URBAN GREEN IN GREATER PARAMARIBO: EXPLORATIONS OF ACCESSIBILITY AND SOCIAL INEQUALITY

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MARCH, 2022

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Enschede, The Netherlands, March, 2022

Thesis submitted to the Faculty of Geo-Information Science and Earth Observation of the University of Twente in partial fulfilment of the requirements for the degree of Master of Science in Geo-information Science and Earth Observation.
Specialization: Geoinformatics

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ABSTRACT

Urban green spaces (UGS) provide many benefits to people, including providing shade, temperature and air quality regulation, and a place for social cohesion and recreation. These benefits help assuage the negative effects of urbanization and improve the living standards of people in today's urbanizing world. Research has been done on the distribution and accessibility to UGS, but these studies are concentrated in the Global North. Even though most studies compare UGS access throughout an area, the differences in access due to geographical and socio-economic factors have been overlooked. There has been recent research on the issue of social inequalities even though there has been little emphasis on cities in the Global South. This research examines inequalities in access to UGS based on socio-economic factors such as age, income, and ethnicity in Greater Paramaribo, Suriname a country in the Global South. This study classified the types of UGS using a visual interpretation based on aerial images and looking at the distribution of the UGS types. Using network analysis, the accessibility to UGS was then done using the sizes of UGS and different modes of transportation. To assess the level of social inequality this research used the Gini coefficient and the Pearson correlation. The results show there is more variation of the types of UGS available in the central part of the Greater Paramaribo Region than in the outskirts. Results also indicate that the socio-economic group with the highest access is the Javanese followed by the Hindustani ethnic group. The Creoles have the least access to UGS in the Greater Paramaribo Region followed by the Natives ethnic group. The elderly, and children in the Greater Paramaribo Region have good access to UGS and income does not affect accessibility. It is recommended that there should be a concentrated effort to increase UGS in disadvantaged ressorts to alleviate the negative impacts of lack of UGS.

Keywords: Urban Green Space; Accessibility to UGS; Social Inequalities; Global South

ACKNOWLEDGEMENTS

I don't even know how to start this. First, I will say Glory be to God for how far He has brought me. If not for his mercies, grace, kindness, favour and peace, this thesis wouldn't have been possible. My family, my best support system, my cheerleaders, thank you for the encouragement. Even when I thought I was a disappointment, you all reassured me that I was the best in all my peers. My first love (Daddy) and his queen (Mummy), thank you for the constant check-up, worry and prayers. Words cannot express how much I love you and how grateful I am for pushing me and supporting my dreams. My siblings, Nana, Boat and Akwasi, thank you for allowing me to be the baby of the family, so I can do anything I want without thinking about responsibilities, for the money you contributed and your support and cheering, I love you all. To my auntie (Maa Boat) and her husband (Pastor Noah), thank you for the prayers, encouragement, and the constant call to make sure I am well in every aspect. My brother (Mr.Twumasi) and his wife (Auntie Martha), thank you for your care and love and for making me a part of the family.

My heartfelt gratitude to my supervisors Dr. Nina Schwarz, Prof. Louise Willemen and Dr. Marija Bockarjova for their guidance, constructive feedback, and support. Dr. Nina Schwarz and Prof. Louise Willemen, thank you for taking a chance on me to work on your project and for your supervision even when I was not yet in school. Thank you for understanding my plight and being considerate and pushing me to achieve my goal before my deadline. To Dr. Marija Bockarjova, my advisor who became my first supervisor, thank you for the extra meeting hours to go over ideas I was not comfortable sharing during the regular meeting hours and for encouraging me to write for a great mark.

To everyone at the ITC Faculty who pushed for me so that I can get a second chance. Jeroen, Theresa and Maria-Chantal, thank you for guiding and lending a listening ear to me through the difficult phase of my studies. To the ITC Excellence Scholarship program coordinator John, thank you for agreeing to pause my funding so that I can have a second chance without the burden of funding myself.

Now to the family I made here, Rexford thank you for being my partner here, for staying up with me through the night so I will not be lonely, for the encouragement and sometimes worrying more than I do. Tish, thank you for caring for me when I was going through all the hard times, for listening and for our little cuddles on your bed. You might be a pain to deal with, but you are still my favourite. Anna, Eunice, Afia, and May, thank you for the girls' time, the food we shared, the gist and for checking up to see my progress in this thesis. Nii, Prince, Hani, and Derrick, for all the fun times we shared, and the memories, thank you.

Finally, to everyone who has been instrumental in my journey, I say thank you. God bless you and replenish everything and effort you put in me.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

AI	Aggregation Index
CA	Class Area
GAI	Green Area Index
GI	Green Index
GIS	Geographical Information System
GSA	Green Space Accessibility
GSR	Green Space Ratio
Area_MN	Mean Patch Size
NP	Number of Patches
OSM	Open Street Map
PD	Patch Density
UGS	Urban Green Spaces
UNGI	Urban Neighbourhood Green Index
VGI	Volunteered Geographic Information

1. INTRODUCTION

1.1. Background and Justification

There has been an increase in the population of people living in cities worldwide due to urbanisation. This has put a strain on the natural resources available and led to the conversion of land uses such as urban green spaces for residential purposes (Taylor & Hochuli, 2017). With the reduction in the natural land uses and abundance of concrete and asphalt surfaces in the cities and the issues of increasing populations, limited resources, and the accelerating effects of climate change are putting pressure on many urban communities (World Health Organization, 2017).

The expansion of cities can have negative effects on the environment and the living standards of people in today's urbanizing world (Van de Voorde, 2017). These development of cities leads to degradation of urban green spaces and an increase in the local temperatures when no action is taken by neither citizens nor authorities (Derkzen, van Teeffelen, Nagendra, & Verburg, 2017; Oliveira, Andrade, & Vaz, 2011). The increased temperatures cause urban heat island, a phenomenon that makes urban areas warmer than their surrounding environs and therefore increases the amount of energy needed to cool homes (Kong, Yin, James, Hutyra, & He, 2014). The negative impacts of urbanisation can be alleviated through the enhancement of green spaces for sustainable cities thereby making towns more appealing to live in, reversing urban sprawl, reducing the pressures on transportation and overall improving the quality of life (Badiu et al., 2016; De Ridder et al., 2004).

Urban green spaces (UGS) in this research is described as natural, semi-natural, and artificial green lands inside, near, and between urban environments, at all spatial scales, that serves different ecological purposes for people of various groups (Jim & Chen, 2003; Tzoulas et al., 2007). UGS can be maintained or unmaintained environmental areas in the cities (Agarwal, 2019). Parks, forests, public green spaces, private gardens, and roof gardens are all examples of vegetation covers that make up UGS in cities (Haase et al., 2017). The advantages of UGS include the social, aesthetic, health, environmental and economic aspects (Shackleton, 2006; Texier, Schiel, & Caruso, 2018).

In the social and aesthetic aspects of UGS, it serves as recreational benefits in which some activities such as sports can be organised (Kabisch & Haase, 2014). UGS in the urban areas also help improve a sense of belonging, a reduced sense of social isolation and promote social cohesion (Ayala-Azcárraga, Diaz, & Zambrano, 2019; Ward Thompson, Aspinall, Roe, Robertson, & Miller, 2016). Aesthetic pleasure is not only limited to visual stimulation, individuals can derive tremendous joy and satisfaction simply by looking at nature and being immersed in the smells produced by some vegetation (Zhou & Rana, 2012).

The health and psychological benefits of green spaces are also many. Green spaces allow people to relax and interact with nature thereby improving the environmental condition, health and wellbeing of people in the urban communities (Lee & Maheswaran, 2011; Moseley, Marzano, Chetcuti, & Watts, 2013; Rigolon, 2016). People who have access to green spaces have shown enhanced abilities to manage mental stress, reduce procrastination in handling life issues, and a sense that their challenges were less serious, more solvable than those who have no access to nature (Çay & Aşilioğlu, 2016). With the availability of green spaces, people tend to exercise more which reduces the risk of obesity, heart diseases and the rate of mortality and morbidity (Kendal et al., 2016).

It is notable that green plants regulate air carbon, humidity, soil erosion, control flooding and improve air quality (Dwyer, McPherson, Schroeder, & Rowntree, 1992; Morancho, 2003). Compared to other types of measures, UGS design and maintenance may be one of the most time-saving and cost-effective approaches to mitigate climate change (Jo, 2002). In the urban area, trees can help to improve the atmosphere by providing shade, intercepting pollution, and noise filtering (Jim & Chen, 2003). Also, certain trees in densely populated areas help to reduce the amount of dust in the air (Heidt & Neef, 2007). For the economic benefits, some local authorities are providing a variety of funding and sponsorship opportunities to anyone who can handle and protect their green spaces (Abu Kasim, Mohd Yusof, & Mohd Shafri, 2019). Green spaces sometimes serve as places of attraction that brings value to the real estate market, conventions, businesses and tourism (Jafri & Rajaullah, 2018).

The numerous advantages of UGS make it a desirable commodity for most people in urban areas. The benefits of UGS have brought a surge in the request for ample and quality green spaces in urban areas by the public and plans and practices that promote the physical, social, psychological, and economic benefits of the green spaces in neighbourhoods (Abbasi, Alalouch, & Bramley, 2016; Van Herzele & Wiedemann, 2003). However, the distribution and access of UGS are not even. With the increase in urbanization, there have been some differences in the accessibility to natural resources such as the UGS among citizens (Barbosa et al., 2007; Yuan, Xu, & Wang, 2017). Estabrooks, Lee, & Gyurcsik (2003) explained accessibility as pay-for-use and free-for-use of resources. Accessibility in this study is explained as the ease with which people interact and reach a desired destination using an available transport system (Geurs & van Wee, 2004). The differences in accessibility in effect lead to the increase in social inequality (Kechebour, 2015). With the many benefits of UGS for both physical and moral well-being, accessibility to it is often used as a measure of social inequality (Wu, He, Chen, Lin, & Wang, 2018).

Social inequality refers to the social disparity associated with the distribution and accessibility of resources and risk allocation across space (Petrić, 2019; Zuniga-Teran & Gerlak, 2019). It has been established that the socio-economic status of residents is linked with the distribution effects and the locations of UGS, which is usually uneven in the urban areas (Sathyakumar, Ramsankaran, & Bardhan, 2019). Hence, the inequality in access and distribution of UGS is usually based on the socio-economic status of the residents in the cities (Silva, Viegas, Panagopoulos, & Bell, 2018). The poor, indigenous peoples, women, minority ethnic groups are those usually considered the disadvantaged groups and communities (Adebowale, 2008).

This is an issue of social inequality since in most cities, the minority and low income communities reside in the inner cities or environmentally risky areas and have less access to UGSs, and are more usually exposed to pollutants that cause illnesses that tend to affect their health (Byrne, Wolch, & Zhang, 2009; Jennings, Johnson Gaither, & Gragg, 2012; Wolch, Byrne, & Newell, 2014). As stated by many (Crawford et al., 2008; Moore, Roux, Evenson, McGinn, & Brines, 2008) the lack of areas of recreation might be the cause of less active exercises in lower socio-economic neighbourhoods. It was also noted that the differences in location and features of parks affected the use of green spaces in the urban areas (Vaughan, Cohen, & Han, 2018). Furthermore, in a residential setting there is a spatial division of one social community from another, meaning members of different minority communities lived separately from one another as well as from the rest of the population (Johnston, Poulsen, & Forrest, 2007; Park & Kwan, 2017).

With this increase in disparities in the accessibility and spatial segregation between residents, the question of whether public resources are distributed and accessed fairly needs to be addressed (Xiao, Wang, Li, & Tang, 2017). Also, little is known about how demographics and urban boundaries improve or reduce access to high-quality UGS, and whether and how city managers address issues of diversity and inclusion in their daily and strategic planning for service allocation and resource distribution especially in developing countries (Rutt & Gulsrud, 2016; Xiao et al., 2017). Investigations into social inequality is a way of explaining why so few urban inhabitants profit and so many suffer from unequally distributed environmental amenities such as UGS since there have been relatively little written on inequality in access to UGS (Heynen, Perkins, & Roy, 2006). For the sustainable development goals 10 and 11 (United Nations, 2020), which seeks to reduce inequality within and among countries and make cities and human settlements inclusive, safe, resilient and sustainable respectively, this study is a contribution to achieving the goals.

1.2. Research Problem

An increasing interest in the effect of biodiversity and ecosystem function on urban life has prompted studies into UGS (Taylor & Hochuli, 2017b). The issue of unevenly distributed UGS provides a challenge for sustainable urban development as urbanization and population growth intensify (Ma, 2020). In planning or incorporating green spaces in cities, accessibility is an important factor that helps to evaluate how comprehensive cities are (Zheng, Zhao, & Jin, 2019).

For interventions that suit specific areas and a way to bridge the gap created by non-uniform UGS distribution, planners and researchers seek to find areas that are affected by these inequalities (Qin, Liu, Yi, Sun, & Zhang, 2020). Research into the distribution and accessibility of UGS is concentrated in the developed countries with findings from Europe and the United States dominating studies, which are not comparable to developing countries (Kabisch, Qureshi, & Haase, 2015; Wang, Brown, Zhong, Liu, & Mateo-Babiano, 2015). Shackleton (2012) and Shackleton & Blair (2013) suggested that studies into accessibility of green spaces in developing countries might be different from developed countries since transportation networks, biodiversity, climate and rate of urbanisation are different and this changes the strategies applied by planners, hence, a reduced accessibility to UGS especially for poor communities. With there being variances in social, political, and cultural considerations in urban contexts, developed nations have varied patterns in terms of access to parks and green spaces when compared to developing countries (Wei, 2017).

There has been more research on the issue of social inequality even though there has been little emphasis on cities in the Global South than the Global North. There has lately been a surge in studies on social inequality in Global South cities, and it has been discovered that these cities face significant problems such as informal settlements, post-colonialism, larger wealth discriminations than in the Global North, pollution, and high rates of population growth, which tend to exacerbate social inequality (Rigolon, Browning, Lee, & Shin, 2018). Inequalities in urban green areas, especially in terms of proximity, quantity, and quality, are common in cities in the Global South. The Global South cities studies reveal that high-socio-economic status groups benefit from park quantity in the same way as they do in Global North cities as suggested by the majority of research conducted (Rigolon et al., 2018). Although disparities in park proximity and park quality are more widely dispersed in cities in the Global South than in cities in the Global North, therefore cities in the Global South have more shades of inequality than cities in the Global North (Rigolon et al., 2018).

With there being evidence of social inequality according to research in cities in the Global South there is a need for more in-depth research. Access to green spaces in urban areas is critical to achieving social fairness and, as a result, city sustainability in cities of the Global South because the income disparities across socio-economic classes are more pronounced than in cities of the Global North (Almohamad, Knaack, & Habib, 2018). Even though most outcomes of researches show park access throughout a geographic unit, the differences in access due to geographical and socio-economic factors have been overlooked (Almohamad et al., 2018). In general, there is a need to research how socio-economic groups have access to green spaces in cities.

Due to the concentration of research in developed countries, there is a deficit in research on green spaces in urban areas of developing countries, especially in Africa and the tropics. This study therefore seeks to explore the issues of accessibility to UGS and social inequality in Greater Paramaribo Region, a city in a tropical country, Suriname. The unique patterns and trends in the accessibility of green spaces study in Greater Paramaribo may bring insights not found in the developed countries and also expand the knowledge on social inequality relating to the accessibility to UGS based on specified socio-economic factors. This study will also add to the current accessibility literature by comparing UGS distribution and accessibility across various neighbourhoods in the city, which can then be used in other future studies to identify the parallels and variations in equality across cities and nations (Wei, 2017).

1.3. Research Objectives and Research Questions

The main objective of the study is to explore the accessibility and issues of social inequality, that is the relationship between accessibility and the socio-economic factors related to UGS in the Greater Paramaribo Region. The specific research objectives and research questions are presented below:

1: To investigate the spatial distribution of green spaces in the Greater Paramaribo Region.

- What are the types of UGS in Greater Paramaribo?
- How are the types of UGS distributed in Greater Paramaribo?
- Does the distribution of UGS in Greater Paramaribo follow a particular pattern?

2: To assess the level of accessibility to green spaces in the Greater Paramaribo Region.

- What method will be useful for the assessment of the level of accessibility of UGS in Greater Paramaribo?
- What is the level of accessibility to UGS in Greater Paramaribo?
- How many residential houses, schools, and elderly homes in Greater Paramaribo are within accessible ranges of UGS?

3: To assess the level of social inequality associated with the accessibility to UGS in the Greater Paramaribo Region.

- What is the level of inequality in UGS distribution in Greater Paramaribo?
- What is the relationship between accessibility of green spaces and socio-economic factors in Greater Paramaribo?
- Which socio-economic groups have the highest and least access to green spaces in Greater Paramaribo?

1.4. Thesis Structure

There are six chapters in this thesis. The study's first chapter has the background and justification, research problem, research objectives, and research questions. The second chapter reviews literature regarding the key concepts of the study. Chapter 3 presents the study area, data and the methods used. The study's findings are presented in Chapter 4 based on the research objectives and questions. Chapter 5 discusses the findings of the study. Finally, Chapter 6 brings the study to a close by summarizing the major results and giving recommendations.

2. LITERATURE REVIEW

This chapter reviews the concepts associated with the study. This includes a review of UGS typologies, and methods of measuring the distribution and patterns of UGS in Section 2.1. Section 2.2 presents some definitions of accessibility and methods of measuring accessibility to UGS. Social inequality in accessibility against different social groups and methods of measuring social inequality in accessibility to UGS are reviewed in Section 2.3. Section 2.4 summarizes the review and presents a conceptual framework for the study. This review guided the choices made for achieving the research objectives.

2.1. UGS

Taylor & Hochuli (2017) stated that UGS can be interpreted in two ways. The first definition gives preference to nature and refers to green space in a landscape as bodies of water or regions of vegetation, such as forests and reserves, street trees and parks, gardens and backyards, agricultural fields for farming, geological formations, and coastal areas. The second meaning revolves around the urban areas and defines UGS as urban woods, urban farms, and urban vegetation, which includes parks, gardens, and yards.

2.1.1. Typologies of UGS

There have been many types of classification of UGS based on different studies. In Graça et al. (2018), green spaces were classified as shown below in **Figure 1**.

Categories in original survey	Clustered categories	Specific Criteria for classification
Agricultural areas	*Agricultural areas*	Active continuous agricultural areas greater than 2000 m^2; smaller areas were considered private gardens & backyards
Allotments & urbanizations	*Allotments & urbanizations*	Green areas associated with multi-residential buildings, generally publicly accessible
Civic & institutional	*Civic & institutional*	Green spaces associated with institutional buildings or lots
Motorways *Tree-lined streets*	*Motorways & tree-lined streets*	Green corridors associated with motorways and tree-lined streets, including green separators and roundabouts
Private gardens *Backyards*	*Private gardens & backyards*	Private green areas with restricted access, associated with single-family housing or inside residential blocks
Woodlands *Public parks & gardens*	*Woodlands, parks & gardens*	Woodlands consisting in continuous green areas with high tree density (roughly 70%), greater than 2000 m^2, with no explicit spatial arrangement and not included in public parks or private gardens; public parks and gardens comprising designed areas publicly accessible with at least 35% of vegetation cover in permeable soil
Vacant lots & wasteland	*Vacant lots & wasteland*	Public or private permeable unbuilt areas with no evident use, usually covered with ruderal vegetation or in early stages of ecological succession
Watercourses *Cemeteries* *Squares* *Scarps*	*Other green spaces*	Vegetated margins and water bodies associated with watercourses; green spaces with slopes higher than 45°; squares with vegetation cover greater than 35%; cemeteries

Figure 1: **Types of UGS (source: Graça et al., 2018)**

Lepczyk et al. (2017) for the purposes of understanding the ecology of UGS for biodiversity conservation also specified some types of green spaces such as plantings in the city core, green roofs, and community gardens as terraformed patches, city parks and home gardens spaces as managed and unmanaged vegetation, unmanaged vacant lots and brown fields and remnant natural areas. These classifications were based on the sizes and whether it was managed or not. There was another classification of the types of UGS by Czembrowski & Kronenberg (2016) into parks, forests, cemeteries and allotment gardens. These categories were based on sizes and functions for the purpose of valuing ecosystem services associated with UGS. The types of UGS were later subdivided based on their sizes into small, medium, and large. The parks made of huge lawns and having recreational facilities, forests with large areas of greens and lacking facilities for recreation, cemeteries with recreational areas especially for the elderlies and the allotment gardens consisted of fenced plots of green for individual use.

UGS was also classified into eight types by Panduro & Veie (2013) namely parks, lakes, nature, agriculture fields, common areas, churchyards, green buffers, sports fields. The parks comprised of well-kept vegetation which are maintained for a diverse variety of leisure opportunities. Green spaces found around water bodies are characterised as lakes. The combination of vast tracts of grass, pasture, tree cover, and lakes makes up nature. Sport fields were described as having green land on which sport activities take place and usually having trees around it and fenced. The churchyards are usually like gardens with flowers and hedges which are well maintained. Large fields of the same crop with little or no access to the field usually falls under agricultural fields. Trees that serve the primary purpose to reduce the harmful effects of noise and air emissions from nearby facilities such as highway, larger roads, and railways and industries are termed the green buffers. The common areas are shared patches of green space usually connected by footpaths and used by people in close vicinity. The categorization replicates how the general population perceives UGS, using aerial images to map the green space, each green space was then classified to one of the eight distinct categories of green space.

2.1.2. Measuring Distribution and Patterns of UGS

There are various ways of determining the distribution and patterns of UGS. For ascertaining the distribution of UGS, Sun et al. (2017) used three extensive metrics namely the green space area, proportion, and per-capita area to examine the geographic distribution of UGS. The green space area was estimated in ArcGIS, and the green space proportion was obtained by dividing the total of the green space areas by the built-up area. The per-capita green space area was calculated for area by dividing the total green space area by the population of the corresponding neighbourhood. In this research UGS was considered based on the functions of the land which are parks, industrial, road, commercial, residential, public service, public facilities, and others.

Landscape pattern indicators, sometimes known as metrics, are basic assessments of landscape structure that may be determined quickly using widely accessible data and software (Kupfer, 2012). These metrics are used to quantify patterns in a landscape. It has been used in several studies to analyse patterns, Lin, Chu, & Wu (2010) used the metrics for spatial pattern analysis of landslide in Central Taiwan. Also Zhou & Wang (2011) wanting to know the dynamics of UGS in response to rapid urbanization and greening policies specified the landscape metrics in **Figure 2** in order to observe temporal changes in Kunming metropolitan area in China.

Metrics	Description	Unit	Range	Justification
Percentage of landscape (PLAND)	The proportion of the area of certain land use class to the entire landscape area	Percent	$0 < PLAND \leq 100$	General index
Patch density (PD)	The number of patches in certain class divided by the entire landscape area	Number per 100 hectares	$PD > 0$	Index of fragmentation
Largest patch index (LPI)	The largest patch of certain class divided by the entire landscape area	Percent	$0 < LPI \leq 100$	Index of fragmentation and dominance
Landscape shape index (LSI)	Patch perimeter divided by the minimum perimeter possible for a maximally compact patch of the corresponding patch area	None	$LSI \geq 1$	Index of shape
Shannon's diversity index (SHDI)	Minus the sum, across all patch types, of the proportional abundance of each patch type multiplied by that proportion	None	$SHDI \geq 0$	Index of diversity

Figure 2: Landscape metrics used by Zhou & Wang (2011)

McGarigal, Cushman, Neel, & Ene (2002) explained some metrics for the distribution of landscape elements as shown in the **Figure 3** below.

$MN = \frac{\sum_{j=1}^{n} x_{ij}}{n_i}$	MN (Mean) equals the sum, across all patches of the corresponding patch type, of the corresponding patch metric values, divided by the number of patches of the same type. MN is given in the same units as the corresponding patch metric.
$AM = \sum_{j=1}^{n} \left[x_{ij} \left(\frac{a_{ij}}{\sum_{j=1}^{n} a_{ij}} \right) \right]$	AM (area-weighted mean) equals the sum, across all patches of the corresponding patch type, of the corresponding patch metric value multiplied by the proportional abundance of the patch [i.e., patch area (m^2) divided by the sum of patch areas].
$MD = x_{50\%}$	MD (median) equals the value of the corresponding patch metric for the patch representing the midpoint of the rank order distribution of patch metric values for patches of the corresponding patch type.
$RA = x_{max} - x_{min}$	RA (range) equals the value of the corresponding patch metric for the largest observed value minus the smallest observed value (i.e., the difference between the maximum and minimum observed values) for patches of the corresponding patch type.
$SD = \sqrt{\frac{\sum_{j=1}^{n} \left[x_{ij} - \left(\frac{\sum_{j=1}^{n} x_{ij}}{n_i} \right) \right]^2}{n_i}}$	SD (standard deviation) equals the square root of the sum of the squared deviations of each patch metric value from the mean metric value of the corresponding patch type, divided by the number of patches of the same type; that is, the root mean squared error (deviation from the mean) in the corresponding patch metric. Note, this is the population standard deviation, not the sample standard deviation.
$CV = \frac{SD}{MN}(100)$	CV (coefficient of variation) equals the standard deviation divided by the mean, multiplied by 100 to convert to a percentage, for the corresponding patch metric.

