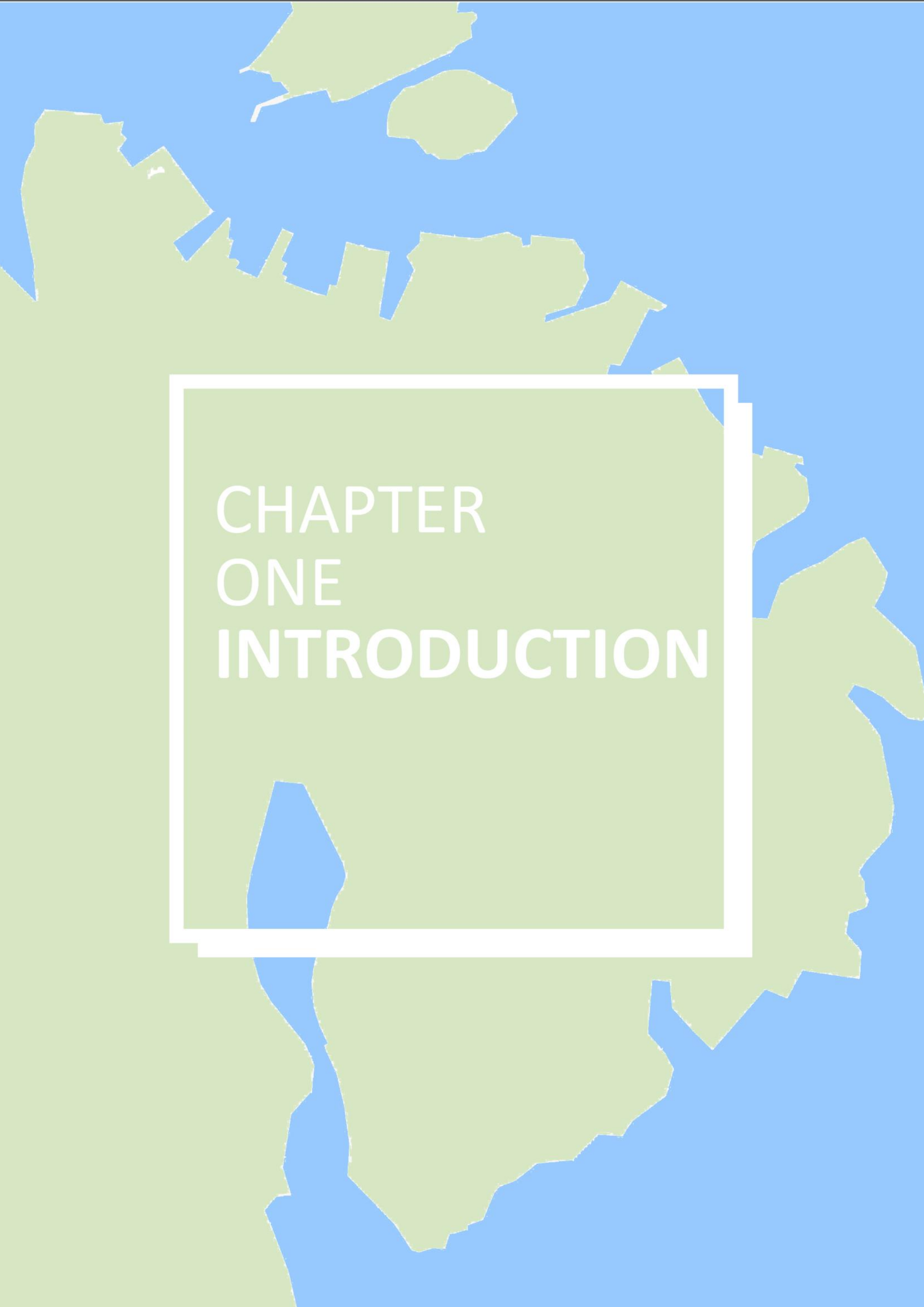


CHAPTER ONE INTRODUCTION

1.0 INTRODUCTION

Urban green spaces play a pivotal role in improving the standard of living *(Maas et al., 2009).* This is mainly due to the opportunities they offer for social interactions and relationships with nature, which lead to several positive outcomes such as stress-relief, relaxation, a sense of place, and social capital *(Konijnendijk et al., 2013)*. Recent research has identified access to green space as one of the critical factors for healthy urban living, with a growing emphasis on the importance and perception of nature *(Hartig et al., 2014)*. Adequate access to green space is essential for maintaining physical and emotional well-being.

In addition to individual benefits, urban green spaces also have positive impacts on communities and social cohesiveness *(Venter et al., 2020)*. Studies have shown that public parks have a favourable effect on mental health, as people living closer to parks perform better on mental health indices than those residing farther from parks *(Sturm & Cohen, 2014)*. The COVID-19 pandemic has led to changes in the use of urban green spaces, with a shift towards more recreational and physical activities and less social interaction. Many survey participants have highlighted the importance of green spaces for their well-being during the pandemic *(Ugolini et al., 2020).*

Despite the growing recognition of the importance of access to green space, disparities in access to public parks still exist across different population groups. Research in The Netherlands has shown a relationship between socioeconomic status and green space access, with neighbourhoods having a lower socioeconomic status having less and lower-quality green spaces than those in higher-status neighbourhoods *(De Vries et al., 2020)*. A similar study in Bristol found that respondents living in more deprived areas reported poorer green space accessibility and lower perceived safety *(Jones et al., 2009).*

Moreover, the current discourse on sustainable cities highlights the need to make the transition towards greener cities a just one. According to *Bullard et al. (2000)*, environmental justice (EJ) refers to the fair and equitable treatment of all people, regardless of race, ethnicity, income level, or socioeconomic status, in the development, implementation, and enforcement of environmental policies, regulations, and practices. It recognizes that certain communities, particularly marginalized and vulnerable populations, often bear a disproportionate burden of environmental hazards, pollution, and degradation.

EJ advocates for the right to a clean, healthy, and sustainable environment for all people and communities, regardless of background. It underscores the interconnectedness of social and environmental problems and emphasizes that environmental problems are not evenly distributed and can lead to significant inequities in access to resources, health, and overall quality of life. It encompasses distributive, procedural, and recognitional justice, key to achieving a successful and inclusive transition towards sustainable cities (*Bennett et al., 2019)*. The recently published European Green Deal recognizes the importance of EJ in protecting the EU's natural capital, ensuring citizens' well-being, and achieving a just and inclusive transition *(European Commission, 2009)*.

The central focus of this research is to investigate the extent to which EJ plays a role in the distribution of green spaces in Stavanger. To achieve this, Storhaug was chosen as the study area. Storhaug is a vibrant district in Stavanger known for its rich history and cultural significance. It has developed into the industrial centre of Stavanger since 1848, when the city limits were extended to the east *(Stavanger Kommune, 2023)*. The district has experienced rapid population growth, with a diverse mix of native and immigrant residents. Storhaug is located in the southwest of the sprawling municipality of Stavanger in Rogaland County, Norway. It covers an area of approximately 11.5 km2 *(Llopis Alvarez & Müller-Eie, 2022)* and is home to 16 597 inhabitants *(Statistisk sentralbyrå, 2023)*, with immigrants accounting for 21% of the total population. The district includes the traditional city center and the main port of Byfjorden. It borders Hillevågsvatnet to the west and the Våland and Eiganes regions. The natural borders include Byfjorden and Gandsfjorden. The district extends from the central urban area into the rural surroundings, specifically at Ramsvik and Rosenli.

The area has little green space per inhabitant, but what is present has exceptional qualities. The advantageous location also ensures short distances to various facilities and makes for pleasant walks in the vibrant Storhaug district. Here, quiet streets with a 30 km/h speed limit coexist harmoniously with splendid, newly developed recreational areas that form an interesting intersection between old and new *(https://www.lufteturen.no)*. This gaps in green spaces in this area has piqued my curiosity to study the complexity of the area by exploring the factors that determine the distribution of green spaces in relation to EJ.

Figure 1. Avaldsnesgata in Nylund, Storhaug

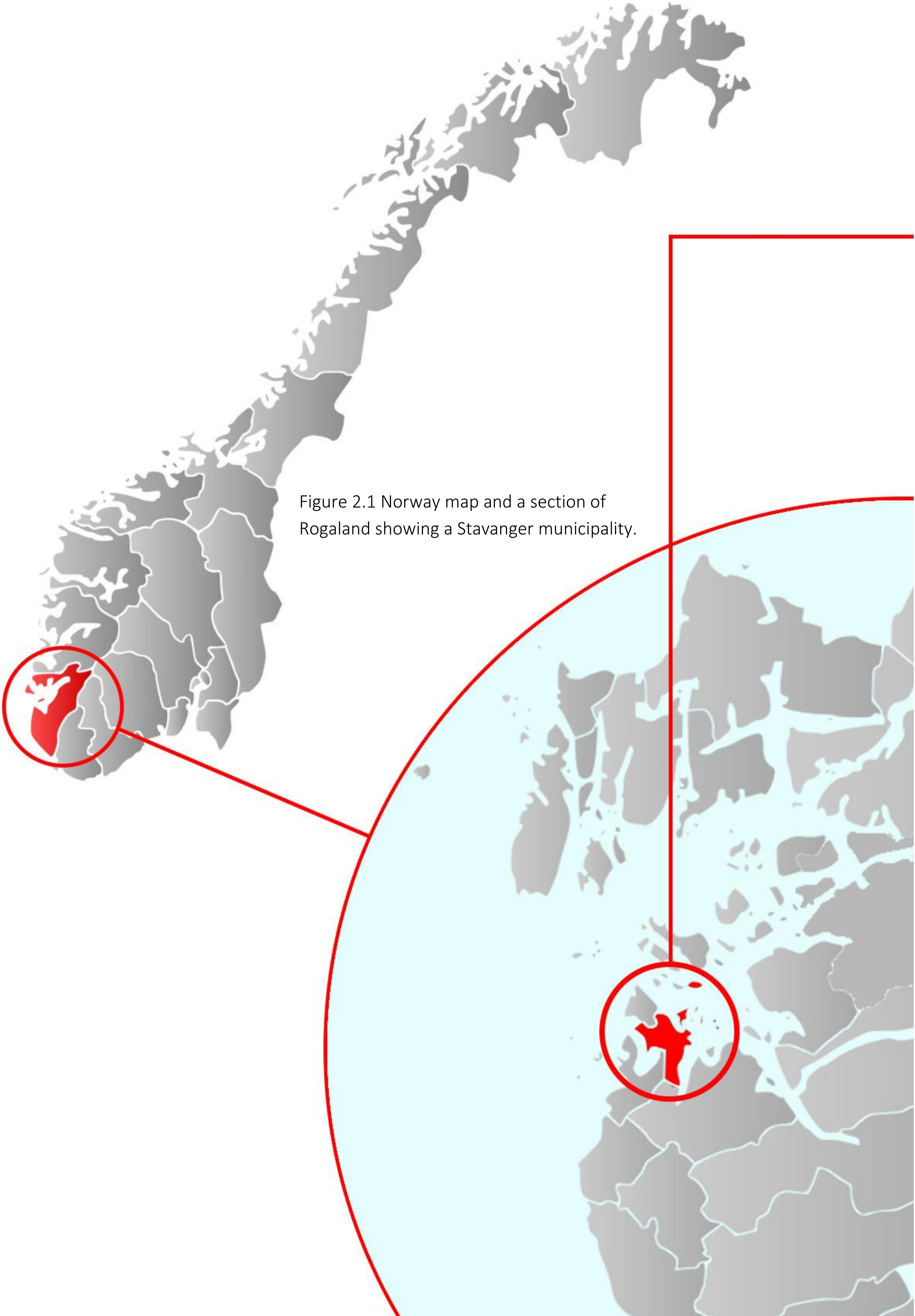


Figure 2.1 Norway map and a section of Rogaland showing a Stavanger municipality.

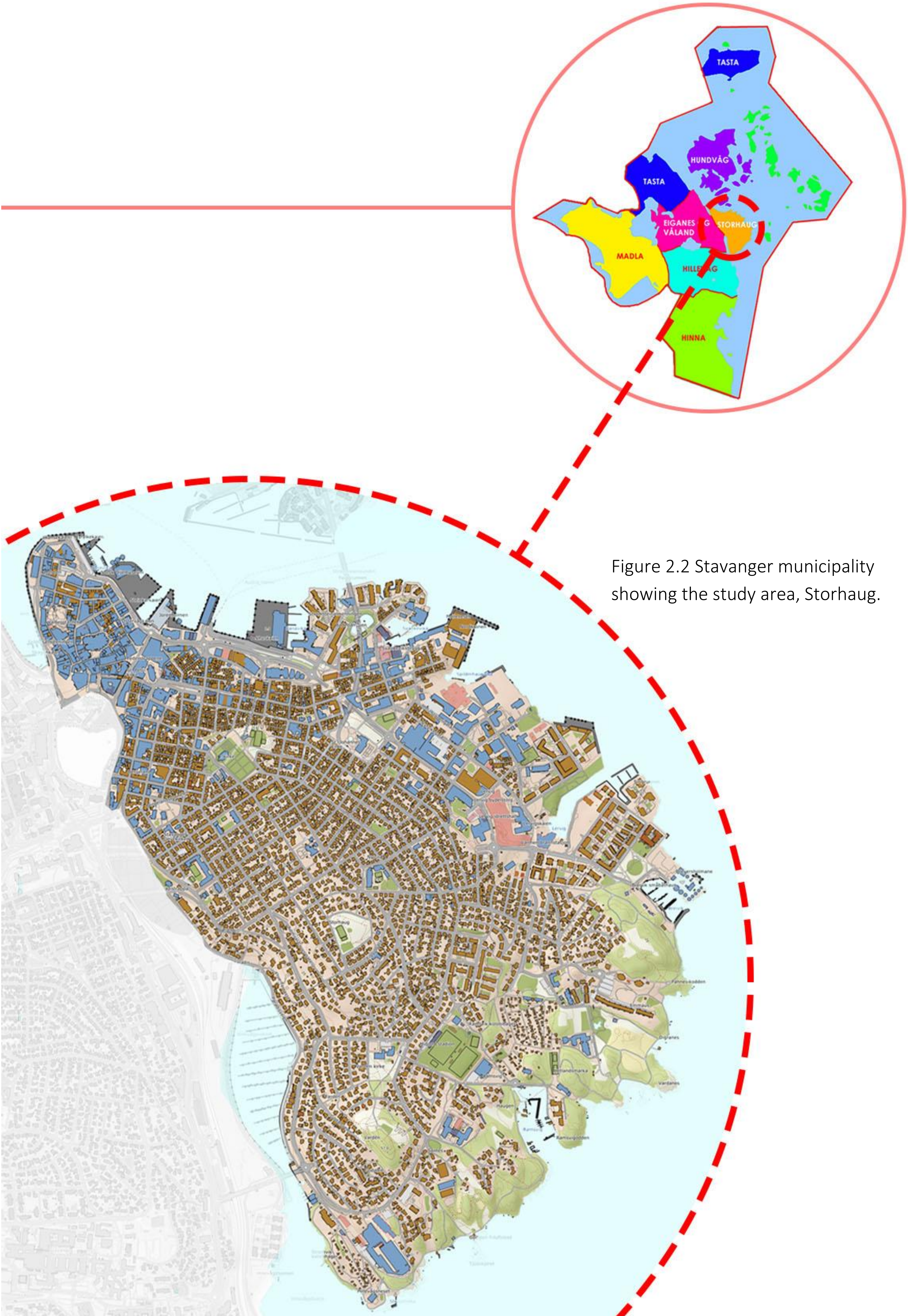


Figure 2.2 Stavanger municipality showing the study area, Storhaug.

This research is structured around the main research questions. In the first chapter, a detailed explanation of green spaces provided, along with a description of the social and scientific significance of the research. The research methods are discussed in the following chapter, including the methods used for data collection and analysis. The theoretical framework is presented next, where the concepts of green space quality and EJ are discussed based on existing literature. In addition, three sub-questions are posed to provide further insight into the main research question. The results chapter then presents the findings from the study, addressing each of the research questions. Finally, the discussion and conclusion chapters are presented to wrap up the thesis.

Figure 3. Varden, central Storhaug

Figure 4. Storhaug school

Figure 5. Resident block in Lervig, Storhaug

1.1 Background and Context

As urbanisation continues to accelerate globally, with a projected 70% of people living in cities by 2050 *(UN, 2018)*, the need for nature-based solutions to ecological, climatic, and social challenges in urban sustainability is becoming increasingly urgent. The value of urban nature in promoting sustainability has been increasingly recognized in European and international policies, particularly within the United Nations' Sustainable Development Goals (SDGs). Goal 11 of the SDGs aims to make cities and human settlements inclusive, safe, resilient, and sustainable, with the provision of safe, accessible, and inclusive green and public spaces as a key objective *(UN 2015)*.

Figure 6. Sustainable Development Goal 11, target 7. (Source: Open development, 2018)

Urban greenery, or blue-green infrastructure, has gained significant attention from researchers and policy makers in Europe, as evidenced by the European Union's Strategy on Green Infrastructure and the Horizon 2020 Research and Innovation policy agenda on Nature-Based Solutions and Re-Naturing Cities *(European Commission, 2020)*. These spaces, which include parks, forests, street trees, gardens, playgrounds, rivers, lakes, and oceans, provide numerous social and ecological benefits, such as mitigating environmental hazards like air pollution and extreme temperatures *(Bratman et al., 2019).* Exposure to blue and green spaces has also been linked to a range of beneficial public health outcomes, including mental and physical health *(Britton et al., 2020).*

Access to urban green spaces is important for the health and well-being of urban residents, as it is associated with improved mental and physical health and social cohesion. However, the distribution of green space in cities is often unequal, with some neighbourhoods having much less access to green space than others. This inequality is often referred to as "green space justice" or "green equity" and is typically associated with socioeconomic factors such as income and race *(Wolch, J. R. et al., 2014*). Low-income and minority communities often have less access to green space due to factors such as historic policy segregation and disinvestment in these neighbourhoods, limited public transportation, and land use policies that prioritise commercial or residential development over parks and green space. In addition, the high cost of land in urban areas often makes it difficult to establish new green spaces in low-income neighbourhoods *(Kabisch, N. et al., 2015)*.

Similar studies show that neighbourhoods with low-income households and minority populations tend to have less access to green space than wealthier and predominantly white neighbourhoods. For example, a study conducted in the city of Denver, Colorado, found that low-income and minority neighbourhoods had less green space per capita and were farther away from parks than higher-income and predominantly white neighbourhoods (*Wolch, J. et al., 2005)*. Another study conducted in ten U.S. cities found that neighbourhoods with higher poverty rates and larger minority populations had fewer parks and other green spaces than neighbourhoods with lower poverty rates and smaller minority populations *(Boone, C. G. et al., 2009)*. This uneven distribution of green space can negatively impact the health and well-being of residents in these neighbourhoods, as they have fewer opportunities to engage in physical activity and spend time in nature.

The World Health Organization recommends that urban residents have access to at least 0.5 to 1 hectare of public green space within 300 m of their homes, yet many urban populations lack adequate access *(WHO, 2017)*. Furthermore, social inequality is an emerging concern associated with urban green spaces, with a distribution of resources unevenly allocated based on factors such as religion, race, gender, and age *(Jennings et al., 2016)*.
While the value of green space has been extensively studied in the context of sustainability, the results are often mixed due to variations in case studies and methods used *(Panduro and Veie, 2013)*. Nonetheless, research on urban green spaces remains a significant focus for

urban scholars, given their critical role in promoting social and ecological well-being in urban areas.

1.2 Problem Statement

EJ has traditionally been focused on the health consequences of exposure to pollution and environmental hazards, especially in low-income and minority communities. However, there is increasing recognition of the positive contributions that ecosystems can make to health and well-being, and these benefits are also seen as an EJ issue. This includes access to green spaces and the ecosystem services they provide *(Agyeman et al., 2016)*. Yet, the positive contributions of ecosystems to health and well-being are increasingly considered an EJ issue *(Jennings et al., 2016)*, including access to green space *(Wolch et al., 2014)* and ecosystem services (ES) they provide *(Marshall et al., 2016).* According to the Schlosberg framework (2004), three different dimensions need to be discussed to address EJ: distributive, procedural and recognition. For discussion's sake, Distributive justice focuses on the fair distribution of the benefits from ecosystems, while procedural justice emphasises the fair integration of affected groups into decision-making processes. Recognition justice involves recognizing the different needs, values, and preferences of social groups *(Zuniga-Teran and Gerlak, 2019*).

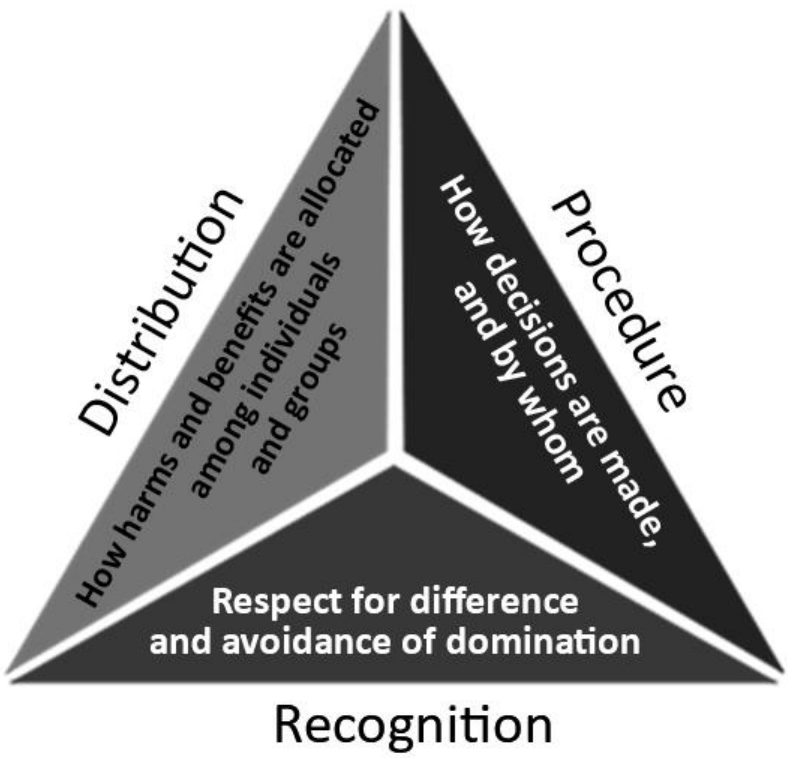


Figure 7. The myriad dimensions of Environmental Justice (Eneko Garmendia et.al, 2015)

Procedural justice focuses on the 'fair integration of all affected groups into the planning and decision process of a public space' *(Kabisch and Haase, 2014)*. Finally, recognition means recognizing the different needs, demands, values, and preferences of all social groups *(Fraser, 1995)*.

The importance of EJ research is growing worldwide, with increasing attention paid to this topic in key international documents (such as the UN Sustainable Development Goals or Habitat Agenda), international research projects, and publications. Most recently, a particularly important strand of research in this context has focused on the availability, accessibility, and attractiveness of urban green and blue spaces (UGBS) to different socioeconomic groups of inhabitants. UGBS is understood here as all those parts of urban land which are covered by vegetation and water. This broad interpretation is supported by the fact that a large share of such spaces in post-socialist cities is not protected as parks, forests, or other forms of formal green spaces *(Sikorska et al., 2020)*, and yet all such spaces and their functional connections and interrelations provide a broad range of services to urban residents *(Andersson et al., 2019)*

However, opportunities for recreation in UGBS are often unevenly distributed, with some social groups having less access. This can include low-income residents, migrants, racial and religious minorities, and others *(Ernstson, 2013).* Factors such as the housing market are driving differences in green space availability in central and eastern European cities, leading to the gentrification of neighbourhoods with more green space *(Kronenberg et al., 2020)*.
To address these differences, urban planning and green space design should consider the recognition dimension of EJ. Various methodologies exist to assess and map recreation, but they often do not take justice dimensions into consideration, with outdoor recreation mainly analysed through quantitative indicators such as green space per capita or distance to green space. The quality of green space is rarely addressed; however, it is an essential aspect that needs to be considered in EJ research *(Kabisch and Haase, 2014)*. However, these studies have neglected the principles of EJ in understanding the uneven distribution of green spaces and the disproportionate availability to a subset of the urban population. This study employs the interplay of socio-economic variables and the concept of EJ to assess the fairness of the distribution of green spaces in Storhaug, in terms of sharing their benefits and burdens, and access to green spaces in their surroundings.

1.2.1 Aims and Objectives

This dissertation aims to evaluate the effect of EJ on green space distribution in Storhaug, Stavanger. These are the objectives:

1. To determine the accessibility and availability of various public green spaces in Storhaug to understand the distribution patterns.

2. To assess the relationship between green space quality and their socioeconomic environment.
3. To examine the factors that affect the allocation of green space in Storhaug, Stavanger.

1.3 Research Questions

1. How much do the green spaces in Storhaug, embody EJ principles?
2. How are green areas distributed in Storhaug, and how does it differ for various social groups?
3. What variables affect the distribution of green space in Storhaug, and how do they interact?
4. What tactics may be used to achieve EJ in urban planning while improving the distribution of green areas in Storhaug, Stavanger?

1.4 Significance of Study

The distribution of green spaces is a crucial aspect of urban planning that has implications for EJ and the overall quality of life for residents in a community. Access to green spaces has been shown to have a positive impact on physical and mental health, social cohesion, and overall well-being. However, research has shown that access to green spaces is often limited for low-income and marginalised communities, exacerbating existing health and social disparities *(Zimmerman and Lee, 2021).*

This dissertation addresses this critical issue by examining the distribution of green spaces in Storhaug and exploring the relationship between EJ and access to green spaces in the area. By identifying the factors that influence the distribution of green spaces and assessing their impact on the health and well-being of residents, this study contributes to the growing body of literature on the importance of green spaces in urban planning and EJ.

The findings of this study have significant implications for urban planning policies and strategies for green spaces in Storhaug and beyond. The study provides insights into the challenges and opportunities for promoting EJ through the development and maintenance of green spaces in disadvantaged communities. The results of this study can inform the design of urban planning policies and strategies that prioritize equitable access to green spaces and address the social and health disparities in urban communities.

Overall, this study contributes to the understanding of the relationship between EJ and access to green spaces and provides evidence-based recommendations for urban planning policies and strategies that can promote EJ and enhance the quality of life for residents in Storhaug and other urban areas.

Part summary:
Urban green spaces are essential for maintaining physical and emotional well-being and have positive impacts on communities and social cohesiveness. However, disparities in access exist across different population groups. EJ is essential for a successful and inclusive transition towards sustainable cities, and this research investigates the distribution of green spaces in Storhaug. The need for nature-based solutions to urban sustainability is becoming increasingly urgent, with the SDGs aiming to make cities and human settlements inclusive, safe, resilient, and sustainable. Access to urban green spaces is important for health and well-being but is often unequal due to socioeconomic factors such as income and race. Social inequality is an emerging concern associated with urban green spaces.

EJ research is increasingly focusing on the positive contributions of ecosystems to health and well-being, including access to green spaces and ecosystem services. Three dimensions need to be discussed to address EJ: distributive, procedural and recognition. This dissertation examines the fairness of green space distribution in Storhaug, Stavanger, using socio-economic variables and the concept of EJ to assess the accessibility of various social groups and the effects of green space distribution on the environment and people. This study examines the distribution of green spaces in Storhaug and explores the relationship between EJ and access to green spaces, providing insights into the challenges and opportunities for promoting EJ.