Figure 3: An example of landscape metrics and explanation by McGarigal et al. (2002)

In determining the patterns of UGS, Hepcan (2013) used landscape metrics. These selected metrics were used to measures the spatial patterning of ground cover patches, groups of land cover patches, or a given area of whole landscape mosaics. To measure the trends and connectivity of UGSs at the district level, the PLAND, NP and AREA_MN metrics were measured at the class level with a cell size of 10 m. In the PLAND (Proportion of landscape) metric, the relative abundance of each green space type in the landscape is calculated. NP (Number of Patch) checks for the number of patches present in a study area for a corresponding green space type. AREA_MN (Mean Patch Size) is the average of polygon areas for a specific green space type. UGS is considered as public spaces including parks, plazas, school yards, campuses, roadside green spaces, cemeteries, sport complexes, playgrounds, waterfront promenades, residential areas, commercial centres for the study.

For the purposes of analysing ecosystem services provided by green spaces in Beijing, Xu, You, Li, & Yu (2016) also made use of the landscape ecological metrics specified in **Figure 4**. Where a_{ij} is the area (m^2) of patch ij, $d_{nearest}$ also the distance to the nearest patch, n_i being the number of patches in each type of land use class i, A is the total landscape area (m^2), e_i equals the perimeter of class i in terms of number of cell surfaces, min e_i as the minimum total length of the perimeter of class i in terms of number of cell surfaces. This formula takes into consideration the boundaries and edges of the green spaces.

Spatial characteristics	LEM	LEM definition*	Notes
Richness	Class Area Ratio (CAR)	$CAR = \sum_{j=1}^{n} a_{ij}$	Ratio between the area of a land use class (urban green space in this case, and the same hereinafter) and the whole landscape area (or the area of the convolution sliding window) (m^2)
Accessibility	Nearest Distance (DIST)	$DIST = d_{nearest}$	Distance from a real estate site to the nearest urban green space patch (m)
Distribution	Landscape Division Index (LDI)	$LDI = 1 - \sum_{j=1}^{n} \left(\frac{a_{ij}}{A}\right)^2$	A measurement of the fragmentation level of a land use class in a certain area. Ranging from 0 (Not fragmented at all) to 1 (Perfectly fragmented)
Shape Configuration	Landscape Shape Index (LSI)	$LSI = \frac{e_i}{\min e_i}$	A measurement of the shape configuration of patches, LSI equals the total length of edge (or perimeter) involving the corresponding class, divided by the minimum length of class edge (or perimeter) possible for a maximally aggregated class, which is achieved when the class is maximally clumped into a single, compact patch (McGarigal, Cushman, & Ene, 2012). LSI = 1 implies a square patch; as LSI increases, the patch gets more complex in shape.

Figure 4: Landscape metrics used for ecological study by Xu et al. (2016)

Garcia, Paiva, Brück, & Sousa (2020) used both a qualitative and quantitative approach to classify and find the patterns of green spaces. In the qualitative approach, there was a groundwork to observe and identify the types of green spaces in the community. For the quantitative method, green spaces that were digitized from orthophotos and the areas calculated, the green area index (GAI) and the green space ratio (GSR) was then done. The GAI produces the m^2 of green space per inhabitant by dividing the total area (m^2) of UGS in a city per the number of inhabitants. The GSR measure the ratio of the UGS to the total urban area by summing all UGS (m^2) up. This gives an indication of the amount of UGS that comprises of the whole urban expansion.

Urban Neighbourhood Green Index (UNGI), another index evaluates the geographic distribution of UGS in urban built-up areas. It expresses urban green as a percentage of green in unit area and can also be known as the green index (GI). This index was used by Gupta, Kumar, Pathan, & Sharma (2012) to measure green spaces in urban areas at the neighbourhood level in the city of Delhi ,the capital of India.

2.2. Accessibility to UGS

2.2.1. Definitions of Accessibility

UGS that are accessible to the general public are described as areas that are open to the public and are mostly used by target groups who live in the designated area (Morar, Radoslav, Spiridon, & Păcurar, 2014). Yet there can be difficulty in accessing these green spaces by vulnerable groups or individuals. Rahman & Zhang (2018) then defines the accessibility of green spaces as the relative difficulty that individuals have while using a certain transportation system to arrive at UGS from a particular location and vulnerability also as issues related to a person's social standing and living level including being women, illiterates, and unemployed individuals and ethnic minorities.

The two most important elements impacting accessibility are overall journey time and walking distance as stated by Fan, Xu, Yue, & Chen (2017) . They realised that for specific neighbourhood-level public green spaces, distance of coverage was emphasized. Also, improved mobility such as the availability of public transit or a private vehicle, can reduce travel time to a site.

There have been some stated rules regarding the accessibility of green spaces in the urban areas for its residents. Pafi, Siragusa, Ferri, & Halkia (2016) stated that there should be provision of at least $9m^2$ per capita green space within 15 minutes walking distance of homes in cities. According to English Nature (2003) there should be a scheme of levels of accessibility to green space into which sites of various sizes fit, where at least 2ha of open natural green space per 1000 population should be provided. In these levels they suggest that:

- Nobody should live more than 300 meters from the location of natural green space.
- Within 2km of every home, there should be at least one open 20ha site.
- One accessible 100ha site should be within 5km.
- One accessible 500ha site should be within 10km.

There are other studies that also state what can be considered as accessibility and some are stated below in **Table 1**.

Table 1: Some types of accessibility and their definition as explained in the literature

Type of Accessibility	Explanation	Authors/ Citation
Proximity Quantity Quality	Distance to the closest green space Number of parks within a specified distance The amenities and maintenance of a park	(Rigolon et al., 2018)
Distance to green Amount of green	Distance to the nearest UGS The amount of UGS within a specified distance of residence	(Wüstemann, Kalisch, & Kolbe, 2017)
Availability Accessibility Attractiveness	Existence of green space in a certain distance Green space is open and welcoming. Green space is desirable and managed well	(Biernacka & Kronenberg, 2019)
Residential proximity Cumulative opportunity	Nearest qualifying green area Distance/Radius to the nearest green space Amount of UGS within an administrative area	(Ekkel & de Vries, 2017)

Park availability Park features Park quality	Density of green space Facilities and amenities. Aesthetic features and security of UGS	(Vaughan et al., 2013)
Quality Quantity Usage	Environmental quality, amenities, and safety of green spaces Size of UGS per neighbourhood Green spaces to adapt to different activities	(Fan et al., 2017)

Research by Rigolon, Browning, Lee, & Shin (2018) reviewed literature on access to UGS in the global south and concluded that on average, cities there have inequities in terms of proximity, quantity, and quality in green space. They also observed that in most of the studies people with a higher socio-economic status had more consistent benefits based on the three categories of access with quantity (85% of the time), proximity (74% of the time) and quality (65 % of cases).

A study by Vaughan et al. (2013) investigated accessibility based on park availability, park features and park quality. Their results showed that in terms of park availability, low income areas had a higher number of parks than high income areas. But in terms of the park features and the park qualities, they found out that the high income areas had more features and parks of good quality than low income areas.

2.2.2. Methods of Measuring Accessibility to UGS

The measurement of accessibility to UGS has been done using many methods. They include the household surveys, buffer or centroid approaches, the network analysis, the so called quasi-public goods perspective and the accessibility indexes with different distances such as the Euclidean, walking, cycling, and driving distance being considered (Cetin, 2015; Chen, Wang, Lou, Zhang, & Wu, 2019; Li, Du, Ren, & Ma, 2019; Xu, Xin, Su, Weng, & Cai, 2017; Zhou & Kim, 2013). These accessibility analyses can also be done at different scales. Some of these methods show proximity to UGS example the Euclidean distances (L. Li et al., 2019), network analysis, others show availability of UGS like the buffer or centroid (Zhou & Kim, 2013). For the quality, household surveys help incorporate the views of people into what they perceive as safety, amenities, and features (Abbasi et al., 2016). Others also consider the size, number, the desire to socialize and sometimes the population pressure (i.e., demands) from various neighbourhoods on the same green space (Cetin, 2015; Dai, 2011).

For the network analysis method, a weighted spatial network analysis with service area function in Geographical Information System (GIS), was used by Rigolon & Flohr (2014) to determine accessibility to parks by walking. In this method an adjustment was done by measuring the percentage of parcels with access inside each census block to improve upon it. Accessibility for each block was then calculated as a ratio using the equation (Access Ratio = Number of Parcels that Have Access in a Block/ Number of Parcels in a Block). Two methods for measuring accessibility were used in the research by Nicholls (2001), namely the network analysis and the radius. In the network analysis the entrances of the parks were given its own service area, which was then combined into a single service area for each park. In the buffer method a radius of a half-mile (0.80 km) radius was set from the geographic centre of each park, and circular buffers, reflecting each park's service area, were built.

Talen (1997) utilized the covering model in which a range of distances are specified and the total acreage of parks within that distance is calculated. The centres of blocks are used as demand points, and park centroids are used as supply points. In this study, two distances (1 and 2 miles) were used as the critical range and what was then measured is the total amount of park acreage located within these ranges of travel distance between each block and each park. The limitation of this method is that it makes assumptions within the covering ranges, green spaces are equally enjoyed and that beyond the specified distance, there is reduction in the use of parks.

Green space accessibility (GSA) index was implemented in the study of Feng et al. (2019) to access the relationship between a resident's position and the urban area's parks. The accessibility to urban park was measured using GIS software as follows:

$$GSA_i = \begin{cases} 0 \\ 1 - \dfrac{dist_i}{D_i} \quad (dist_i < D_i) \\ 1 \end{cases}$$

In this formula GSA_i is the accessibility of the pixel i to the ith park, $dist_i$ is the shortest straight-line distance from the pixel to the edge of the ith park, D_i is the service radius of the park i. The strength of this index is that helps represent a location's proximity to available green spaces at various levels, as well as its access to various forms of urban parks in an area.

Some studies used different thresholds to access accessibility to UGS. To determine the accessibility of UGS, Siljeg, Miloševic, & Vilic (2020) used the total area with respect to the total population (m^2/inhabitant). Yet this method does not show the general distribution of the green spaces and the population, so accessibility was done in a multiscale analysis with three levels which are the macro, meso and micro. UGS accessibility is given as a percentage of the total settlement area with accessible UGS at the macro level of the study and it is measured as a percentage of the entire statistical circle area with accessible UGS at the meso level of the study whiles at the micro level it is expressed as the total units of houses within the UGS service area. Schüle, Gabriel, & Bolte (2017) analysed availability of UGS within and around neighbourhoods of Munich using different distance threshold. Around each administrative neighbourhood boundary five buffers were created in increments of 200 meters (from 200 meters to 1000 meters). At first percentages of green space availability were computed just within neighbourhoods. Second, the emphasis of the green space calculation was centred on which ones fall within the buffer zone in the neighbourhood based on the formula below.

$$\text{Green space}(GS)(\%) = \left(\frac{\text{GS in neighbourhood}\left(m^2\right) + \text{GS in buffer}\left(m^2\right)}{\text{neighbourhood size}\left(m^2\right) + \text{GS in buffer}\left(m^2\right)} \right) * 100$$

Five distinct radii between one and three kilometres (1000 m, 1500 m, 2000 m, 2500 m, and 3000 m) were evaluated around the neighbourhood centroid, based on the already established radii. The percentage of available green space in each area of interest was computed.

Some previous studies suggested that the two-step floating catchment area approach (2SFCA) be used to assess possible spatial accessibility to green areas. It is said to clearly considers resource availability and population needs, as well as their relationships, using a catchment (Dai, 2011). There have been variations with the 2SFCA by applying a Gaussian formed continuous decay function (L. Li et al., 2019) and sometimes with multiple modes (Hu, Song, Li, & Lu, 2020). Hu et al. (2020) proposed a flowchart for the multi-mode Gaussian-based 2SFCA method, which is shown in **Figure 5** below:

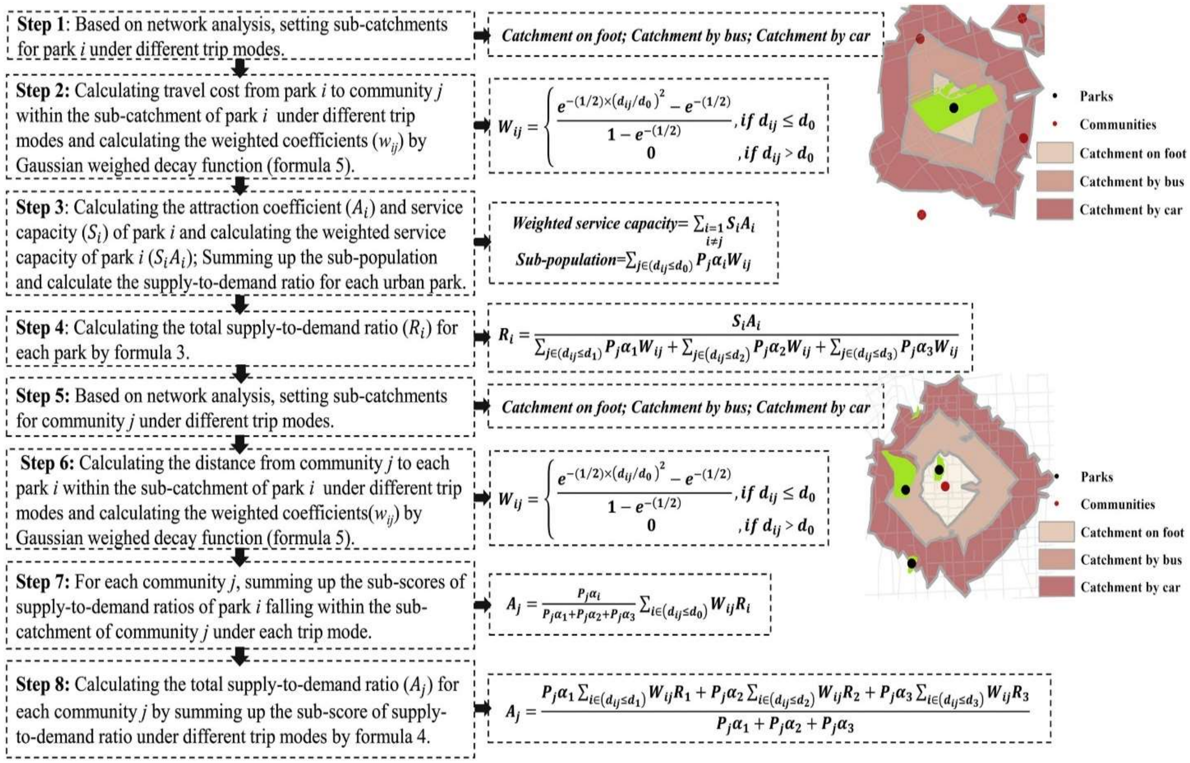


Figure 5: An image showing the steps in two-step floating catchment area approach (2SFCA) (Hu et al., 2020)

2.3. Social Inequality in Accessibility to UGS

2.3.1. Social Inequality in Accessibility against different Social Groups

The commitment to promote fairness, justice, and equality in the creation of public policy, as well as the administration of all institutions, facilities and resources serving the public directly in a fair, just, and equitable manner, has been characterized as social inequality (Jennings, Larson, & Yun, 2016). This same definition can be applied to the social equality associated with UGS as the fair and just provision and accessibilities to green spaces for all people in the society. Some studies found that there were disparities in the provision, distribution, and accessibility of UGS in urban areas and these were based on socio-economic factors such as age, race, ethnicities, income and sometimes level of education of the residents within the communities (Markevych et al., 2017; You, 2016).

The social inequality associated with green spaces have been linked with many side effects. Many health issues associated with physical exercises have been seen to be predominant in lower socio-economic and minority communities and this health disparities have been linked to the lack of green spaces and recreational resources (Abercrombie et al., 2008; Estabrooks et al., 2003; Powell, Slater, & Chaloupka, 2004). Additionally, the desire of people to stay in the same neighbourhood has been associated with social inequality. Gentrification, a process explained as changes in a neighbourhood's physical, industrial , and social surroundings, as well as changes in demographic composition by higher-end real-estate projects into increasingly attractive locations, in which higher socio-economic residents or ethnic level come in and cause relocation of people of lower socio-economic or ethnic status has been attributed to social inequality

(Amorim Maia, Calcagni, Connolly, Anguelovski, & Langemeyer, 2020; Dooling, 2009). Łaszkiewicz, Kronenberg, & Marcińczak (2018) concluded that the presence and accessibility of nearby green space has no effect on the length of residence of richer inhabitants, but the availability and access of nearby green space has a negative impact on the length of residence of less socio-economically privileged inhabitants.

Venter, Shackleton, Van Staden, Selomane, & Masterson (2020) concluded in their research that there are more green spaces in high income and White neighbourhoods comparative to the low income, Black African and Indian neighbourhoods in South Africa. It was also discovered that in the USA higher poverty or larger percentages of blacks or Hispanics were underserved in terms of green space accessibility Wen, Zhang, Harris, Holt, & Croft (2011). The findings of Moore, Roux, Evenson, McGinn, & Brines (2008) also showed that parks and recreational resources were allocated differently depending on the degree of wealth and racial/ethnic diversity of the area, with lower income and minority communities having fewer parks and recreational amenities but also parks that were fee-free to access were more in minority areas and those that had to be paid were in abundance in wealthy neighbourhoods in Maryland. According to the studies of Crawford et al. (2008) in Melbourne, green space in higher socio economic status communities were more likely than those in lower socio economic status communities to have better characteristics.

Also, Wen, Albert, & Von Haaren (2020) concentrated on access to UGS for the elderly population in Hannover, Germany at the neighbourhood level. Their research established that in terms of access to green areas in general, the elderly population are not at a disadvantage when compared to other age groups, but that the degree of accessibility varies depending on the neighbourhood. Sikorska, Łaszkiewicz, Krauze, & Sikorski (2020) studied inequalities in UGS accessibility according to age gaps with more reference on children and seniors in Warsaw and Lodz cities in Poland. The elderly people of Warsaw are the most marginalized age group. They have a lower UGS accessibility for agricultural land, unmanaged vegetation, and green spaces than others. Children are the least well-served age group in terms of UGS accessibility in Lodz. Children have a smaller percentage of residents who have UGS accessible within a 5-minute walk than other citizens for various UGS categories.

Furthermore various studies have confirmed that there exists a relationship between the size and number of parks and income level and minority people in a community in the urban setting. Abercrombie et al. (2008) indicated that irrespective of financial level, mixed-race areas have the most parks and that in a White dominated neighbourhood the low- and middle income groups had the least access to public parks, whiles high income groups living in mostly-minority neighbourhoods had the most access in Baltimore, Washington DC. The existence of environmental features such as green sport fields, parks and green spaces etc that promote physical activity, is substantially linked with race, ethnicity, and socio economic characteristics, and was discovered that low and medium socio economic communities had less of these resources than high socio economic areas in Midwestern U.S (Estabrooks et al., 2003; Powell et al., 2004). Same as a research by Anderson, Jackson, Egger, Chapman, & Rock (2014) in Sydney, Australia indicated there were more trees providing natural shade for higher socio economic regions than in lower socio economic regions, meaning there is more provision of green spaces there. Within Edmonton, Canada, green spaces associated with playgrounds were dispersed equally, with the low social economic neighbourhoods having the most playground access, when playground quality is considered, however, there is less of amenities in the playgrounds in these regions and more in high socio-economic neighbourhoods (Smoyer-Tomic, Hewko, & Hodgson, 2004).

However, in other works the widely known assumption that low socio-economic status neighbourhoods had few green spaces and little access to the available ones than the high socio-economic status neighbourhoods were found to be wrong. When the population and overall geographic area served are considered, the availability and access to open space appears to be spread evenly between communities whether they are being paid for or free in Central Business District of Melbourne (Timperio, Ball, Salmon, Roberts, & Crawford, 2007). Carlson, Brooks, Brown, & Buchner (2010) also observed that although the safety and qualities of green spaces were low in minority racial/ethnic groups, accessibility to green spaces for most of the residents in the community was unaffected regardless of race or ethnicity.

Some studies also considered access to preferred UGS for different socio-economic groups as social inequality. According to Arnberger et al. (2017) vulnerable groups, are those who have limited ability to adjust because they are less mobile and often live in social isolation which often includes the elderly who reside in cities and children. This study observed that older people have preferences when it comes to the social, and physical features of green spaces than younger people also the elderly were shown to prefer the recreational function of urban green areas over the conservation function (Arnberger et al., 2017). Some of the preferences of elderly people as described by Wen, Albert, & Von Haaren (2018) are playgrounds for children, chairs in green spaces, optimally with seatbacks and armrests, UGS having canopies and shades in summer, and places for enjoying the sunshine in winter, UGS with cultural heritage, festival activities, or traditional atmosphere. As a result, while investigating elderly people's access to UGS, a number of unique criteria should be considered. These considerations might include park or green space distribution, the distance between greenery and senior people's residences, cultural features and aesthetic preferences, infrastructure (Wen et al., 2020).

For school going children, it was revealed by Akpinar (2017) that children in elementary and high school students, elderly between 6–19 years when exposed to green spaces around schoolyards, their emotions improve and stress, anger, depression, anxiety, inattention, and problem behaviour decrease. Wheeler, Cooper, Page, & Jago (2010) expressed that if children have access to specific type of green spaces such as playgrounds etc, it can improve their willingness to exercise. Also, trees, grass, flowers, trails etc which form UGS provides rich surroundings with various affordances, such as exploring, running, sliding, and meeting others, or opportunity to learn new things which can be a positive influence on children (Jansson, Sundevall, & Wales, 2016).

2.3.2. Methods of Measuring Social Inequality in Accessibility to UGS

Some methods have been used to measure social inequality associated with the access to UGS, this includes the Gini coefficient, correlation. For different municipalities in the region of Munich, Germany, the Gini coefficient was used by Xu, Haase, Pribadi, & Pauleit (2018) to calculate the spatial inequality in green space accessibility across the population. This coefficient is expressed as:

$$GC = 1 - \sum_{i=1}^{n} \frac{P_i}{P}(B_{i-1} + B_i)$$

Where Pi denotes the number of people in grid cell i and P is the total population in an area. B represents the total amount of green area in a 300-meter buffer surrounding grid cell i. Gini coefficient ranges from 0 to 1, with 0 suggesting perfect equality and 1 suggesting complete inequality in possible access to the same quantity of green space. The more uneven the distribution of green space among a municipality's people, the higher the Gini coefficient. It has a wide range of applications in many disciplines. In economics, the Gini coefficient is used to quantify inequality in income distribution. It has also been used to examine disparity in sustainable urban development, biodiversity, carbon dioxide emissions, and green space supply (C. Xu et al., 2018).

Venter et al. (2020) used the simple linear regression to quantify the magnitude of relationships between socio-economic data and green infrastructure statistics. In this approach, the study transformed population density, per capita income, park distance, size, and cover into log. The median values and interquartile ranges instead of means and standard deviations were obtained as the results.

The relationship between the amount of private facilities, number of parks, and maximum park size were examined among block groups by Abercrombie et al. (2008) using a series of 3 (percent minority) X 3 (median income) two-way analyses of covariance (2-way ANCOVA).

To evaluate the relationship between population size and accessibility, Ma (2020) found the Spearman rank correlation coefficients between the population and the distance from each population point to the nearest UGS. At the local and city-wide scales, correlations were calculated to assess the relationships between population size and distance. The index was then calculated in various locations on a local and city-wide basis. Statistical significance was defined as a P-value of less than 0.05.

2.4. Summary of Literature Review and Conceptual Framework

Based on the literature reviewed, this study makes use of some methods are rules specified in other researched. Many studies reviewed have used typologies of UGS to study green spaces in the urban areas. There are different types of UGS such as forest, parks, cemeteries etc. This study will classify the types of UGS in order to know which ones are more readily available in different areas of a city. Some definitions of UGS provided in the literature by Panduro & Veie (2013) such as the agricultural lands, green buffers, sports field, public parks and Graça et al. (2018) such as private gardens were used along with some local knowledge of what UGS exist in Greater Paramaribo Region. How these types are distributed also has various ways of being measured. The method considered out of the many is the landscape metrics with the metrics Patch density (PD), Mean patch size (AREA_MN), Class area (CA) and Aggregation index (AI) chosen. In this research, the type of UGS that is dominant in a ressort, the area occupied by that particular type of UGS and how they are dispersed is what is being looked at. The selected metrics depict the relative abundance of each land use type more than the other metrics.

Just as there are different typologies and ways of measuring UGS, there are different methods and rules for accessibility. The rules in English Nature and network analysis were chosen for measuring accessibility. This is because the rules consider different sizes of UGS, and distances within which UGS should be accessible. The network analysis is selected because it considers all the road network and uses it to calculate the range of UGS that can be accessed by various modes of transportation. This method also reflects accurately the usage of green spaces by residents, and which means of transportation that is often utilised by them. Also the vector data used helps reduce the issues of granularity of generated raster data (Yang et al., 2015).

With the knowledge that active participation in communal life and social contact, may significantly improve psychological health and self-esteem in the elderly, green spaces that have these to offer are beneficial to the elderly thereby increasing the empowerment, and independence of the elderly (Yung, Conejos, & Chan, 2016). The elderly prefering peaceful and lovely natural settings that are easily accessible with features such as shade, blue spaces, benches or seat to sit on and being in the company of others (Arnberger et al., 2017), UGS types was used for the accessibility assessment instead of sizes. For schools UGS that promote exploring, learning and excercising will be considered for assecibility assessment.

Many studies on who is mostly affected in the unfairness of accessibility to UGS were reviewed and some of the socio-economic groups which were concluded to be usually marginalised were of low income class, minor ethnic groups, kids, and elderly people. Therefore, this study considers age, income and ethnicity as the socio-economic data based on it being frequent in majority of literature reviewed and the diversity of the study area. To assess the level of social inequality this research used the Gini coefficient and the Pearson correlation, the Gini coefficient considers not only the population size but also the size of the different areas within the city. The correlation gives a value of how strong the relationship between accessibility and the socio-economic factors are.