CHAPTER TWO METHODOLOGY

2.0 METHODOLOGY

The use of both a qualitative and a quantitative research method in this study is appropriate because the former allows for a more in-depth examination of participants' experiences and perceptions of the research topic, while the latter allows for a more comprehensive assessment of neighbourhood conditions by examining various factors and variables and a more general overview of the research topic by analysing the responses of a large number of individuals. Qualitative methods are particularly useful in understanding complex social phenomena and are well suited to research that seeks to capture subjective experiences, such as those related to emotions, beliefs, and attitudes *(Thagaard, 2013)*. The qualitative method also allows for a more flexible and adaptable approach to data collection, which can be important when studying phenomena that are difficult to quantify. It gathers non-numerical data through methods such as interviews, observations, and open-ended surveys to gain insights into individuals' experiences and perspectives *(Johannessen et al., 2016).*

On the other hand, the quantitative method focuses on using numerical data and statistical analysis to identify patterns, trends, and relationships among variables. It collects data through a combination of desktop research and geographic information system analysis (GIS). These methods allow for the collection and analysis of data in a numerical format, which enables statistical exploration and identification of patterns and trends related to the research topic. By integrating results from quantitative and qualitative approaches, the study aims to achieve a more comprehensive and holistic understanding of the research topic. By integrating findings from quantitative and qualitative approaches, the study aims to achieve a more comprehensive and holistic understanding of the research topic. Quantitative data provide broader context and the potential for generalisation, while qualitative data offer nuanced insights and a deeper understanding of participants' experiences.

It is important to recognise that both quantitative and qualitative data have their limitations. Quantitative data may lack the richness and contextual detail that qualitative data provide, while qualitative data may not be readily generalizable to larger populations. However, using a mixed methods design that combines both approaches help overcome these limitations. By leveraging the strengths of both approaches, researchers can conduct more robust analyses and interpretations that lead to a more comprehensive understanding of research findings.

2.1 Literature Review

In the field of social science, a typical starting point for a research project is to conduct a thorough literature review to identify existing research on the subject matter, the methods used, and the current state of knowledge in the field *(Johannessen et al., 2016)*. The review involves compiling relevant literature, reports, scientific articles, and previous empirical findings. The literature review for this thesis has been carried out in two stages, covering the phenomena of "environmental justice" and "urban green spaces", as well as the concept of "green space distribution". Through the literature review, the thesis aims to define EJ, synthesise existing requirements for green space distribution, and, most importantly, investigate the relationship between the two concepts. To achieve this, the research will examine the history and current state of research on EJ and urban green spaces, as well as compare different geospatial methodologies for studying green space access.

2.2 Spatial Analysis

Geospatial data analysis uses software to interpret, explore, and model GIS data, from acquisition to understanding the results. The information obtained is processed by a computer and varies in complexity depending on the task. The simplest form of spatial data analysis is visualisation, while more complex tasks require specialised tools and extensive analysis to gain actionable insights.

In this work, spatial data is used to map and analyse the characteristics of the study area by collecting objective information about Storhaug and mapping existing conditions in the neighbourhood, such as topographic information like elevation, land use, street patterns, open and green spaces, transportation systems and infrastructure, and pollution factors like noise. The analysis and results were presented in maps created using ArcGIS Pro and data from SSB.

This will be responding to some of the following queries:

- Are the green spaces more evenly distributed in planned or unplanned (slum) areas or semi-modern areas?
- What infrastructures are available to support this use of these spaces.
- What factors contribute to usage preferences of the green spaces.
- What factors impede the use of green spaces.
- Which land use category (or types) has the greatest concentration of green space?

The data obtained from the analysis is used to analyse objective information related to the project vision, progress, implementation method and results.

2.2.1 Site Visit

This includes a reconnaissance conducted on the site ground to gather data and information about the physical, social, and environmental characteristics. It is an essential step in the planning and development process because it provides a first-hand understanding of existing site conditions and constraints that can inform planning and design decisions.

During this visit, factors such as the topography of the site, existing land uses, building types, infrastructure and utilities, environmental features, and socioeconomic characteristics of the area were examined. The information gathered during this process helps to identify the site's strengths, weaknesses, opportunities, and threats, which can be used to develop a comprehensive plan for the area, if needed.

Overall, this is a crucial step in city planning that helps to ensure a comprehensive understanding of the existing conditions and constraints of the site, which allows for the development of effective plans that meet the needs of the community while addressing the unique characteristics of the site. Visits to various public parks and green spaces in all parts of the Storhaug district were carried out on different days, mainly on Saturdays at midday when the sun was at its warmest. These visits served as an opportunity to observe and assess the sites first-hand. In addition, questionnaires were distributed to collect information and feedback from the visitors.

Google Earth and google map were used to navigate through the site and to locate the different green areas in Storhaug. Are the green spaces concentrated in the traditional core areas (inner neighbourhoods) or in the modern areas (newly developed neighbourhoods) of the district? is one of the queries to be answered during the reconnaissance which relates to answering research questions 2 and 3.
The site reconnaissance helped future inquiries into the causes of the uneven distribution of green spaces and the identification of underprivileged populations in addition to recognising existing green spaces.

2.3 Data Collection Methods

Data collection methods refer to the various techniques that will be used to gather the necessary information and data from various sources that are essential to this study. Each data collection method has its strengths and weaknesses, and the choice of method to be used in this study will depend on the research questions, context, and available resources. The methods to be used in this study include questionnaires, desktop research, site observation and geographic information systems (GIS).

2.3.1 Questionnaire

In accordance with the objectives of this research, a questionnaire will be developed to structure the discussion by highlighting the topics of interest for analysis. The questionnaire was detailed and based on the interests and experiences of the respondents. It aims to learn more about demographic attributes of the study area. Demographic data are statistical facts that describe the characteristics of a population or group of people. This usually includes information such as age, gender, race, ethnicity, education level, income, marital status, occupation, and place of residence.

By analysing demographic data, it is possible to understand the composition of a population and to identify trends, patterns, and influences related to the social, economic, and political conditions of a population. In this study, demographic data used to answer research questions

1, 2, 3 and 4, which focus on examining different social groups and variables related to green space distribution patterns in Storhaug.

Questionnaires were used to collect both objective and subjective indicators, focusing on people's perceptions of the issue to generate primary data. The questionnaires served as a tool to obtain personal information from participants, as well as their perceptions and satisfaction regarding the use of green spaces and other environmental and socioeconomic factors that affect their distribution. A digital version of the questionnaires was created using Google Forms to collect both objective and subjective information from participants.

A total of 55 questionnaires were distributed in all neighbourhoods of the case study, including Sentrum West and East, Badedammen, Lervig, Bergeland, Nylund, Midjord, and Varden, but only 33 responses were received. There were some limitations in conducting this data collection method, such as timing, climatic conditions, accessibility of people, and ethical concerns regarding privacy and consent.

2.3.2 Desktop Research

This involves gathering information from a variety of sources including books, publications, journals, websites, databases, and other media. As part of this research process, a desktop search will be conducted to gain a better understanding of the subject matter and identify areas for further research. It allows for exploration of a variety of sources and identifies the key elements of this thesis.

In this way, an overview of the current situation of urban green spaces in Storhaug and the existing greening measures in the city will be provided. The Norwegian Planning and Building Act is responsible for the implementation of infrastructures such as green spaces and open spaces. Therefore, there are several national laws, regulations, and guidelines that apply to green open spaces in Norway, e.g., open spaces associated with residential buildings are not considered part of the green space but are included in the building purpose *(Planning and Building Act, 2008)*. These and other approved national guidelines and regulations that have at the municipal level were adopted in this study.

For this data collection method, the first phase involved data collected from both primary and secondary sources: the primary sources consist of planning and policy documents from the Norwegian Planning and Building Acts, the Norwegian Environment Agency, and other respective authorities in relation to urban greening guidelines. Besides these documents, primary sources also include information retrieved from the municipal website such as the “Green Plan”, Stavanger’s green structure plan, which focuses on themes such as outdoor recreation, natural diversity, and nature-based solutions, and Statistisk sentralbyrå (SSB).

These are considered primary sources because they were created for purposes other than research *(Bryman 2012).*

Secondary sources of data consist of previous studies conducted by researchers regarding EJ and urban green spaces. Both primary and secondary sources have been selected based on their relevance for the research topic. An overview of the sources of data are provided in tables 1 and 2. The projects that were selected are those that appeared to be most relevant for the research topic, due to addressing aspects related to EJ.

Table 1. Primary sources

Original title	Translated in English	Author	Date of publication	Type of study
Plan- og bygningsloven (2008)	Planning and Building Act (2008)	Ministry of Local Government and Regional Development	2008	Planning act.
Planlegging av grønnstruktur i byer og tettsteder.	Planning green structures in cities and towns.	The Norwegian Environment Agency	2014	Urban green structure planning
Network of public spaces	-	The Ministry of Local Government and Modernisation	2016	An idea handbook for design ideas, strategies, and examples of green spaces.
Climate and Environmental Plan 2018-2030	-	Stavanger City Council	2018	Climate and Environmental Plan

Table 2. Secondary source				
Title	Author	Date of publication	Type of study	Study description
Environmental justice in a very green city: Spatial inequality in exposure to urban nature, air pollution and heat in Oslo, Norway	Zander S. Venter et al.	2022	Academic publication	This study explores whether environmental injustice exists in a city where one would least expect to find it: a city with abundant nature.
Relationships between socio-demographic / socio-economic characteristics and neighbourhood green space in four Nordic municipalities – results from NORDGREE	Geir Aamodt et al.	2022	Academic publication	This paper reports on access to different types of green space for residents in four Nordic cities.
Who benefits from nature in cities? Social inequalities in access to urban green and blue space across Europe	European Environmental Agency	2022	Environmental publication	This publication examines how access to health benefits from urban green and blue spaces varies based on socio-economic and demographic factors in Europe. It provides examples of green spaces that have been created to meet the needs of disadvantaged and vulnerable social groups.
Neighbourhood Conditions and Quality of Life Among Local and Immigrant Population in Norway	Ana Llopis Alvarez et al.	2021	Academic research	This paper examines the correlation between quality of life and neighbourhood features in Storhaug (Stavanger) and Grünerløkka (Oslo), two Norwegian neighbourhoods, for both immigrants and local populations. The study focuses on characteristics such as green spaces and transportation systems.

Environmental justice and outdoor recreation opportunities: A spatially explicit assessment in Oslo metropolitan area, Norway	Marta Suarez et al.	2020	Academic publication	The aim of this paper is to map and assess nature-based outdoor recreation opportunities with a focus on green space accessibility for different social groups and discuss the results considering environmental justice.
Nordic Urban Green Space Survey	Thomas B. Randrup et al.	2020	Academic research	A study of how urban green spaces currently are being perceived by green space managers, and what challenges existing larger cities in the Nordic countries.
Urban Green Space as a Matter of Environmental Justice- The Case of Lisbon's Urban Greening Strategies	Jessica Verheij	2019	Academic research	This research finds that Lisbon's urban greening strategies reflect environmental justice concerns by seeking to expand GI across the city and increase green space availability.
Environmental Justice in Accessibility to Green Infrastructure in Two European Cities	Catarina de Sousa Silva et al.	2018	Academic research	The aim of this study was to explore the concept of environmental justice in the distribution of the public green spaces in two contrasting cities, Tartu, Estonia; and Faro, Portugal.

2.3.3 GIS

Geographic Information System is a computer-based tool used to capture, store, manipulate, analyse, and visualize geographically referenced data. GIS technology enables the integration of multiple data sources such as satellite imagery, digital maps, and spatial databases into a single platform, allowing for the visualisation and analysis of complex spatial relationships. In this study, ArcGIS Pro is used to map green spaces in the study area such as parks, forests, and other natural areas, and to create a visualisation of the various spatial analyses performed for this study, as mentioned in the previous section. These maps will analyse various characteristics of green spaces such as function, size, shape, proximity to existing facilities, and accessibility. This will allow understanding how these characteristics affect the use and enjoyment of green spaces by different groups of people. In addition, analysing data from GIS may allow for the identification of areas that could be targeted for the creation of new green space. Therefore, this method of data collection is appropriate for answering research questions 2, 3, and 4.

2.3.4 Site Observation

Site observation is a research method that involves the systematic observation of a particular location or site to gather data and information about human behaviour, social interactions, and other phenomena that occur in that location. It involves the researcher visiting and observing the site directly and taking detailed notes on the observations made *(Patton, M. Q., 2015).*

In this study, this method was used to collect data by recording behaviours, events, and situations as they occurred in real time at the study site. Different green spaces in different neighbourhoods of the study area were visited at different intervals, including different days and times, to systematically observe people using these spaces. This allowed for an understanding of the types of activities that take place in these areas, as well as the conditions of the green spaces themselves. Most observations were made in public parks, open green spaces, nature preserves, and public sports fields, as well as on the roads and trails leading to these areas. For climatic reasons, observations were made mainly on warmer days and during daylight hours.

Part summary:

The use of a qualitative research method in this study allows for a more in-depth exploration of participants' experiences and perceptions of EJ and green space distribution. It also allows for a deeper analysis than quantitative methods, but it has its limitations. This study examines the history and current state of research on EJ and urban green space and compares different spatial methods for studying access to green space. Spatial analysis is used to map and analyse the characteristics of the study area, while a site reconnaissance is conducted to identify the area's strengths, weaknesses, opportunities, and threats. The site reconnaissance helps to understand the existing conditions and constraints of Storhaug, which allows for effective planning to meet the needs of the community. Questionnaires were used to collect objective and subjective data to examine the distribution of green spaces in Storhaug.

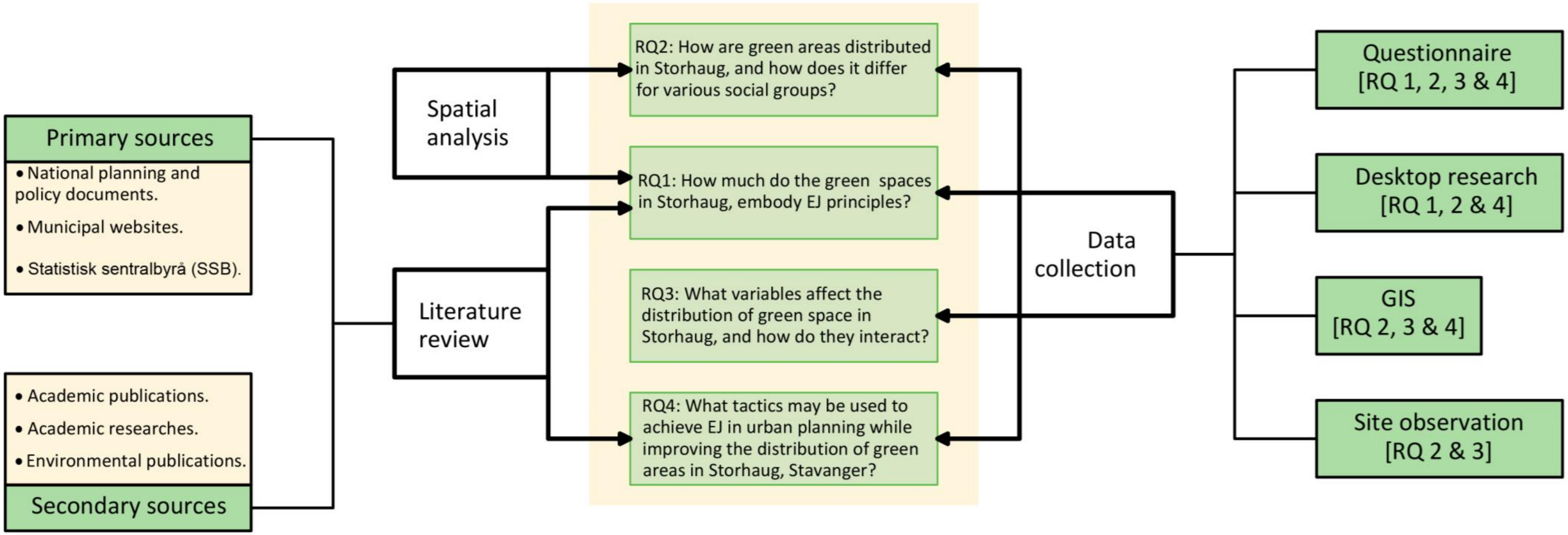


Figure 8. Research model (Own illustration)

CHAPTER THREE
LITERATURE REVIEW

3.0 LITERATURE REVIEW

This chapter aims to explore the historical background and current research related to EJ, prior research on urban green spaces, and different geospatial methods used to study access to green spaces. The chapter is structured into four main sections, which include environmental justice, urban green spaces, and accessibility to green space.

3.1 Understanding Environmental Justice

Environmental justice is achieved when all people regardless of race, colour, national origin, gender, or income live in neighbourhoods free of health hazards, can enjoy equal access to safe, healthy places, and participate meaningfully in the planning of their communities *(adapted from US EPA)*. Landfills, industry, and other types of high pollution uses have historically been disproportionately concentrated in low-income, minority, and native communities. In the 1980s, the EJ movement emerged from local community struggles over the siting and operation of toxic and waste sites in black and Hispanic communities. Residents affected by these hazards mobilised against various threats to their health from pollution, leaks, and contamination and tapped into the discourses of the civil rights movement to create change through advocacy and lawsuits.

Over time, the definition of EJ has expanded to not only address the presence of health hazards, but also the lack of access to resources, such as public transportation, parks, and fresh food. In addition to environmental burdens and lack of access, marginalised groups have not historically had a voice in urban planning and policymaking, and therefore have not been able to advocate for urban design changes that would benefit their health and well-being. Design for EJ invites everyone to the table to consider policy and design decisions using participatory and inclusive tools. This process is highly localised, contextual, and grounded in the circumstances of each community, its problems, and visions for the future.

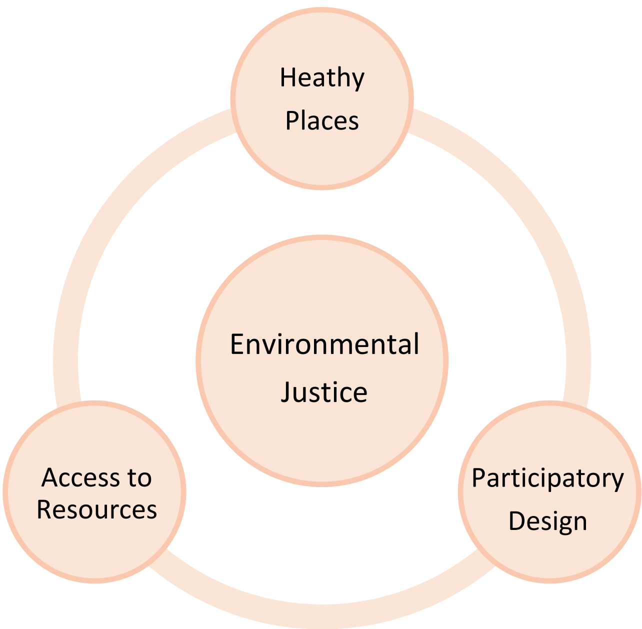


Figure 9. Environmental Justice (Own illustration)

Minorities may confront a variety of EJ concerns in their communities. It is an environmental injustice when the affluent or the authorities choose to build landfills, power plants, or other hazardous buildings near low-income and minority areas, affecting human health and limiting access to green space *(Sister et al. 2010)*. These low-income and ethnic minority groups are frequently subjected to severe environmental pollution and deterioration *(Massey, 2004).*

Toxic or chemical wastes cause human health concerns such as asthma and cancer. Individuals who live near these places frequently suffer from health problems because of the poor quality of their living environment. Although access to urban green space can help alleviate these health risks, it is limited. The excellent quality of living environment should not be restricted to the privileged and wealthy classes. According to *Massey (2004)*, income, environmental quality, and access to health care can all have an impact on human health.
As a result, minority groups should enjoy the same living conditions and amenities as privileged groups.

People are increasingly interested in urban green areas because they allow them to get some fresh air, mingle with friends, and play with their children. Nonetheless, most studies have found that minority populations have reduced access to green places. According to *Wolch et al. (2005)*, as Los Angeles has grown and gotten more congested, some minority groups have lost access to parks and green spaces. Minority communities typically reside in the inner city, in places with poor planning behind their built environment.

As a result, residents in those locations frequently lack recreational amenities such as green spaces. The privileged groups can change their living habitats, whereas the poor and minority groups might lack the funds to alter their living environments and must rely on public urban green space. A healthy community should have plenty of green spaces for residents to relax, socialise, and exercise. So where are these urban green spots typically located? Are they distributed evenly throughout the city? When academics are interested in studying accessibility, these two questions must be investigated and explored further.

3.2 Historical Context of Environmental Justice

EJ developed as a social movement in the United States in the 1980s when civil rights groups banded together to prevent the state of North Carolina from dumping 120 million pounds of PCB-contaminated soil in Warren County, which has the highest population of African Americans *(Mohai et al., 2009)*. Protests in the county quickly gained national attention, raising public awareness of Black Americans' and other people of colour's environmental concerns (Pellow and Brulle, 2005).
Benjamin Chavis invented the phrase "environmental racism" in 1982 to refer to "any policy, practice, or direction that differently affects or disadvantages—whether intended or

unintended—individuals, groups, or communities based on race or colour" *(Bullard, 1996)*. Following this tense atmosphere, a series of events occurred that strengthened the visibility and momentum of the EJ movement *(Mohai et al., 2009)*. The movement was an attempt to address environmental disparities, dangers to public health, unequal protection, discriminatory enforcement of environmental legislation, and disparate treatment of the poor and people of colour *(Bullard and Johnson, 2000).* EJ has emerged as a topic in academic literature and gained significant attention in the global south in recent years, in close contact with this social movement *(Travassos et al., 2021).*

The phrase "environmental racism" refers to any low-income group or minority population that is exposed to chemical waste, pollution, degraded habitats, or hazardous waste that impacts their health *(Massey, 2004).* Around 30,000 gallons of PCB-contaminated waste oil were unlawfully discharged in Warren County. As a result, 60,000 tonnes of PCB-contaminated soil were collected and disposed of in a landfill specifically designed for this purpose in a largely African American and low-income community in Warren County *(Sister et al. 2010)*. This incident had a significant impact on the EJ movement. While the EJ movement has typically concentrated on pollution issues affecting people's health near toxic sites or infrastructure, it has recently expanded to include the distribution of environmental benefits *(De Sousa Silva et al., 2018)*. For example, Gould and Lewis (2017) emphasised the necessity of examining the entire distribution spectrum, from environmental burdens to environmental benefits such as green infrastructure.

Green infrastructure is defined as "an interconnected network of green space that conserves natural ecosystem values and functions and offers associated benefits to human populations" *(Benedict and McMahon, 2002)*. In an European Commission (2013) study “Creating a Green Infrastructure for Europe”, the Commission lists in detail the benefits of green infrastructure. This entails an analysis that served as a critical basis for EU funding programmes (the Green Deal), on how green infrastructures and nature-based solutions benefit the environment by eliminating pollutants from air and water, preventing soil erosion, and conserving rainwater. They also have a range of positive societal impacts, from promoting human well-being and health to boosting tourism and local economies. Green infrastructure is considered a useful strategy for climate change adaptation and mitigation. Finally, it contributes to biodiversity by, for example, improving wildlife habitats and ecological corridors.

The concept of EJ has evolved and is now applied to a variety of sectors, from transportation to disaster management *(Schlosberg and Collins, 2014)*. Climate change is not an exception. Climate change is a threat to physical and mental health, and vulnerable communities often face the greatest risks as they live in flood zones or areas exposed to heat *(Travassos et al., 2021).*

Part summary:
Environmental justice (EJ) is achieved when all people live in neighbourhoods free of health hazards, have equal access to safe places, and participate meaningfully in the planning of their communities. Design for EJ invites everyone to consider policy and design decisions using participatory and inclusive tools. EJ was a social movement in the 1980s to address environmental disparities, dangers to public health, unequal protection, and disparate treatment of the poor and people of colour. The EJ movement has expanded to include the distribution of environmental benefits such as green infrastructure, which has a range of positive societal impacts, including climate change adaptation and mitigation.

3.3 Green Space as an Environmental Justice Concern

As Environmental justice (EJ) studies progressed, they expanded beyond examining the uneven distribution of environmental hazards and began analysing the unequal access to environmental benefits, which includes green spaces *(Byrne 2017)*. While green spaces offer many benefits through ecosystem services, their actualization often hinges on one's ability to access them *(Davoudi and Brooks 2016)*. The uneven distribution of green spaces means that certain segments of the urban population have better access than others. However, research has highlighted the fact that privileged social groups tend to enjoy even greater access to green spaces and the direct benefits associated with their use, while those with limited access may experience poorer health, fewer environmental amenities, and lower levels of mental well-being *(Costanza et al. 2017; Maas et al. 2006)*. As a result, access to green space has increasingly become recognized as an EJ issue *(O'Brien et al. 2017).*

Ecosystem services, which are the benefits people receive from functioning ecosystems, vary significantly based on scale and context *(Andersson et al. 2015)*. Green spaces and Green Infrastructure provide ecosystem services on multiple scales, ranging from local (e.g., the shading effect of trees) to global (e.g., trees absorbing carbon dioxide). Consequently, not all ecosystem services provided by green spaces require people to use or visit the space. For example, one can enjoy cleaner air resulting from trees in a park without actually visiting the park. However, research indicates that people living near green spaces typically derive more benefits, while frequent use can result in significant mental and physical health benefits *(Davoudi and Brooks 2016).*

Studies have demonstrated how the uneven distribution and availability of green spaces in cities affect the extent to which different social groups can access them. For instance, a study conducted in the USA *(Wolch et al. 2014)* revealed that green space in cities disproportionately benefits predominantly White and more affluent communities. *Kabisch & van den Bosch (2017)* analysed the unequal distribution of green space in Berlin and argued that certain social groups, such as immigrant communities, suffer limited access to the benefits of Green Infrastructure.

Similarly, a recent study from Lisbon University provided evidence of unequal access to Lisbon's green spaces *(Luz et al. 2019)*. The study, which included a survey of Lisbon residents and a spatial analysis of green space density, revealed that while Lisbon's average green space coverage is 21%, most zip code areas (12 out of 19) have less than 10% green space coverage. The survey also indicated that residents frequently visit green spaces within their residential area, but in areas with low green space coverage, they travel to adjacent areas to visit green spaces. Therefore, the study underscores the importance of ensuring the availability of green space in proximity to where people live. The authors conclude that Lisbon's residents do not have equitable access to green spaces due to the uneven distribution of green spaces across the city, and they recommend that policymakers prioritize areas with low green space coverage while addressing EJ concerns.

3.3.1 Access to green spaces

Access to green space is influenced not only by distribution but also by the qualities of the space. *Brien et al. (2017)* note that access to green space is affected by various types of barriers beyond just geographical distance, and advocate for a broader understanding of "access" that includes the preferred and actual use of green space. These barriers include social, personal, and economic factors such as physical barriers, lack of recreational infrastructure and quality, lack of information and knowledge, cultural norms, safety, and confidence issues. Access to green space is also influenced by people's diverse social and cultural identities, and some groups may experience these barriers more significantly than others. EJ requires recognizing these differences in needs and limitations regarding green space access and addressing them through strategies that accommodate a variety of users.

3.3.2 Urban Greening Strategies

Studies have also shown unexpected outcomes of urban greening strategies, such as increased housing costs and property values in neighbourhoods lacking adequate green spaces *(Wolch et al., 2014)*. Urban greening strategies should be shaped by community concerns, needs, and desires to avoid these paradoxical outcomes. *Haase et al. (2017)* call attention to the social implications of urban greening strategies, which are often neglected by policymakers. Urban greening strategies are often market-driven and cater primarily to higher-income residents, leading to greater social disparities in access to green space.

It is important to study urban green spaces in relation to EJ, not only in terms of distribution but also in terms of the factors and processes that determine disparities and why these outcomes are inequitable and/or unjust. Policymakers must consider the justice implications of urban greening strategies and consider the specific local contexts in which they are implemented.