The **Figure 6** shows the conceptual framework of the study. This shows that there are various types of UGS with different patterns. Accessibility to UGS can be by various transport networks, at different distances, and to different sizes of UGS with different social economic groups having different levels of accessibility. Due to the many benefits UGS give to the general population there should be fairness or equal accessibility for all social groups. Yet accessibility to UGS is based on social economic status such as age groups, ethnicity, and income. The accessibility to UGS being based on social status of an individual or a social group is an issue of social inequality, and this study considers the relationship between accessibility to UGS and the socio-economic factors as social inequality. As a result, especially for the minority social economic groups, it is important to analyse the social inequality associated with the accessibility to UGS in urban areas. This will aid in the identification of the possible knowledge gaps in developing tropical regions and reduce the lack of information that impedes informed urban decision-making.

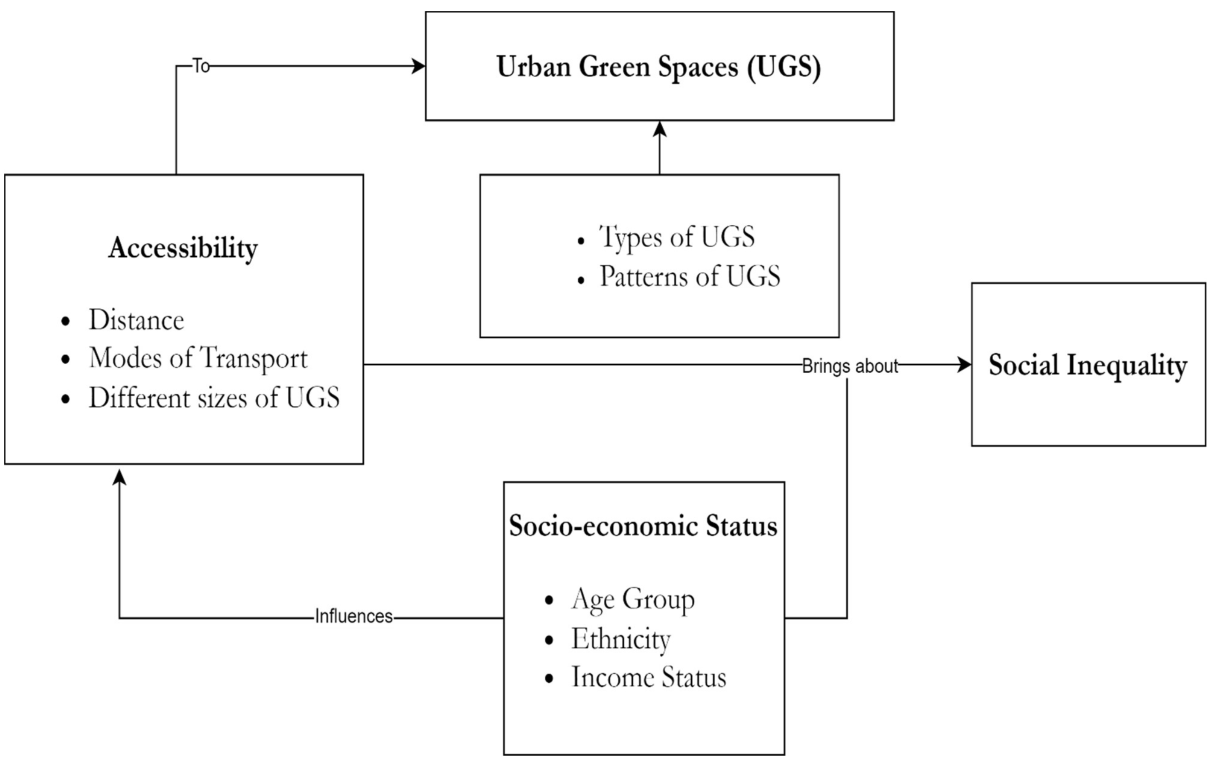


Figure 6: Conceptual framework of the study

3. METHODOLOGY

In this chapter, the overall research design and study area description are discussed in Sections 3.1 and 3.2 respectively. Section 3.3 describes the data, data sources, the methods and approaches used in conducting the study. A research matrix showing a summary of the methods, data used, results obtained, and the objectives is presented in **Appendix 1.**

3.1. Research Overview

A quantitative method was used in this study. Specifically, this research uses a Geographical Information System (GIS) and a statistical approach to achieve the main objective through realising the specific objectives. Since the Greater Paramaribo Region has the segregation among the socio-economic groups, it was a good study area for assessment to understand the social inequality related to the accessibility of UGS in Suriname. The overall research workflow of the study is shown explained below and shown in **Figure 7**.

For the first objective of the study, which investigates the spatial distribution of green spaces in Greater Paramaribo Region, the UGS, transport systems, residential houses and schools in the region were extracted from Open Street Map (OSM) and the elderly homes were extracted from Google Earth. For the classification of the UGS types, the UGS obtained from OSM were visually identified from aerial images from Google Earth and classified based on already stated rules. These rules were done using a decision tree which was based on the physical characteristic of the UGS types. The classified UGS types were then used to find the distribution and patterns of UGS in the Greater Paramaribo Region.

With reference to the objective 2 which seeks to assess the level of accessibility to green spaces in Greater Paramaribo Region, the Network analysis method was used for the assessment of accessibility this is because it reflects the reality of how residents have access to UGS. With the combination of the results from the accessibility and the residential houses, schools, and elderly homes data, the number of houses, schools, and elderly homes within accessible ranges is determined.

To analyse the social inequality associated with the accessibility to UGS in Greater Paramaribo Region as stated in objective 3, some socio-economic factors were chosen at the ressort level to reflect their socio-economic status this is based on evidence from prior studies (Li, Zhang, Li, Kuzovkina, & Weiner, 2015). Income, the proportion of the major ethnic groups in the ressorts, the age of residents, are the three socio-economic factors chosen. Several variables for these factors were selected to explore the relationship between accessibility to UGS and socio-economic factors across the different ressorts. The Gini coefficient was used to access the relative level of disparities within UGS distribution among the ressorts (Nero, 2017). A statistical analysis was done on the accessibility and the socio-economic factors to know the strength of the relationship between them. The results were later be analysed, discussed with some conclusions, and recommendations made.

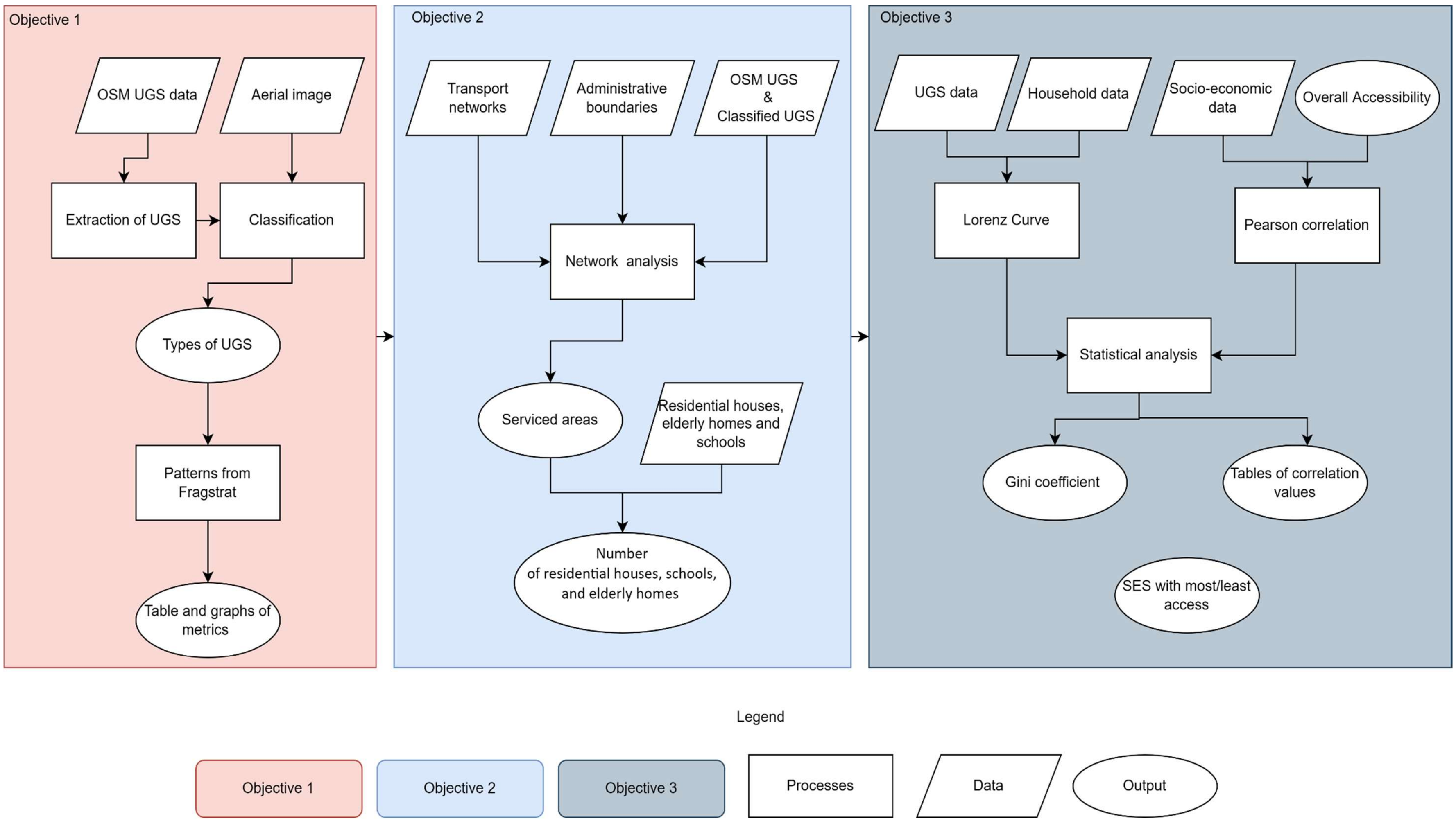


Figure 7: Overall research design workflow

3.2. Study Area Description

Suriname, a country located on the northeast coast of South America (**Figure 8**(C)), covers 163,265 square kilometres, with rain forest covering about 90% of the land and a population of around 575,990 people (Naipal & Tas, 2009). About 97% of the population is concentrated in the low-lying coastal zone, with almost 70% particularly in and around Paramaribo, the capital (Naipal & Tas, 2009). Suriname (**Figure 8**(B)) has 10 districts, divided into 62 municipalities or ressorts and specifically the Greater Paramaribo Region is the study area, which includes the districts of Paramaribo, Wanica, and part of Commewijne (Fung-Loy & Rompaey, 2017).

The Greater Paramaribo Region (**Figure 8**(A)) has in all 22 ressorts. This region has seen an increase in population between 2000 and 2015 by 14%, with the biggest increase of 11% being in the district of Wanica, inside the municipality of Koewarasan, this might be because of the urban pull impact of the metropolis on the rural population (Fung-Loy, Van Rompaey, & Hemerijckx, 2019). Paramaribo which is the biggest district in the region, has always had a trend of an increase in population leading to more conversion of agricultural and other green lands into built up areas (Verrest, 2010). Furthermore, economic and political developments inside the city resulted in several functional divisions and leading Paramaribo into a city with neighbourhoods that are ethnically and socio-economically diverse (Fung-Loy & Rompaey, 2017; Verrest, 2010).

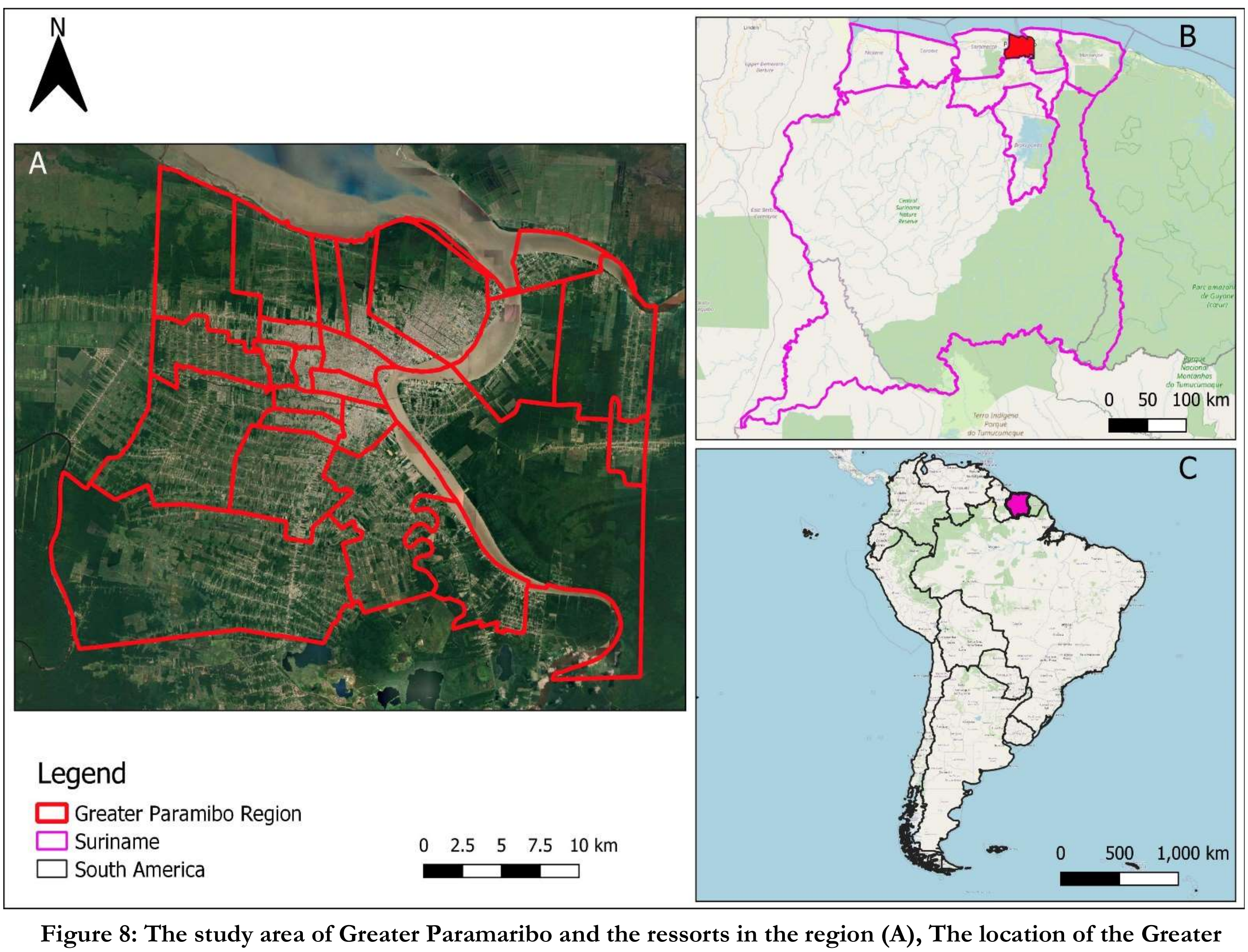


Figure 8: The study area of Greater Paramaribo and the ressorts in the region (A), The location of the Greater Paramaribo Region in Suriname (B), The location of Suriname in South America (C).

Even though the region is ethnically varied, various ethnic groups tend to cluster in various neighbourhoods, also with the higher and lower income categories being separated (Fung-Loy & Rompaey, 2021). The Hindustani (descendants of Indian contract laborers), Creoles (descendants of former African slaves who remain within the city), and Javanese (descendants of contract labourers from Indonesia) are the major ethnic groups in the Greater Paramaribo Region. Mixed (people of mixed race), Maroons (descendants of African slaves who escaped into the interior of the nation), Caucasians, Chinese, and Amerindians (indigenous people of the Americas) are some of the smaller ethnic groups. The central areas of Greater Paramaribo is dominated by Creoles, whereas west Paramaribo and Wanica are dominated by Hindustanis, and the Javanese population is concentrated in the Commewijne district (Verrest, 2010).

In all the districts that form the Greater Paramaribo Region, Paramaribo had the highest number of affluent and poor residential houses, middle and middle to low residences were mostly found in Wanica and Commewijne (Fung-Loy & Rompaey, 2021). These findings are confirmed from studies of Fung-Loy et al. (2019) which showed rich people lived largely in the north of Paramaribo, while poor people lived largely in the south and central neighbourhoods of Paramaribo. This might be because of the availability of squatter communities and government-sponsored social housing complexes (Fung-Loy & Rompaey, 2021). This shows there is some segregation between affluent and poor neighbourhoods, with both clustered in distinct locations.

For the demographic characteristics of the area as gender and age is important. There has been an expansion in Suriname's population since 2004 and 2012, with a growth rate of 9.9%. The census data show that the sex ratio is 99.9%, with slightly more women than males. There are generally three groups of age, the first being 0-14, second is 15-59 and beyond 60 as the third group. The first is known as the schooling or children group, the second is the economically active age group/ labour force and third is usually retirees or seniors (Algemeen Bureau voor de Statistiek, 2013).

The education status of districts revealed that the outskirts of Paramaribo had a large proportion of people with low education level (Verrest, 2010). Approximately 30% of the total household population is enrolled in one of the four levels of schooling (Weidum, 2014). Most children in the obligatory education group attend primary school. It is estimated that 12% of the economically productive group attends higher education or university and high school. The majority of the students are in secondary school (Algemeen Bureau voor de Statistiek, 2014).

The Greater Paramaribo Region has land use which includes water bodies, residential, agriculture and commercial. Agriculture is the major land use in the region (Weidum 2014; Commewijne District - Wikipedia, n.d.). In recent times most of these lands have been turned into commercial hubs with the increase in the establishment of more shops, companies, and banks in the region (Paramaribo - Wikipedia, n.d.). This is especially true for the major towns in Paramaribo, Wanica and Commewijne like Lelydorp and Meerzorg. With an increase in the population in the region, more land is being used as residential areas to accommodate the growing residents. As the region lies in a coastal zone, some of the land is occupied by water and some serve as a port for the country.

The network of roadways, routes, and street layouts, which make up the transportation systems that connect different areas of cities and allow people and places to be connected has seen little improvements over the years in the region. The transport sector is dominated by the bus system which usually serves the lower economic classes (Weidum, 2014). Other means of transport are through the use of personal vehicles, walking and biking. Among this personal cars is popular and this might be because the road is dangerous for bicyclists and even pedestrians (Weidum, 2014).

3.3. Data Sources and Methods

This section of the thesis describes the data used for the study, their sources and the methods used to achieve the specified objectives. Section 3.3.1. describes in detail the data acquired and their sources. Sections 3.3.2 explain the method for classifying UGS and Section 3.3.3 showing the procedure for identifying the distribution and patterns of the classified UGS in Greater Paramaribo. Section 3.3.4 describes the method for accessibility and Section 3.3.5 explains the approach for social inequality through the correlation of socio-economic data and accessibility.

3.3.1. Data Sources

UGS were extracted from OSM landuse (OpenStreetMap, n.d.). The OSM data is Volunteered Geographic Information (VGI) initiative collected by volunteers from scratch performing systematic ground surveys using tools such as a handheld GPS unit. The OSM's geographical data are extensive and its excellent/high positional accuracy in urban areas has been validated. This spatial data is freely available together with appropriate attribute data and can be used without restrictions (History of OpenStreetMap - OpenStreetMap Wiki, n.d.). Land use types used for the accessibility to UGS include farmland, forest, grass, heath, meadow, orchard, park, recreation ground, and scrub. These comprised of landuse classes that were recognized as green spaces based on their definitions from OSM (Talk:Key:landuse - OpenStreetMap Wiki, n.d.) as follows:

- Farmland -an area used for tillage and planting for cereals, vegetables, oil plants, flowers etc.
- Forest - a woodland or area used for charting trees that is well-managed
- Grass - An area of mowed and maintained grass
- Heath - Open, low-growing woody vegetation characterizes a dwarf-shrub environment
- Meadow - pasture or grazing ground is predominantly covered with grass and non-woody plants.
- Orchard - Trees or shrubs planted with the goal of producing food.
- Recreational grounds - An open green space that may contain pitches, nets, and other amenities for recreation
- Scrub - Shrubs, bushes, and stunted trees on an uncultivated ground

The transport networks, green spaces, residential houses were obtained from OSM. Residential houses are defined as a place that people live which included single houses, grouped dwellings, apartments, flats etc by OSM (Talk:Key:landuse - OpenStreetMap Wiki, n.d.).

Because of its enormous spatial coverage, information-rich nature, and high temporal resolution, remote sensing technology has been widely used in other UGS studies and in this research. Google Earth uses satellite images to generate a three-dimensional representation of the Earth. The software maps the Earth by superimposing satellite images, aerial photography, and GIS data onto a 3D globe, allowing users to view towns and landscapes from a variety of angles. Google Earth can show a variety of images superimposed on the surface of the earth.

For the income level of neighbourhoods, it was obtained from Fung-Loy et al. (2019) who used housing type to classify the income status of residents. They classified residences according to their spatial features. Four categories were used to classify the residential urban area namely rich, middle-class, middle-to-low-income, and poor shown in (**Appendix 4e**). Houses larger than 300 m^2 and land sizes more than 600 m^2 were regarded to be dwellings for the rich, 350 m^2 as the minimum land sizes for the middle class, 300 m^2 as that of the middle to low class and a maximum 300 m^2 for the poor residences.

The major ethnic groups Hindustani, Creoles, Javanese included as race/ethnicity variables for the study. Mixed, Maroons, Natives will also be considered since they dominate some neighbourhoods in the south even though they are not major ethnic groups (Weidum, 2014). Because prior research has linked access to green space to age (X. Li et al., 2015), this study will include two age groups, the children (0-14) and seniors (above 60) as age variables. The summary of data sources, and data for the study is presented in **Table *2*** below.

Table 2: Source of data and data used in studies.

Data	Format	Source	Date (Year)
Greater Paramaribo Region and ressorts boundaries	Shapefiles	(Tropenbos Suriname, 2019)	2019
Green spaces	Shapefiles	OSM	2021
Socio-economic data	CSV (Excel)	Suriname census bureau	2013
Transport networks	Shapefiles	OSM	2021
Residential houses	Shapefiles	OSM	2021
Schools	Shapefiles	OSM	2021
Elderly homes	Shapefile	Google Earth	2021
Aerial Image	Raster/Imagine	Esri/ Google Earth	2021
Income level of neighbourhoods	Raster	(Fung-Loy et al., 2019)	2019

3.3.2. Classification of UGS

The first objective which seeks to access the spatial distribution of UGSs in Greater Paramaribo starts with the classification of UGS and how they are distributed are identified. As already discussed in the literature review, typologies of UGS were used for the study. This part of the study was carried out together with an MSc. student (Druti Gangwar) from University of Twente, Faculty ITC who is also working on her thesis in Paramaribo, Suriname. For the classification of the types of UGS, the areas considered as UGS were extracted from OSM. This was then reclassified by visual interpretation into the use types (Chen et al., 2018) e.g., private gardens, public parks, forest/forest fragments, sport/recreation fields, agricultural lands, green buffer, and green squares, examples of which are shown in **Figure 9** and **Appendix 2**. This was done to eliminate other UGS types that did not have any evident use.

For a visual/ photo interpretation only continuous green spaces more than 500 m² at a spatial scale examined. Those below were only considered for private gardens or backyards of residential neighbourhoods. In this UGS classification, both physical characteristics such as the presence of shrubs, grass, crops, and trees and how they appear were put into consideration such as in rows, clustered etc. Also, the location of these green spaces example at road intersections, roundabouts at within houses were used as a characteristic to identify specific UGS types. The social functions which are based on properties that indicate how individuals particularly use vegetation patches such as public parks, playgrounds, sport fields and green buffers are seen as essential (Chen et al., 2018).

A decision tree (**Figure 10**) was constructed based on physical characteristics specified in **Table 3**. Using Google Earth, a very high-resolution image, the green areas are identified based on the basis of the decision tree and given a class accordingly. The areas of the classified UGS are then calculated to know how each UGS types is distributed in the ressorts.