3.4 Urban Green Spaces and Accessibility

Urban green infrastructure (UGI) comprises various green spaces such as parks, forests, community gardens, and waterway corridors that serve as vital connections between nature and urban areas *(Artmann et al., 2017)*. The Norwegian Directorate of Nature Management (June 1994) handbook defined green infrastructure as:

> "The web of large and small natural areas in cities and towns",

Planning for UGI involves the development of green space networks in densely populated urban areas, which offer several ecosystem services and benefits to the community, such as promoting physical activity, enhancing mental health, and facilitating social interaction among residents *(Zwierzchowska et al., 2018).* Additionally, UGI can contribute to building resilience to climate change and improving the liveability of cities by creating a cleaner and healthier environment *(Loja et al., 2018).*

According to some studies *(Kabisch et al., 2016),* the availability of green spaces in European cities may be related to their location, with more public green spaces found in Northern and Central European countries compared to Mediterranean ones. Additionally, the distribution of public green space is associated with the social class location *(Park & Kwan, 2017)*. This means that socioeconomically deprived sections of society, such as low-income groups or ethnic minorities, often have less access to or are deprived of green spaces compared to the rest of the population *(Hoffimann et al., 2017).*

Accessibility is essential in determining green structures' suitability for outdoor life and activities. It is a relative term, however, as different people have different needs and different conceptions of what is readily accessible. The most motivated users, such as avid walkers and joggers, are content to accept the challenge of traveling a certain distance and overcoming barriers to reach usable green spaces. Others, however, may require more convenient access and may not be willing to make such a journey *(Norwegian Environment Agency, 2014)*.

The distribution of green space access in urban environments is a growing research area. For instance*, Comber et al. (2008)* researched green space access for different religious and ethnic groups in Leicester, UK, and found that Indian, Hindu, and Sikh communities, who are ethnic minorities in Leicester, have limited access to green space. *Kuta et al. (2014)* studied the accessibility of urban green spaces for various socioeconomic groups in the United Kingdom and discovered that socioeconomically poor groups lack access to green spaces within 300 meters of their residence. *Sotoudehnia and Comber (2011)* explored physical and perceived accessibility to urban green space in the United Kingdom and found that only 15% of the population in Leicester has physical access to up to 300m. However, *Nicholls (2001)* used GIS and the Mann-Whitney U test technique in SPSS to examine the accessibility and distributional equity within a system of public parks in Bryan County, Texas, and the results showed that there was no imbalance. These examples illustrate that knowledge of EJ and urban green space is expanding, and there is more concern about environmental inequity.

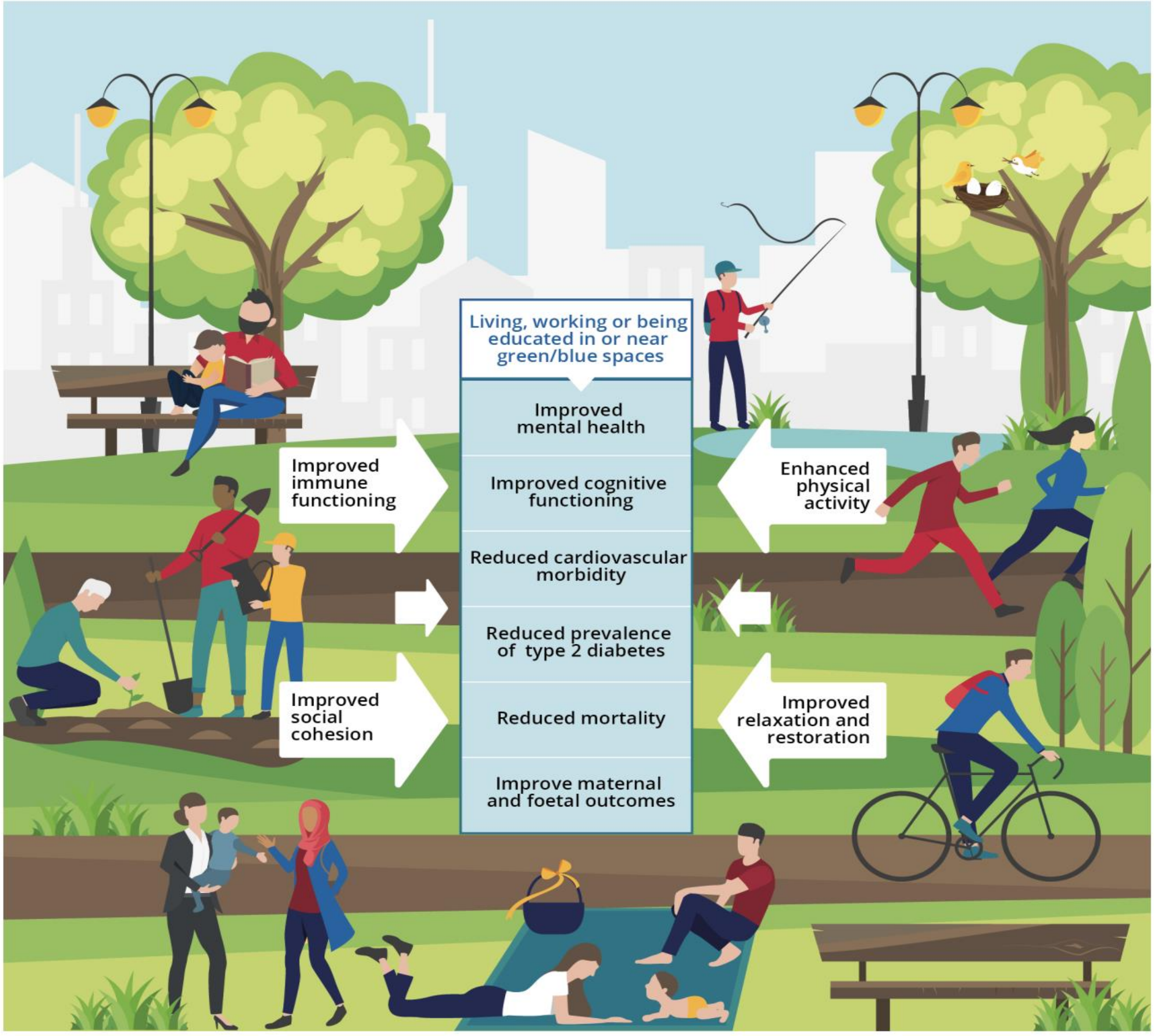


Figure 10. Benefits of Urban Green Space (EEA, 2020)

Most importantly, this research focuses on green spaces seeking to indicates if there are environmental disparity in many parts of the study area. According to *Harlan and Ruddell's (2011)*, urban green spaces have positive impacts on human health, especially in metropolitan areas. Greater vegetation improves air quality and reduces the temperature of high-heat concrete spaces, thus improving the overall well-being of urban residents. Their research found that individuals who are physiologically vulnerable, socioeconomically disadvantaged, and living in degraded areas have a higher risk of health issues. Meanwhile, living near urban green spaces provides access to public spaces and opportunities for social interactions, as per *Boone et al. (2009)*. In addition, *Giles-Corti et al. (2005)* discovered that people living near green spaces are three times more likely to meet the recommended amount of physical activity. *Maller et al. (2006)* also found that urban green spaces can improve mental health.

These studies suggest that urban green spaces have a positive impact on residents' health and well-being.

Part summary:
Access to green space is an EJ issue, with certain segments of the urban population having better access than others, leading to poorer health, fewer environmental amenities, and lower levels of mental well-being. Studies have shown how the uneven distribution and availability of green spaces in cities affect the access of different social groups. Access to green space is influenced by physical, personal, and economic barriers, as well as people's diverse social and cultural identities. Urban greening strategies should be shaped by community concerns, needs, and desires to avoid paradoxical outcomes.

3.4.1 Determinants of Urban Green Space Accessibility

The Norwegian Planning and Building Act of 2008 described green spaces as “a contiguous, or nearly contiguous, vegetated area that is within or adjacent to a city or town. " According to *Fan et al. (2017)*, public urban green space consists of parks and other green areas accessible to the public and managed by the local government. *Lindholst et al. (2016)* outline three key factors for evaluating the quality of urban green spaces:

a) structural and general attributes such as size, location, accessibility, and character,
b) functional and experiential elements including social and recreational aspects, natural biodiversity, cultural and historical significance, landscape aesthetics, and environmental climate, and
c) management and organisation, which includes maintenance, communication and information, and overall management of the green space.

In general, accessibility can have a broad connotation. However, in the literature on green spaces and in this study, accessibility refers to the walking distance between the entrance points of the green spaces and the residential areas. There are several national laws, regulations, and guidelines that apply to green open spaces, in Norway, excerpts from the national guidelines and regulations that have been adopted at the municipal level which state that green open space should be accessed within 200m in a built-up area and 300m in a dispersed settlement, access to a larger green open space should be within an approximately 2 km walk at a maximum distance of 500m from place of residence *(Ministry of Local Government and Modernisation, 2019).*

The United Kingdom has a set of recommendations called Accessible Natural Greenspace Standards (ANGSt) for evaluating the availability and accessibility of green spaces *(Comber et al. 2008),* which states:

i. No one should live more than 300m from their nearest area of green space of at least 2 hectares in size.
ii. There should be at least one accessible 20-hectare site within 2 km from a residential area.
iii. There should be one accessible 100-hectare site within 5 km.
iv. There should be one accessible 500-hectare site within 10 km.

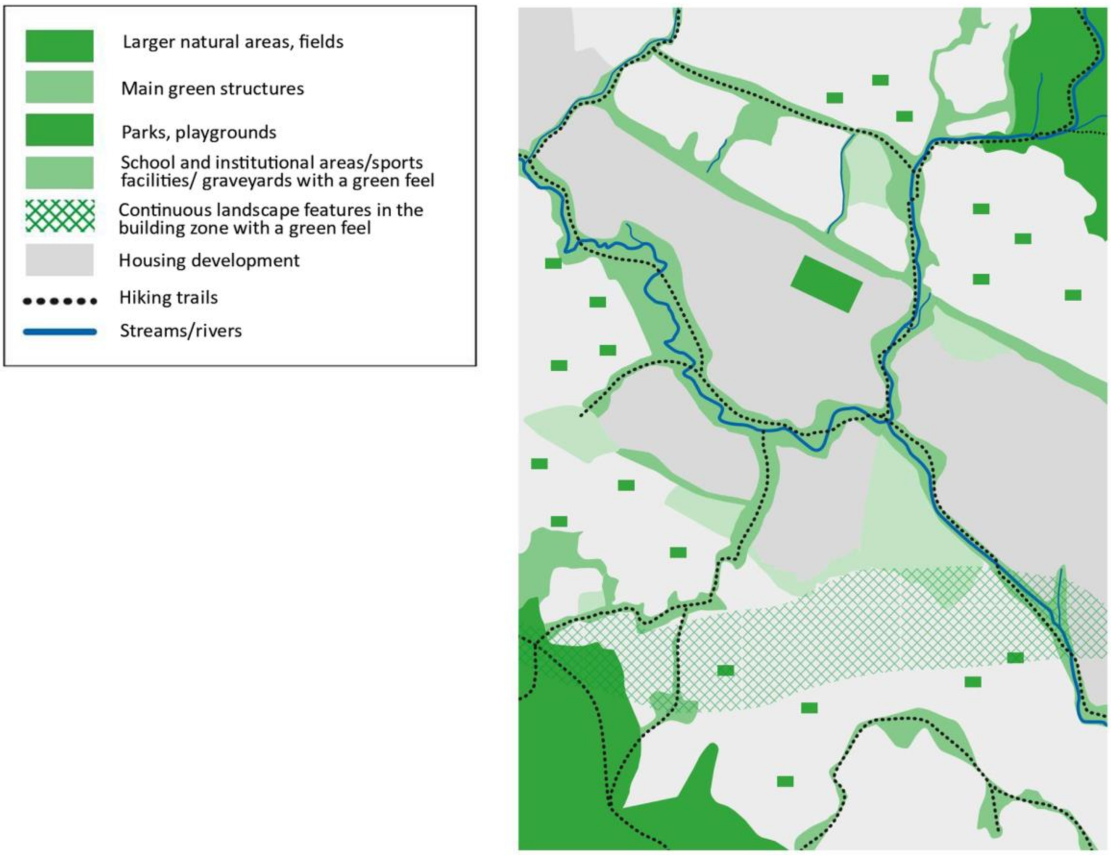


Figure 11. Comprehensive green structure plan (NEA, 2014)

Despite the fact that the ANGSt model provides a comprehensive set of recommendations, it is not appropriate for every city or country. Other countries may not have as many green spaces as the United Kingdom, and not all green places are accessible *(Boone et al. 2009)*.
There are inequalities in the distribution of green infrastructure in most cities, the different groups of society have more or less access to green infrastructure, depending on their socioeconomic status. To study the inequalities of access to UGS and to provide solutions, it is necessary to measure them. Most research on accessibility has focused primarily on two aspects:

i. distance to green spaces and

ii. the area available at that distance, providing threshold values of urban green space per habitant.

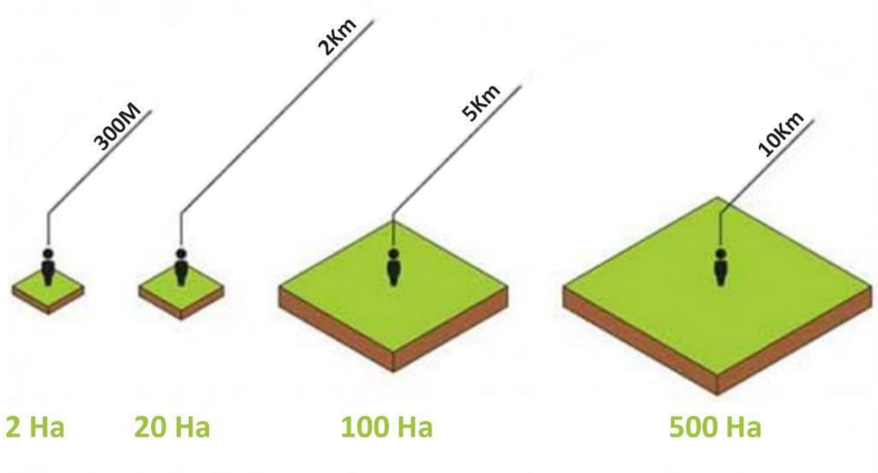


Figure 12. Threshold for measuring the availability and accessibility of green spaces according to some excerpts from this literature. (Own illustration)

However, in some cases, accessibility has been estimated using only one of these factors *(Rojas et al., 2016)*. The European Environment Agency (EEA) recommends that people should live within 15 min walking distance of green spaces to their place of residence *(Chiesura, 2004)*, but does not specify the available area of green space per resident. Also, *Wolch et al. (2014)* defined 400 m, a five-minute trip, as the standard distance between a public park and people's houses.

In other studies, both aspects have been combined. *Coles and Bussey (2000)* considered that green spaces should be a 5 to 10-minute walk from the residential area and have a minimum area of 2 ha. *Van Herzele and Wiedemann (2003)* suggested a 5-min walk, equivalent to 400 m, to the closest 1 to 10 ha green space. The UK government agency, English Nature, recommends, in the Accessible Natural Greenspace Standards, that at least 2 ha of accessible natural green space should be provided per 1000 population, with a minimum distance of 300m from the place of residence. The World Health Organization assumes a minimum of 9 m2 of green space per person, and the ideal minimum area of green space should be 50 m2.

According to *Maroko et al. (2009)*, accessibility to public urban green spaces can be measured with the container approach, the walkability distance method, and the Kernel density estimation. The container approach measures the accessibility using a particular geographic unit of aggregation, such as zip code, neighbourhood, or census unit, to determine the location of a park or recreational facility, instead of using a proximity measure. In this method, the number of parks per aerial unit can be estimated for the unit of aggregation used, and related to specific population characteristics, for example, socioeconomic status. The walkability distance method considers a standard walking distance (5–10 min walk, 400 m or

800 m) to parks as a proxy for access. Nevertheless, in this method, the actual street network was not considered, only Euclidean distance.

Meanwhile, the relationship between distance and willingness to walk is a continuous curve without sharp breaks, thus, the Kernel density estimation used by *Moore et al. (2008)* may estimate, more accurately, the accessibility for every point of a study area, because it uses blocks of areas, instead of giving a binary answer of accessible or not in just a few meters of distance. *Fan et al. (2011)* proposes five variables for evaluating access to public urban green spaces:

a) A citizen-based opinion, reflecting the quality of a green space where residents live.
b) Multiple functional levels, including a quantitative evaluation of the green space from neighbourhood to city level according to their functional scales.
c) Preconditions for users, for example, accessibility and safety.
d) A quality measure that assesses the variety of suitability of green spaces to accommodate different activities; and
e) Multiple uses according to the diverse conditions.

Meanwhile*, Dai (2011)* argues that a common descriptive approach is based on the availability of green spaces per inhabitant, calculating the rate of supply vs the demand within a predefined region. However, it is not always predictable that people go to the closest green space for various reasons, such as its size, fear of dogs, or fear of crime and racial attacks.

3.5 Urban Green Spaces & Public Health

The importance of urban green space for health and well-being has been the subject of extensive research in recent years. The obesity and mental illness epidemics, which are harming people in both wealthy and developing nations, are getting worse on a global scale. Nonetheless, there has been a rising understanding of the potential utility of urban design interventions in addressing problems in recent decades *(Barton & Grant, 2015)*. For instance, engaging in diverse activities in green spaces can help address some of the mental health concerns occurring in modern society and the physical health issues brought on by modern diets and sedentary lifestyles. Urban green space has been the subject of a lot of research, especially regarding its potential health benefits and methods for maximising them *(Barton & Pretty, 2010).*

Urban green spaces provide a variety of functions, including that of social gathering places, recreational areas, and cultural venues. They serve economic and environmental objectives as well. Urban greening initiatives have been launched because of their practicality and aesthetic appeal in maintaining and raising property values. Urban green spaces are places where people can engage in activities that are good for their health, including exercise or rest and relaxation. They thus have a direct impact on urban residents' quality of life *(Haq, 2011).*

The relationship between contact with green areas and health advantages both at the individual and population levels has been demonstrated in a variety of research over the last ten years. They have included positive connections to health outcomes, like reduced mortality from cardiovascular and respiratory diseases *(Lee and Mahehwaran, 2011).*

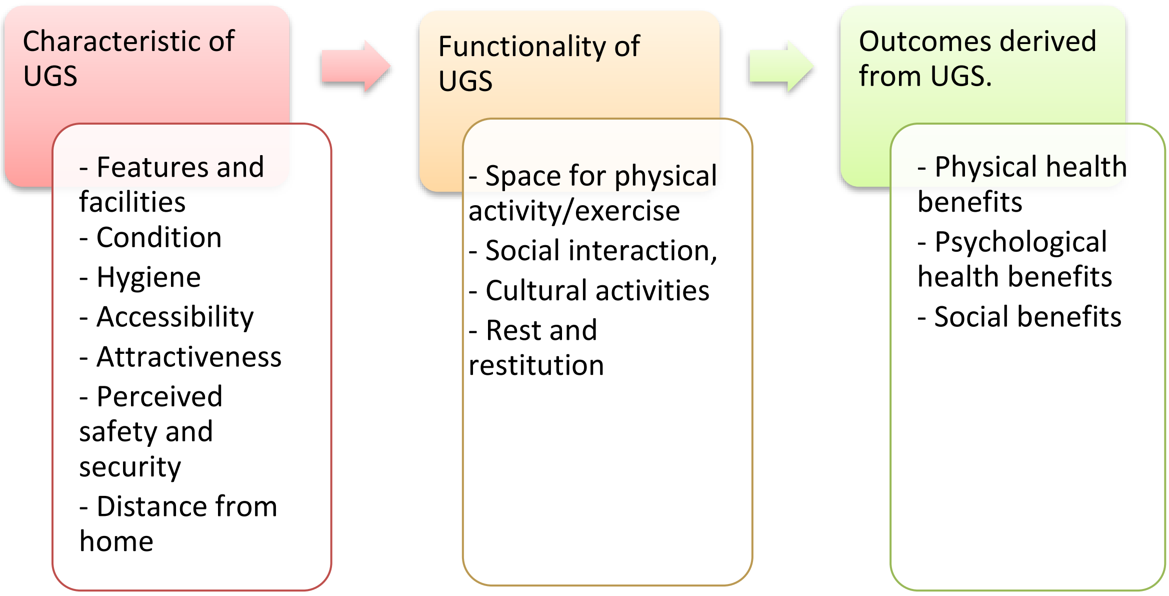


Figure 13. Relationship between UGS features, functionality, and results as stated by Lee et al., 2015 (Own illustration).

A rising body of research, according to *Mytton et al. (2012)*, suggests that the urban environment may have an impact on people's levels of physical activity. Urban green space accessibility and levels of physical activity have been linked in studies. Parks and other urban green areas give individuals a crucial place to engage in physical activity.

As was already said, there are opportunities for social contact in urban green spaces. As a result, there may be a decrease in social isolation, the creation of social capital, and an increase in personal resiliency and well-being. For older population groups, this seems to be especially crucial.

Even closer to home, the Norwegian city of Stavanger has developed a plan centred on a new park on the city's seafront, but the work schedule also includes the redesign of a public park and schoolyard. Stavanger is on a mission to improve the health and quality of life of its residents by creating new green spaces *(Borges, 2022).*

3.6 Current Issues and Debates in Urban Green Spaces

Despite the numerous benefits of urban green spaces, several issues and debates have emerged in recent times.

3.6.1 Access to Urban Green Spaces

Access to urban green spaces is a major issue in many places throughout the world. While some cities have an abundance of green areas, others, particularly in low-income and minority districts, have restricted access to such spaces. *Jimenez et al. (2019)* discovered that inhabitants in low-income New York City neighbourhoods have restricted access to green spaces, which has a negative influence on their health and well-being.

3.6.2 Green Space Quality and Maintenance

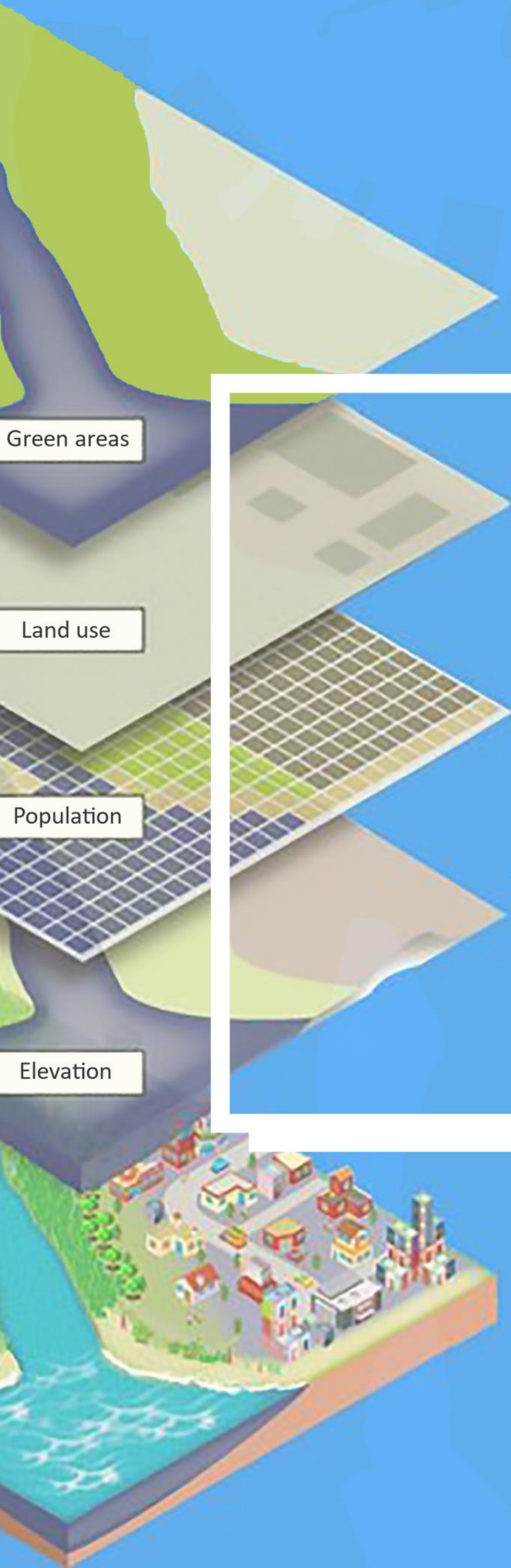
The quality and upkeep of urban green spaces is critical to their sustained use and pleasure. Nonetheless, many cities confront issues in sustaining their green spaces due to a lack of financing and resources. As a result, green places may degrade, become dangerous, or become unusable. In a study by *Colding et al. (2013)*, the researchers discovered that the quality of the space and its care had a considerable influence on inhabitants' impressions of green spaces.

3.6.3 Urbanization and Green Space Loss

Urbanisation poses a severe threat to urban green spaces since it frequently results in the loss of green spaces. Because of the increased desire for urban expansion, green spaces are being converted to other purposes such as residential and commercial sectors. The loss of green spaces can have serious effects on urban ecosystems, including the loss of biodiversity and ecosystem services. According to *Pauleit et al. (2020)*, urbanisation and land-use change have had a substantial impact on urban green areas, resulting in a decrease in their quality and quantity.

Part summary:

Green spaces are accessible to the public and managed by the local government, and accessibility refers to the walking distance between the entrance points of the green spaces and the residential areas. The ANGSt model provides a comprehensive set of recommendations, but there are inequalities in access to green infrastructure. To measure these inequalities, research has focused on two aspects: distance to green spaces and area available at that distance. Access to public urban green spaces can be measured using the container approach, walkability distance method, and Kernel density estimation. Fan et al. (2011) propose variables for evaluating access which revolves around quality, functionality, and preconditions for use of urban green spaces.



CHAPTER FOUR **SPATIAL ANALYSIS**

4.0 SPATIAL ANALYSIS

As stated in the preceding chapter, Storhaug was selected as a case study because it is a vibrant district in Stavanger with a rich history and culture that offers many opportunities for exploration and recreation, having been the industrial centre of Stavanger since 1848 when the city boundary was moved eastwards *(Stavanger Kommune, 2023)*. The area has experienced rapid population growth that includes a diverse mix of native and immigrant residents. Storhaug is situated in the southwest region of the extensive Stavanger municipality in Rogaland County, Norway. It covers a land mass of 11.5 km² *(Llopis Alvarez & Müller-Eie, 2022)* and has 16597 inhabitants, with 21% of the population being immigrants *(SSB, 2023)*. It includes the traditional city centre and the main port of Byfjorden *(mapcarta.com)*. Storhaug borders Hillevågsvatnet to the west and the Våland and Eiganes regions. The border runs from Hillevågsvatnet to Breiavatnet and further to Vågsbunnen. Other natural borders are the Byfjorden and the Gandsfjorden. At Ramsvik and Rosenli, the district extends from the central urban area into the rural surroundings *(Stavanger Kommune, 2023).*

To carry out this study, the area was sub-divided into nine major neighbourhoods – Stavanger Sentrum (west and east sentrum) Bergeland, Badedammen, Nylund, Lervig, Varden, and Midjord, as measuring points. These geographical delimitations were done using ArcGIS Pro to map out the boundaries within development areas including landscapes and existing road networks, while respecting borders defined by the Municipal Development Plan as administrative boundaries. This means that the mapping was carried out considering the spatial extent of development in the region, the sea lines, and the various factors that may have influenced the distribution of land use types and land cover within these areas. The use of development boundaries as a reference point for mapping allowed for a more accurate and comprehensive understanding of the study area and helped to provide a more accurate and nuanced understanding of the different land use patterns and associated dynamics.

GIS helped collect some of the objective information (distribution of services as transport and parking facilities, and size of green spaces) as well as create the maps for this study. It served not only as a tool to collect objective data, but also to link observed data and the participants' subjective data to spatial figures. The study area consists of approximately 15% green spaces, most of which are located along the boardwalk and are interconnected *(Llopis Alvarez & Müller-Eie, 2022)*.

Figure 14. Storhaug showing administrative neighbourhoods' boundaries. Scale 1: 12000. (Source: Own's Illustration using Esri ArcGIS).

4.1 Green spaces

The study area includes a variety of green spaces, including public parks, open green spaces, sports facilities, a cemetery, and smaller neighbourhood street gardens and playgrounds. These green spaces range from larger, sprawling facilities to small, intimate gardens. In addition to these public spaces, there are also semi-public green spaces adjacent to flat blocks and office buildings, as well as private green spaces belonging to residential buildings. All these green spaces fall under the categorisation of green spaces according to the *Norwegian Environmental Agency (NEA).*

For the purposes of this study, the analysis focused specifically on public green spaces (PGS), as they serve as a distinguishing feature between the different neighbourhoods in the study area. These public green spaces serve as common features that can be compared and contrasted between the different neighbourhoods.