Figure 9: Examples of UGS in Greater Paramaribo

Table 3: UGS types and their defining characteristics

Code	Category	Physical Characteristics	Other Characteristics
1	Forest/ Forest Fragments	• Very dense trees • No tracks or walking paths within them	• People cannot enter them but use the edges
2	Agriculture/Croplands	• Fields of crops, cattle grazing grounds, meadows • Signs of tillage	
3	Private gardens/Backyard	• Green patches found within the houses/ premise of the house	• Well maintained patches of greens • They have bounding fences / walls • For individual uses
4	Playgrounds/ Sports fields	• Grass and tree covered areas with play areas for kids • Have field markings	• Grass covered areas dedicated for sports activities • Fenced and maintained as sports centres • May include running paths
5	Public Parks/ Gardens	• Has both trees and grass patches • May be with seating and walking paths	• Used for leisure or recreation • Maintained and managed
6	Green squares	• Green patches of trees and grass usually found at the intersection of the roads	• Areas used for gatherings/events with seating • Common areas with partial green space and partial concrete
7	Green buffers/ Street trees	• Rows of trees usually around roads, streets, or roundabouts	

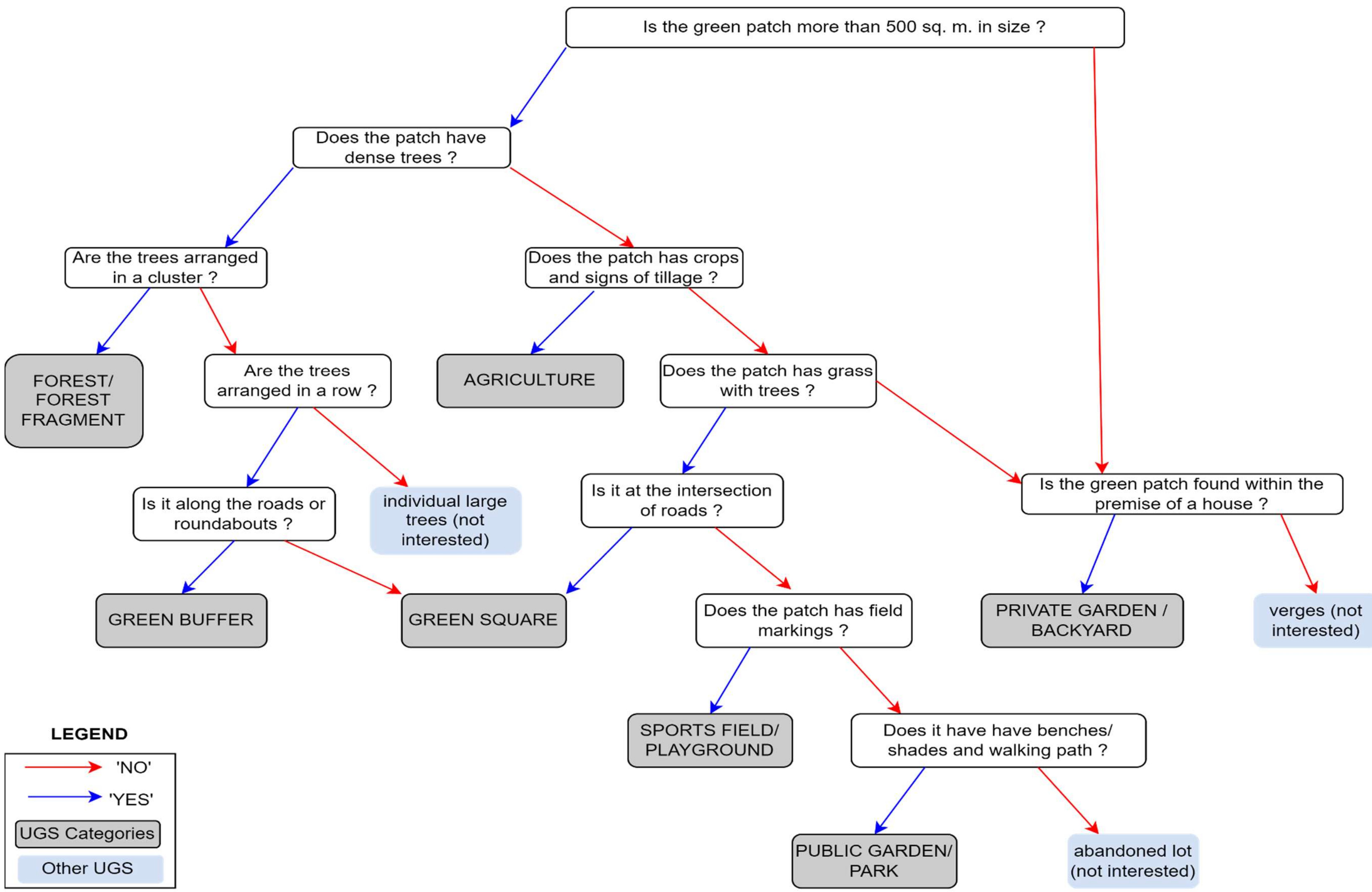


Figure 10: Decision tree for UGS classification

3.3.3. Spatial Distribution and Patterns of UGS

In assessing the patterns of UGS distribution, this study made use of the FRAGSTATS software. The landscape metrics in **Table 4** are utilized to quantify the UGS pattern throughout the study area. This helped to identify how the various types of UGS are spread in the ressorts and how much of each type is in a particular ressort. For this aspect of the study the classified UGS shapefiles were converted into raster (10mx10m), and then masked to the ressort shapefiles. This result was imported into the FRAGSTATS software. The user defined tiles were used for the analysis to be for individual ressort. Class metrics were chosen under the No sampling strategy in the Analysis parameters. The metrics in **Table 4** were chosen under the Class metrics to obtain the landscape metrics at the ressort level. The resulting metrics were imported into excel and plotted for each of the UGS types.

Table 4: The landscape metrics used in study

Landscape Metrics	Descriptions	Units
Patch density (PD)	The number of patches per UGS type It checks for the number of patches present in a study area for a corresponding UGS type	Number per 100 hectares
Mean patch size (AREA_MN)	Average size of patches per type of UGS	Hectares
Class area (CA)	The sum of the areas (m^2) of all UGS of the corresponding UGS type divided by 10 000 (to convert to hectares)	Hectares
Aggregation Index (AI)	Measure of dispersion/compactness per UGS type. It shows how close or distant the different patches of a UGS type are within the ressorts	Percentage

3.3.4. Accessibility to UGS

To measure accessibility to UGS, the GIS approach network analysis was selected for the study. Some rules set by English Nature (2003) was used for assessment of accessibility to UGS. These rules were chosen because they give different options for UGS sizes and accommodates different distances to the UGS from the residential houses. The rules of English Nature (2003) state that:

- There should be at least a 2ha green space within 300m from the residences of people.
- At least one accessible 20ha green space should be within 2km from homes.
- One accessible 100ha green space within 5km.
- Within 10km of homes there should be one accessible 500ha green space.

The network analysis model considers different modes of transportation that can be used by residents to calculate the range of UGS that can be accessed by residents. This gives a clear and accurate reflection of the means to reach UGS by residents. The transport systems in the Greater Paramaribo Region which includes the residential roads, secondary roads, tertiary roads, walkways, cycling lanes and footpaths etc. were extracted from OSM to find areas of service for UGS. With the different means of transportation having specific roads used for travelling, different types of roads that suit the mode of transportation as shown in **Table 5** were selected for the network analysis. These roads were selected based on their usage as defined by OSM (Talk:Key:highway - OpenStreetMap Wiki, n.d.).

Table 5: **Roads used for the various modes of transportation in the Network analysis**

Road types in OSM	Walking	Cycling	Driving
Primary	No	No	Yes
Secondary	Yes	Yes	Yes
Tertiary	Yes	Yes	Yes
Service	Yes	Yes	Yes
Residential	Yes	Yes	Yes
Streets	Yes	Yes	Yes
Tracks	Yes	Yes	Yes
Paths	Yes	Yes	No
Footway	Yes	Yes	No
Cycleway	Yes	Yes	No
Unclassified	No	Yes	Yes

The Network Analyst geo-processing tool in ArcGIS 10.8.1 was used to determine accessible areas. The Network Analysis approach is based on distance measurements between green spaces and the neighbourhoods they serve and the network service area is a geographic area that includes all roadways that are accessible (that is, streets that are within specified impedance) (Kuta et al., 2014). UGS accessibility zones were determinate using the New Service area tool under the Network Analyst extension. The parameters below were specified as properties for the service areas for all the different transportation modes.

- Impedance- Length
- Default breaks- 300m, 2km, 5km and 10km
- Polygon type-Generalised
- Multiple facilities options - Merge
- Overlap type - Discs

A network service area was identified from each green space using this geo-processing technique and the service area polygons were clipped to the boundary of Greater Paramaribo. The serviced areas were intersected with the residential houses to find the number of residential houses that were being serviced. The results of the intersection were used to find the percentage of areas that have access to the different sizes of UGS through the various modes of transportation.

To have one accessibility measure, all the accessibility maps were combined to form one overall accessibility. This was done to find the average accessibility within each ressort. This was done by adding all the accessibility for the different sizes of UGS for the various modes of transportation in the raster calculator in ArcGIS. The overall accessibility values were aggregated to mean values per ressort in R. Because the distribution of values was not skewed and had no extreme values, aggregating using the mean was a more robust way for evaluating the central tendency.

The accessibility for elderly homes uses the network analysis to measure accessibility.This study chooses to consider the distance to UGS from elderly homes and distribution of particular UGS avaible within accessibe ranges. With considerations for the stated preferences as suggested by many (Arnberger et al., 2017; Wen et al., 2018, 2020), UGS that offer these preferences were the main focus. A new service area was created using the Network Analyst tool. Time was used as an impedance and a service area of 5 minutes walk from the elderly homes was created. This service area was intersected with the type of UGS to find which ones are within the accessible range of elderly homes. Based on the study of Wen et al. (2018) and Arnberger et al. (2017), UGS which provided playgrounds for children, had areas for resting such as chairs, benches and walking paths from the classified UGS in section 3.3.2 were considered and how much of the preferred UGS types within the serviced areas were calculated.

The accessibility to UGS for schools was studied for 5 minutes' walk access to green spaces (Markevych et al., 2014). A new service area was created using the Network Analyst tool with time as the impedance and a service area of 5 minutes' walk from schools was created. The resulting service area was then intersected with the types of UGS to find the desirable UGS type. UGS types from the classified UGS in section 3.3.2 which gave opportunities for activities such as exploring, running, sliding, and meeting others, or opportunity to learn new things were the main focus and how much of these types within accessible range was calculated.

3.3.5. Social Inequality associated with UGS

Table 6 presents the socio-economic factors used in the study. They are further visualized according to the ressorts as shown in **Appendix 4**.

Table 6: Description of socio-economic factors

Socio-economic data	Year	Data Level
Age (0-14)	2013	Ressort
Age 60 and above	2013	Ressort
Natives	2013	Ressort
Mixed	2013	Ressort
Maroons	2013	Ressort
Creoles	2013	Ressort
Hindustani	2013	Ressort
Javanese	2013	Ressort
Income level based on residences	2019	Pixel (30m*30m)

To find the spatial inequality associated with the distribution of green space across the population in Greater Paramaribo, the Gini coefficient and correlation was used. The Gini coefficient is an index that measures an uneven distribution. The Gini coefficient is a number between 0 and 1, with 0 indicating full equality in green space availability that means there is an evenly distributed percentage of UGS within the region and 1 indicating perfect inequality showing that the share of UGS is extremely high in some ressorts. The ranges of the Gini coefficient are explained as < 0.2 is perfect equality, 0.2-0.3 represents adequate equality, 0.3-0.4 represents relative inequality, 0.4-0.5 means a big accessibility gap, above 0.5 represents severe accessibility gap, close to 1 means large proportions of the population have poor access to UGS with a few others having really great access (Shaw et al., 2017).

The Gini coefficient for the UGS distribution was computed for the Greater Paramaribo Region using the population data and the UGS. This was done by calculating the UGS area per capita per ressort sizes and the population density. The Lorenz curve was constructed using the cumulative proportion of population in the ressorts and cumulative proportion of UGS cover per the population in each ressorts. The Lorenz curve is used for measuring social inequality. The level of inequality is determined by the amount of variation (level of separation) between the Lorenz curve and the line of absolute equality. To measure this, if the area between the line of perfect equality and Lorenz curve is A, and the area under the Lorenz curve is B, then the Gini coefficient is A/(A+B).

The relationship between accessibility and the socio-economic factors was analysed. This was done using correlation, a bivariate analysis that determines the intensity of connection and the direction of the link between two variables. The value of the correlation coefficient ranges between +1 and -1 in terms of the strength of the association. A value of 1 shows that the two variables are perfectly positively linked and -1 means they are perfectly negatively linked. Specifically, the Pearson correlation was the type of correlation used for determining the degree of association between some socio-economic variables (ethnicity and age) and the overall accessibility for the Greater Paramaribo Region. The significance of the correlation was determined using the p-value. This analysis was done using RStudio, a free open-source programming software mainly used for statistics.

The ethnicity and age socio-economic groups correlations were done at the ressort level. The correlation between the overall accessibility and the income status was done at the pixels level to have a more detailed assessment. This was done by doing a random sampling of points (3 points within each of the 106 neighbourhoods) in the income data provided by Fung-Loy et al. (2019) and using the same points to extract accessibility values. The correlation was then done between these points. To test the robustness of this sampling, a second set of points (1 point within each of the 106 neighbourhoods) was obtained through another sampling. This was also used for another correlation for results.

The socio-economic groups with the highest and least access to UGS in Greater Paramaribo were evaluated. For this analysis 200 random points was sampled from the residential houses using the extent of school and elderly homes. The accessibility to the different types of UGS within 5 minutes' walk of the random residential points was done using the Network analyst tool. The service area was then intersected with the random residential points and UGS types to know how much of UGS is accessible and how many homes have access. The results of this were compared with that of elderly homes and schools to find which group have more access to UGS in Greater Paramaribo Region.

4. RESULTS

The findings of the study on UGS in Greater Paramaribo Region are presented in this chapter. The chapter is divided into three sections. With reference to the first objective which investigates the spatial distribution of green spaces in Greater Paramaribo Region, the results for the distribution and patterns of UGS are shown in Section 4.1. Section 4.2 presents results on the accessibility to UGS which relates to objective 2. The findings for objective 3 on social inequality associated with UGS are presented in Section 4.3.

4.1. Classification and Spatial Distribution and Patterns of UGS

This section presents the results obtained for the classification and distribution of UGS in the Greater Paramaribo Region. This is done according to the ressorts as shown in **Figure 11**. Section 4.1.1. explains the classified image. Section 4.1.2. and 4.1.3 describes the distribution and patterns of UGS in the region as obtained from the landscape metrics.

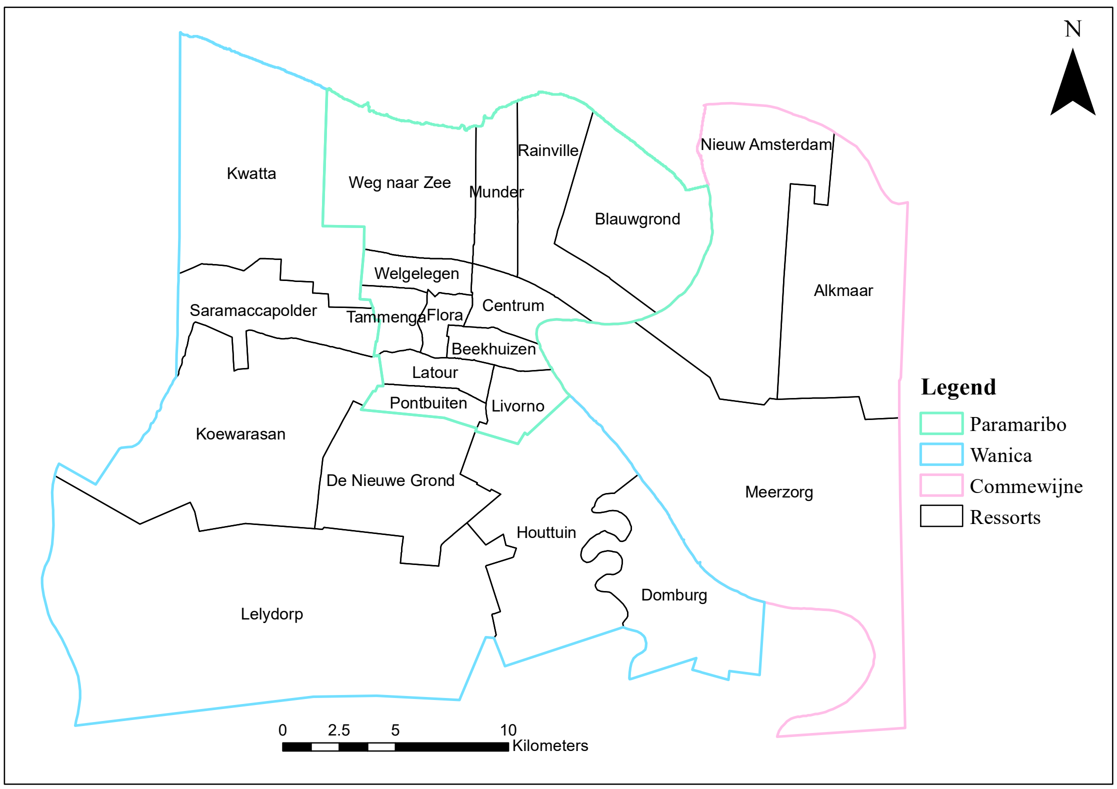


Figure 11: Distribution of the ressorts across Greater Paramaribo

4.1.1. Classification of UGS

Figure 12 presents the results of the classification of UGS in the Greater Paramaribo Region based on the decision tree (**Figure 10**) classification method. The classified green spaces resulted in seven classes. There is about 48246.7 ha of green spaces in the whole of Greater Paramaribo, with agricultural lands having 28003.2 ha of the total green areas making a percentage of 58.0% which is more than half of the total green areas. The forest and forest fragments makes up 39.2% of the green spaces covering a total of 18919.8 ha. The Green buffers have an area of 458.1 ha making up 0.9% of the total green spaces. Public parks are 58.8 ha of the total area of green spaces which constitutes 0.1% with private gardens being 596.3 ha which is 1.2% of the whole green spaces in Greater Paramaribo. The green squares and the sports field are 12.4 ha and 10.6 ha respectively representing 0.1% of all the green areas in the region.

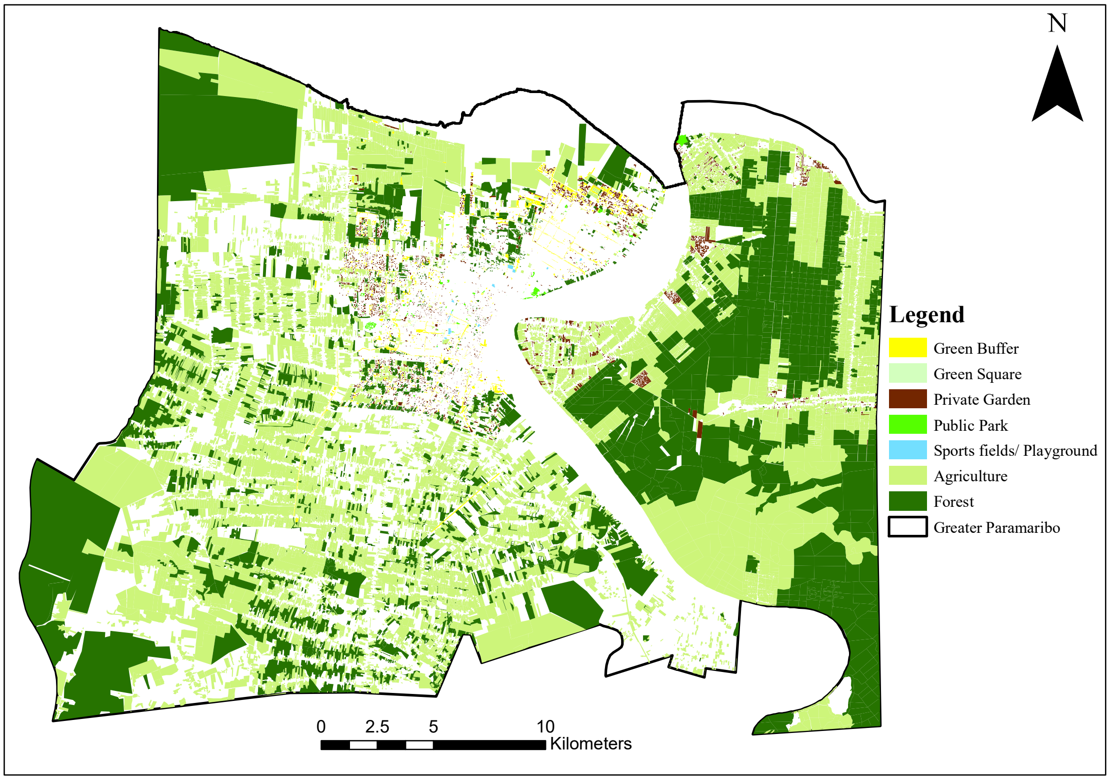


Figure 12: Classified map of UGS in Greater Paramaribo

When a closer look is taken at the areas with more settlement like in the central part and northern areas of the Greater Paramaribo Region (Paramaribo district) in **Figure 13**, it shows that there exists a variation of the types of UGS available in the region as opposed to the south, east, and west sides (Outskirt regions) which is dominated by forest and agriculture lands. The classified map was crosschecked with information given by the locals about the study areas (**Table 7** and **Figure 13**) to see how correct the classification was. The check showed that just two areas was incorrectly classified, adjustments were done accordingly.

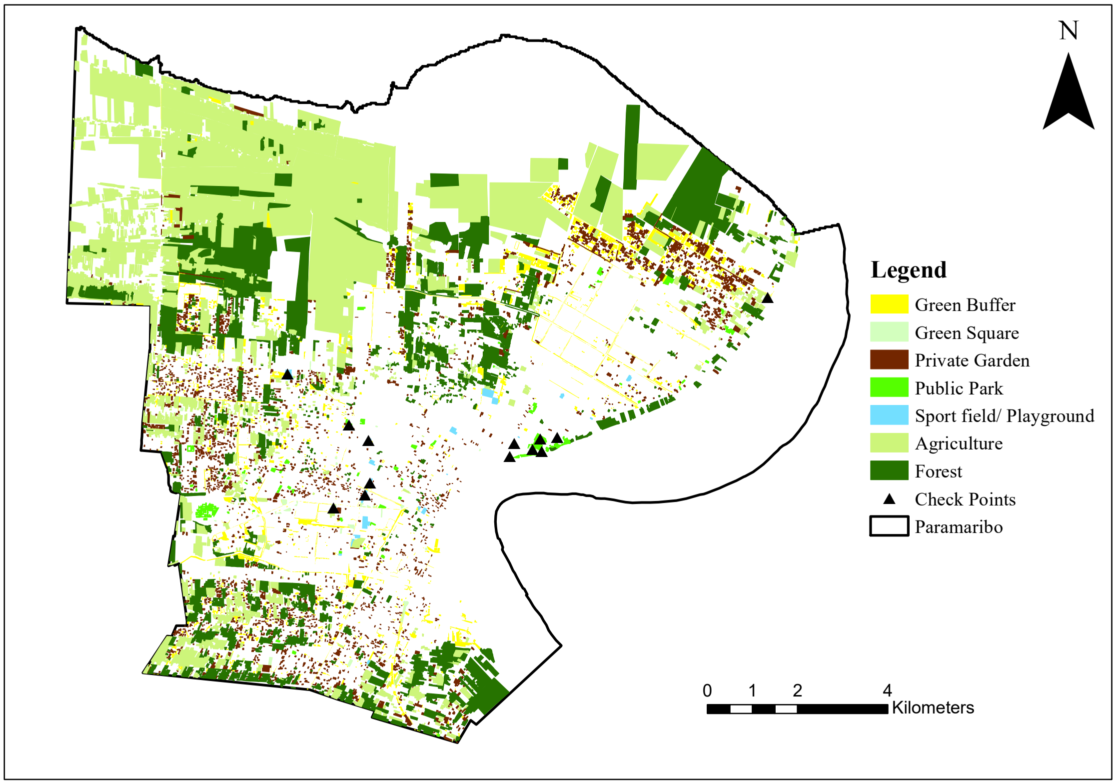


Figure 13: Spatial distribution of UGS and check points in Paramaribo

Table 7: Check table for the classification of UGS types

Name of Green space	**Location**	**Indicative uses**	**Our Classification**
Onafhankelijkheidsplein	Onafhankelijkheidsplein	National square: events are organised	Green Square
Leonsbergplein	Einde Anton Dragtenweg	Small green square with trees and benches	Green Square
Coen Ooftplein	Gemenelandsweg	One of best playgrounds; many trees	Sports field/playground
Gladiolenplein	Gladiolenstraat	Sport area	Sports field/playground
LTS Plein	J. Lachmonstraat (omgeving Nickeriestraat)	Small green square with plants surrounded by roads	Green Square
Floraplein 1,2,3	Floralaan/Fajadjanstraat	Two of these are small green spaces with lawn, plants, and benches. The third one is a playground in a residential area;	Sports field/playground
Kerkplein	Kerkplein	Is a paved square in the center of downtown with some trees and benches;	Green Square
Oudvlaggen plein		Paved square; surrounded by plants; formerly flag square	Public Park

Rensproject	Peu Et Contentstraat/Kwattaweg	Residential square with sport field, playground, green, plants.	Sports field/playground
Revoplein	Waterkant	Paved square with monuments and benches in middle of downtown	Green Square
Rietbergplein	Kleine Waterstraat	Small verge between two roads with plants	None
Tropical speeltuin	Lelydorp	A good playground, well used, but not situated in Paramaribo	Sports field/playground
Vriendschapspark	J. Lachmonstraat	Green square with trees and benches	Green Square
Zinniaplein	Gladiolenstraat	Sports area with green, not sure it its used	Sports field/playground
Wakapasi/Palmentuin	Grote Combeweg	Park with playground, very nice to relax, wander in nature, foodstalls, selling of souvenirs.	Public Park
Waterkant/Fort Zeelandia	Waterkant	Area along the River, boulevard.	Public Park

4.1.2. Distribution of UGS

Figure 14A ,B, and **C** shows the distribution of agricultural land, forest and forest fragments and public parks respectively across the various ressorts in the Greater Paramaribo Region. From **Figure 14A** it can be seen that most of the forest are found at the outskirts of the region with the forest fragments found within the ressorts in the central parts of the region. Specifically in Alkmaar, Niew Amsterdam,Meerzorg, Lelydorp and Kwatta which are located in the outskirt regions, there are bigger areas of Forest than the central areas. This might be because they border the surrounding ressorts. The public park (**Figure 14B)** are all concentrated in the central parts of the region. They are all distributed within the ressorts which form the Paramaribo district and Nieuw Amsterdam and Meerzorg which is in Commewijne district with none in any ressort in Wanica. **Figure 14C** shows that the agricultural land is concentrated in the north which are ressorts Kwatta, Blauwgrond, Rainville, Weg naar Zee, Munder, south (De Nieuwe Grond, Houttuin, Domburg and Lelydorp), west (Koewarasan, Saramaccapolder) and Niew Amsterdam, Alkmaar and Meerzorg in the eastern part of the Greater Paramaribo Region, with little pieces spread within the central part. There is none in the Centrum ressort and a few are found in Welgelegen, Flora, Tammenga, Latour, Pontbuiten, Livorno, Beekhuizen.

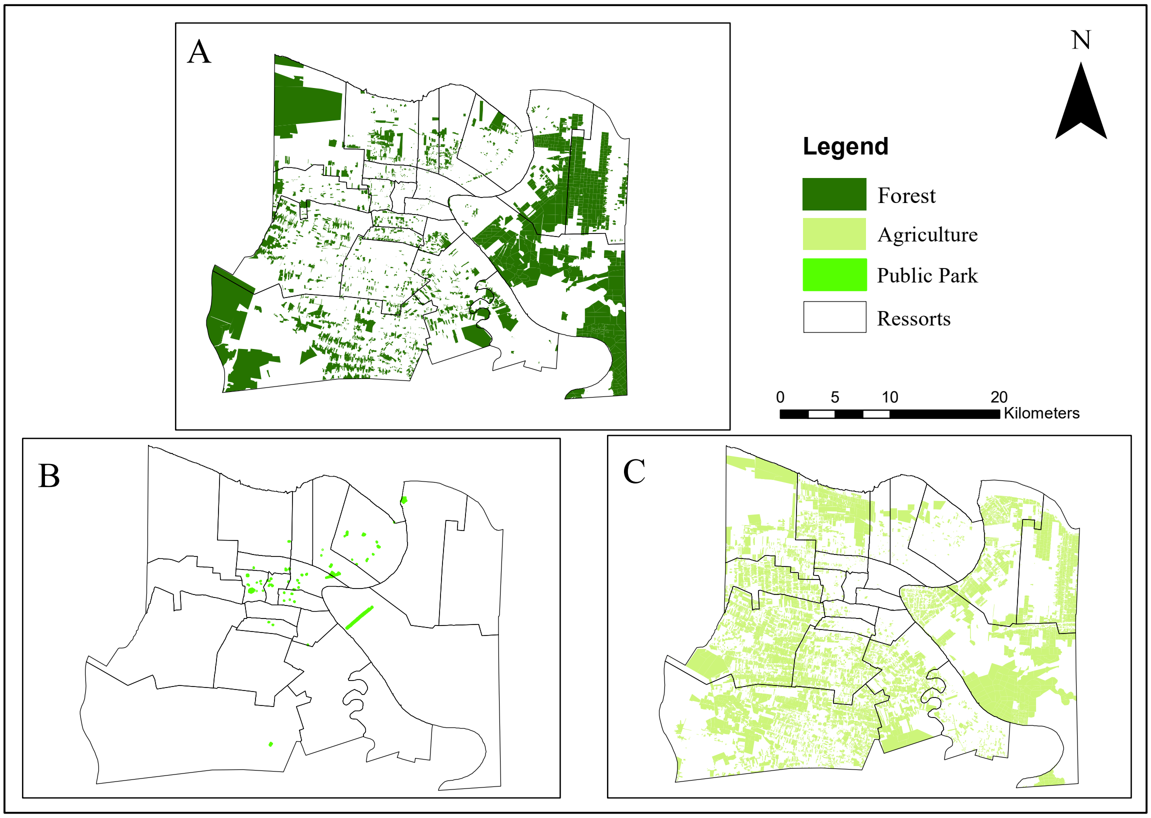


Figure 14: The spatial distribution of UGS (A) Forest, (B) Public park and (C) Agriculture across the ressort in Greater Paramaribo

Figure 15A ,B, C and **D** shows the distribution of green squares, sports field, private gardens and green buffers across the various ressorts in the greater Paramaribo. The green squares are found within the areas where settlements are concentrated which is in the Paramaribo district (Welgelegen, Centrum, Flora, Tammenga, Latour, Pontbuiten, Livorno, Beekhuizen, Blauwgrond, Rainville, Weg naar Zee and Munder). There is none of the green squares in the Wanica and Commewijne district which is in the east, west and south side of the region. There are few sportfields and playgrounds in the Greater Paramaribo Region. The few available are found in the central areas and southern regions. No sportsfield is found in the northern and eastern parts of the region. There seems to be the a concentration of the private gardens in areas where there are residential housess like the central, nothern and eastern regions of Greater Paramaribo, specifically in Welgelegen, Centrum, Flora, Tammenga, Latour, Pontbuiten, Livorno, Beekhuizen, Blauwgrond, Rainville, Weg naar Zee, Munder, Niew Amsterdam, Alkmaar and Meerzorg. The green buffers are also found in the central and northern areas of the region. This might be because there are a lot of developed roads available than the west, south and eastern Greater Paramaribo.

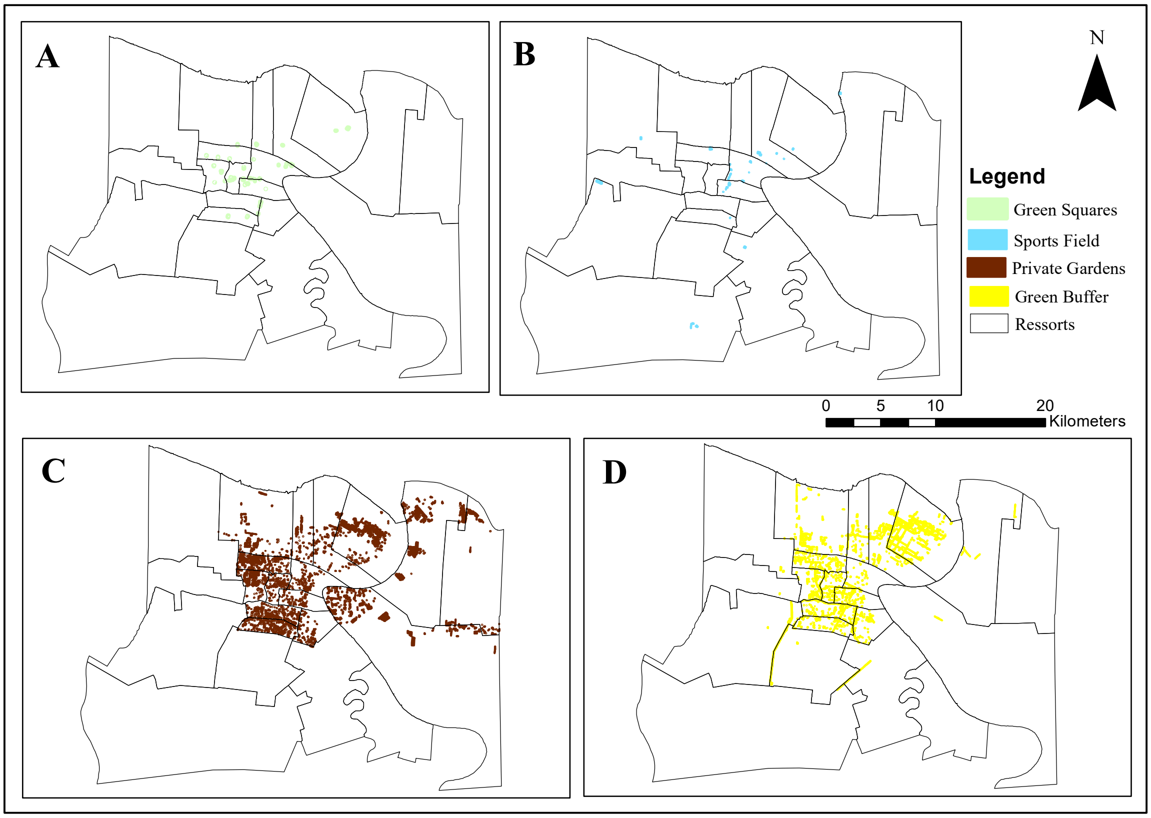


Figure 15: The spatial distribution of UGS (A) Green squares, (B) Sports field (C) Private Gardens and (D) Green buffers across the ressort in Greater Paramaribo

4.1.3. Patterns of UGS

Figure 16- **Figure 22** show the results for the landscape metrics (**Table 4**) for the types of UGS across the various ressorts. Values obtained for the landscape metrics for each UGS types across the ressorts are also shown in **Appendix 3**. Overall forest, agriculture shows to be high in all the chosen landscape metrics except patch sizes in the outskirts of the region than the central areas, meaning they are concentrated and clustered together in the outskirt areas. Also, this shows that even though there are forest and agriculture patches in the central areas of the region, they are very small in sizes. Green buffers have very small patch sizes in both the central and outskirts of the region, showing that they generally come in small sizes. They have a wide range of aggregation index indicating that they might be evenly dispersed.

There are very low values of class areas and mean patch size for green squares, showing that this UGS type comes in small sizes, and they are not much in the Greater Paramaribo Region. For sports field/ playground, even though there are high patch densities in the central areas, they have low mean patch sizes and aggregation index. This indicates that they come in small sizes and are dispersed in the central area of Greater Paramaribo. **Figure 21** show that most public parks are clustered around each other in the all the ressorts that they are present in and even though they found mostly in the city central areas they have small mean patch sizes. There are numerous patches of private gardens in the central area of Greater Paramaribo, but they are smaller in size and scattered than in the outskirt, where there are fewer patches, but they are larger and closer together.

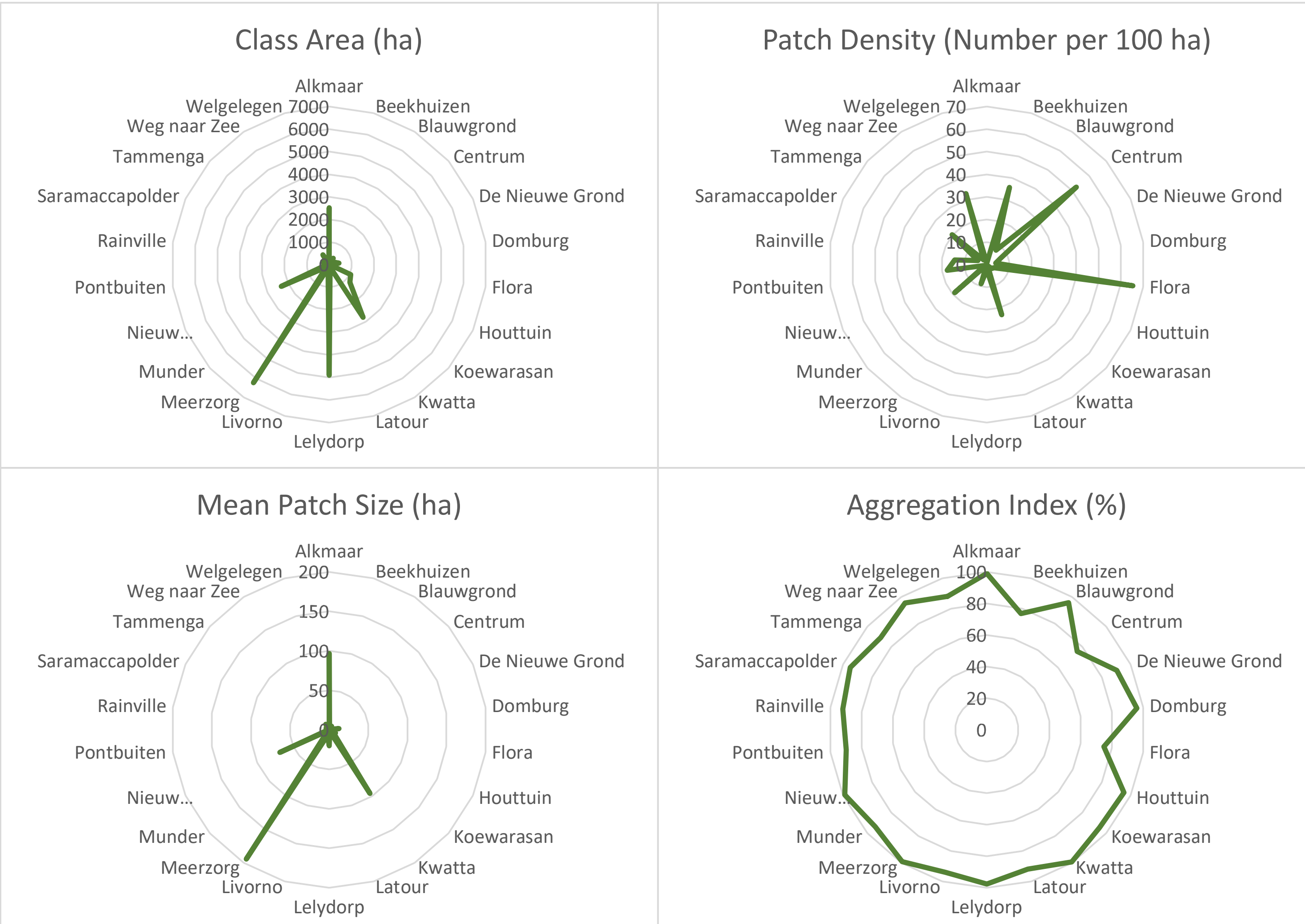


Figure 16: Landscape metrics for Forest

The class areas for forest have high areas in Meerzorg, Lelydorp and least in the central part with Centrum, Flora and Beekhuizen being the least.

For the patch density in **Figure 16**, forest even though the patches are not many in the central area of the region it is high in the ressort there with Flora and Centrum ressorts having the highest and the regions in the outskirts of the region having low patch density.

There are large patches of forest all around Greater Paramaribo with the least being 0.2 for Flora and the highest in Meerzorg with 194.3. The ressorts in the outer regions of Greater Paramaribo have high mean patch sizes than the ressorts in the central parts.

Forest has very high aggregation index percentages ranging from 99.5401 to 74.8252. The outer ressorts in the region have the highest percentages, specifically with the lowest percentages occur at the central parts, specifically Beekhuizen, Centrum, Flora having below 80% aggregation index. This means that forest/forest fragments in the outskirts of the region are clustered together but in the central parts of the region they are littered all around.

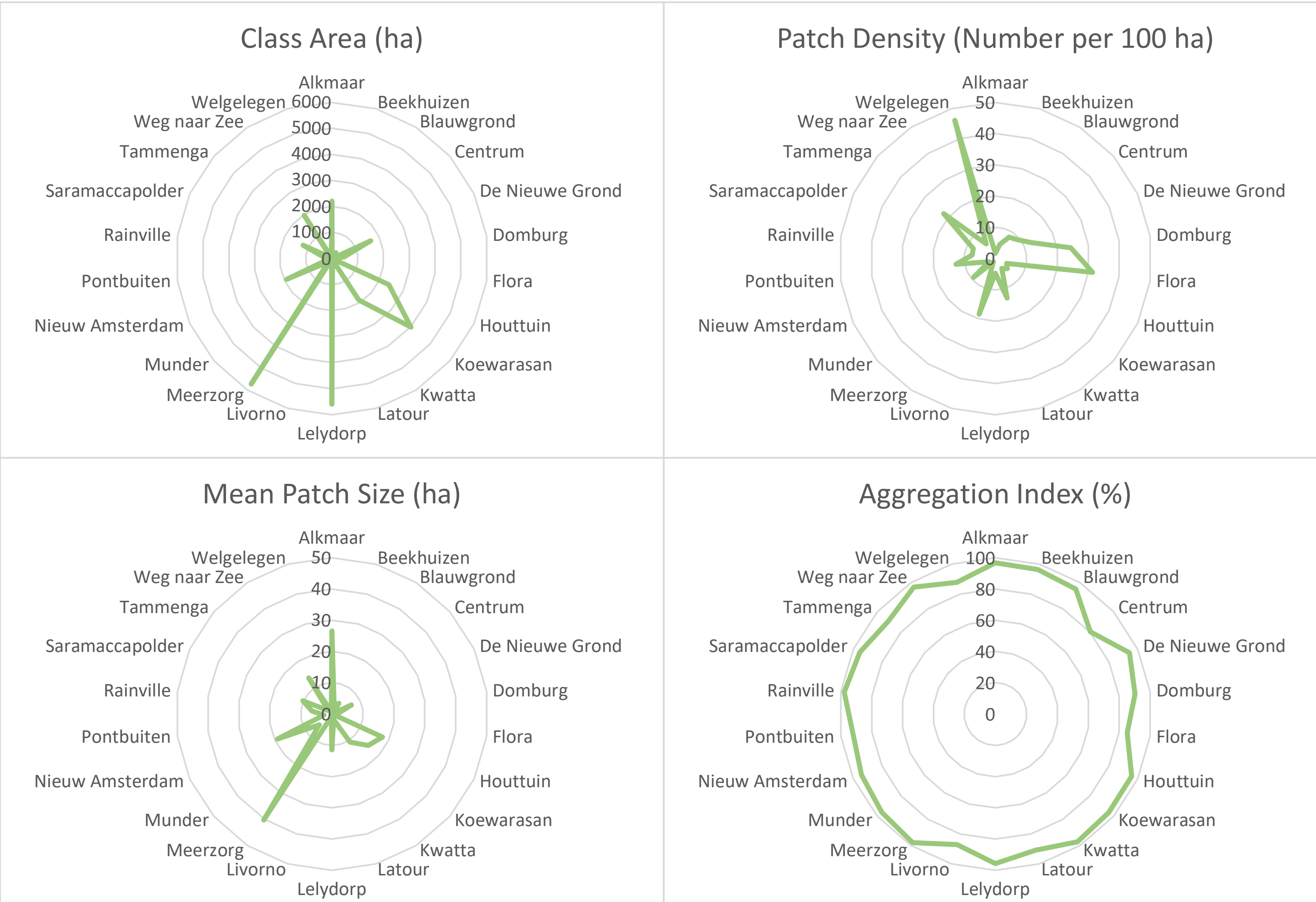


Figure 17: Landscape metrics for Agriculture

With agriculture, there are large class areas shown in **Figure 17** in the outer ressorts such as Meerzorg and Lelydorp and very low values in the inner or central ressorts such as Beekhuizen, Flora and Centrum.

Agriculture has high patch densities in the city centres and low patch densities in outer areas of Greater Paramaribo.

There are patches of agriculture everywhere in the Greater Paramaribo Region, with the lowest mean patch sizes in the central parts of the region and the highest mean patch sizes in the outer areas of the region, specifically Meerzorg (40.3), Alkmaar (26.5) and Nieuw Amsterdam (19.2).

For agriculture, across all the ressorts in the region of Greater Paramaribo there are high percentages of aggregation index showing that the agricultural lands are crowded around each other. This is truer for ressorts in the outskirts than the very central parts of the Greater Paramaribo Region.

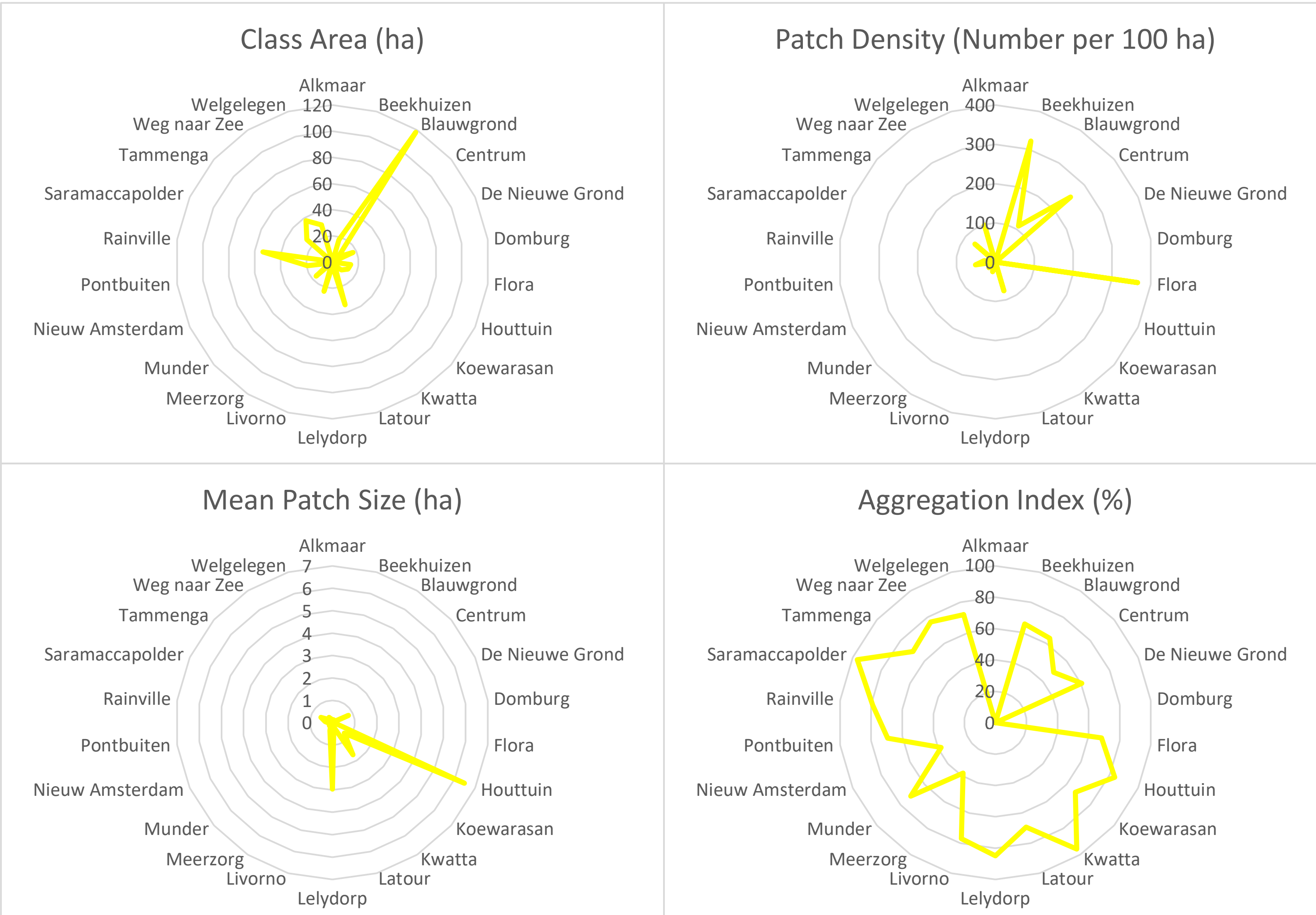


Figure 18: Landscape metrics for Green buffers

There are high values of class area (**Figure 18**) occurring in Blauwgrond, Rainville, Weg naar Zee and low values in Meerzorg, Saramaccapolder with Domburg and Alkmaar having no green buffer.

There are high patch densities for green buffer in the inner city with Flora and Beekhuizen having the highest and least in the outskirts ressorts.

Most of the ressorts have mean patch sizes of green buffer less than 1 ha with Houttuin (6.48), Lelydorp (2.97) and Kwatta (1.7) being the exceptions. This shows that green buffers are very small in sizes for

The aggregation index for the green buffers covers a large range than most of the other types of UGS. It starts at 96.9 for Saramaccapolder to 38.0 for Nieuw Amsterdam. Most of the ressorts in the central part like Beekhuizen, Blauwgrond, De Nieuwe Grond, Centrum have average aggregation index even though there are a lot of green buffers in the ressorts, this shows that the green buffers are dispersed. Saramaccapolder, Kwatta, Lelydorp and Houttuin in Wanica have very high aggregation index showing the green buffers in these ressorts are concentrated together.