Figure 15. Map of green areas in Storhaug (Source: Stavanger Kommune, modified by Author)

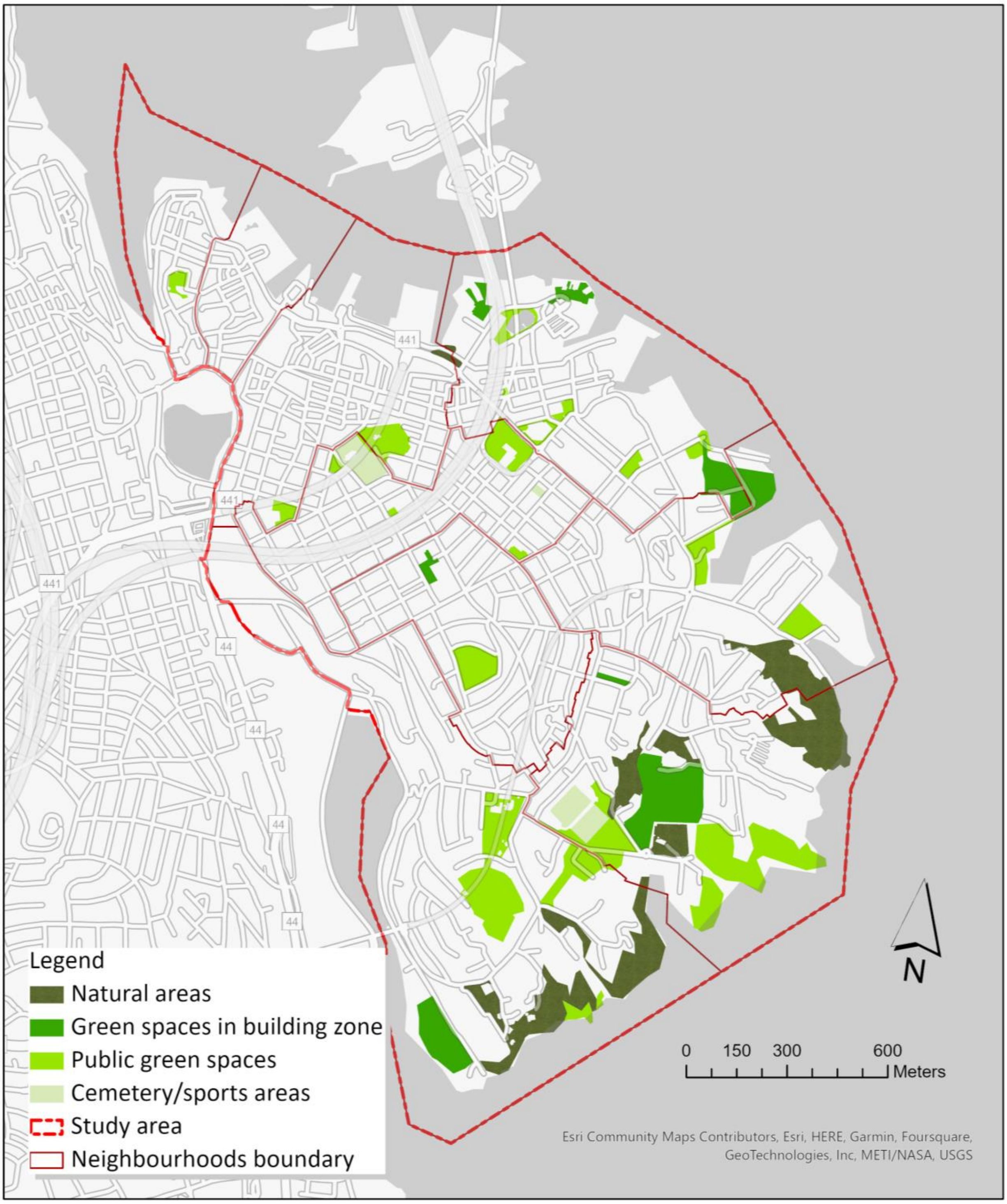


Figure 15.2. Classification of green spaces in Storhaug according to the Norwegian Environmental Agency (NEA). Scale 1: 12000. (Data source: SSB, 2019, Image source: Own's Illustration using Esri ArcGIS).

There are three notable recreational parks in the study area: Badademmen, Johannesparken, and Kyviksmarka. Badammen, in particular, offers a number of amenities and attractions. It features an outdoor playground, a designated outdoor fitness area, a sand volleyball court, and a water pool that happens to be the oldest public bath in the city. Because of its diverse offerings, Badammen has become a popular place for families with children, especially during the summer season, but also for individuals of all ages. In addition, the park offers public toilets, comfortable seating and ample parking for cars and bicycles, making it convenient and easily accessible for its users.

Figure 16. Bathing pool in Badedammen

Figure 17. Outdoor gym in Badedammen

Johannesparken is beautifully situated on a hill overlooking Kjelvene and offers a breathtaking view of the fjord and the majestic Ryfylke mountains. The character of the park is defined by the iconic St. Johannes church, which is a prominent and easily recognizable landmark in the area. Johannesparken features several amenities that enhance the visitor experience. A designated barbecue area invites outdoor cooking and dining, while strategically placed seating areas provide comfortable spots to relax and soak in the surroundings. A charming fountain and intriguing sculptures add to the park's artistic atmosphere. It is also home to the Honningbakken neighborhood garden, which contributes to the green and tranquil ambiance of the park. On one side, the park is bordered by the Bybrua pier, which forms the outer boundary towards the city center. This connection with the bridge gives Johannesparken an air of grandeur and accessibility.

Across Havneringen, towards the waterfront promenade, lies the Kjelvene skatepark, a lively hub that attracts numerous users due to its prime location and exciting urban activities. The skatepark has a high density of fantastic facilities such as ball courts, skate ramps, a carousel, slides and a playground with a sandbox. It serves as a meeting place for lovers of various sports and recreational activities. Furthermore, the skate park plays an important role in connecting several traffic routes and facilitates access for pedestrians, cyclists, motorists and public transport. Overall, Johannesparken and the neighbouring Kjelvene Skatepark offer a delightful mix of natural beauty, cultural attractions, and recreational opportunities that make them popular destinations for residents and visitors alike.

Figure 18. Johannesparken

Figure 19. Kjelvene Skatepark

As reported by Dagsavisen.no, Kyviksmarka is one of the parks in Stavanger municipality that has undergone significant changes in the last five years. Along with other PGS in Storhaug, it has been transformed into a vibrant recreational area. The park now offers various amenities such as a brand new parkour facility, a sand volleyball court, a barbecue area and a table tennis court.

Near Kyviksmarka is the Hetland graveyard, a quiet and peaceful place surrounded by lush green landscape. The cemetery provides a peaceful resting place for deceased loved ones and is carefully maintained to provide a tranquil atmosphere for visitors. A walk on the grounds, is surrounded by a variety of trees, manicured lawns, and colorful flowers that create a calming environment conducive to reflection. The green surroundings of Hetland graveyard add to the overall natural beauty of the area, providing a peaceful sanctuary where visitors can find solace and connect with nature amidst the bustling urban environment of Storhaug.

Lervigtunet Park has also been recently restored and offers visitors a glimpse into its history as a brewery. The old brewery buildings now host cultural activities at the Tou Stage. Right next to the Tou scene, you'll find Sjøparken, a gorgeous new playground with local flair, located right on the waterfront.

Figure 20. Kyviksmarka

Figure 21. Lervigtunet Park


Figure 22. Sjøparken


Figure 23. Storhaugmarka

Moving away from the waterfront towards the center of Storhaug, is Storhaugmarka. The name of this district is derived from the old burial mound "Storhaugen", which still stands as one of the highest points in the area. Storhaugmarka ia a spacious field, with climbing trees, a football field, and a playground equipped with a sandpit, playhouse, swings, and a climbing house with a slide. Additionally, from this vantage point, is a panoramic view of the charming wooden homes that populate the neighborhood.

A ten-minute walk from Storhaugmarka through Jelsabakken leads to Varden, the highest elevation above sea level in Storhaug. Here, amidst the greenery, one can enjoy the cool sea breeze and take in the picturesque view of the sea and the city, especially Våland.

4.2 Land use

The study area is characterized by a high degree of functional mix, with a variety of uses including publicly accessible stores, housing, offices, cultural institutions, galleries, education, and industry. The northern and eastern portions of the area have a higher concentration of mixed land uses, while the central and southern portions are primarily residential.

In Sentrum, both east and west, there is a remarkable concentration of industry, public and private services, restaurants, hotels and shops. The Norwegian Petroleum Museum is also located in this area, as are various cultural and religious institutions. Pedersgata is a hub for public amenities such as restaurants, pubs and shops serving a diverse population, including immigrants who can enjoy a range of Indian, Asian and African cousins here. This serves as a popular spot for tourist while visiting Stavanger.

Figure 24. Tou scene

Figure 25. Land use map (Source: www.temakart-rogaland.no)

Figure 26. Residential garden area in Størmig, Varden

In Nylund, Varden and Midjord, land is primarily used for residential purposes, with a variety of housing types. In Nylund, there are white-painted wooden houses with 1 to 2 storeys and attic, whose facades have a uniform appearance and the streets are determined by house frames. In Varden, the small private houses are adorned with beautifully landscaped gardens teeming with plants and flowers, creating a charming and attractive neighbourhood.

Overall, the mix of land uses in the study area can influence the types of activities that take place, as well as the attractiveness of the area to residents and visitors. The areas with a greater concentration of commercial and cultural institutions tend to attract more people, while the residential areas offer a quieter and more peaceful environment for residents to enjoy.

Badedammen and Lervig also have a mix of residential, industrial, institutional and cultural uses. Svankeviga is home to the Verven 44 condominium complex and the Stavanger Health Centre, while Spilderhaugviga is home to Tou Scene, an arts and cultural institution, and Innovation Dock, a coworking space. Lervika is dominated by private service companies and the Varmen fire station.

Part sumary:
The way people use an area on a daily basis is usually determined by the land use in that area. For example, in a residential area there are parks and playgrounds for residents to use, whereas in a commercial area there is less green space because more buildings and parking are needed. Therefore, the land use surrounding a green space can significantly influence the use, choice and frequency of visitors to that green space.
Similarly, a green space near a factory or industrial area may have a negative impact on its use and attractiveness, as it may be exposed to pollutants and contaminants that can affect the health of visitors. On the other hand, a green space near a school or community centre may be attractive to families with children because it provides a safe and easily accessible place for children to play and learn. In summary, the land use surrounding a green space can significantly influence the frequency, choice, and use of that green space.

4.3 Transportation and infrastructure

The Stavanger metropolitan area is highly dependent on car mobility, with 57% of residents using cars as their main mode of transportation *(Østerhus, 2020).* This trend can be attributed to several factors, including distance between home and work, limited accessibility and convenience of public transportation, insufficient parking, public transportation frequencies, and travel times. In addition, many people choose to drive because of the time savings associated with private transportation. A survey conducted by *Tanu Priya Uteng and Nils Gaute Voll in 2016* found that only 7% of Stavanger's population regularly uses public transportation. This low amount can be attributed to the city's history of car use, which has contributed to a culture that favours individual transportation.

The following section provides an in-depth analysis of Storhaug's transportation modes and available infrastructure. The study was conducted through a combination of on-site observations, the use of Google Maps for visual analysis, and data obtained from SSB. The collected data was further analysed using ArcGIS Pro software to provide a comprehensive overview of the area's transportation network.

4.3.1 Walking and cycling

The study was conducted through a combination of field observations, use of Google Maps for visual analysis, and data from Stavanger municipal and SSB websites. The collected data was further analysed using ArcGIS Pro software to provide a comprehensive overview of the area's transportation network.

A hike in the Storhaug area offers a variety of options, thanks to the impressive landscapes and open spaces found along the way. First, immersing in the youthful energy of Kjelvene

Skatepark before admiring the architectural beauty of St. Johannes Church. The rest of the way leads through quiet residential streets and green promenades, surrounded by the rich history of immigrants from Ryfylke, which is reflected in the street names. A well-deserved break in Storhaugmarka is a unique experience. The district takes its name from the old burial mound "Storhaugen", which bears witness to its historical significance. With an elevated heart rate, a brisk walk rewards the small climb to Varden with a breath-taking panoramic view from the top.

Figure 27. Walking and hiking trail in Storhaug (Source: Stavanger Kommune, modified by Author)

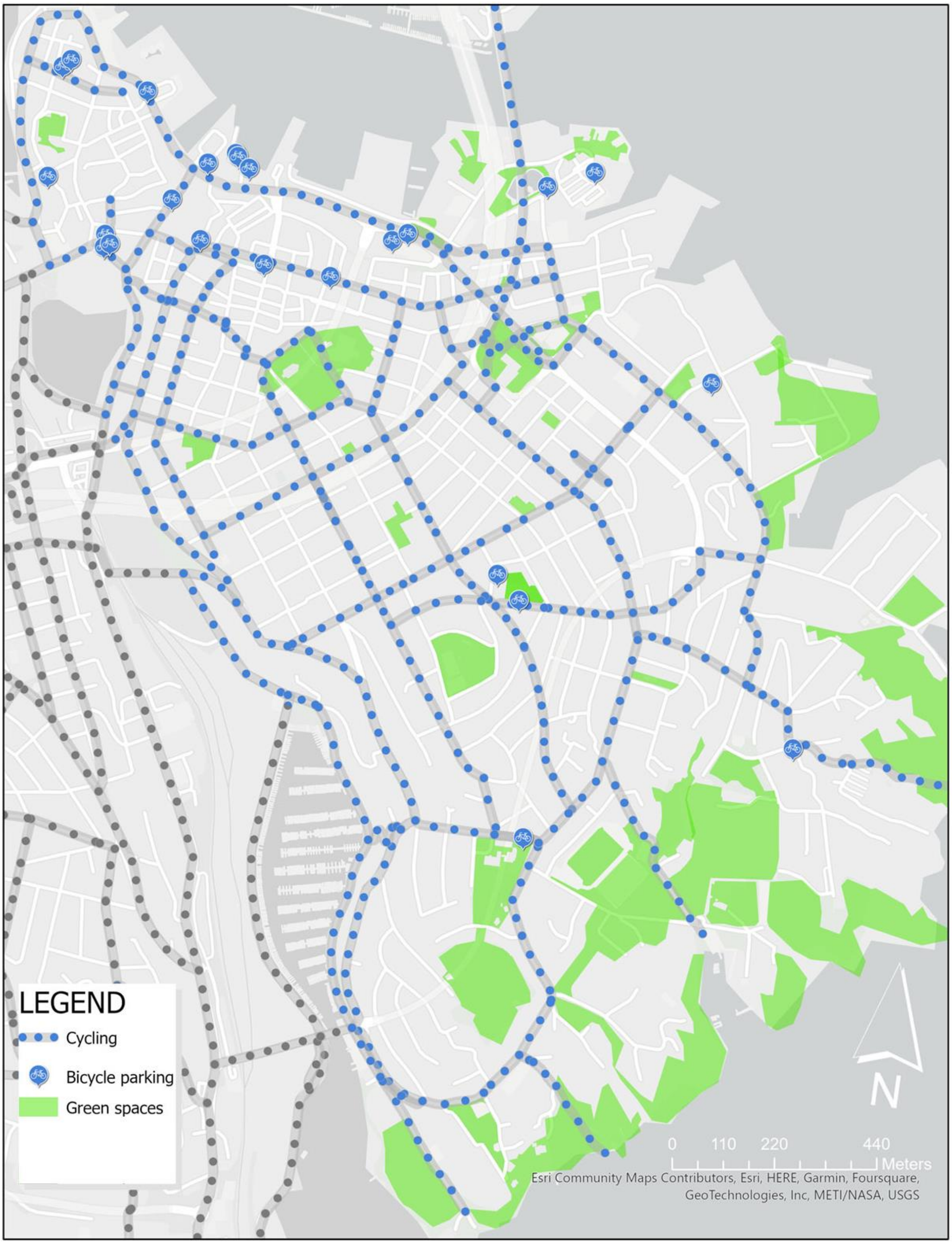


Figure 28. Illustration showing cycling paths in Storhaug (Own's Illustration using Esri ArcGIS)

Figure. 29 Walk and cycling path in Emmaus, Storhaug.

One of Stavanger's most charming hiking trails takes adventurers along the lush coastal strip of Storhaug. The trail gently winds its way between bays and south-facing slopes adorned with a variety of well-established tree species that thrive in the warm climate.
Along the way, numerous swimming spots such as Godalen, Vaisenhusstranda and Rosenli offer opportunities to cool off in the crystal-clear waters. Remarkably, swimming is possible all year round in Storhaug, even in the middle of winter when the thermometer is at its bluest.

A detour to the mini farm in Godalen before continuing the coastal walk adds to the charm. In Ramsvig, a lovely spot awaits where dogs can run free while taking a colourful break in the nearby colony garden. When spring is in the air, the scent and sight of spring onions, which give the area its name, delight the senses. Until the end of 2020, cyclists are allowed to ride at walking pace between Breivik and Strømvig to promote harmonious coexistence with pedestrians on the beautiful paths (Stavanger Kommune, 2023).

The journey continues to Rosenli, where Leonor A. Mydland once cultivated a magnificent orchard and produced fruit wine. Although the horticulture activities ceased in 1967, the enchanting landscape intoxicates visitors with its beauty. The trail leads through the deciduous forest and eventually back to the bustling city streets. Before ending the adventure, be sure to look for the fingerprints that adorn the Lervigtunet and add a touch of whimsy to the surroundings.

Figure. 30 Lysefjordgata in Nylund, showing double sided pave on street.

In Storhaug, most streets have paved sidewalks on both sides. In Sentrum, streets such as Pedersgata typically have a sidewalk width of about 1.5 meters, while in Badedammen and Lervig the width can be up to 4 meters, due to recent phases of development. Two pedestrian bridges improve accessibility in the study area: one in Bergeland connecting Johannesparken and Kjelvene, and the other spanning the tunnel opening at Bekhuskaien.These bridges not only facilitate pedestrian movement but also promote easy access to the green spaces in Bergeland and Badedammen, allowing residents and visitors to fully enjoy the surrounding natural beauty.

The cycling paths in the study area are well distributed and interconnected and provide pedestrians with good access to other green spaces outside of their neighbourhood as shown in Figure 29. Bicycling can also be a faster alternative for those who find walking too far, or for those who cannot afford to take the bus or car. Nevertheless, there appears to be more bicycle parking in Sentrum than in other neighbourhoods in Storhaug, possibly to compensate for the lack of bus and car access in these areas.

4.3.2 Public transport and parking

There are a total of two culverts and two tunnels in the study area. One of the culverts connects Bybrua with Haugesundsgata running over Badedammen, the other connects Stavanger Sentrum, Badedammen and Bergeland via Bekhuskaien and Haugesundsgata. The first culvert runs from Banaviga to Bergelandsbrua, the second connects Lervig and Midjord with Varden and extends from Haugesundsgata to Storhaug Tunnelen. These tunnels and culverts act as physical barriers for pedestrians.

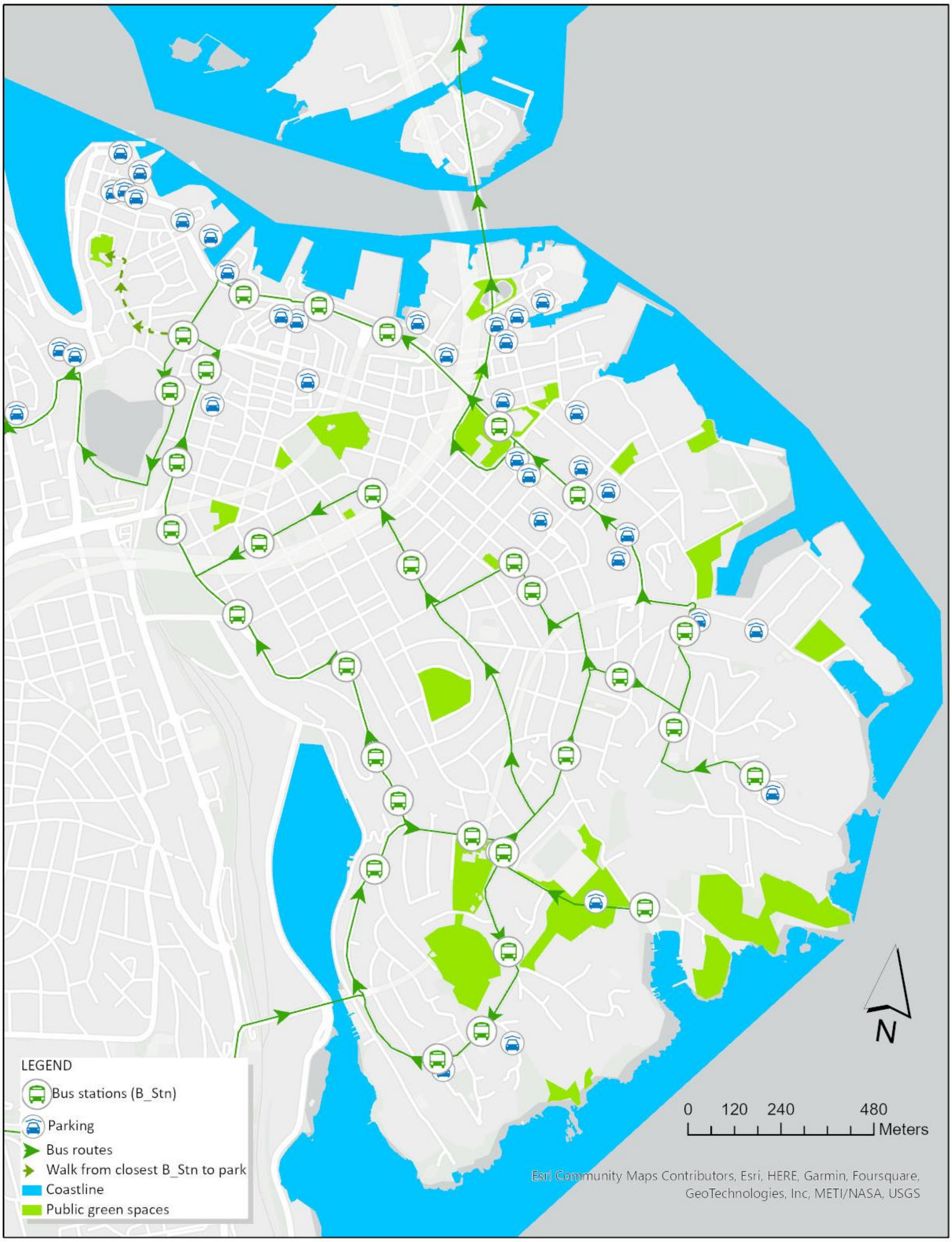


Figure 31. Available bus stations and routes in Storhaug. (Source: Own's Illustration using Esri ArcGIS)

In terms of parking, most of the area's streets have parking lots, and there is some private parking as well. Many of the residential blocks have dedicated parking within the block.
Public transportation in the study area is well developed, with most bus departures every 15 minutes (four departures) during weekday work hours and every 30 minutes during night-time hours (see Table 3). The area is served by long bus routes, e.g., from Ramsvig to Byhaugen, from Rosenli to Stavanger via Tjensvoll-Sus, and from Godalen to Stavanger, according to Kolumbus.no. These routes ensure sufficient access to green areas along their routes.

The road network in the area can be divided into three levels depending on the traffic load: Main roads, collector roads for local traffic and local streets. Traffic volumes on the remaining roads are generally low, as many of them have less than 100 ÅDT (Average Daily Traffic). Ferry traffic on Bekhuskaien accounts for 1,800 ÅDT (Anna Hannah, 2016). In addition, there are 31 bus stations serving the Storgaud district area.

Table 3. Public bus stations in Storhaug

Bus stations	Bus routes number
Rosenli	4 Rosenli 4 Madlakrossen via SUS-Madlamark 4 Madlakrossen via SUS-Tjensvoll
Sandeidgata	
Sandnesgata	
Søilands gate	
Avaldsnesgata	
Saudagata	13 Stavanger 13 Godalen
Haukeligata	13 Stavanger 12 Byhaugen
Varden kirke	X74 Hundvåg X74 Forus 13 Stavanger
Jorenholmen	1 Hundvåg vest/øst 4 Rosenli 100 Jørpeland
Midjord	13 Stavanger 12 Byhaugen
St. Svithun skole	13 Godalen 13 Stavanger
Stavanger tinghus	13 Stavanger 13 Godalen
Stiftelsesgata	13 Stavanger 13 Godalen
Karlsminnegata	12 Byhaugen
Kjelvene	
Nylundsgata	12 Byhaugen X74

Sørnes	13 Stavanger
Nymansveien	12 Byhaugen X74
Opheimsgata	12 Byhaugen
Paradis	13 Godalen
Admiral Cruys gate	13 Stavanger 13 Godalen
Emmausveien	X74 Hundvåg X74 Forus
Fiskepiren	1 Stavanger 1 Hundvåg vest/øst 4 Rosenli 4 Madlakrossen via SUS-Madlamark 4 Madlakrossen via SUS-Tjensvoll 100 Jørpeland
Ramsvig	12 Byhaugen
Bekhuskaien	1 Stavanger 1 Hundvåg vest/øst 4 Rosenli 4 Madlakrossen via SUS-Madlamark 4 Madlakrossen via SUS-Tjensvoll 38 X60
Frue terrasse	13 Stavanger 13 Godalen
Godalen	13 Stavanger
Godalen vgs.	13 Godalen
Godalsveien	13 Stavanger X74 Hundvåg
Klubbgata	1 Stavanger 1 Hundvåg vest/øst 4 Rosenli 4 Madlakrossen via SUS-Madlamark 4 Madlakrossen via SUS-Tjensvoll 38 100 Jørpeland X30 X60
Byparken	13 Stavanger 13 Godalen