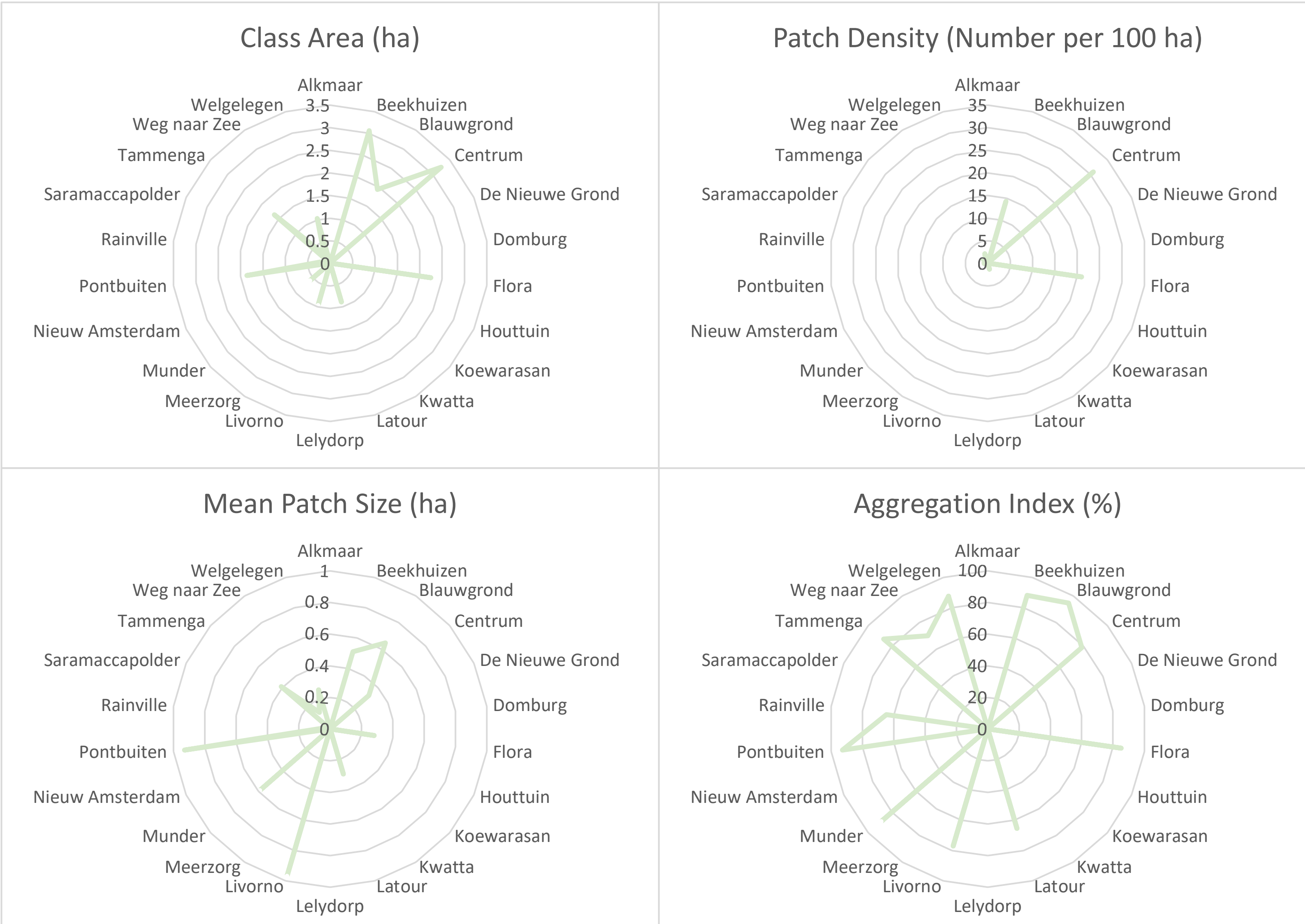


Figure 19: Landscape metrics for Green Squares

There are high class areas in the central parts of the region for green squares, the highest three being Centrum (3.2), Beekhuizen (3.1) and Flora (2.3) with most of the ressorts in the outer areas like Alkmaar, Saramaccapolder, Domburg, De Nieuwe Grond, Meerzorg having none as shown in **Figure 19**.

For green squares, high patch densities occur in the central regions of Greater Paramaribo and the least in the outer regions of Greater Paramaribo in ressorts.

There are little sizes of patches for green squares throughout the Greater Paramaribo Region which is all below 1 ha. The highest being Livorno (0.97) and the lowest being Rainville (0.04).

The central parts of the Greater Paramaribo Region have the highest aggregation index. Specifically, Blauwgrond, Pontbuiten and Munder have the highest percentages and the lowest percentages are Weg naar Zee (70), Latour (65.4), Rainville (64.7) which are in the outer parts of the Greater Paramaribo Region.

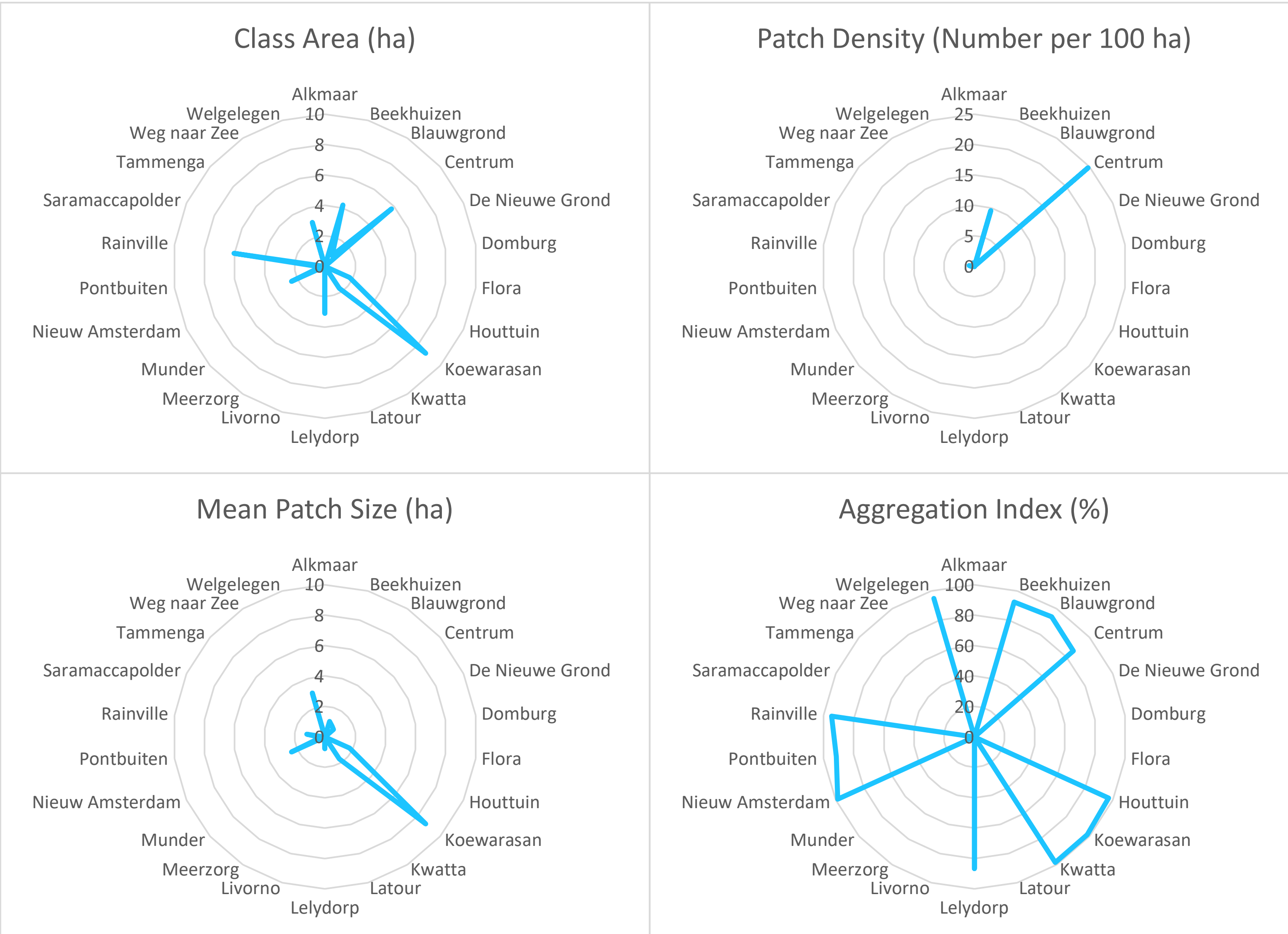


Figure 20: Landscape metrics for Sports field/ Playgrounds

For the sports field/ playground, Koewarasan have most playgrounds with a total area of (8.8) and lowest being in the ressorts on the outskirts of the Greater Paramaribo Region.

There are very low patch densities (**Figure 20**) throughout the whole region with most ranging from 0.9 to 0.02 and the highest patch densities in Centrum (24.7) and Beekhuizen (9.5).

With patch sizes ranging from 8.75 to 0.29 from Koewarasan to Pontbuiten for sports field/ playground, the ressorts in the central areas have low mean patch size than the outskirts in the Greater Paramaribo Region.

The aggregation index is showing high percentages for sports field/ playground for all the ressorts. With the highest being in Nieuw Amsterdam (98.7) and the lowest in Centrum (86.2). There are some also having 0 aggregation index. This shows most of the sports field/ playgrounds in the ressorts in the central parts of the region are not as close together as the ones in the other regions.

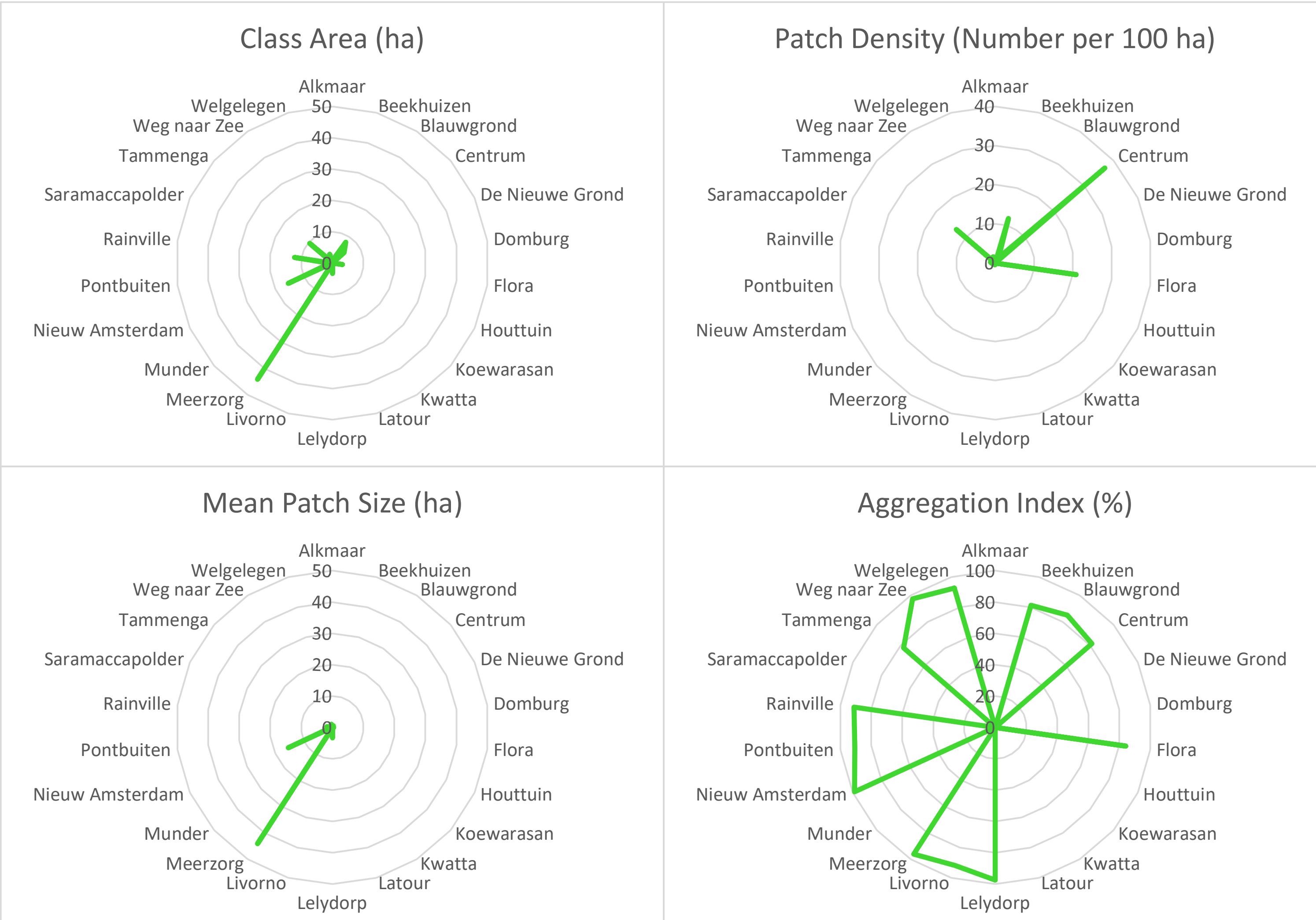


Figure 21: Landscape metrics for Public Parks

Meerzorg has the highest area of 44.1 with most of the ressorts at the outskirts having no public parks. Most of the ressorts have public parks with areas below 20 ha.

Ressorts at the most central parts of the region have the highest densities of public park as compared to the outer regions in Greater Paramaribo with ressorts like Centrum, Flora, Tammenga, and Beekhuizen having the highest densities. The other ressorts have a range of 1.7 - 0.008 and others having 0 because there are no public parks in the ressorts.

Meerzorg has the highest patch size for public parks with 44.1 and the lowest in Beekhuizen with 0.3. Most of the patches of public parks in the central part of Greater Paramaribo have low patch sizes.

There is a high aggregation index for public park (**Figure 21**) ranging from 98.9 for Nieuw Amsterdam to 77.5 for Tammenga. There are areas with 0 aggregation index which means there might be none or many public parks in the ressorts. This shows that the public parks are clustered around each other in all the ressorts.

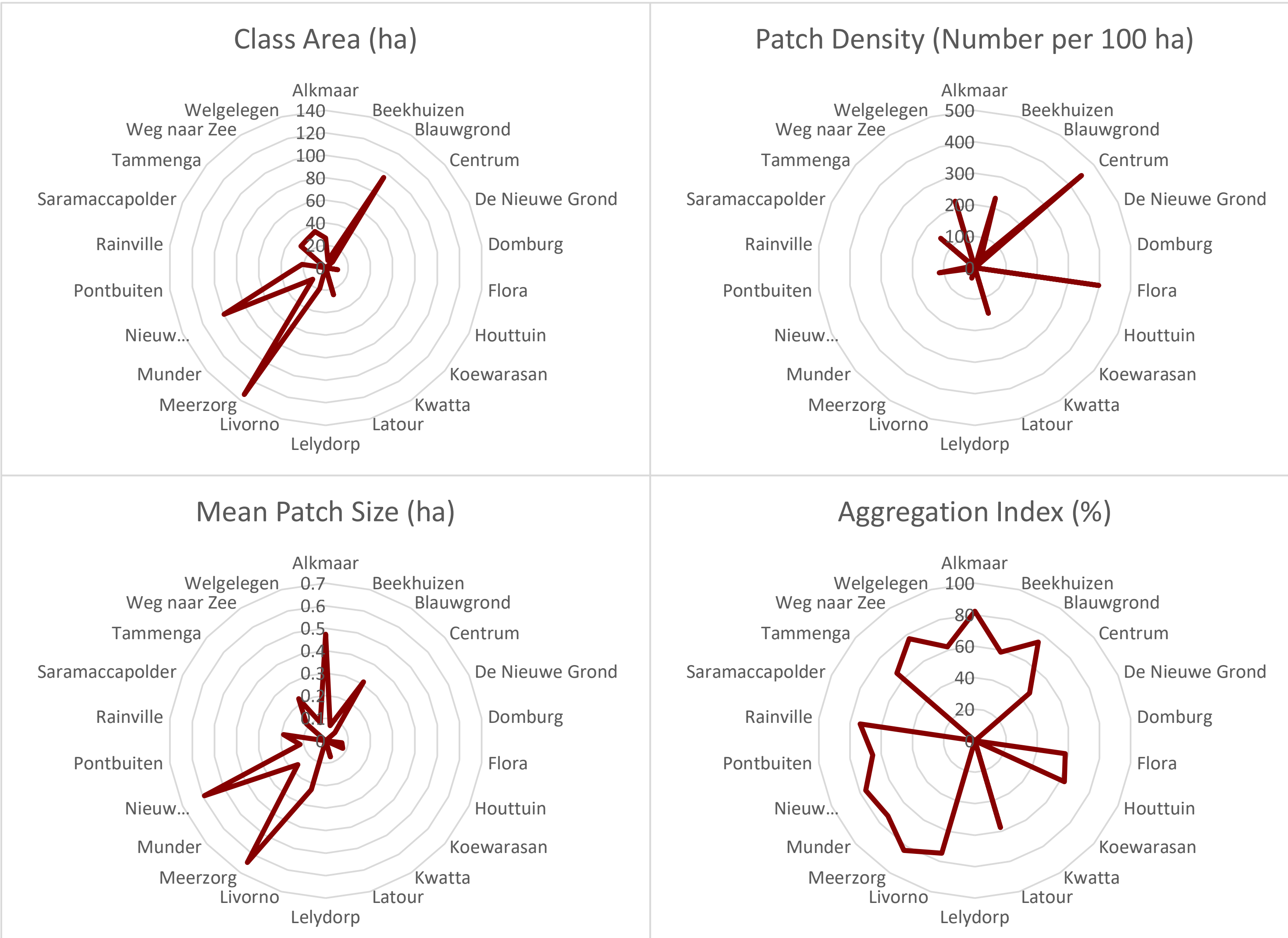


Figure 22: Landscape metrics for Private Gardens

Meerzorg also has most private gardens with an area of 133.9 ha, with there being none in most of the ressorts in Wanica.

The Centrum (448.1) and Flora (397.4) have the highest patch densities of private gardens. This shows that most of the outer regions have low patch densities for private gardens than the city centres.

The patch sizes for the private gardens range from 0.6 to 0.05 with the highest in Meerzorg and the lowest in Centrum which shows there are not big patches of it in the Greater Paramaribo Region.

The **Figure 22** shows that private gardens are dense or close to each other in Meerzorg (83.1), Alkmaar (82.2), Weg naar Zee (76.9) Yet they are loosely clustered in Latour (57.5) and Centrum (46.0).

4.2. Accessibility to UGS

This section of the study presents the results of the accessibility to UGS in Greater Paramaribo Region based on the rules of English Nature (2003) and road networks specified in Table 5. The results are for walking, cycling, and driving, and UGS sizes of 2ha, 20ha, 100ha and 500ha. The results from the accessibility to UGS indicate that most of the residential houses have access to small-sized green spaces which is the UGS ≥ 2 ha than large-sized green spaces considering all the modes of transport.

The total number of residential houses within the Greater Paramaribo Region from OSM is 62015. The results of the accessibility analysis show that there are 34353 residential houses within the serviced area of UGS ≥ 2ha by walking (**Figure 23**) at 300m distance which constitute 55.4 % of the total residential houses in Greater Paramaribo Region. Considering cycling (**Figure 24**), the number of residential houses within the serviced area for UGS ≥ 2ha at 300m distance is 41068 which makes up 66.2 % of the total number of residential houses (**Table 8**). With regards to driving (**Figure 25**), 34706 number of residential houses have access to UGS ≥ 2ha at 300m distance representing 56% of the total residential houses in Greater Paramaribo Region (**Table 8**). The accessibility analysis results show that a larger share of residential houses in Greater Paramaribo Region have access to UGS ≥ 2ha by cycling compared to walking and driving.

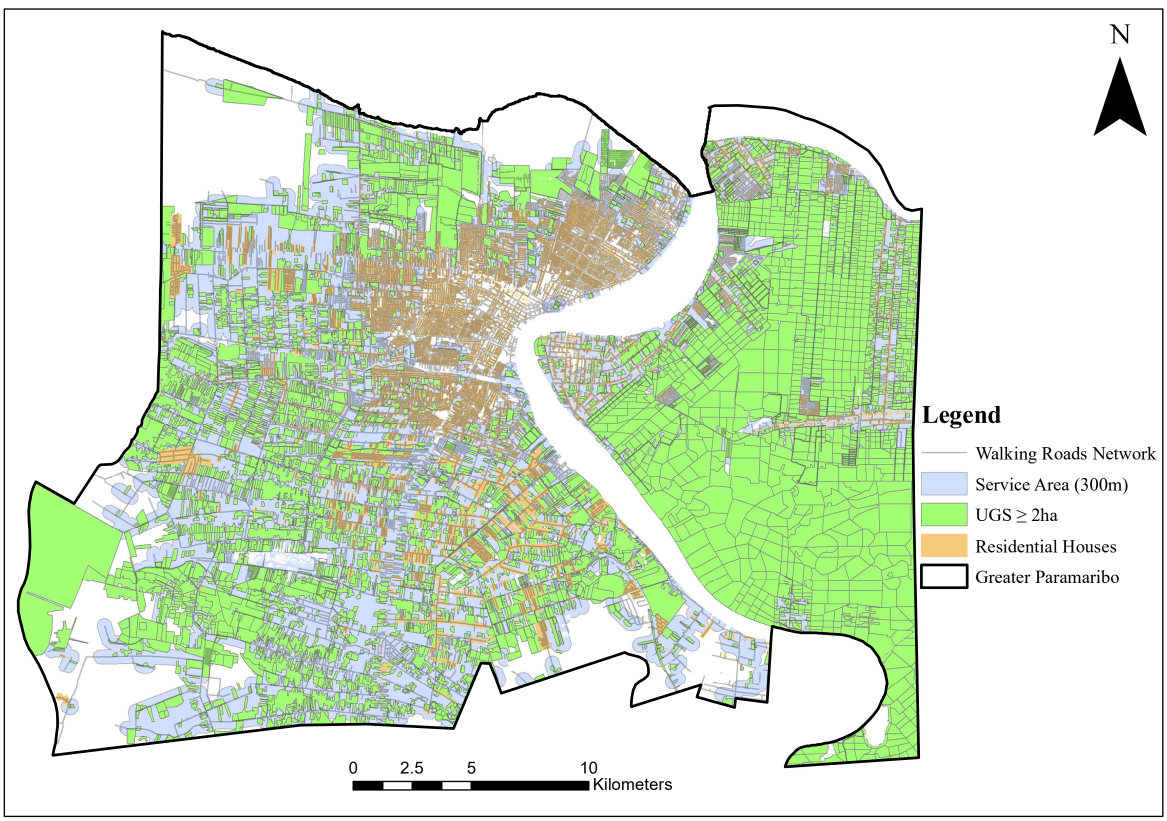


Figure 23: Accessibility to UGS ≥ 2ha by walking

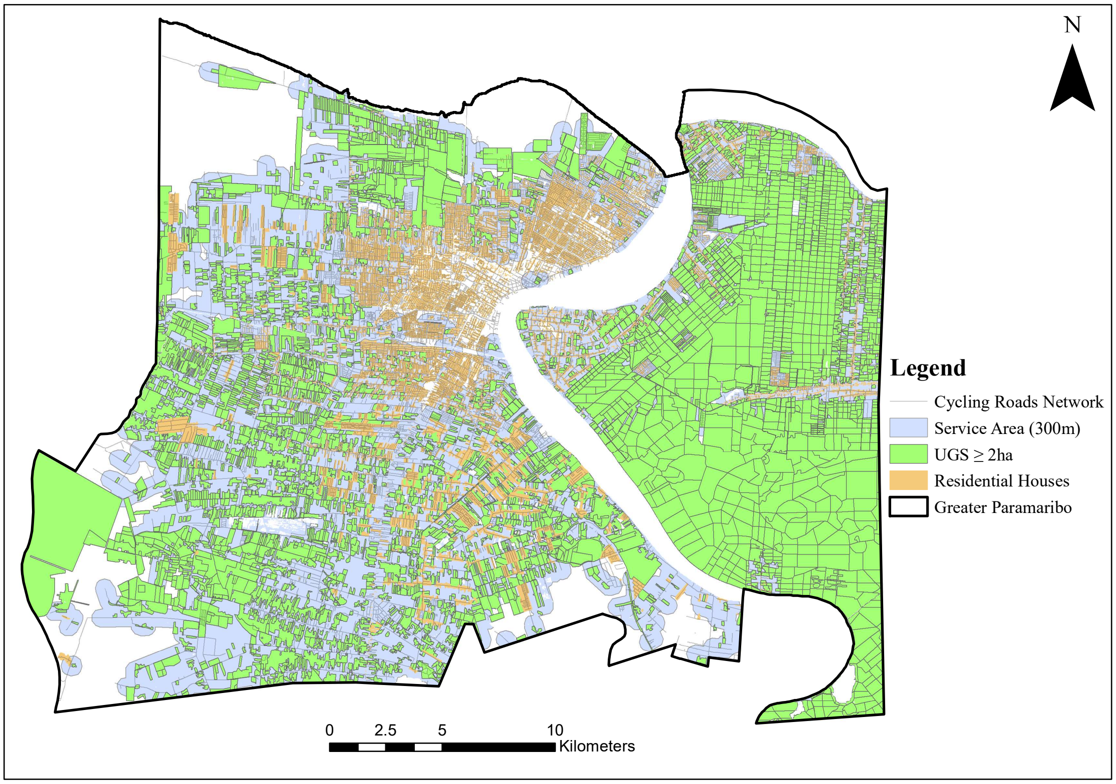


Figure 24: Accessibility to UGS ≥ 2ha by cycling

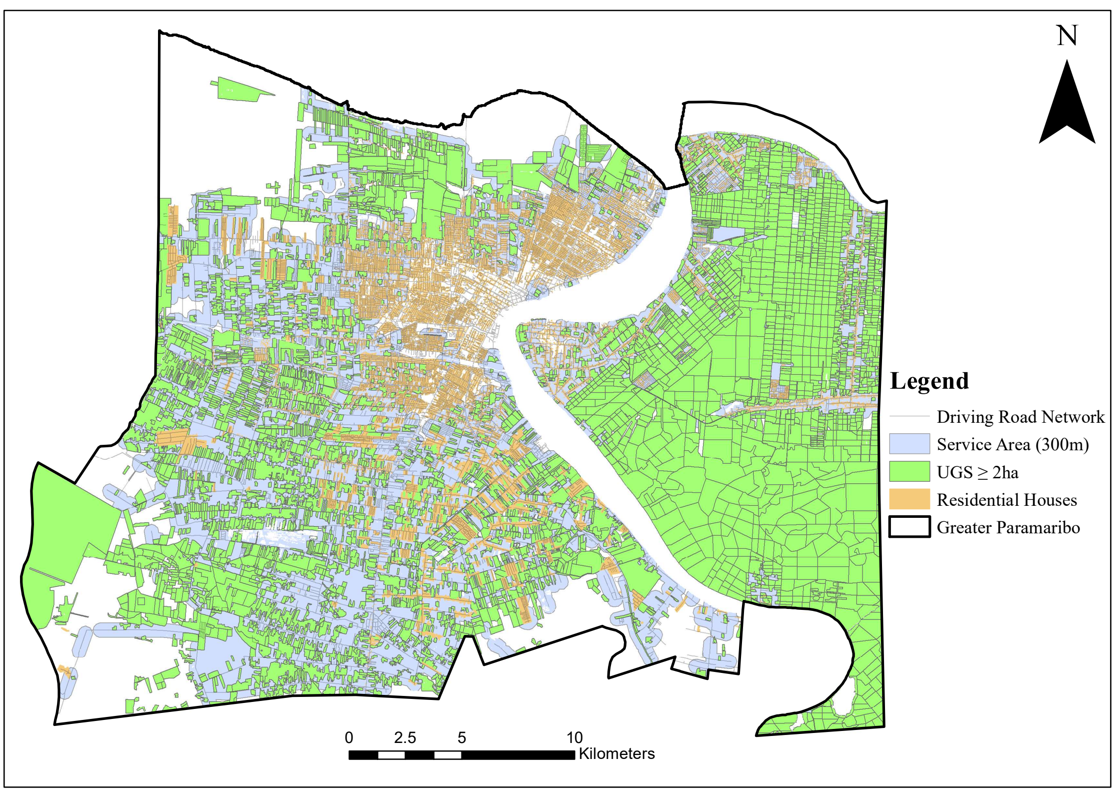


Figure 25: Accessibility to UGS ≥ 2ha by driving

Table 8: Residential Houses within the Service Areas of UGS ≥ 2ha in the Greater Paramaribo Region

Size of UGS	Mode of Access	Distance	Number of Residential Houses in GPR	Percentage of Residential Houses in GPR
≥ 2ha	Walking	300m	34353	55.4 %
	Cycling		41068	66.2 %
	Driving		34706	56%

Table 9 presents the results of the accessibility analysis to UGS ≥ 20ha within a 2km distance from residential houses by walking, cycling, and driving in Greater Paramaribo Region. The results show that 13143 residences have access to UGS ≥ 20ha within a 2km distance by walking (**Figure 26**) representing 21.2 % of the total residential houses in the area. Moreover, with respect to cycling (**Figure 27**), 16927 of the residential houses (27.3%) in Greater Paramaribo Region have access to UGS ≥ 20ha within a 2km distance. Also, 16797 residential houses are within the serviced area of UGS ≥ 20ha within a 2km distance of driving (**Figure 28**) which constitute 27.1% of the total number of residential houses in the area. A similar share of residential houses in Greater Paramaribo Region have access to UGS ≥ 20ha within a 2km distance by cycling and driving. This differs from that of accessibility to UGS ≥ 2ha where a larger of the residential houses have access by cycling.