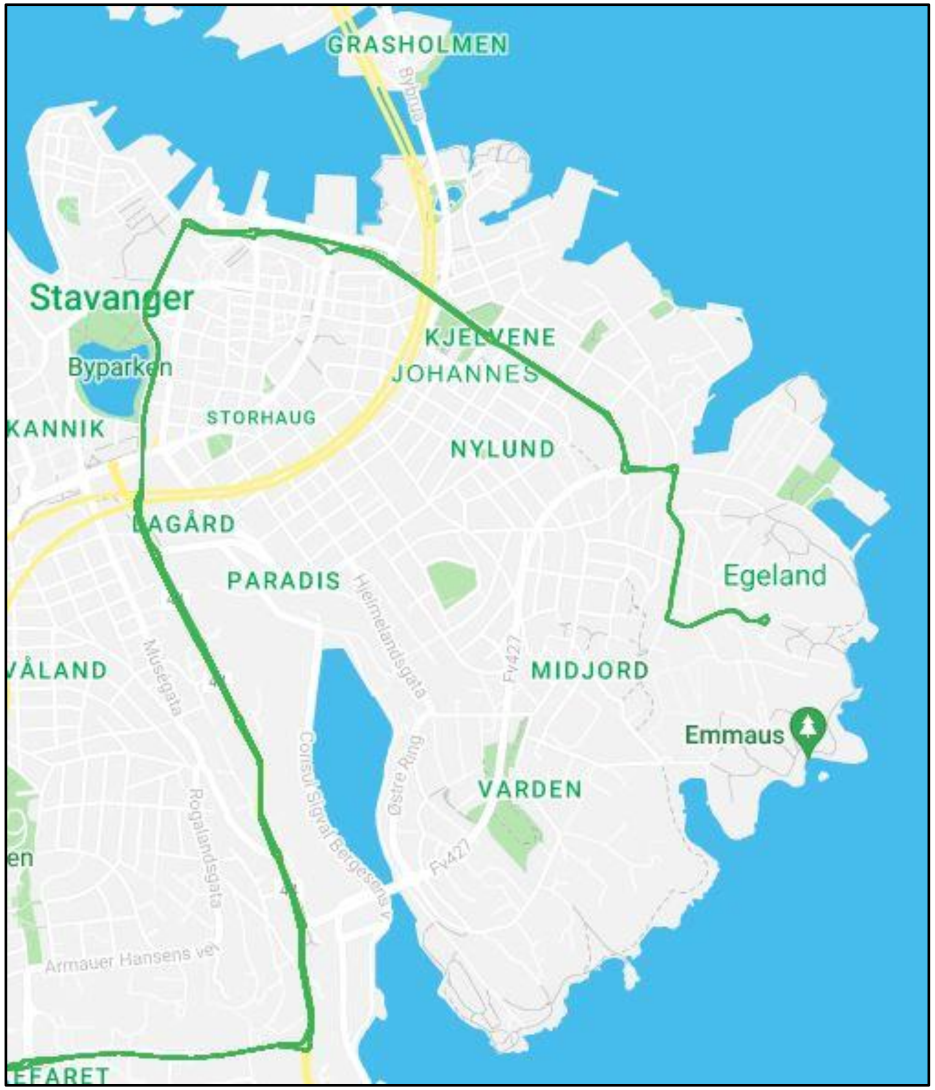


Figure 32. Rosenli Via Tjensvoll-SUS

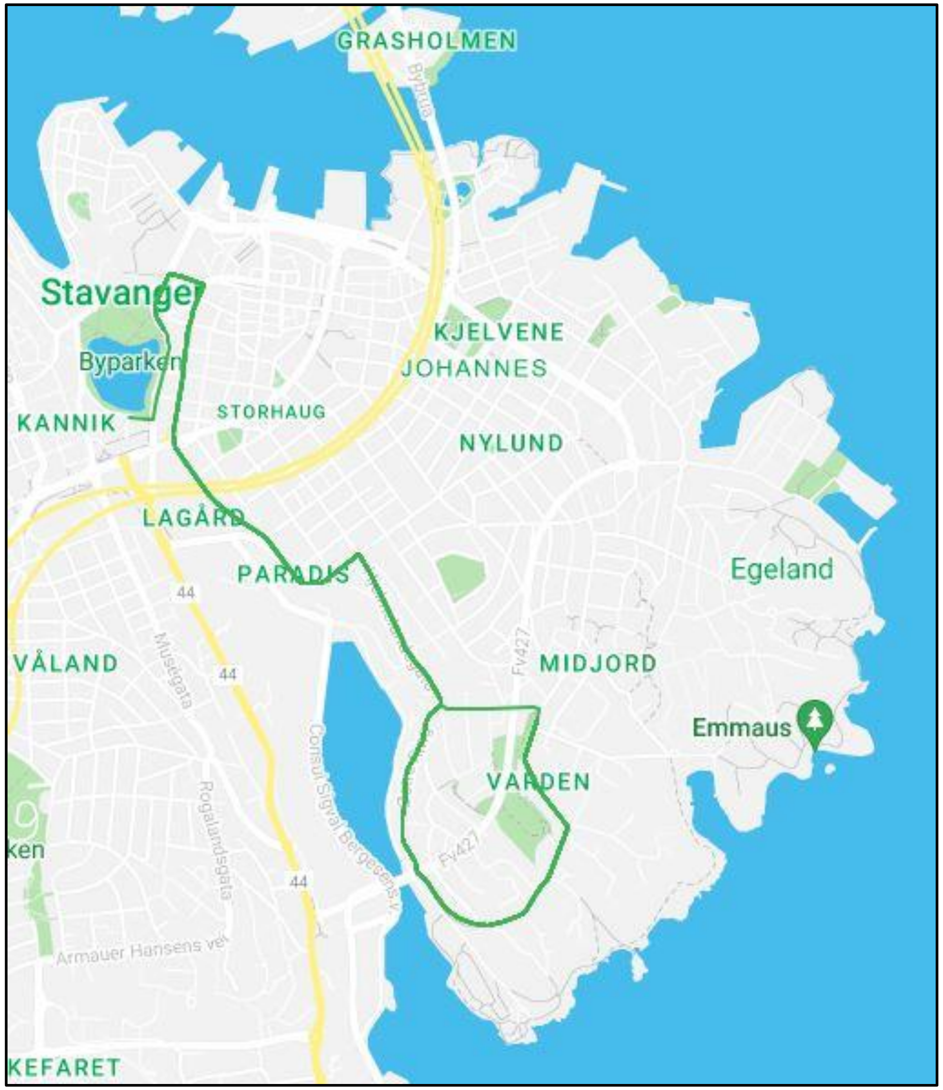


Figure 33. Godalen to Stavanger

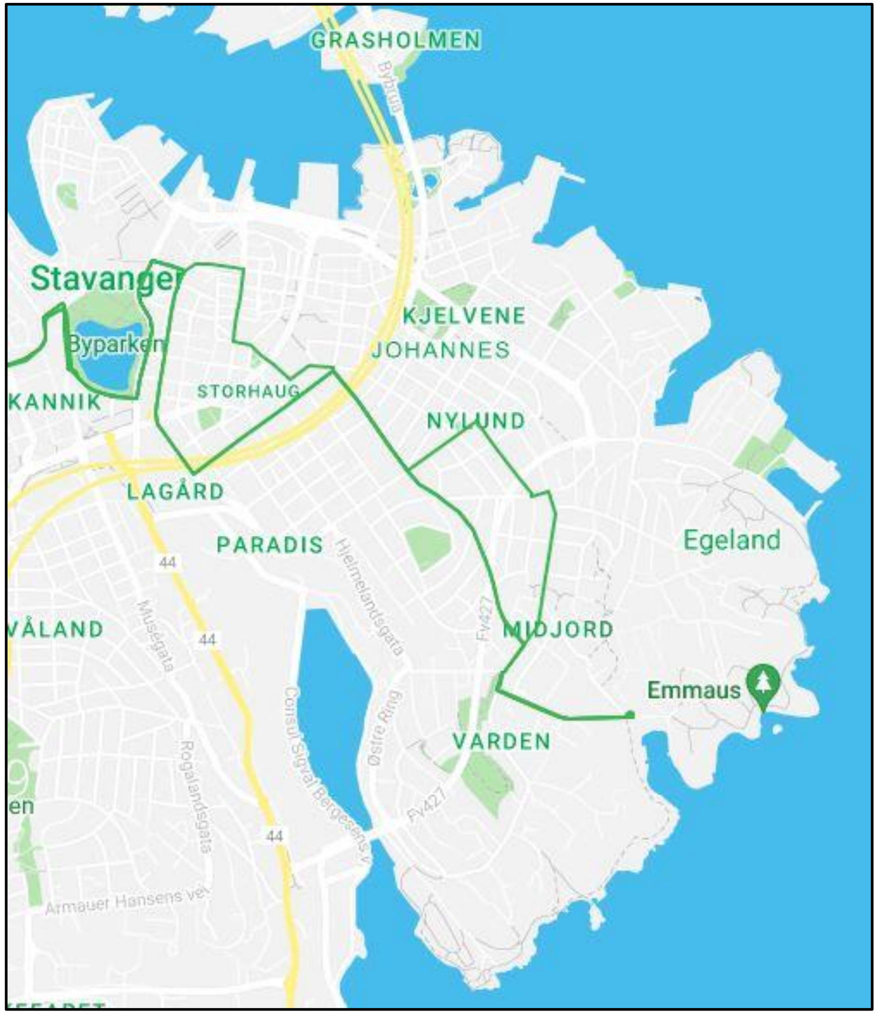


Figure 34. Ramsvig to Byhaugen via Stavanger

Figure 35. Karlsminnegata in Nylund

Part summary:
To encourage better use of green spaces, there should be a shift towards public transportation in Stavanger, which is important to improve the convenience and accessibility of public transport options and provide better parking facilities for public transport users. Reducing private users parking could also create more space for green or outdoor areas, which would improve the urban environment and make walking more enjoyable. Pedestrian and public transport routes should follow each other to generate foot traffic and avoid conflicts between pedestrians and public transport passengers. Sufficient space such as green areas should also be provided adjacent to bus stops to ensure a comfortable experience for both pedestrians and public transport users.

4.4 Traffice noise

Figure 24 illustrates the average daily traffic noise in various areas of the district. Noise levels are categorised by the type of road and the volume of traffic in the area. Along the main road, the noise level is quite high, ranging from 65 to 69 dB, mainly due to the constant flow of traffic with cars, trucks, and buses.

On the other hand, the noise level along the collector roads for local traffic is lower at 55 to 60 dB. This is because these roads are designed for local traffic, which generates less noise compared to the main roads. Noise levels in other streets are not reported, but low average daily traffic (ÅDT) indicates quiet streets. This means that the noise level in these areas is minimal because they are not heavily travelled.

However, the noise level along the main road at Bekhuskaien in Badedammen is high and ranges between 60and 69 dB. This is due to traffic noise in the eastern part of Bekhuskaien, especially the acceleration of cars and the combination of noise from the culvert openings, which creates a high noise level. In addition, traffic from Bybroa, which is just over the area, also contributes to the high noise level.

In the areas of the Sentrum, the noise level is between 65and 69 dB in Havneringen, Østervågkaien and Skansegata. This is most likely due to the fast traffic flow of cars and pedestrians in these areas. In Pedergata, on the other hand, the noise level is between 60and 65 dB, which is probably due to the dominance of car traffic due to the narrow streets.

Noise levels in Bergeland, Nylund, and Midjord appear to be low because these areas are located away from major roads and busy commercial areas. Therefore, there is minimal traffic flow there, resulting in low noise levels.

Figure 36. Noise map zone (www.temakart-rogaland.no)

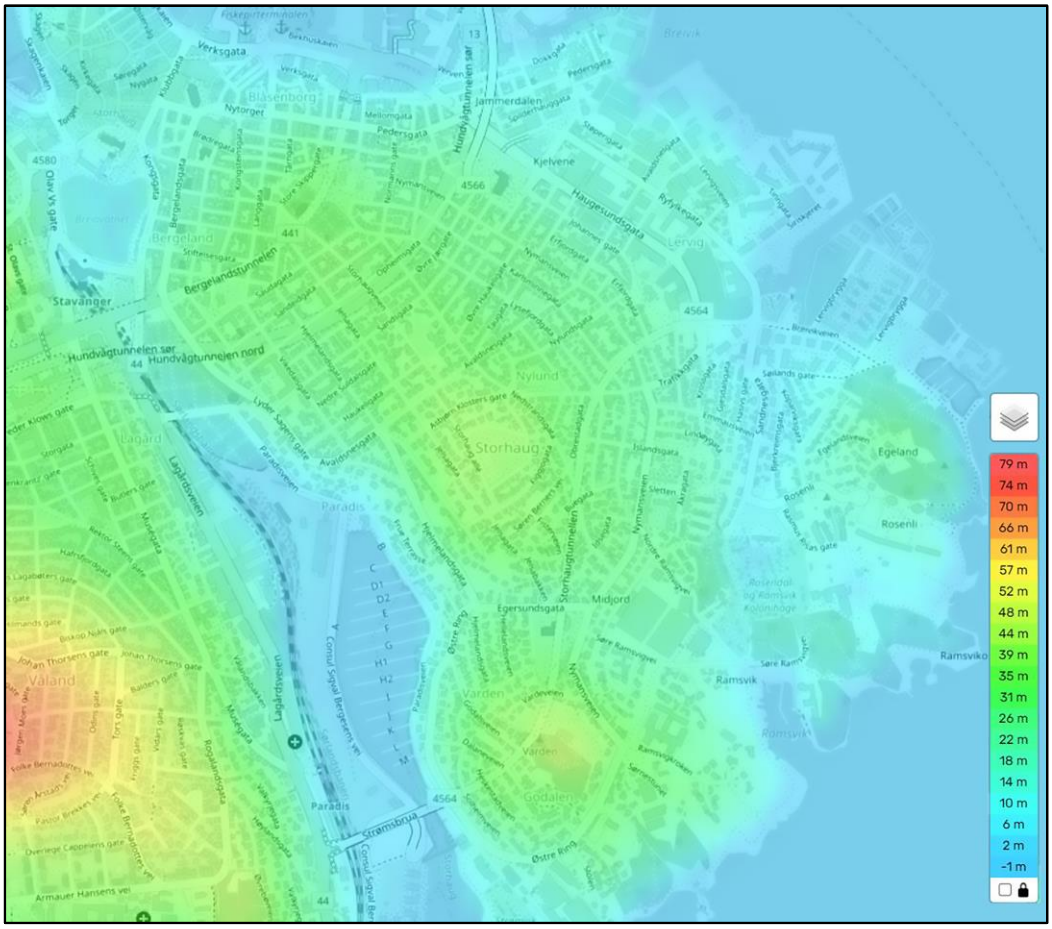
Part summary:
Preference for quiet green spaces is generally higher because they provide a peaceful environment suitable for relaxation and recreation. User choice may be influenced primarily by the noise level surrounding a green space, which can create a sense of an unsafe environment. This is because most people seek out green spaces to spend time with their children, relax, and relieve stress, anxiety, and depression. Therefore, noise levels can significantly affect the attractiveness and appeal of a green space. As a result, some green spaces are used more than others depending on the level of noise pollution in

4.5 Climate and topography

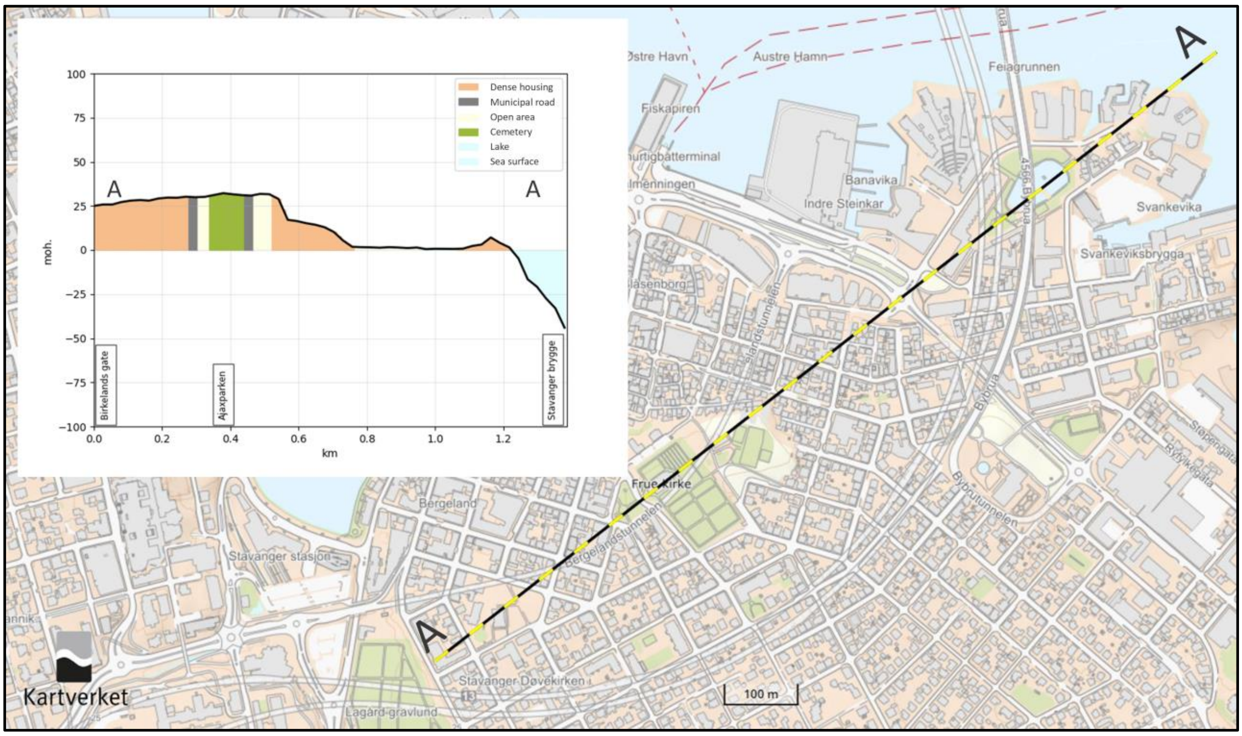
As a coastal city, the city of Stavanger places great emphasis on its waters and scenic views of the surrounding mountains. The Storhaug district is characterized by frequent winds, which is a typical feature of Stavanger. These windy conditions often bring freezing temperatures. The city experiences about 200 precipitation days annually, with rain being the main form (precipitation over 0.1 mm), with about half of these days having over 3 mm of precipitation.

Unfortunately, there is no protection from rain in green areas, and wind protection is not given special importance. This is especially true for the protected green areas along the seafront, such as Breivikparken and Emmaus, which are exposed to strong winds on windy days. Nevertheless, the study area generally has good sun conditions in summer seasons.

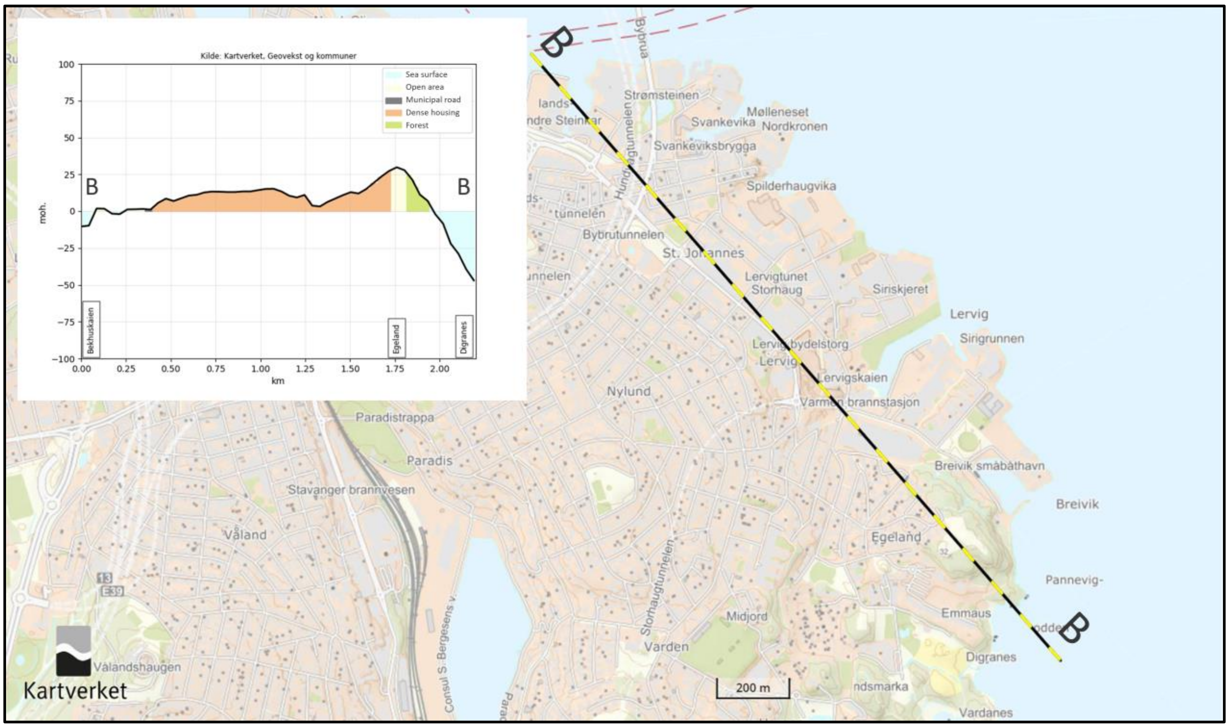
The study area extends from the seafront of Hillevagsvika, passing through Ramsvik, Breidvika, Lervika, Spilderhaugviga, and up the slope towards Pedersgata, Storhaug, and Varden. Varden, reaching a height of 52 meters above sea level (refer to figure 36), stands as the highest point in the area.



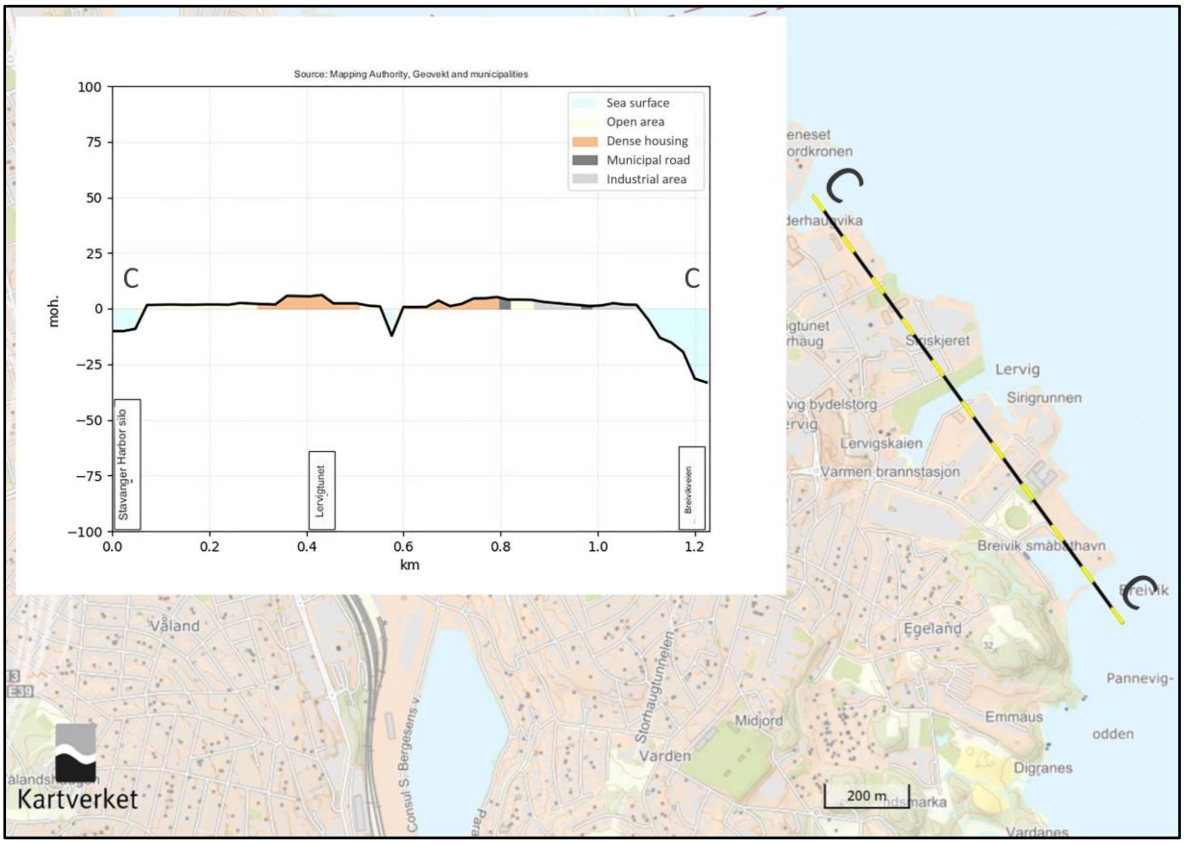
Figiure 37. Topographic map showing study area heights above sea level (Source: topographic-map.com)



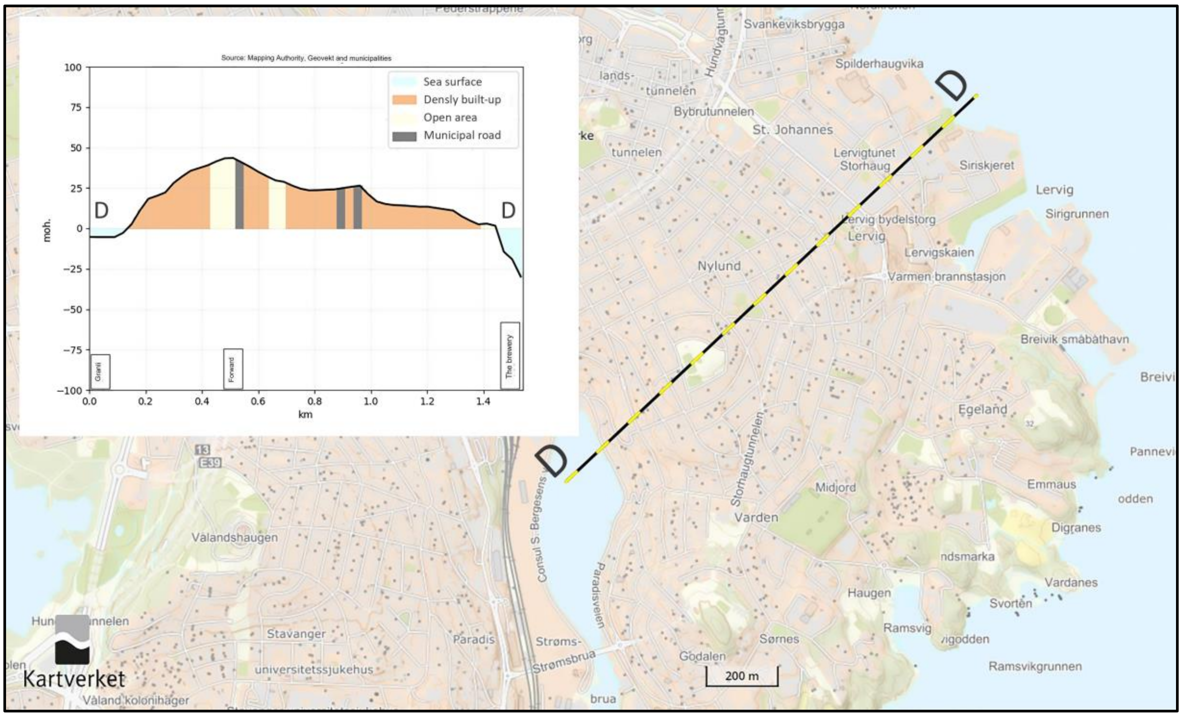
Figiure 37.1. Elevation profile A of study area (Illustration modified by author. Map source: https://kartverket.no)



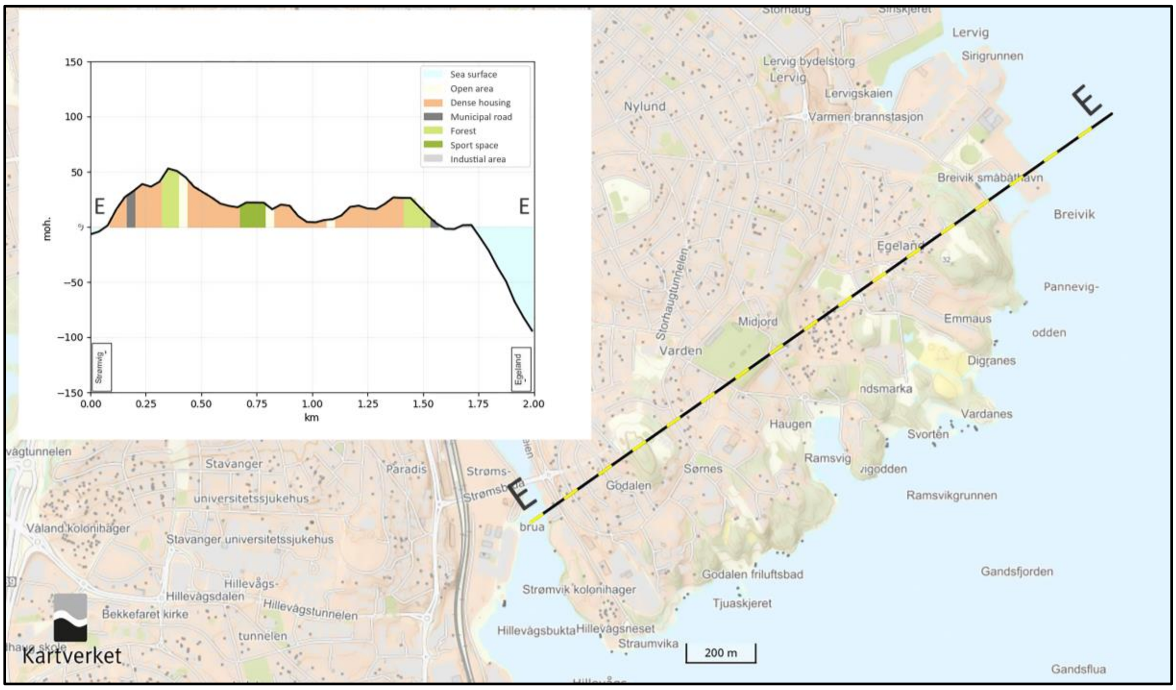
Figiure 37.2. Elevation profile B of study area (Illustration modified by author. Map source: https://kartverket.no)