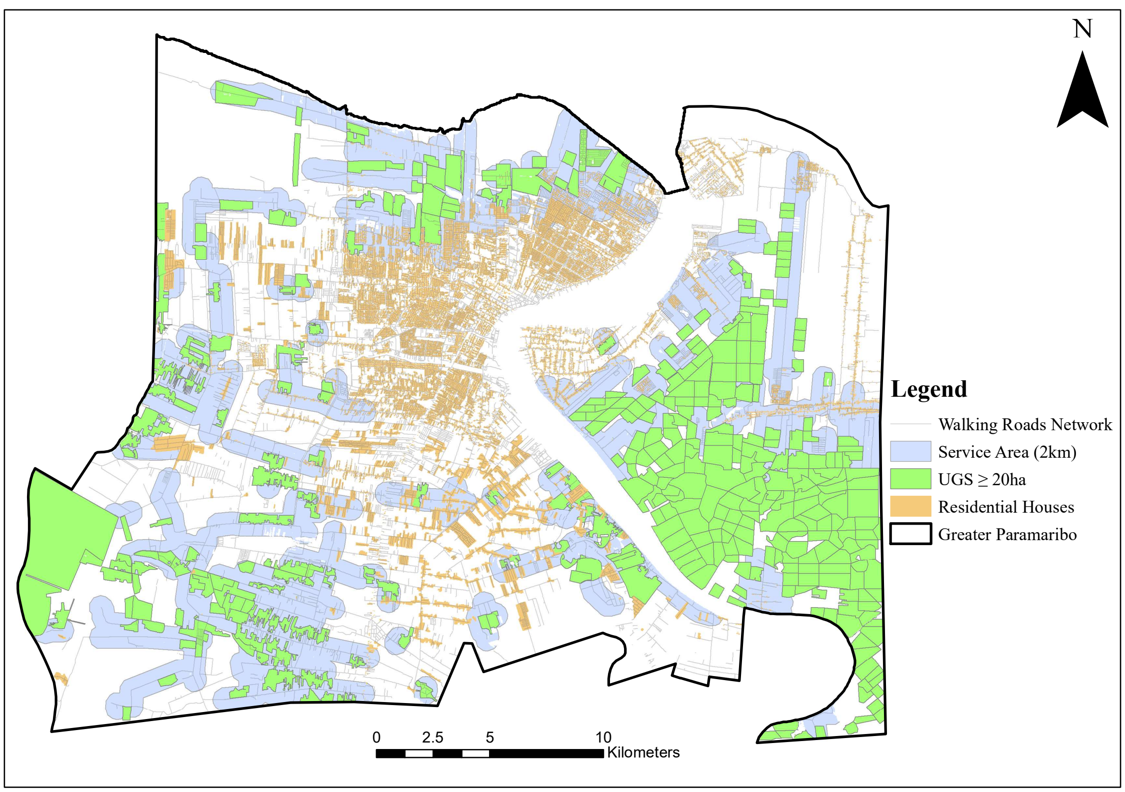


Figure 26: Accessibility to UGS ≥ 20 ha by walking

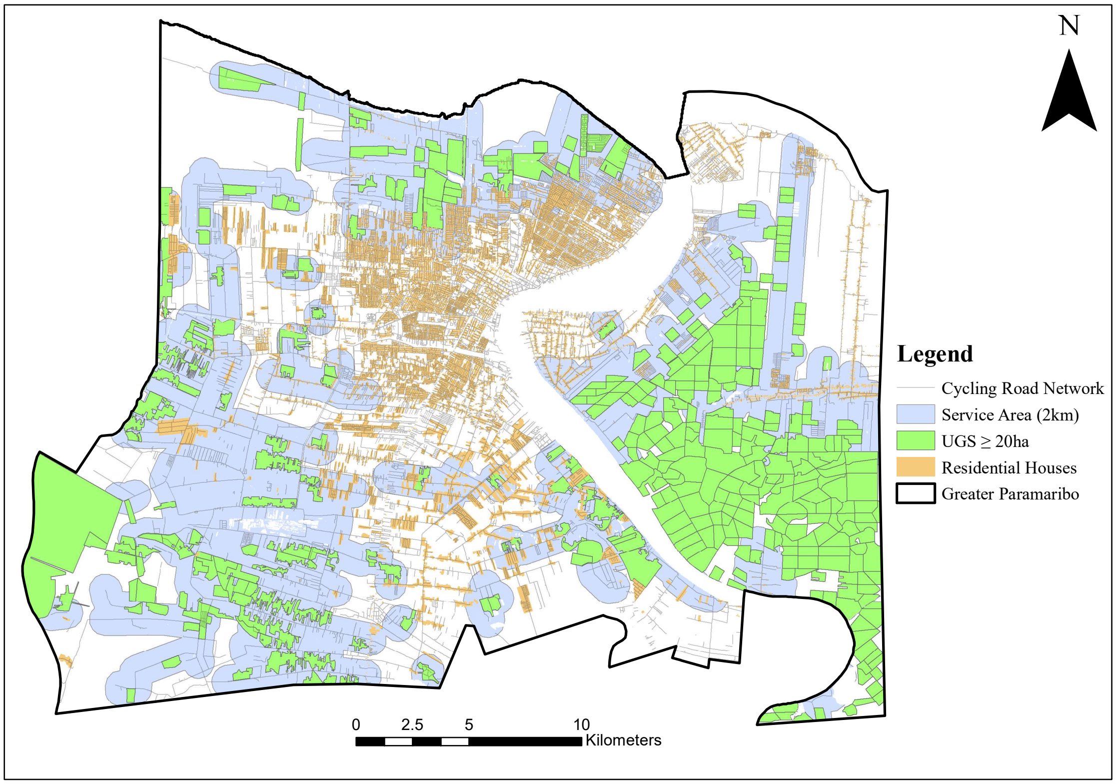


Figure 27: Accessibility to UGS ≥ 20 ha by cycling

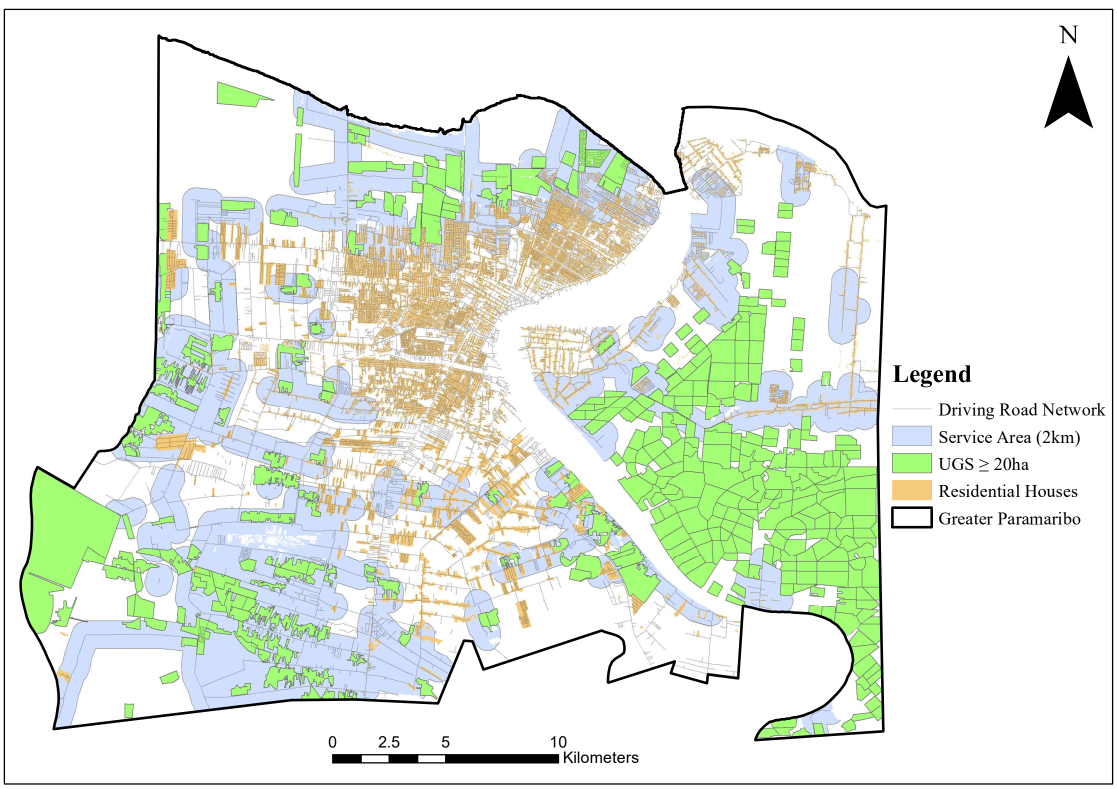


Figure 28: Accessibility to UGS ≥ 20 ha by driving

Table 9: Residential houses within the service areas of UGS ≥ 20ha in the Greater Paramaribo Region

Size of UGS	Mode of Access	Distance	Number of Residential Houses in GPR	Percentage of Residential Houses in GPR
≥ 20ha	Walking	2km	13143	21.2 %
	Cycling		16927	27.3 %
	Driving		16797	27.1 %

The results of the accessibility analysis (**Table 10**) shows that 9954 residential houses representing 16.1% of the total number of residential houses in Greater Paramaribo Region have access to UGS ≥ 100ha within a 5km distance by walking (**Figure 29**). In addition, 13181 residential houses have access to UGS ≥ 100ha within a 5km distance by cycling (**Figure 30**), which constitute 21.2 % of the total number residential houses in Greater Paramaribo Region. In the case of driving (**Figure 31**), 13099 residential houses have access to UGS ≥ 100ha within a 5km distance which represent 21.1 % of the total number residential houses in Greater Paramaribo Region. The share of residential houses in Greater Paramaribo Region with access to UGS ≥ 100ha within a 5km distance by cycling and driving is relatively the same. This is similar to that of accessibility to UGS ≥ 20ha and differs from that of accessibility to UGS ≥ 2ha.

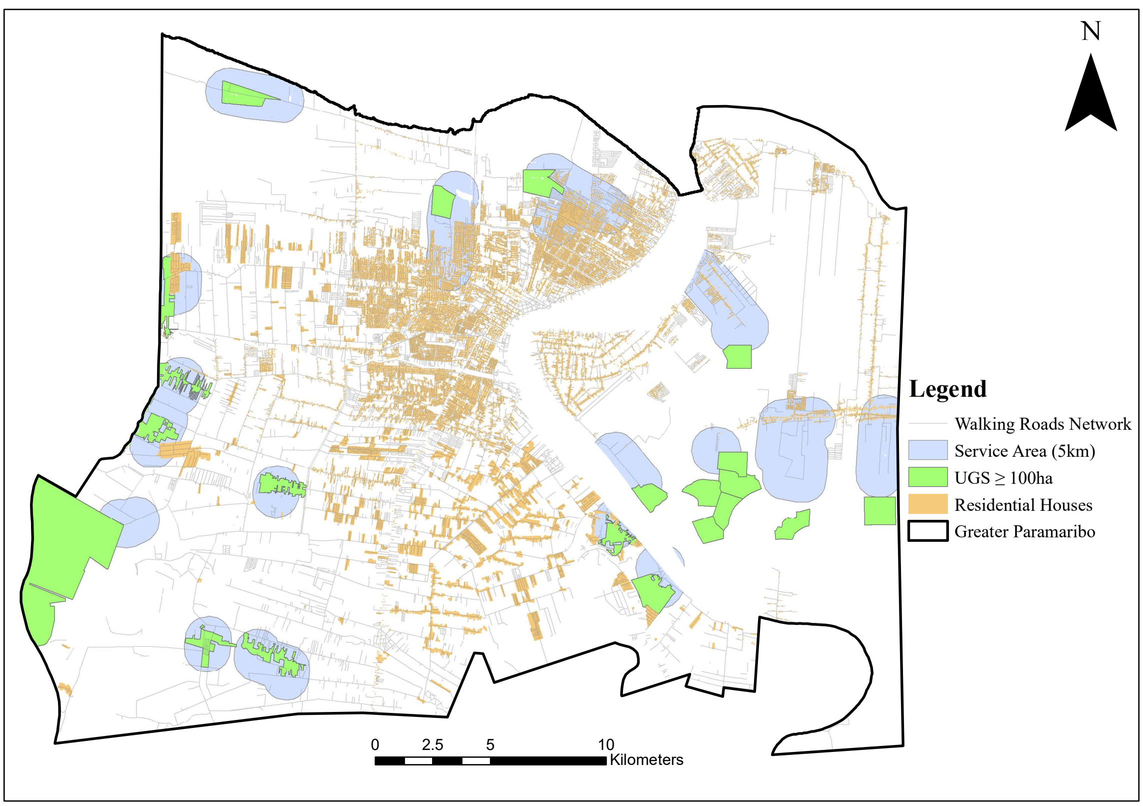


Figure 29: Accessibility to UGS ≥ 100 ha by walking

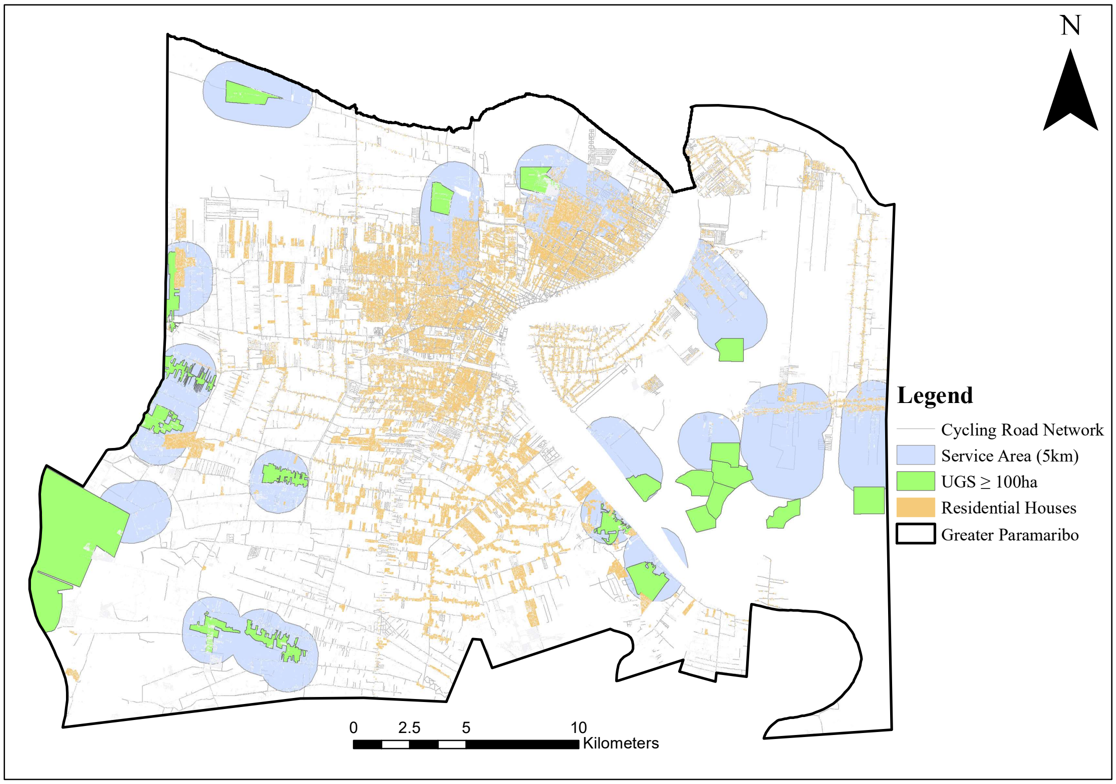


Figure 30: Accessibility to UGS ≥ 100 ha by cycling

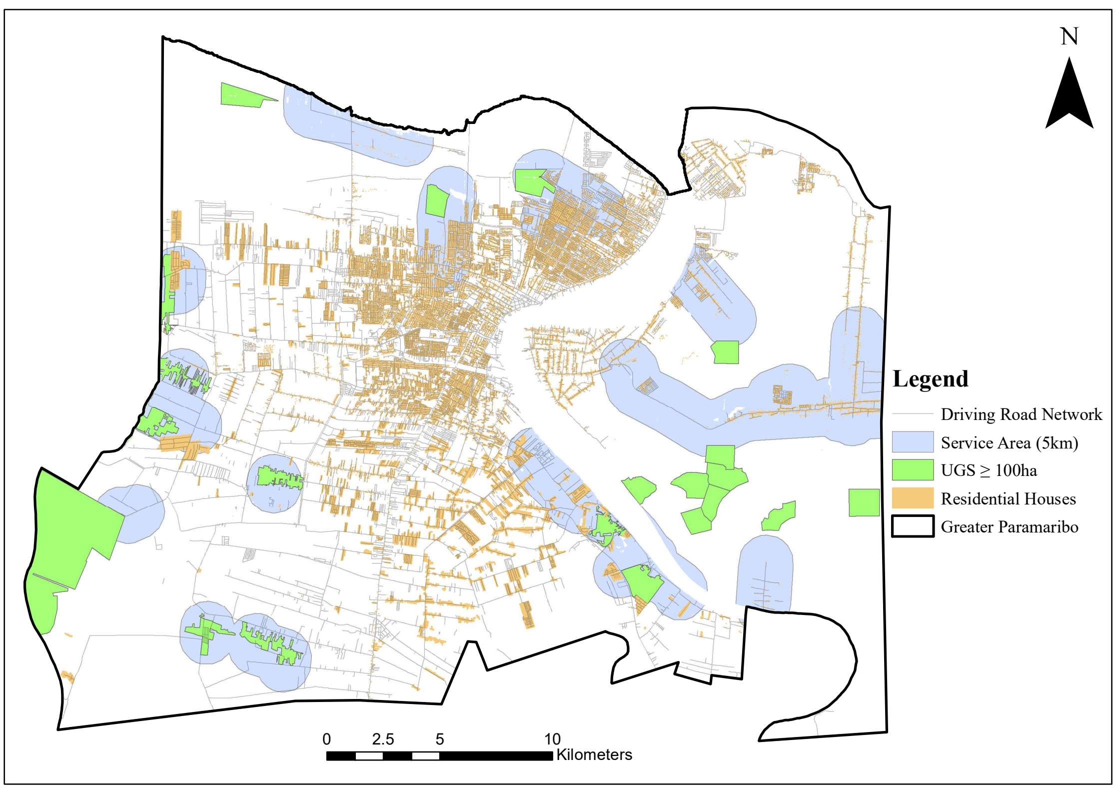


Figure 31: Accessibility to UGS ≥ 100 ha by driving

Table 10: Residential houses within the service areas of UGS ≥ 100 ha in the Greater Paramaribo Region

Size of UGS	Mode of Access	Distance	Number of Residential Houses in GPR	Percentage of Residential Houses in GPR
≥ 100ha	Walking	5km	9954	16.1 %
	Cycling		13181	21.2 %
	Driving		13099	21.1 %

The accessibility analysis results (**Table 11**) show that only 1 residential house in the Greater Paramaribo Region have access to UGS ≥ 500ha within 10km considering walking (**Figure 32**), cycling (**Figure 33**), and driving (**Figure 34**). Overall, the results of the accessibility analysis show that a larger share of residential houses in the Greater Paramaribo Region have access to small-sized UGS (≥ 2ha) than medium-sized UGS (≥ 20ha) and large-sized UGS (≥ 100ha; ≥ 500ha).