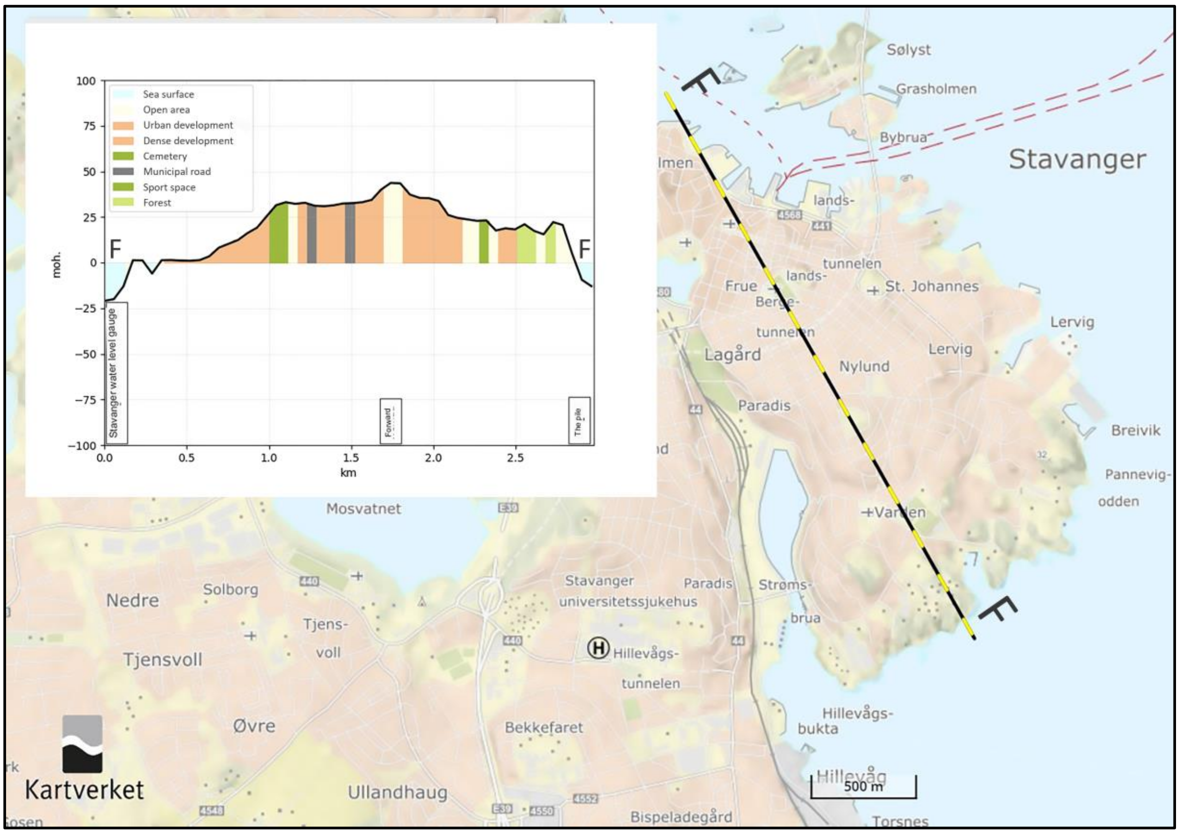
Figiure 37.3. Elevation profile C of study area (Illustration modified by author. Map source: https://kartverket.no)



Figiure 37.4. Elevation profile D of study area (Illustration modified by author. Map source: https://kartverket.no)



Figiure 37.5. Elevation profile E of study area (Illustration modified by author. Map source: https://kartverket.no)



Figiure 37.6. Elevation profile E of study area (Illustration modified by author. Map source: https://kartverket.no)

The use of Stromvig and Egaland as measurement nodes for the elevation profile in Figure 36.5 reveals a disparity in height that illustrates the elevation differences in the region. From the data, it appears that the highest point in the area is Varden, which has an impressive elevation of 52 meters above sea level. In contrast, the lowest point is in Breivika båthavn, which is only 2 meters above sea level. This stark contrast between the highest and lowest points shows the diverse topography of the region and highlights the different elevations at the various geographical locations.

This observation provides a clear explanation for the lack of open streams or channels in the study area. Due to the topography of the region, the natural terrain acts as a reliable support system for effective stormwater runoff management.

CHAPTER FIVE
DATA ANALYSIS & FINDINGS

5.0 DATA ANALYSIS

Quantitative data are obtained in this study by analysing data collected by desktop research and geographic information systems (GIS). These methods allow for a more comprehensive assessment of neighbourhood conditions by examining different factors and variables. Quantitative data provide a more general overview of the research topic by analysing responses from a large number of people. They focus on numerical data and statistical analysis to identify patterns, trends, and relationships among variables.

Qualitative data, on the other hand, are collected through questionnaires and field observations and provide a more detailed understanding of participants' perspectives. Qualitative data address the individual experiences and perspectives of participants and provide rich, descriptive information. This approach is about exploring the thoughts, feelings, and behaviours of individuals and capturing their unique points of view.

By combining quantitative and qualitative data, the study integrates findings from both approaches and gain a more holistic understanding of the research topic. The quantitative data provides broader context and generalizability, while the qualitative data provides nuanced insights and a deeper understanding of the participants' experiences.

It is important to note that both quantitative and qualitative data have their limitations. Quantitative data may lack the richness and context that qualitative data provide, while qualitative data may not generalize to larger populations. However, combining these two approaches in a mixed-methods design helps to mitigate these limitations by leveraging their respective strengths and allowing for more robust analysis and interpretation of research findings.

Table 4. Indicators used for environmental justice analysis

Category	Indicator	Definition	Thresholds
Environmental benefit	Accessibility of public green and open space	Percentage of inhabitant living near public green space	2 Hectares (Ha) of accessible green space per 1000 population, with a minimum distance of 300 m from the place of residence.
	Availability of public green and open space	Size of public green space per inhabitant.	15 m² of public green space per inhabitant within a neighbourhood.
Socio economic factors	Age and gender	Green space quality and functionality as perceived by different demographic groups.	
	Ethnicity		
	Income		
	Education level		

5.1 Quantitative data

This section focuses on socio-demographic and socio-economic factors, such as age, migration status, education level, and average income. It explores the relationship between access to green space and these indicators within the study area. Additionally, the approach includes the application of *Dai's (2011)* descriptive approach, which evaluates the accessibility and availability of public green spaces per inhabitant. These calculations are done using data retrieved from SSB (Statistics Norway), and objective and subjective data mapped using ArcGIS Pro. As noted in this study, green spaces in Storhaug are not adequately identified or mapped in municipal planning documents. Therefore, it was critical to identify these areas using satellite imagery from Google Maps and Open Street Map, followed by field investigations. Once an inventory of green spaces in the city was created, each area was mapped using ArcGIS Pro.

The collected data was then analysed using the key indicators presented in Table 4 as proposed by (Kabisch et al.,2016). This approach provided a comprehensive understanding of the distribution of public green spaces in the neighbourhoods and helped to determine EJ in the allocation of public green spaces in the study area.

5.1.1 Assessing the accessibility and availability of urban green spaces in study area.

The walkability method was used to measure the accessibility of public green spaces. To evaluate accessibility, 200- and 300-meter buffers were created using the multiple ring buffer input tool in ArcGIS Pro. These buffer distances correspond to approximately 4 and 7 minutes of walking in dense and sparse settlements respectively, according to the recommendations by the Norwegian Environmental Protection Agency.

The use of multiple buffer distances was considered appropriate because different minimum distances between public green spaces and residential areas *(Rojas et al., 2016; Wolch et al., 2014; Comber et al., 2008)*, as reported in the literature of this study. By using both buffer distances, the study sought to compare results and gain a comprehensive evaluation of accessibility. This approach allowed for the estimation of the percentage of residents who can access the nearest public green space within 200 to 300 meters of their residence.

By using the walkability method and considering buffer distances, the study attempted to capture the proximity and ease of access to public green space for residents. The 200-meter and 300-meter buffers were chosen based on the walking time typically recommended for easy access to such areas. This analysis provides information on the percentage of the population living within a reasonable walking distance of a nearby public green space, thus assessing the level of accessibility in the study area (see figure 38).

To determine the population accessible to public green space (PGS) within various buffer distances, the calculation procedure involved two steps. First, the population density of each neighbourhood was determined. Then, the population density was multiplied by the respective area of each neighbourhood, resulting in the population accessible to public green space.

A population projection of 16597 residents for the year 2023 *(according to the SSB)* was used to calculate the percentage of residents living near a public green space. This was derived from a population grid with a resolution of 250 meters. In addition, ArcGIS Pro was used to define an area of 389 hectares as a geographic boundary to ensure that it corresponds to the extent of the development while respecting the internal administrative boundaries as defined in the Municipal Development Plan.

Table 5. Available PGS in the study area

Neighbourhood	Area (m²)	Population	Public green Space (PGS)	Area of PGS (m²)
Sentrum West	198,878	233	Valberget Utsiktspunkt	3,137
Sentrum East	155,571	198	-	-
Sentrum	400,144	2,185	Sven Oftedals plass	3,344
			Kyviksmarka	7,482
			Sub total	**10,826**
Bergeland	295,882	2,681	Johannesparken	6,196
			Stjernelekeplassen	1,269
			Opheim Park	545
			Vår Frues plass	1,470
			Sub total	**9,480**
Badedammen	501,679	2,668	Badedammen park	4,187
			Bakgata	365
			Hermetikkparken	2,173
			Kjelvene skatepark	2,326
			Lervigtunet	2,764
			Sjøparken	3,640
			Sub total	**15,455**
Nylund	296,753	2,691	Storhaugmarka	13,384
Lervig	518,501	1,642	Breivikparken	7,611
Midjord	617,593	1,905	Emmaus Park	39,098
			Storhaug hundepark	10,130
			Vitenhagen park	30,785

			Sub total	**80,013**
Varden	906,069	2,394	Godalen strand park	4097
			Varden park	36,464
			Sub total	**40,561**

Figure 38. Accessibility of public green spaces (PGS) in Storhaug, using the "walkability" distance method of 200m and 300m (Source: Own's Illustration using Esri ArcGIS)

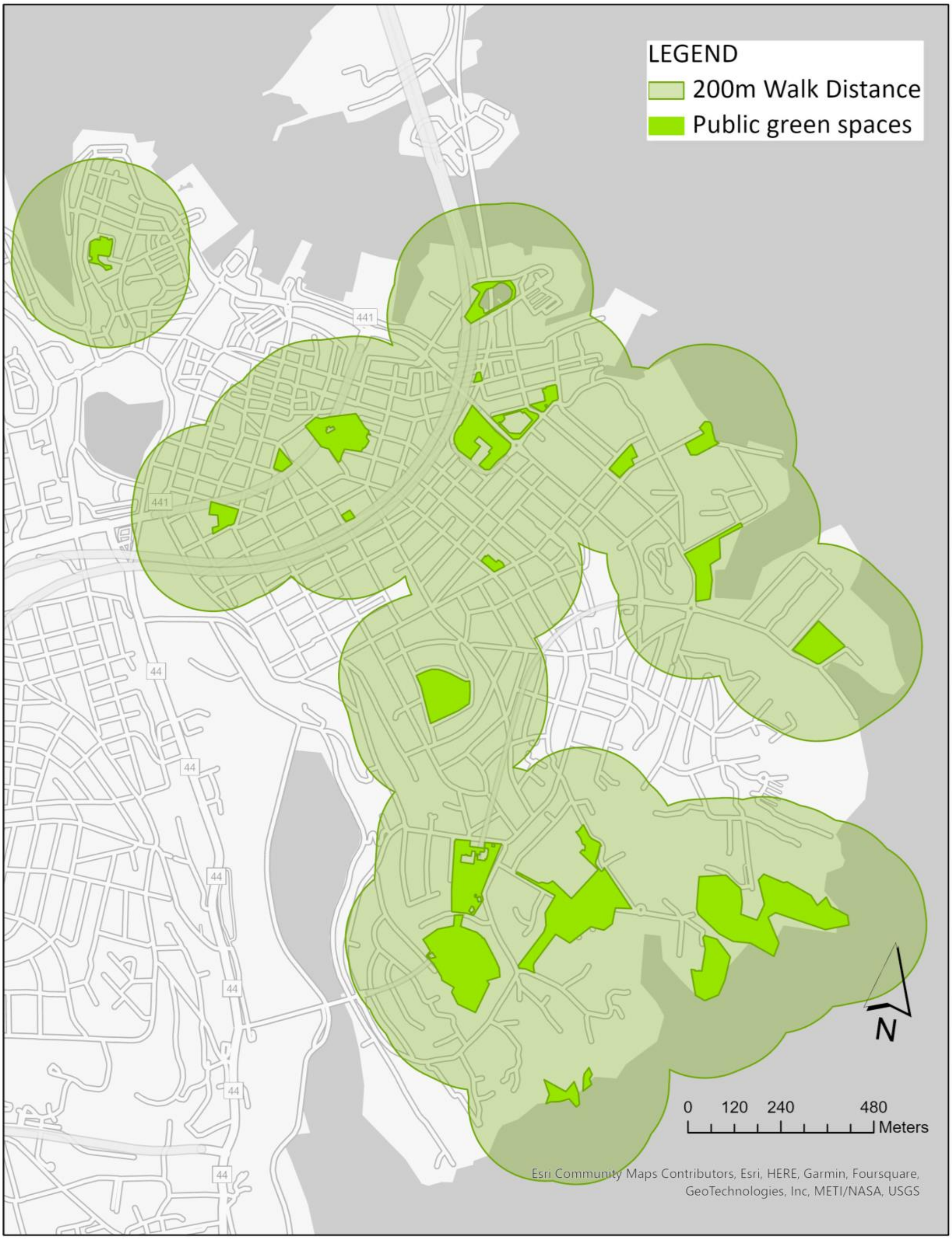


Figure 38.1. Accessibility of public green spaces (PGS) in Storhaug, using the “walkability” distance method of 200m (Source: Own’s Illustration using Esri ArcGIS)

Figure 38.2. Accessibility of public green spaces (PGS) in Storhaug, using the “walkability” distance method of 300m (Source: Own’s Illustration using Esri ArcGIS)

In order to evaluate the availability and supply of public green spaces (PGS), the study utilized a method based on the work of Kabisch et al. The approach involved examining the relationship between population density and the availability of neighbourhood public green spaces. To perform this assessment, the walkability maps was intersected with the 250-meter population grid of the designated study area, as shown in Figures 41 and 42. The grid dataset corresponds to the WGS 1984 UTM Zone 33N coordinate system and includes the population of the inhabited area of Storhaug. Each grid cell within the dataset is associated with attribute data representing the population of the particular area to which it belongs. Open Street Map and ESRI aerial imagery served as the map bases for this analysis. Subsequently, the area of public green space per resident within each grid unit was calculated. The purpose of this analysis was to determine how the distribution of green spaces was spread across the population.

To determine the adequacy of PGS availability, a threshold of 2 hectares (ha) of accessible green space per 1000 residents was assumed, as suggested by *Kabisch et al. (2016)*. A walking distance of 300 meters from individual's homes was considered significant. From this application, it was established that 2 hectares of accessible green space per 1000 residents within 300 meters of their homes would be necessary. To calculate the equitable distribution of PGS for the entire population within 300m accessibility, the first step involved determining the number of units of 1000 residents within the population. To do this, the total population 14509, was divided by 1000, which resulted to approximately 14.5 units. Then, the total area of PGS required for the population within 300 m walkability was obtained by multiplying the number of population units by 2.

To determine the percentage of the population benefiting from available PGS, the number of people benefiting from PGS was divided by the total population and then multiplied by 100. However, before this calculation could be made, the number of individuals benefiting from PGS need to be determined. To determine the number of people benefiting from available public green space, the study referred to Table 4, which computes that the total area of available public green space. To determine the proportion of the population benefiting from this area, the available PGS area, 18 hectares was divided by the required PGS area of 29 hectares. This calculation aimed to determine the ratio of the provided green space provided to total green space required to achieve an equitable distribution. It should be noted that this calculation is based on the stated thresholds and minimum distance criteria. Any adjustments or deviations from these criteria may produce different results.

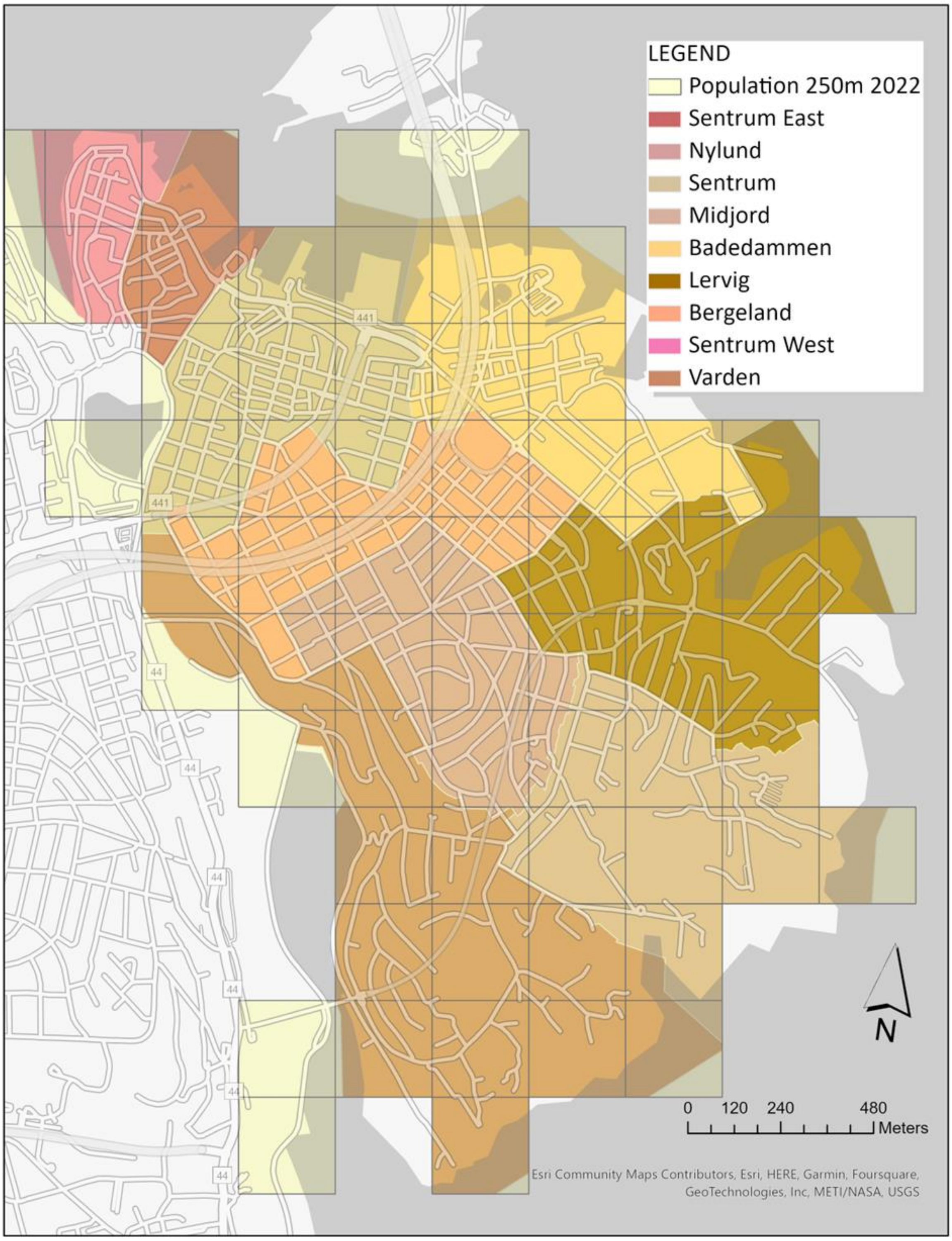


Figure 39.1 250m population grid (Data source: SSB, 2023. Image source: Own's Illustration using Esri ArcGIS)

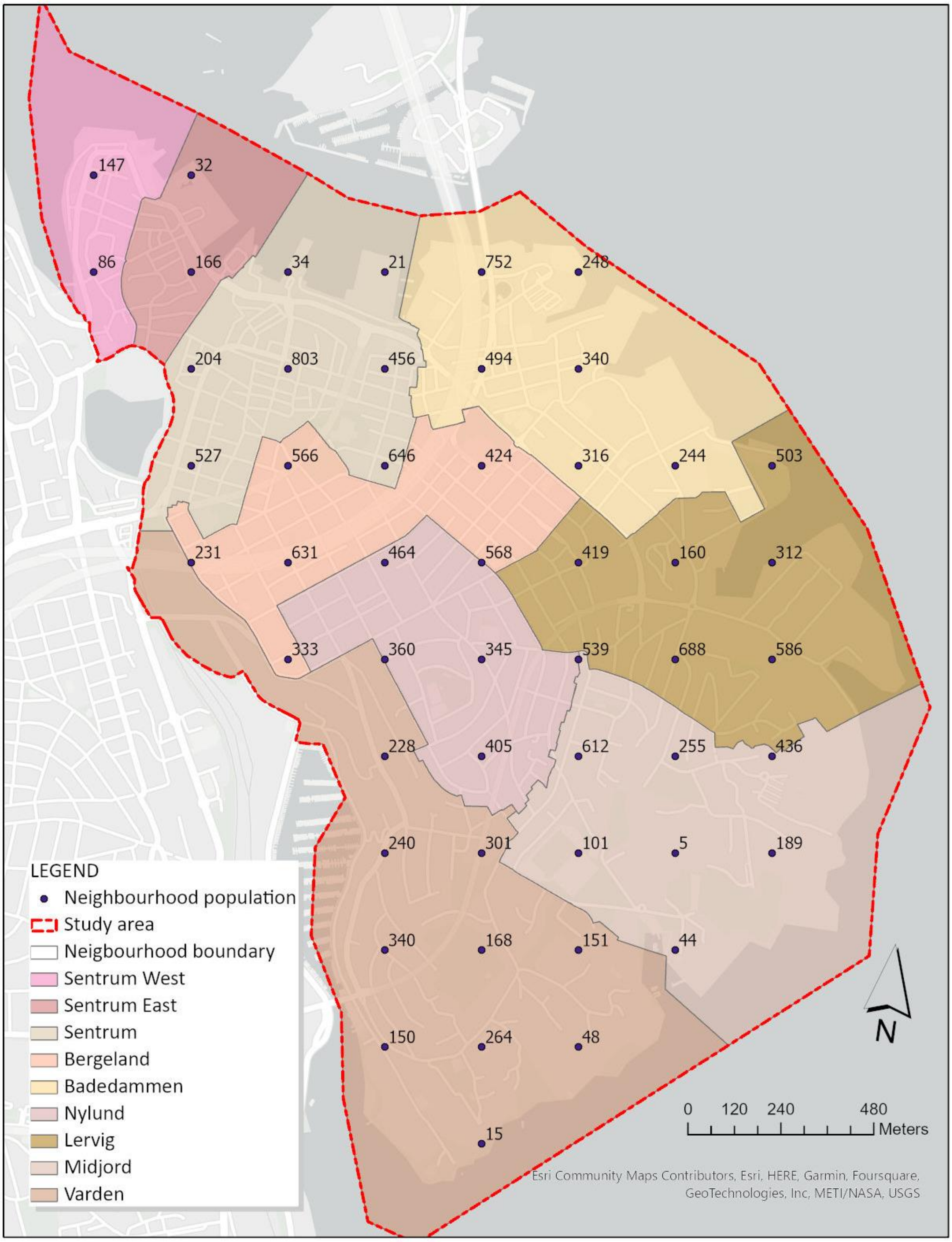
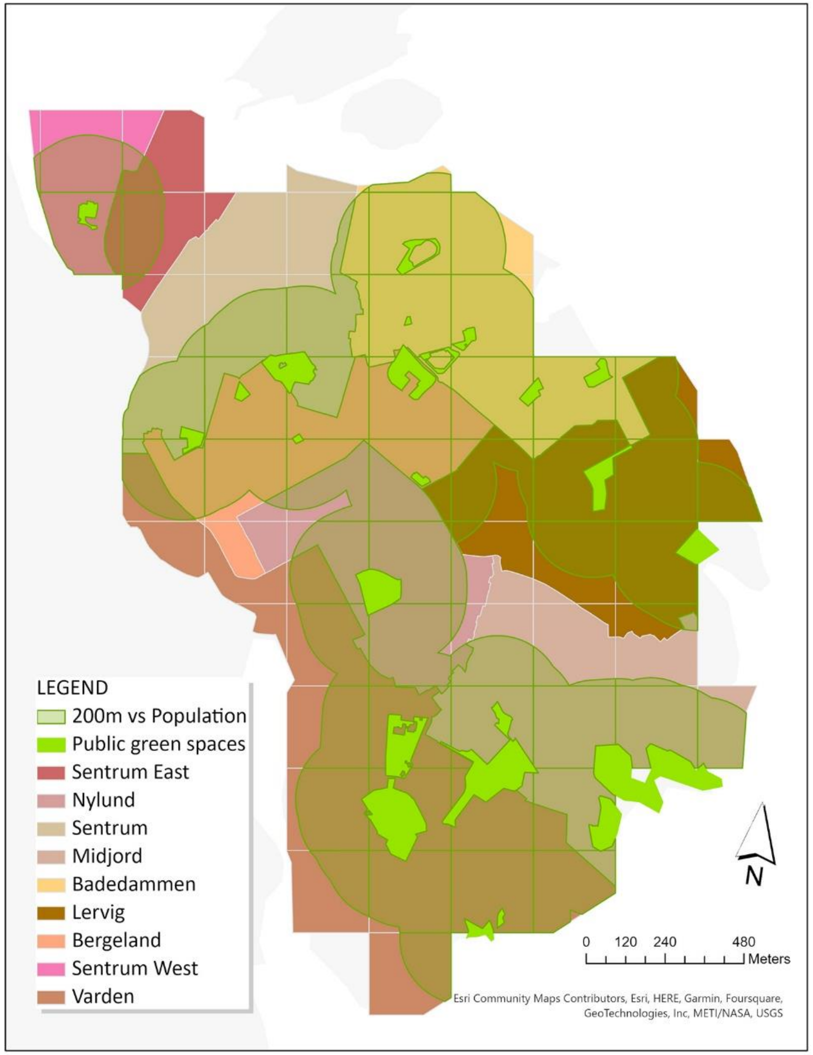


Figure 39.2. Population of neighbourhoods in Storhaug (Data source: SSB, 2023. Image source: Own's Illustration using Esri ArcGIS)



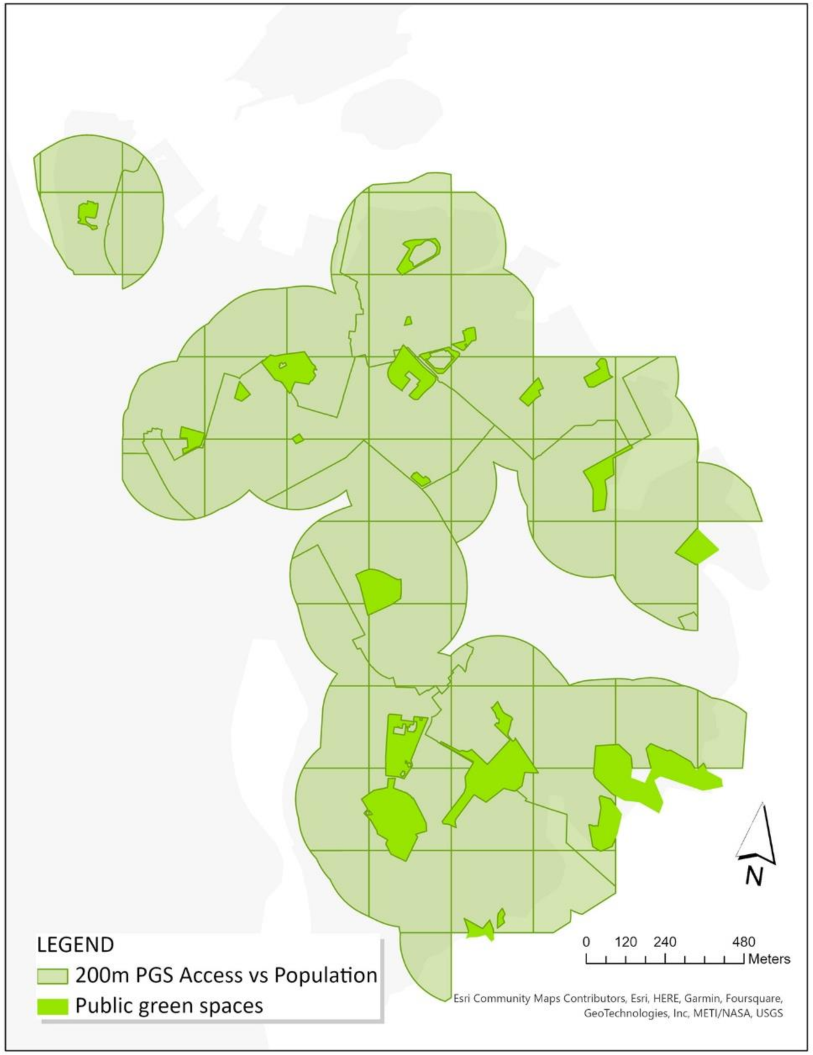


Figure 40. calculation of PGS per inhabitant using 200m walking distance (Source: Own's Illustration using Esri ArcGIS)

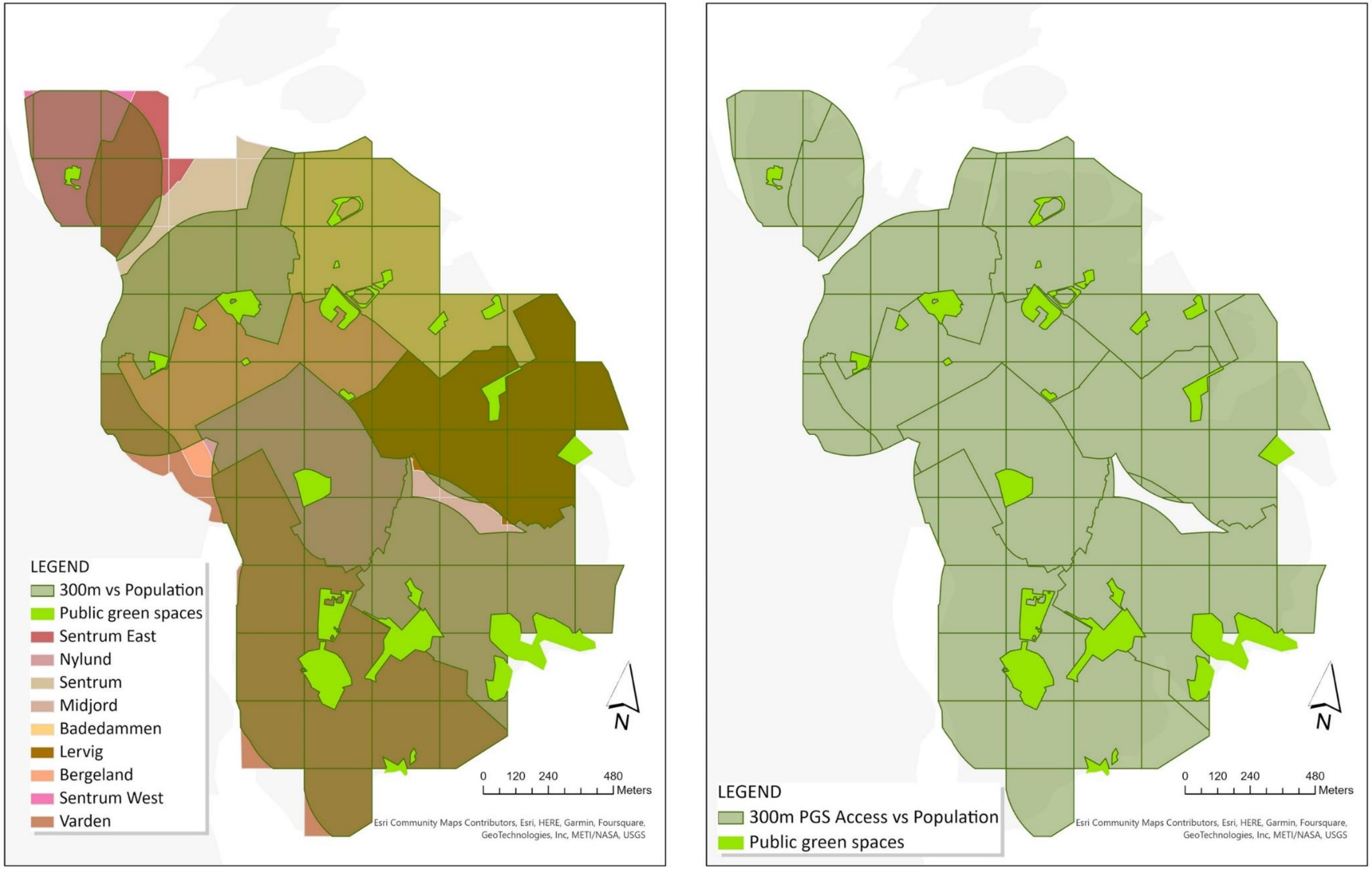


Figure 41. Calculation of PGS per inhabitant using 300m walking distance (Source: Own's Illustration using Esri ArcGIS)

5.1.2 Section result

Tables 5 and 6 provide a comprehensive assessment of the accessibility and availability of public green spaces (PGS) in each neighbourhood using the 200m and 300m walkability methods, as shown in Figures 40 and 41. The analysis shows that most neighbourhoods have satisfactory access to public green space when the 300-meter buffer is used. However, certain neighbourhoods such as Sentrum, Sentrum West, and Sentrum East have less than 50% accessibility when the 200-meter buffer is applied. This discrepancy can be attributed to the scarcity of PGS in these specific neighbourhoods. In addition, the different sizes of PGSs have a significant impact on accessibility for residents, further highlighting the existence of strong spatial inequalities. Figure 40 shows that residents of neighbourhoods in the central and southern parts of the study area such as Bergeland, Badedammen, Varden, and Midjord have multiple options to access PGS within 300 meters.

Table 6. Existing accessibility values of individual neighbourhoods in study area using 200m and 300m

Neighbourhood	Area of PGS (m²)	Number of inhabitants within 300m to PGS	Areas of population within 300m (m²)	No. of inhabitants within 200m to PGS	Areas within 200m (m²)	Population within walking distances (%)	
						200m	300m
Sentrum West	3137	156	133435.6	108	91994.9	46	67
Sentrum East	-	125	98523.1	64	50257.4	32	63
Sentrum	10826	1597	292445.2	1054	193039.4	48	73
Bergeland	9480	2449	270276.2	2322	256248.1	87	91
Badedammen	15455	2562	481699.7	2343	440555.6	89	96
Nylund	13384	2556	281875.2	2094	230869.0	78	95
Lervig	7611	1581	499221.6	1249	394323.9	76	96
Midjord	80013	1576	510880.0	1146	371458.0	60	83
Varden	40561	1907	721936.5	1434	542714.2	60	80

Source: Own calculation based on SSB database 2023 and GIS analysis

Consequently, the evaluation shows that about 87% of the total population of the study area has access to most of the PGS within 300m of their residence; however, given the area of available PGS, an equitable distribution cannot be achieved because the available ratio per inhabitant is low as shown in Table 6. It is obvious that neighbourhoods such as Midjord and Varden have a surplus of green spaces compared to their respective populations. This surplus leads to an oversupply of public green spaces per inhabitant. In contrast, most other neighbourhoods in the study area are well below the equitable value of green space availability per inhabitant. This analysis was carried out by dividing the total area of public green space by the number of inhabitants within a walking distance of 300 meters in each neighbourhood. Therefore, to achieve equitable distribution, a total of 29 hectares of public green space is required to serve the population of 14509 residents living within 300 m walking distance of public green space, providing 20 m² to each resident. 100% population accessibility can be achieved by increasing the walkability buffer to 500 m, as recommended by other researchers *(Wolch et al., 2014)*, and an equitable supply of public green space per resident is achieved with approximately 33 ha for 16597 inhabitants, the total population of the study area.

It can be inferred that good access to green space does not necessarily mean that there is an adequate supply of green space. As mentioned in the literature review, the World Health Organization defines a supply of PGS to be a minimum of 15m² per inhabitant, therefore anything below that is inequitable *(WHO, 2018).*

Table 7. Calculation of availability values of individual neighbourhoods in study area within 300m

Neighbourhood	Area of PGS (m²)	Number of inhabitants within 300m to PGS	Areas of population within 300m (m²)	Accessible population within 300m (%)	PGS Availability (m²/ inhabitant)
Sentrum West	3137	156	133435.6	67	20
Sentrum East	-	125	98523.1	63	0
Sentrum	10826	1597	292445.2	73	6.8
Bergeland	9480	2449	270276.2	91	3.9
Badedammen	15455	2562	481699.7	96	6.0
Nylund	13384	2556	281875.2	95	5.2
Lervig	7611	1581	499221.6	96	4.5
Midjord	80013	1576	510880.0	83	50.8
Varden	40561	1907	721936.5	80	21.3

Table 8. Calculation of availability values of individual neighbourhoods in study within 300m using proposed area of PGS						
Neighbourhood	Area of PGS (m^2)	Number of inhabitants within 300m to PGS	Areas of population within 300m (m^2)	Accessible population within 300m (%)	Proposed 29 Ha equitable area of PGS. (m^2)	PGS Availability (m^2/ inhabitant)
Sentrum West	3137	156	133435.6	67	3120	20
Sentrum East	-	125	98523.1	63	2500	20
Sentrum	10826	1597	292445.2	73	31940	20
Bergeland	9480	2449	270276.2	91	48980	20
Badedammen	15455	2562	481699.7	96	51240	20
Nylund	13384	2556	281875.2	95	51120	20
Lervig	7611	1581	499221.6	96	31620	20
Midjord	80013	1576	510880.0	83	31520	20
Varden	40561	1907	721936.5	80	38140	20

Source: Own calculation based on SSB database 2023 and GIS analysis

5.2 Qualitative data

This section aims to delve into the perspectives of the participants, focusing on sociodemographic and socioeconomic factors. These factors include age, migration status, education level, and average income, which can provide a more comprehensive understanding of how different individuals perceive and interact with urban green spaces. To gain insight into the relationship between green spaces and their users, questionnaires were completed, and on-site observations were conducted.

5.2.1 Evaluation of quality and functions of PGS by observation

It is an important objective of this study to find out whether there is any relationship between the quality of UGS and the socioeconomic background of their potential users. To thoroughly assess the quality and functions of public green spaces (PGS), each space was studied individually. Fieldwork included observation and evaluation of the functions and conditions of each PGS. The evaluation process involved categorizing the PGS based on its identified functions, including none (no specific functions), passive (quiet environment for relaxation), active (promoting physical activities), playground (with designated play areas), and a combination of these functions. Several aspects were considered in the evaluation, such as the appearance of the green spaces, the quality of the existing vegetation, and the condition of the infrastructure in each PGS. In addition, the maintenance and cleanliness of the public green spaces were also considered when evaluating overall quality.

Based on the results of the quality assessment, the PGSs were classified into five categories according to their quality level: very poor, poor, medium, good, and very good.

This detailed evaluation and classification process provides a comprehensive understanding of the conditions and functions of each urban green space and allows for a more nuanced analysis of participants' experiences and perceptions of these factors. By considering participants' socio-demographic and socio-economic backgrounds, as well as on-site observations, this study aims to provide a comprehensive understanding of the relationship between individuals and urban green spaces.

Table 9. The quality classification of PGS and relevant data

Quality of PGS	PGS identifiers	PGS	Total area of PGS (m²)	Inhabitants within 300 m
Very poor	-	-	-	-
Poor	N	Varden park	36464	1716
	A	Storhaugmarka	13384	2556
		Total	**49848**	**4272**
Medium	G	Sven Oftedals plass	3344	493
	L	Godalen strand park	4097	191
	M	Valberget Utsiktspunkt	3137	156
		Total	**10578**	**840**
Good	B	Johannesparken	6196	1592
	C	Hermetikkparken	2173	359
	I	Sjøparken	3640	615
	H	Lervigtunet	2764	458
	K	Emmaus park	39098	770
	F	Vår Frues plass	1470	380
		Total	**55341**	**4174**
Very good	D	Badedammen park	4187	694
	E	Kyviksmarka	7482	1104
	J	Breivikparken	7611	1581
		Total	**19280**	**3379**

Figure 42. PGS where on-site observations where conducted. Scale 1:12000 (Source: Own's Illustration)


Figure 43. PGS “A” of poor-quality classification


Figure 44. PGS “C” of medium quality classification


Figure 45. PGS “J” of very good quality classification

Based on the results presented in Table 7, the public green spaces (PGS) in Storhaug can be classified predominantly as good, followed by very good and medium, in terms of their quality. The largest total area of PGS falls into the "good quality" category. Nevertheless, it is important to note that for most of the population, most of the available PGS within 300-meter radius are of poor quality.

In addition, the total area of very good quality public green spaces is relatively small, less than 2 hectares. While these areas provide high quality, they are only easily accessible to a very limited number of people, about 20% of the population, within a 300-meter distance. Moreover, the availability area per inhabitant in these PGS is very low, measuring 5.6m², compared to the minimum area of 15m² proposed by WHO. This suggests that the provision of very good quality PGS is not sufficient to meet the needs and preferences of a larger part of the population.

Part summary:
These findings highlight the importance of considering not only the total area of PGS but also their quality and accessibility. While the quantity of good quality PGS is substantial, their distribution and availability need to be improved to ensure equitable access for a greater proportion of the population. In addition, efforts should be made to improve the quality and accessibility of PGS with very good features to better meet community needs and promote a higher standard of well-being.

5.3 Relationship between PGS and sociodemographic and socioeconomic environment using questionnaires.

This section of the chapter focuses on the results of the questionnaire that was distributed in the study area. The questionnaire served as a valuable tool to collect a considerable amount of data, and the results presented here are considered very relevant in addressing the research topic. To ensure that the questionnaire covered a wide range of perspectives and captured essential information, an extensive literature review was conducted in both Norwegian and foreign sources. This enabled the formulation of the study questions, which resulted in the creation of a questionnaire consisting of 20 questions. The survey was specifically designed to explore various aspects related to environmental justice and the distribution of green space.

The survey was conducted among individuals residing in the case study area using an electronic scan code embedded in Google Forms, an online survey platform. A total of 55 questionnaires were distributed to gather responses from participants, of which 33 individuals completed and returned the survey. It is important to note that this sample size represents a relatively small proportion of the total population of the study area.

This is the result of limitations that occurred during the survey, such as timing, climatic conditions, accessibility to people, and ethical concerns related to privacy and consent, which contributed to the relatively small number of respondents. Despite these limitations, combining the results from this data collection method with other research methods provides valuable insights that allow for meaningful conclusions to the research topic. Although the sample size is smaller than desired, the data collected still provide insight and perspective from a subset of the population in the case study area. Considering the limitations and broader research context, the insights gained from the survey, in combination with other data sources, contribute to a comprehensive understanding of the research topic.

For a more in-depth understanding, the full survey questionnaire can be found in Appendix I, which provides the reader with insight into the specific questions and responses collected as part of the study. By using the data gathered from the questionnaire and combining it with the relevant literature on environmental justice, the subsequent analysis and discussion provide valuable understanding into residents' perceptions and experiences of green space distribution and related issues in Storhaug, Stavanger.

5.3.1. Respondents' Ethnicity by Gender and Age

The data in this section provide information on the ethnicity of the respondents, broken down by gender and age, as shown in Figure 46. Of the total 33 respondents, 7 described themselves as indigenous, representing approximately 21% of the surveyed population. The remaining 26 respondents were classified as migrants.

Table 7 below illustrates the distribution of respondents across gender and age groups. From the analysis of this table, certain patterns and trends can be deduced regarding the use of green spaces by the respondents. In particular, the predominant gender group using green spaces is males, especially in the 30-39 age group. In addition, it is worth noting that most people in this category are migrants.

Table 10. Classification of Ethnicity group by gender and age.

	Native			Migrant		
	18 – 29	30 – 39	40 – 49	18 – 29	30 – 39	40 – 49
Female		2		3	4	
Male	1	3	1	7	10	1
Prefer Not to say				1		

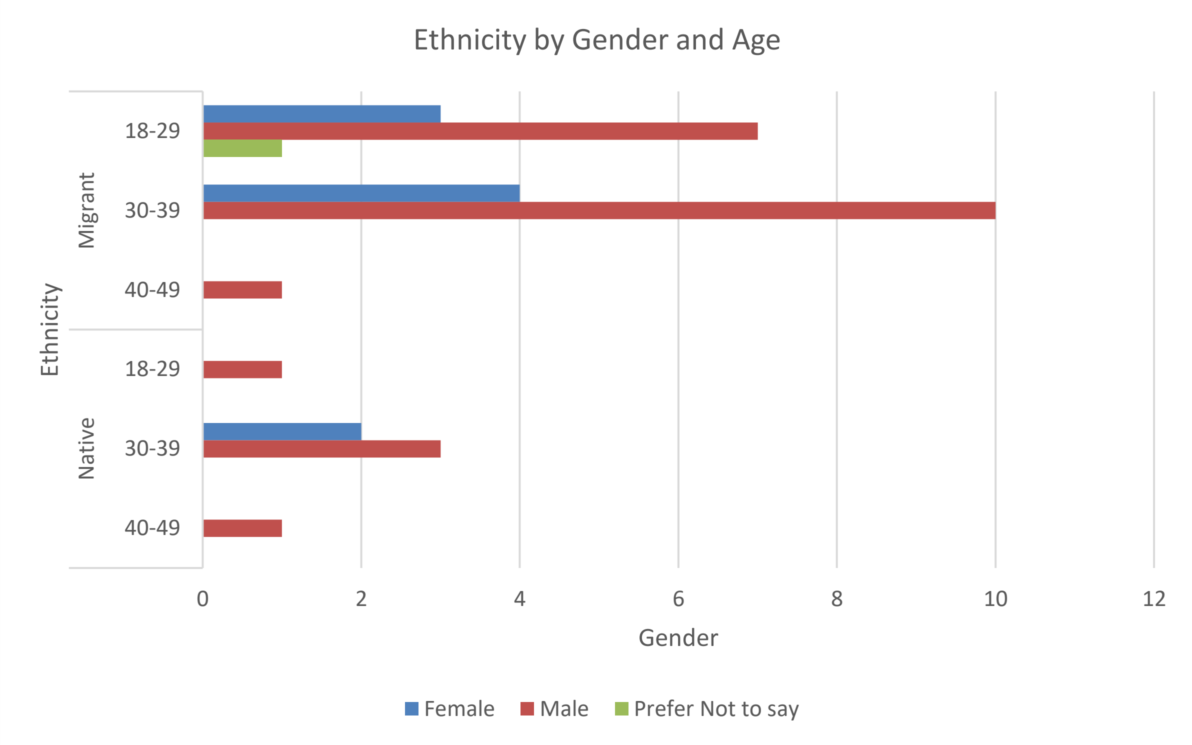


Figure 46: Bar chart showing respondents' ethnicity group.

Part summary:
These results provide valuable insight into the demographic characteristics of respondents and their engagement with green spaces. Understanding the demographic characteristics of green space users can help inform future planning and development initiatives and ensure that the design and accessibility of green spaces meet the needs and preferences of diverse demographic groups.

By understanding the predominant gender and age groups that use green spaces, policymakers and urban planners can focus on developing targeted strategies to improve the experience of green spaces and accessibility for these specific populations. In addition, addressing the needs of immigrants within these groups can help create inclusive and diverse green spaces that serve the entire community.

5.3.1 Green Space Access

This section presents a comprehensive analysis of the results related to access to public green spaces for both native and migrant groups. The findings for each group, native and migrant, are discussed separately in the following subsections. The focus of this chapter is on the perceptions of the respondents who participated in the questionnaire.

The table below illustrates the distances respondents reported walking to reach a green space. Examining this data sheds light on the specific outcomes related to access to and proximity of public green spaces as perceived by respondents. The analysis considers the perspectives of both native and immigrant populations and sheds light on any differences between these two segments of the population.

Table 11. Summary of access to green space.

	< 5 minutes	5 – 10 minutes	10 – 20 minutes	20 – 30 minutes	> 30 minutes
Native	1	4	1	1	0
Migrant	5	8	8	3	2

Green Space Access: Natives

Figure 47 shows access to nearby public green spaces as reported by the Native respondents. The results show that the majority, about 71%, can comfortably reach green spaces within 5 to 10 minutes on foot. This indicates that these individuals have relatively easy access to nearby green spaces, allowing them to enjoy the benefits of nature and outdoor recreation without having to travel long distances.

In contrast, the remaining 29% of Native respondents said that it takes them between 10 and 30 minutes to reach the green spaces. This suggests that for this part of the population, accessing public green spaces requires a somewhat greater investment of time and effort. Even if they must walk a little longer, this is still within a reasonable range that allows them to enjoy the benefits of the green spaces.

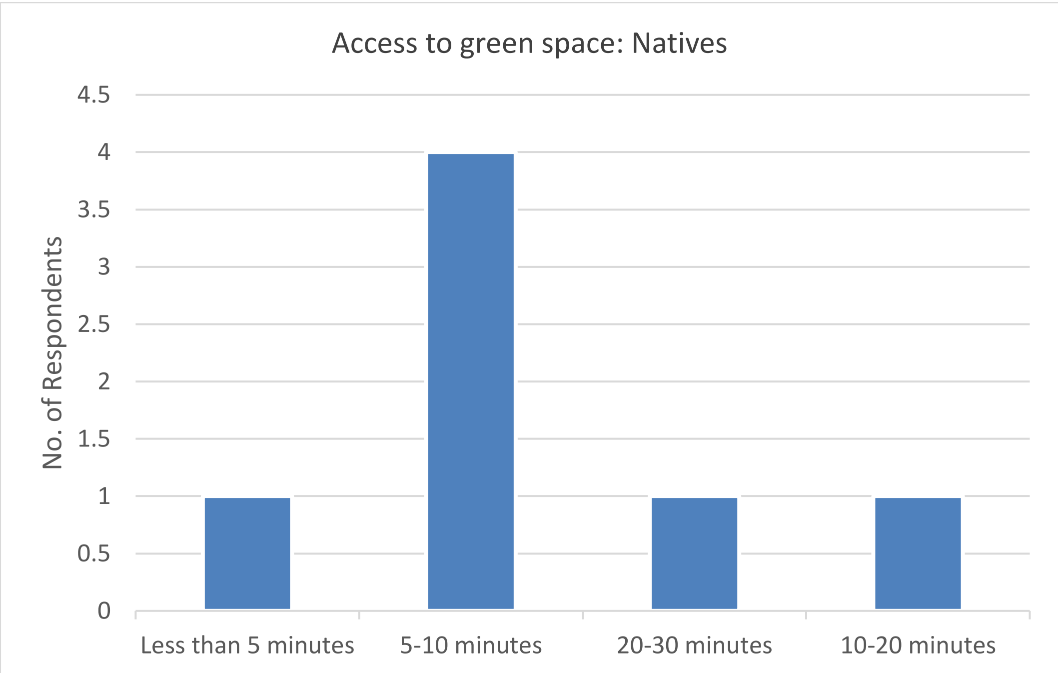


Figure 47. Native access to green space.

Part summary:
By examining these proportions, the study highlights that a significant proportion of Native respondents have convenient access to nearby green spaces that are relatively easy to reach on foot. However, it should be noted that a portion of the Native population takes a somewhat longer travel time to reach these areas. These findings provide insight into the accessibility of public green spaces for the Native group and highlight both the positives and potential areas for improvement in terms of reducing travel time and improving convenience for all individuals.

Green Space Access: Migrants
Figure 48 below shows access to nearby public green space as reported by immigrant respondents. The results show that just over 50% of migrant respondents reported being able to walk to nearby green spaces within 5 to 10 minutes. This suggests that a significant proportion of migrants have relatively convenient access to the green areas, allowing them to enjoy the benefits of nature and outdoor activities without having to travel far.

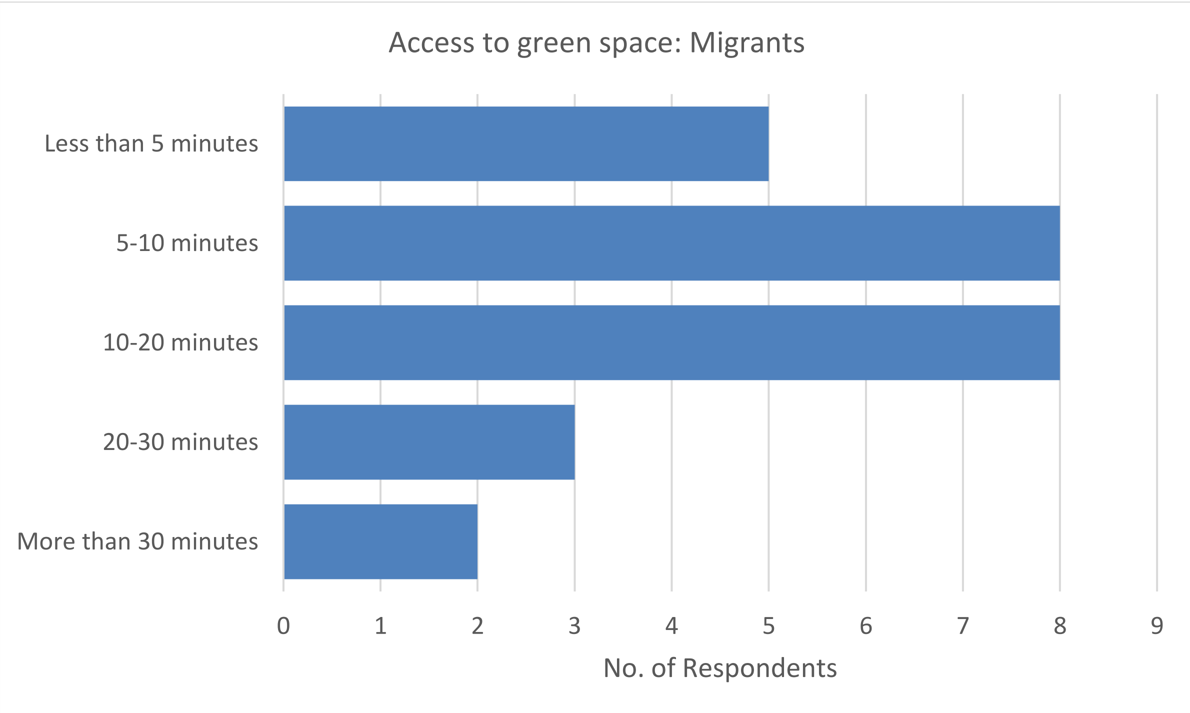


Figure 48. Migrants access to green space.

In addition, 30% of migrant respondents reported that it takes them an average of 10 to 20 minutes to reach green spaces. While this group takes a little more time to walk, it is still within a reasonable range that allows them to reach the green spaces without major inconvenience.

It is worth noting, however, that a portion of immigrant respondents, who make up the remaining percentage, reported taking more than 20 minutes to access a green space. This suggests that for some migrants, the availability of green spaces nearby may be limited, requiring them to invest more time and effort to reach these areas.

Part summary:
Results from immigrant respondents show that accessibility to nearby public green spaces vary. While the majority have relatively convenient access within a short walking distance, a significant portion must travel longer distances. These findings highlight the need to address the distribution and proximity of green spaces in areas where immigrants live to ensure equal access for all. By addressing these inequities, the community can improve the overall accessibility and inclusivity of public green spaces for the migrant population.

Green Space Access: Overall

Looking at overall access to public green spaces in Storhaug, the percentages are comparable for both the native and migrant groups. Most respondents from both groups reported taking between 0 and 10 minutes to reach a green space, representing 54% of respondents overall. This suggests that a significant portion of the population, regardless of native or migrant status, has relatively convenient access to nearby green spaces that are only a few minutes' walk away.

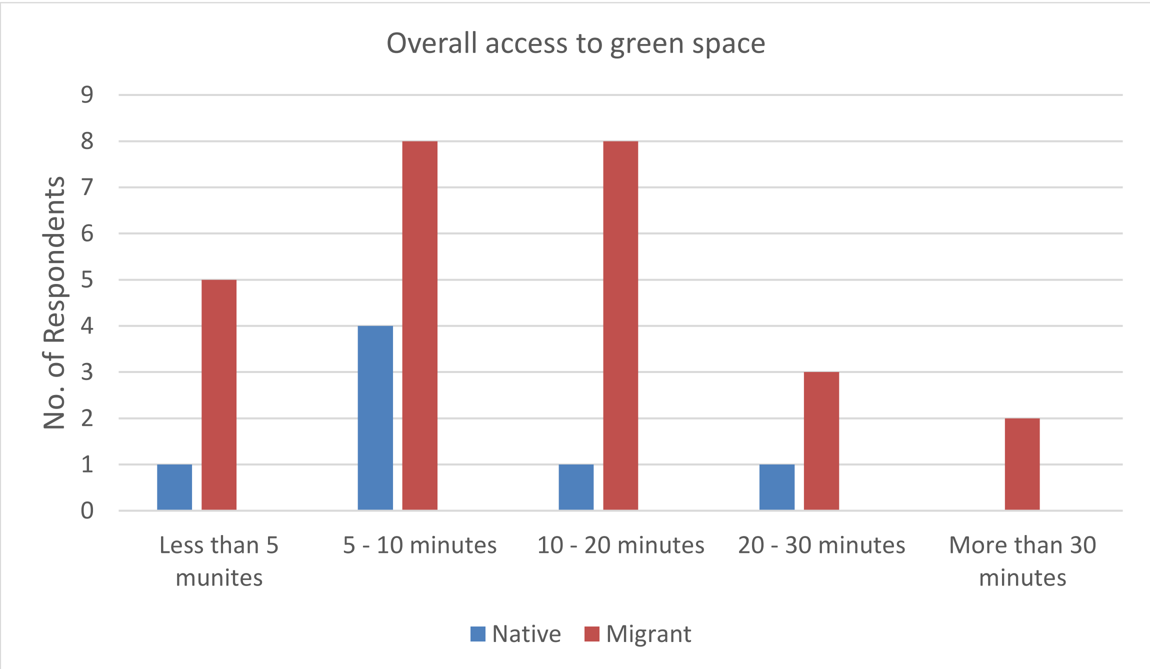


Figure 49. Overall access to green space between Natives and Migrants.

Contrary to expectations, the results suggest that the migrant population does not necessarily have a higher percentage of people living near or having better access to public green spaces compared to the native population. The distribution of access to green space appears to be relatively consistent across both groups, suggesting that factors other than migration status may influence access to green space. However, it is worth noting that the native population is dispersed over different walking distances, indicating a wider range of access experiences in this group. This suggests that while most native and immigrant respondents have relatively convenient access to green space, there are differences within the native population in terms of proximity and availability of this space.

Part summary:
These findings underscore the importance of considering the overall distribution and accessibility of green spaces in the community, ensuring equitable access for all residents regardless of their background. By addressing any disparities and providing equal opportunities for green space access, the community can promote a healthier and more inclusive environment for all individuals.

5.3.2 Green Space Distribution: Social Groups

During the survey, respondents were asked whether they perceived the distribution of green spaces in Storhaug to be unequal. Out of the total respondents, 16 individuals answered affirmatively, indicating that they believed there is an unequal distribution of green spaces in the area. On the other hand, 13 respondents replied negatively, suggesting that they did not perceive any inequality in the distribution of green spaces. Additionally, 4 respondents expressed uncertainty and were unsure about the unequal distribution.

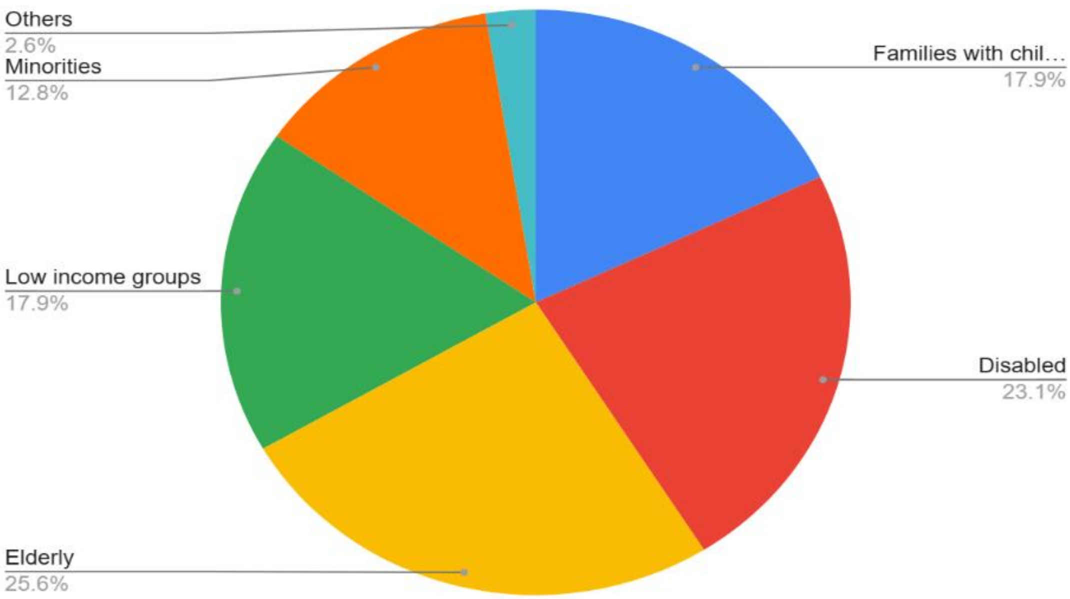


Figure 50. Green space distribution among social groups.

For those who answered "Yes" to perceiving an unequal distribution of green spaces, they were further asked to specify which social groups they believed were most affected by this inequality. Figure 50 above provides a visual representation of their responses across different social groups.

The responses from these participants shed light on their perceptions regarding the impact of green space distribution on various social groups within Storhaug. The data collected provides insights into the participants' perspectives on the social aspects of green space accessibility and the potential disparities that may exist within the community.

Part summary:
By examining these findings, researchers and policymakers can gain a deeper understanding of the community's perception of green space distribution and the groups they believe are disproportionately affected. This information can be valuable in guiding future planning and development initiatives aimed at promoting equitable access to green spaces for all social groups within Storhaug.

5.3.3 Green Space Distribution: Demographics factors

The respondents were asked if they believed that demographics such as race, age, disability status, and income level played a role in determining the distribution of green spaces in the area. Out of the total respondents, 6 individuals indicated that they did not perceive demographics to have any influence on the allocation of green spaces in Storhaug. On the other hand, 27 respondents expressed their belief that demographics do impact the distribution of green spaces.

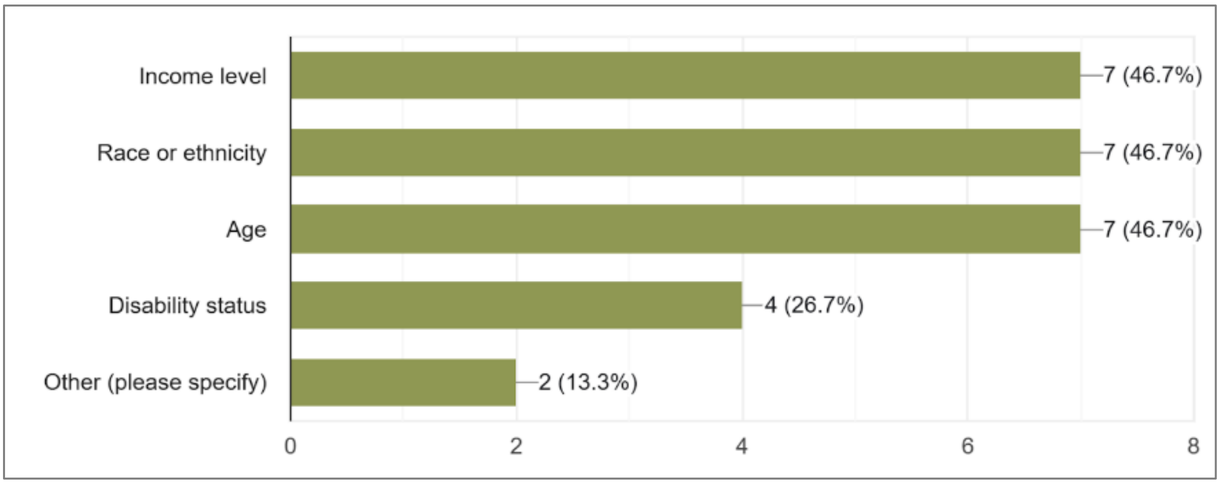


Figure 51. Illustration of responses regarding the factors influencing the allocation of green spaces in Storhaug.

To gain a deeper understanding of the respondents' perspectives, they were further asked to specify which factors they thought influenced the allocation of green spaces in Storhaug. The responses provided by the participants were analysed and the findings are presented in Figure 51. The graph provides a breakdown of the respondents' answers based on various demographic categories. These categories could include race, age groups, disability status, income levels and other social factors. The purpose of this analysis is to examine if there are any notable patterns or variations in the respondents' perceptions based on these demographics.

Part summary:
By analysing the data in Figure 51, one can observe the distribution of responses across different demographic groups. This information allows for a more comprehensive understanding of how different factors may be perceived to influence the allocation of green spaces in Storhaug, according to the participants of the study.

5.3.4. Use of green space

Figure 52 provides an overview of the frequency with which respondents visit the various green spaces in the study area. The data show that a significant portion of respondents (27.3% each) reported using these green spaces a few times a week and a few times a month. This indicates that these individuals regularly engage with the green spaces in their neighborhood.
In addition, 9.1% of respondents indicated that they visit the green spaces on a daily basis, indicating a strong propensity for frequent use. Another 12.1% of respondents reported visiting the green spaces weekly, indicating a constant level of engagement.

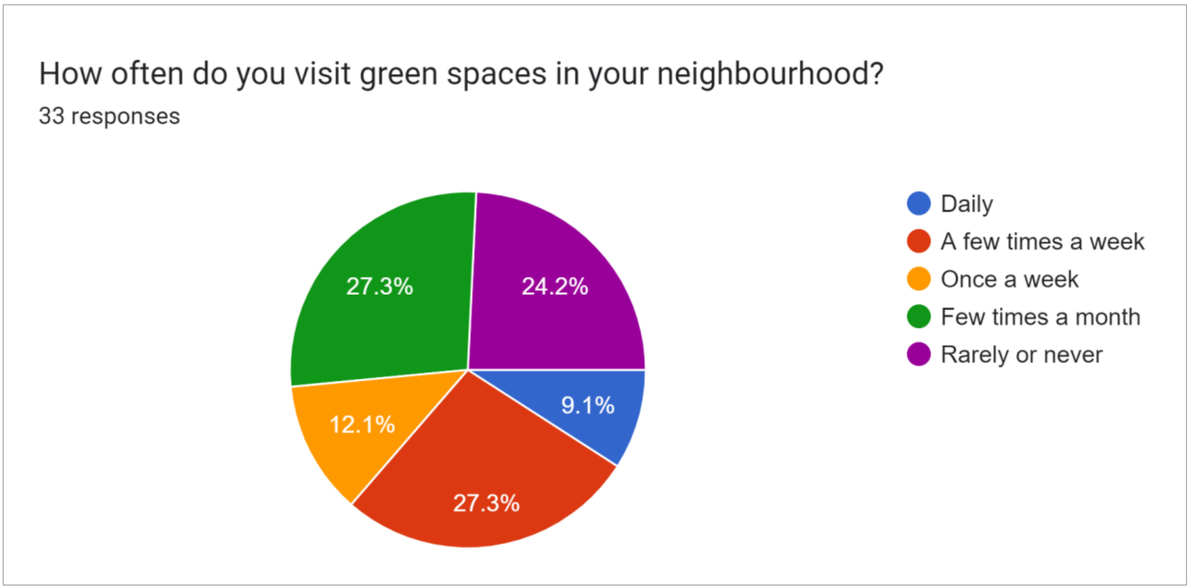


Figure 52. Frequency of visit to green space.

On the other hand, it is worth noting that a significant percentage of respondents, 24.2% of the population, indicated that they rarely or never use the green spaces in any of the study area. This finding suggests that there is a segment of the population that may not prioritize or actively engage with these green spaces.

In terms of reasons for using green spaces, as shown in Figure 53, respondents gave a variety of reasons, including relaxation, recreation, exercise, socializing, and more, which are based on the quality and available infrastructures present in these spaces. These results highlight the multifunctional nature of green spaces, serving as spaces for leisure, well-being, and social interaction. However, it was surprising that only a small proportion of respondents reported visiting green spaces to spend time with their children. This may indicate that there is room for improvement in promoting and supporting family-oriented activities in green spaces to allow parents and children to interact and spend quality time together.

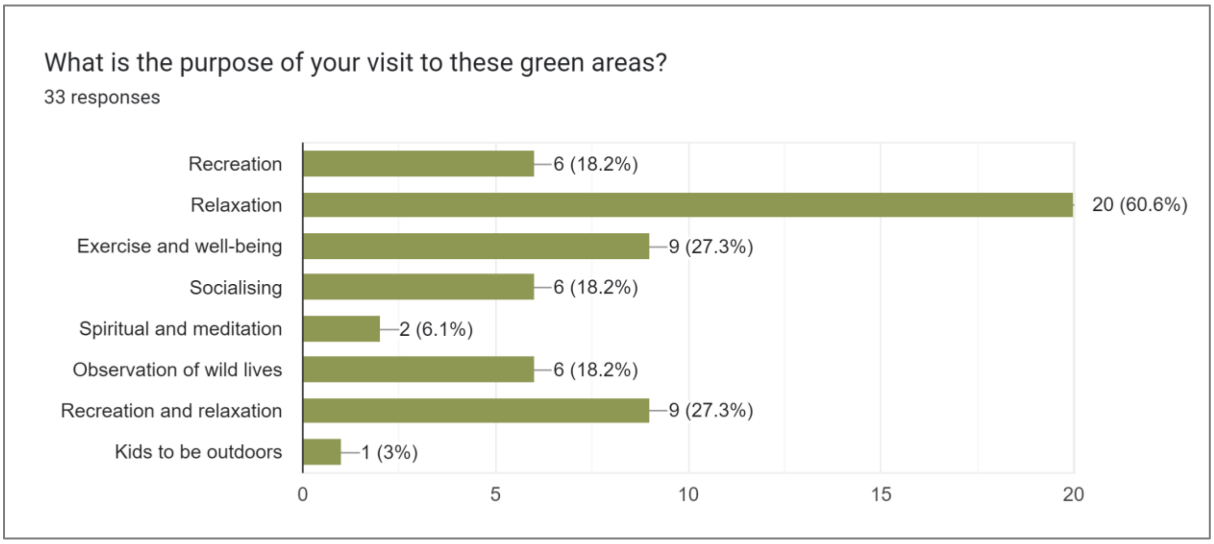


Figure 53. Frequency of visit to green space.

Part summary:
Understanding the frequency and motivations for visiting green spaces is crucial for urban planners and policymakers to develop strategies that meet the needs and preferences of the population. By removing barriers and making green spaces more attractive, efforts can be made to increase use and promote the multiple benefits they provide, including opportunities for family bonding and recreation.

CHAPTER

SIX

CONCLUSION

6.0 CONCLUSION

The summary and conclusion of the study provide a comprehensive overview of the findings and their implications. The utilization of ArcGIS network played a major part in the analysis and finding part which allowed for a detailed examination of the distribution of public green space and its relationship to environmental justice in the Storhaug area. The following points summarize the main conclusions and observations of the study.

In the context of the distribution of public green space in Storhaug, this study's initial analysis with GIS found an irregular pattern, showing that certain areas have a limited supply of public green space. While it was found that most of the population can easily access public green space in or near their neighbourhoods with ease, these findings do not confirm the adequacy of green space availability, as the amount of green space per person in most neighbourhoods is below the recommended standard as proposed previous researchers and planning regulatory authorities.

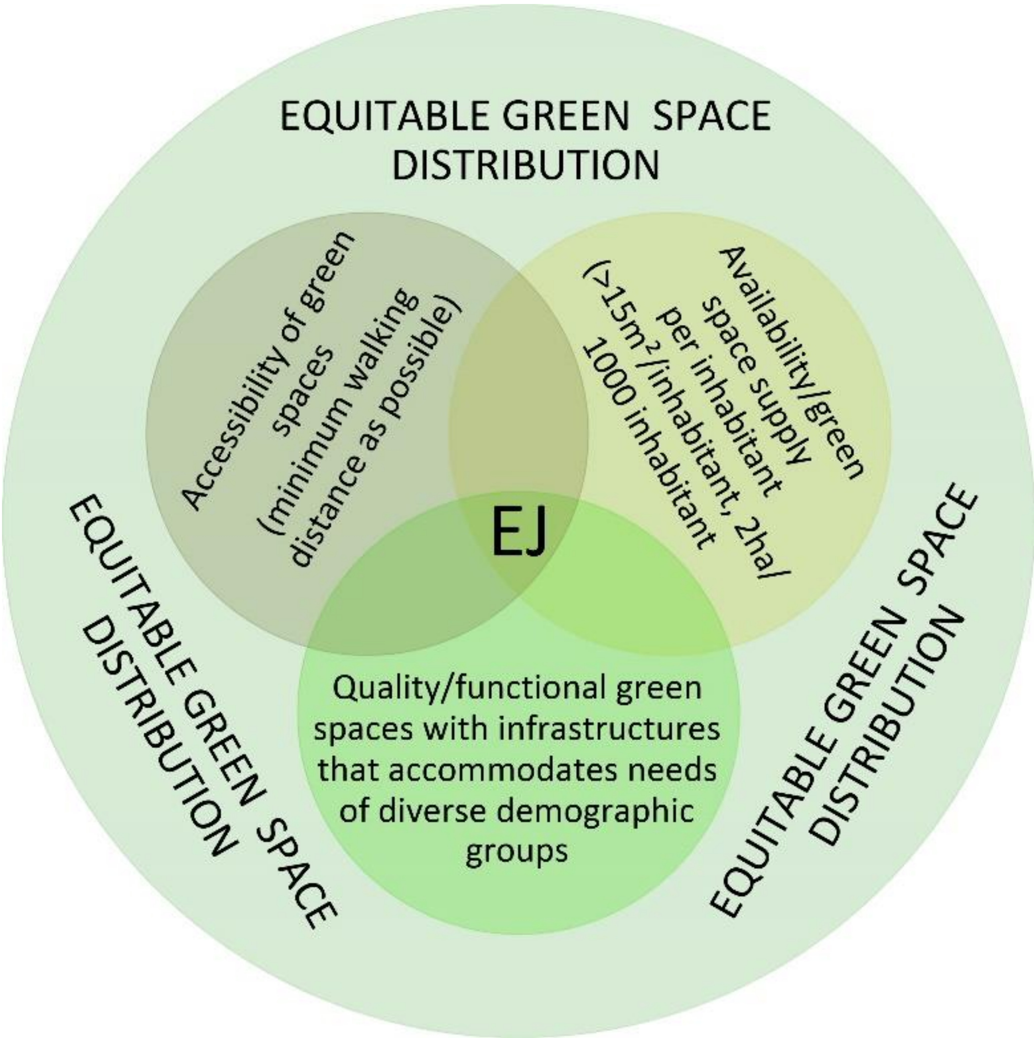


Figure 54. Conceptualisation of study (Source: Author)

Moreover, the analysis of available public green spaces reveals differences in their quality such as available facilities to carter for different users need, and proper maintenance, which have a significant impact on the motivation of users to visit these spaces. It can be concluded that easy access to green spaces does not necessarily indicate an adequate supply of such spaces. This study highlights the importance of achieving equitable distribution of green spaces, which requires a balanced consideration of environmental factors (accessibility and availability) as well as relationship between quality and socioeconomic characteristics of users such as age groups and gender. This refers to distributive justice, a fair distribution of the benefits from ecosystems. The conceptualisation of this study finding is illustrated in Figure 54 above. The subsequent part of this study analyses factors affecting distribution from responses based on personal experiences of the residents of the study area. It was found that most individuals can access public green areas within 0–15 minutes by feet from their homes and maximum of 30 minutes by public transport, which shows a good accessibility factor as stated in the previous paragraph. Also, the findings indicate that indigenous Norwegians do not have preferential access to public green space over other ethnic groups.

Furthermore, the analysis revealed that the majority of respondents believed that the distribution of green space among social groups was unequal which could be influenced by demographic factors. These results provide valuable insights into the demographic characteristics of respondents and their interactions with green spaces. The study shows that public green spaces are predominantly used by individuals who identify as male as most respondents reported to be male. This gender disparity can be attributed to factors such as safety concerns that affect the participation of minority gender or societal beliefs that are prevalent in certain social groups. One possible approach to solving the highlighted problem is to involve the affected individuals in the decision-making process. This practice, known as procedural justice which involves public participation otherwise known as medvirkning in Norwegian, allows for their active participation and input in determining the most appropriate approach to alleviate the problem. By considering their perspectives and including them in the decision-making process, procedural justice can foster a sense of fairness and inclusivity, leading to more effective and sustainable solutions.

Understanding the demographic characteristics of green space users such as gender, age group, social groups, etc, and their various needs to use a public green space (recognition justice), future planning and development initiatives can ensure that the design and accessibility of green spaces meet the needs and preferences of diverse demographic groups. For instance, creating public green spaces with infrastructures that promotes inclusiveness can bridge the gap between indigenes and immigrants, young and old, and male and female. Providing a public green space with free Wi-Fi and charging facilities can significantly increase the appeal to Gen Z users and encourage them to spend more time in these areas than they otherwise would. This underscores the importance of implementing targeted strategies to improve the overall experience and accessibility of green spaces, focusing specifically on the needs of these particular populations. In this way, it becomes possible to promote inclusive and diverse green spaces that serve the entire community.

Figure 55. Wi-Fi in public green space (Source: https://www.unlv.edu/)

Figure 56. Jardim de Parada, a community park in Campo de Ourique, Portugal (Source: https://rr.sapo.pt/)

A notable example is the Jardim de Parada in Campo de Ourique, Portugal. This garden not only has a rich natural heritage, but also serves as a place for people of all generations, both children and adults, to meet and enjoy. Its ability to bring together people of different ages shows how much such places can encourage community interaction and engagement.

6.2 Significance of Findings

The primary finding of this study shows that there are certain neighborhoods in Storhaug where the supply of public green spaces is lower compared to others. However, it is important to note that the native population does not have better access to public green spaces than the immigrant community. Rather, the problem lies in the insufficient amount of green spaces that do not meet the needs of the overall population for which they are intended. In essence, this study highlights the presence of environmental inequality in Storhaug, where both native Norwegians and migrants face difficulties in accessing sufficient public green spaces. This finding aligns with the broader understanding that environmental inequality exists at various borders around the world, as discussed in Chapter 2.

6.3 Limitations

There are restrictions that could impact the findings based on the methodology used in this investigation. First of all, in addition to the approach itself, the datasets used in the analysis, such as population, street networks, and park entrance positions, can result in mistakes. Because this study uses secondary data that were obtained from other people or organisations, it is unable to determine whether the data were accurate when they were collected. On the other hand, the methodology mostly relies on ArcGIS software and street network data. ArcGIS does all computations, including time and distance, automatically. As a result, this study may have inaccuracies that originated in the datasets.

Numerous factors can affect where the potential green spaces are located in the real world. This approach has a flaw in that it ignores other factors that can have an impact on the outcomes and only considers how many diverse people lack access to public green spaces on a large scale. Future studies on the accessibility of green spaces may focus on additional variables to identify suitable sites for green spaces. Finding green areas for various racial communities may be a smart idea with the help of site suitability studies.

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Questionnaire

Environmental justice and green space distribution in Storhaug

You Hi, my name is Kalu Oji Ndukwo, a master's student of City Planning at the University of Stavanger. I am conducting a survey to
evaluate the impact of environmental justice on green space distribution in Storhaug, Stavanger.

Respondents' identities will remain anonymous.

* Indicates required question

Registration of participant

1. Gender *

   Mark only one oval.

   - ◯ Male
   - ◯ Female
   - ◯ Non Binary
   - ◯ Prefer Not to say

2. Age *

   Mark only one oval.

   - ◯ 18-29
   - ◯ 30-39
   - ◯ 40-49
   - ◯ 50-59
   - ◯ 60+

3. Are you? *

   Mark only one oval.

   - ◯ Native
   - ◯ Migrant

4. Do you live, work and/or visit Storhaug?

   Tick all that apply.

   - ☐ Live
   - ☐ Work
   - ☐ Visit
   - ☐ Other: ______________

5. If you live in Storhaug, which area of area in Storhaug do you live?

Mark only one oval.

- ( ) Kvelvene
- ( ) Badedammen
- ( ) Nylund
- ( ) Varden
- ( ) Sentrum
- ( ) Midjord
- ( ) Lervig
- ( ) Other: ____________

6. If you live in Storhaug, how long have you lived here?

____

Visit and location of green areas in Storhaug.

7. How often do you visit green spaces in your neighbourhood? *

Mark only one oval.

- ( ) Daily
- ( ) A few times a week
- ( ) Once a week
- ( ) Few times a month
- ( ) Rarely or never

8. What is the purpose of your visit to these green areas? *

Tick all that apply.

- [ ] Recreation
- [ ] Relaxation
- [ ] Exercise and well-being
- [ ] Socialising
- [ ] Spiritual and meditation
- [ ] Observation of wild lives
- [ ] Other: ____________

9. How far do you travel to access a green space next to where you live? *

Mark only one oval.

- ( ) Less than 5 minutes
- ( ) 5-10 minutes
- ( ) 10-20 minutes
- ( ) 20-30 minutes
- ( ) More than 30 minutes

10. Are there available infrastructures that enables access to green spaces within your neighbourhood? *

Tick all that apply.

- [ ] Footpaths
- [ ] Bicycle trails
- [ ] Bus stops
- [ ] Bus routes
- [ ] Parking spaces
- [ ] E-bike stations
- [ ] Disability access
- [ ] Other: ______________

Distribution of green areas in Storhaug

11. Do you think the distribution of green spaces in Storhaug is unqual? *

____

12. If your answer to the last question is YES, please select which social groups you think are affected the most.

Tick all that apply.

- [ ] Low-income groups
- [ ] Minorities
- [ ] Elderly
- [ ] Disabled
- [ ] Families with children
- [ ] Other (please specify)

13. Have you ever felt that the allocation of green spaces in Storhaug, Stavanger is influenced by demographics? (e.g., Age, gender, income level, social groups, etc.) *

Mark only one oval.

- ( ) Yes
- ( ) No

14. If you answered YES to the previous question, please select the factors that influences the allocation of green spaces in Storhaug, Stavanger?

Tick all that apply.

- [ ] Income level
- [ ] Race or ethnicity
- [ ] Age
- [ ] Disability status
- [ ] Other (please specify)

15. Do you think that some neighborhoods lack access to better green spaces than others? (If the answer is YES, please specify neighbourhoods) *

Contributions to improving green spaces and distributions.

16. Have you ever participated in any initiatives to improve the number or quality of green spaces in your neighbourhood? (If YES, please identify) *

17. Do you have any suggestions on how green spaces and access to them can be improved in your neighbourhood and Stavanger municipal as a whole?