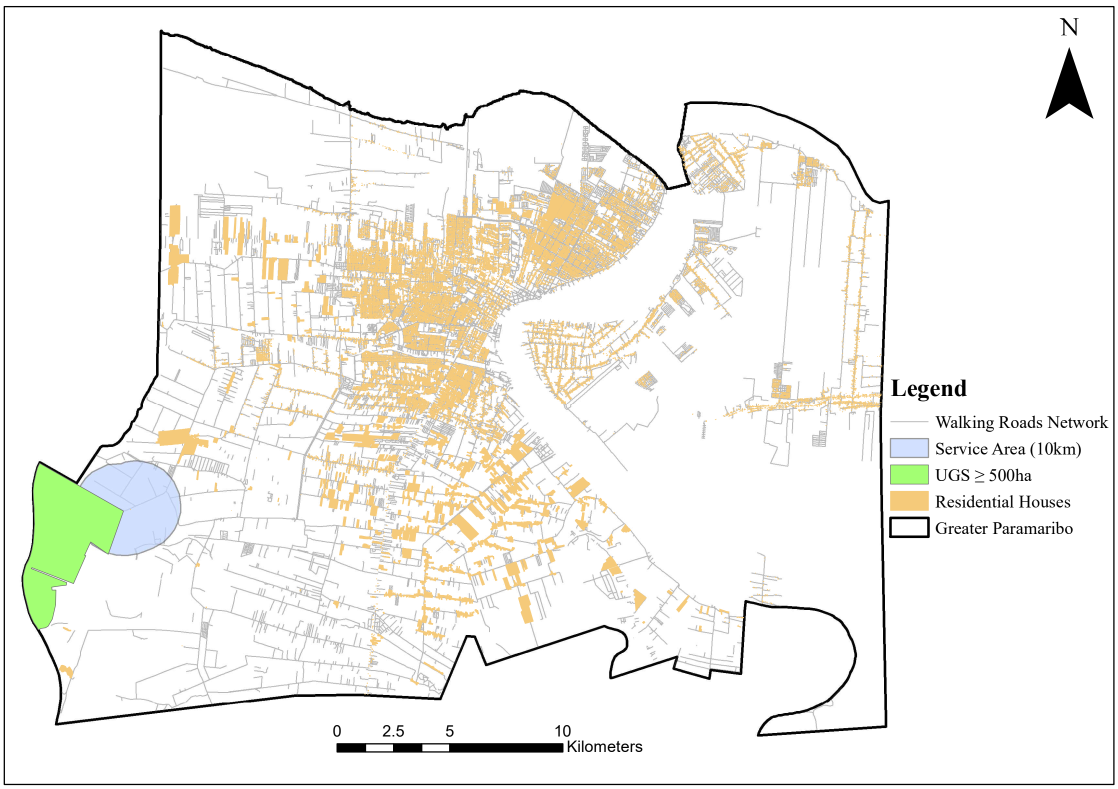


Figure 32: Accessibility to UGS ≥ 500 ha by walking

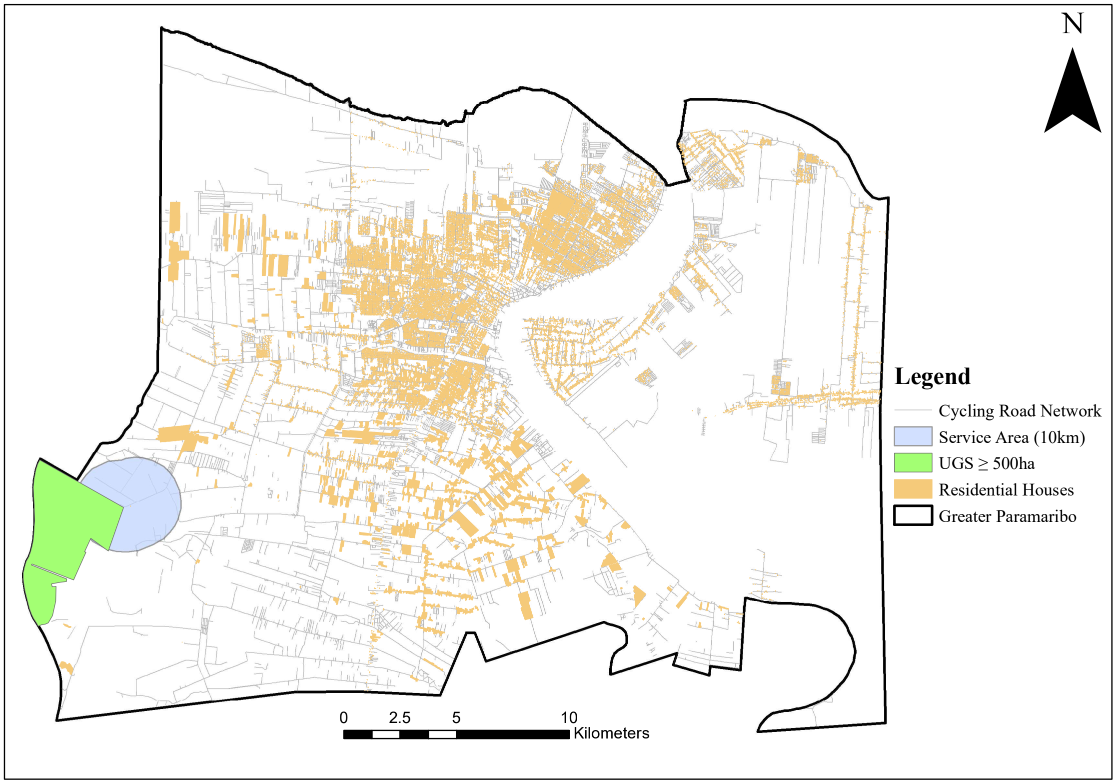


Figure 33: Accessibility to UGS ≥ 500 ha by cycling

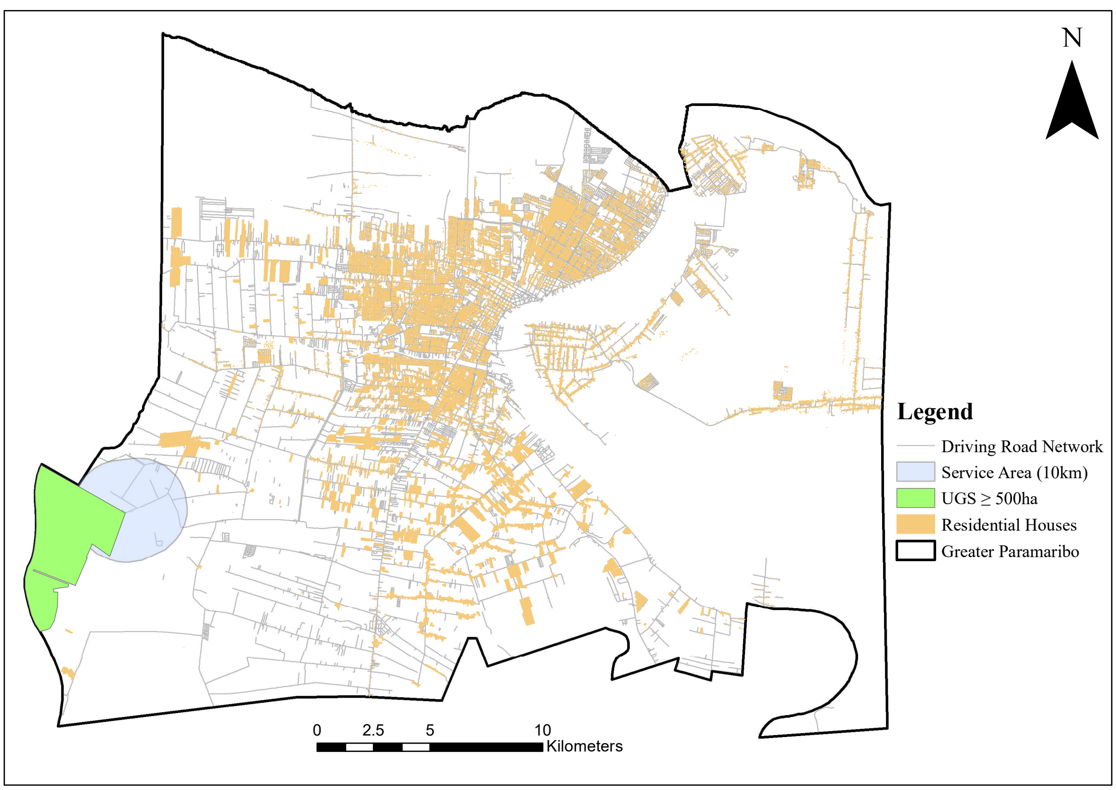


Figure 34: Accessibility to UGS ≥ 500 ha by cycling

Table 11: Residential houses within the service areas of UGS ≥ 500 ha in the Greater Paramaribo Region

Size of UGS	Mode of Access	Distance	Number of Residential Houses in GPR	Percentage of Residential Houses in GPR
	Walking		1	0 %
≥ 500ha	Cycling	10km	1	0 %
	Driving		1	0 %

4.2.1. Overall Accessibility

The overall accessibility to UGS in **Figure 35** shows that most of the residential houses in the Greater Paramaribo Region have access to UGS when all the UGS sizes and all the modes of transportation are considered. The ressorts in the central parts of the region have the least number of accessible options. The lowest being Flora, Centrum, Beekhuizen, Tammenga, Latour, Livorno. Ressorts in the outskirts of the Greater Paramaribo Region have overall a greater number of accessible options especially in the southern and upper eastern areas.

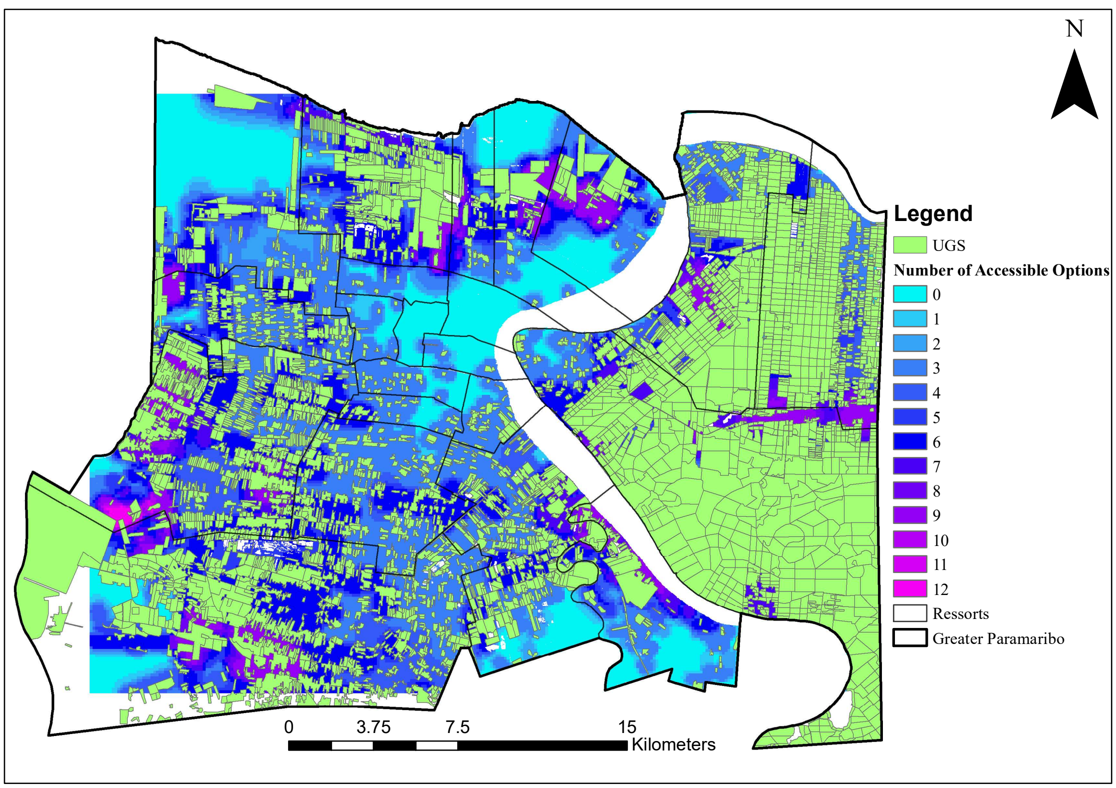


Figure 35: Overall accessibility for all the sizes of UGS for all the transportation modes

Table 12 shows that about 1/3 of the residential houses have 3 access options to UGS. Also, there is more than 10% of the 62015 residential houses having 6 accessible options when all the sizes and transportation modes are involved. There are very little residential houses that have access to UGS more than 9 access options. There is only one residential house that have access to all the sizes of UGS and through all the modes of transportation. The overall accessibility shows that at least 29% of the residential houses have 0 access to UGS when all sizes and transportation modes are merged.

Table 12: **Residential houses within respective accessible options within the Greater Paramaribo Region**

Access options	Number of houses	Percentage of Houses out of 62015 (%)
0	18088	29.2
1	4572	7.4
2	3531	5.7
3	20388	32.9
4	3397	5.5
5	2384	3.8
6	6922	11.2
7	1706	2.8
8	1708	2.8
9	3252	5.2
10	0	0
11	0	0
12	1	0

4.2.2. Accessibility to UGS for Schools

Figure 36 and **Table 13** show the results of the accessibility to UGS within 5 minutes' walk of schools. The results show that within the service area forest has the most area and the least is sports field/ playground. These UGS are within a maximum of 300m buffer making up an area of 999.4 ha of UGS within the serviced area. Out of the 146 schools in the Greater Paramaribo Region more than half have access to green buffer and the least accessible UGS type is green square having only about 28 schools having access to it.

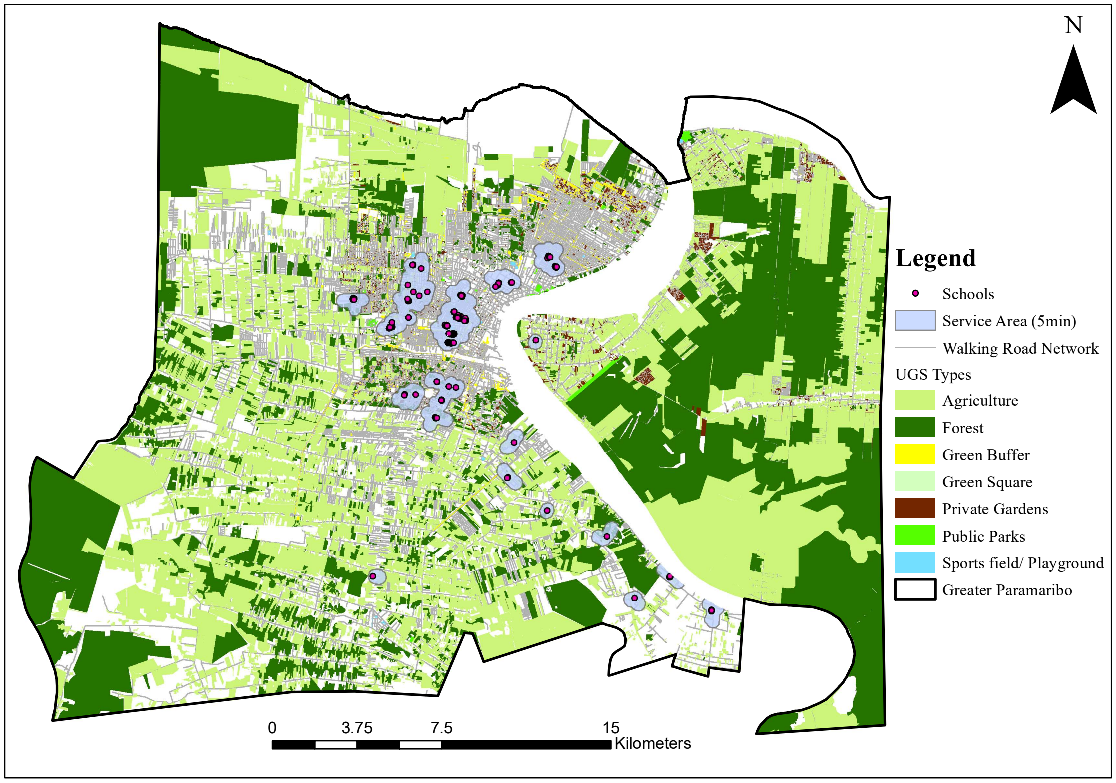


Figure 36: Accessibility to UGS for schools within 5 minutes' walk

Table 13: UGS types and schools within 5 minutes' walk service area of schools in the Greater Paramaribo Region

UGS Type	Number of UGS patches	Area (ha)	Number of schools	Percentage (%)
Forest	207	459.1	59	40.4
Agriculture	283	410.8	61	41.7
Green Square	24	7.0	28	19.2
Green Buffer	362	60.2	99	67.8
Sports field/ playground	20	3.8	32	21.9
Public park	21	6.2	38	26.0
Private Gardens	587	52.4	71	48.6

4.2.3. Accessibility to UGS for Elderly Homes

For retirement homes, most of the residents want company and public parks and green squares are the most useful. Considering **Figure 37** and **Table 14**, there is more forest and agriculture available than public parks and green square. There are together 4.4 ha of the public parks and green square which are within the service area of elderly homes. Within the service area, out of the 10 elderly homes, 3 have access to green square and 5 homes have access to public park. Only 1 home have access to sports field and playgrounds. About 90% and 80% of the elderly homes have access to agriculture and forest.

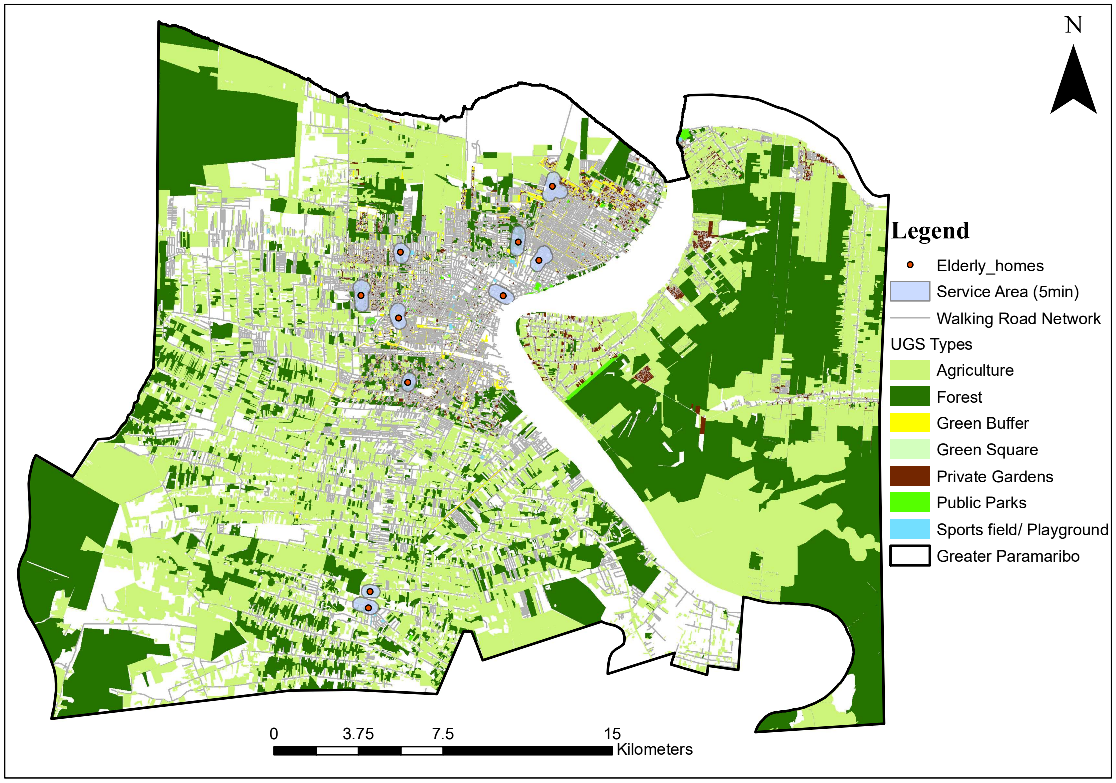


Figure 37: Accessibility to UGS for elderly homes within 5 minutes' walk

Table 14: UGS types and elderly homes within 5 minutes' walk service area of elderly homes in the Greater Paramaribo Region

UGS Type	Number of UGS Patches	Area (ha)	Number of Homes	Percentage (%)
Forest	105	125.0	8	80
Agriculture	86	261.8	9	90
Green Square	6	0.5	3	30
Green Buffer	105	32.8	8	80
Sports field/ playground	1	0.3	1	10
Public park	11	3.9	5	50
Private Gardens	245	28.4	8	80

4.3. Social Inequality associated with the Accessibility to UGS

This section of the study focuses on the results obtained from accessing the social inequality associated with the accessibility of UGS. Section 4.3.1 explains the results for quantifying the inequalities in UGS distribution across the Greater Paramaribo Region. Section 4.3.2 describes the relationship between accessibility of green spaces and socio-economic factors in Greater Paramaribo and Section 4.3.3 explains the socio-economic groups with the highest and least access to green spaces in Greater Paramaribo.

4.3.1. Spatial Inequality in UGS Distribution

The results of quantifying inequalities in UGS distribution are shown in **Figure 38**. The figure shows that the Lorenz curve is a bit away from the line of equality, a closer look at the Lorenz curve also shows that some parts in the region are above, and below the equality line. This might be an indication that there is very relative inequality in the distribution of all the UGS across the total population in the Greater Paramaribo Region. The computed Gini coefficient was 0.4, indicating that there is relative inequality in UGS distribution across Greater Paramaribo.

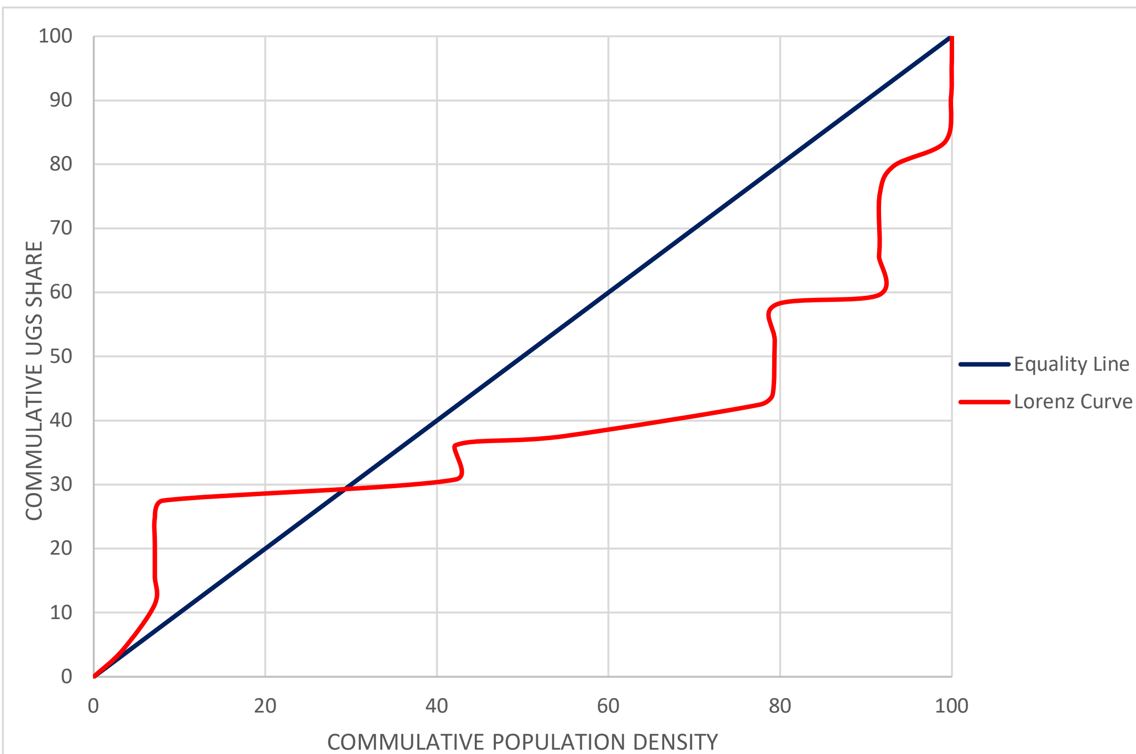


Figure 38: Graph for the Gini index of UGS distribution in the Greater Paramaribo Region with X-axis showing the cumulative population density and Y -axis showing the percentage of cumulative UGS share

4.3.2. The Relationship between Accessibility to UGS and Socio-economic Factors

This section describes the distribution of the various socio-economic factors across the ressorts in the Greater Paramaribo Region. It also describes the relationship between accessibility to UGS and the socio-economic factors.

From the socio-economic data (**Table 6**) processed, it was revealed that there is a very high cluster of children aged 0-14 years at the mid of the central part of the Greater Paramaribo Region (**Appendix 4a**). Four notable ressorts with very high cluster (26 to 32 percent) of children aged 0-14 years are Beekhuizen, Latour, Pontbuiten and Houttuin and the lowest (18 to 20 percent) being Welgelegen and Rainville. On the side of people aged 60 years and above (**Appendix 4a)**, a very high cluster was identified at some of the ressorts in the northern part of the Greater Paramaribo Region: Rainville, Centrum and Welgelegen (18 to 20 percent). Kwatta and Houttuin have the lowest percentages of people aged 60 years and above (5.2 percent).

There are the highest percentage of Natives (**Appendix 4b)** in the region is in the Beekhuizen Ressort. Overall, there is low percentages of Natives over the total population in the ressorts. They make up 0.5 to 3 percent the population with Alkmaar and Koewarasan ressort having the lowest numbers. The Mixed ethnic group (**Appendix 4b)** are 5.8 to 26.2 percent of all the population in Greater Paramaribo. With their highest concentration in Blauwgrond, Rainville, Centrum, Tammenga and Flora and lowest in Koewarasan, Alkmaar, Saramaccapolder, Pontbuiten and Latour.

For the spatial distribution of Creoles and Maroons (**Appendix 4c**) in Greater Paramaribo it was revealed that there is very low concentration of Creoles in the eastern, and western parts of the region ranging from 5 to 10 percent. The highest concentrations of Creoles are in the very central part of the region, specifically in Beekhuizen, Centrum, and Flora ressorts. The maroons form 1 to 53 percent of the entire population in the various ressorts. With a very high cluster in Pontbuiten and Latour and very low clusters in the eastern and northern areas of the Greater Paramaribo Region.

There is a very high percentages of Hindustani (**Appendix 4d)** in the whole of Greater Paramaribo ranging from 12.3 to 67.3 percent. The highest clusters are found in Koewarasan, Kwatta, Saramaccapolder and Houttuin and the lowest clustered specifically in Pontbuiten, Latour, and Centrum ressorts. There is very high concentration of Javanese (**Appendix 4d)** in the ressorts on eastern parts and the Lelydorp ressort in the south of Greater Paramaribo. The central parts of the Region have the lowest concentrations of Javanese.

For the spatial distribution of the income levels (**Appendix 4e**) of residents in the Greater Paramaribo Region, it was shown that the poor are not many in the ressorts. Latour had the most cluster of poor residents. The rich are concentrated in the central and northern areas of the region especially in Flora, Welgelegen and Blauwgrond ressorts. The southern, eastern, and western parts of the Greater Paramaribo Region is dominated by the middle and middle to low income class.

The results of the Pearson correlation analysis show that four of the socio-economic factors (Natives, Creoles, Hindustani, and Javanese) considered have significant associations with accessibility to UGS in the Greater Paramaribo Region as shown in **Table 15**. There is a moderate negative correlation (-0.44) between the Natives and UGS accessibility. This shows that the higher the level of accessibility to UGS, the lower the concentration of the Inheems/Natives in that area of Greater Paramaribo. The Creoles have a strong negative correlation of -0.81 with UGS accessibility, which implies that the higher the level of accessibility to UGS, the lower the concentration of the Creoles in the Greater Paramaribo Region.

Moreover, both the Hindustani (0.53) and Javanese (0.60) have strong positive correlations with UGS accessibility. Hence, the higher the level of accessibility to UGS, the higher the concentrations of the Hindustani and Javanese in the Greater Paramaribo Region. There is no significant correlation between accessibility and Age 0-14, Age 60 and above, Maroons and Mixed ethnic groups.

Table 15: Correlation between the overall accessibility and the socio-economic factors

		Age 0-14	Age 60 and above	Inheems/ Natives	Maroons	Creoles	Hindustani	Javanese	Mixed
Accessibility to UGS	Pearson Correlation	-0.20	-0.12	-.435*	-0.35	-.81**	.53*	.60**	-0.32
	Sig. (2-tailed)	0.369	0.588	0.043	0.115	0.000	0.012	0.003	0.141
	N	22	22	22	22	22	22	22	22

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

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

Considering the accessibility and income level at the pixel level, the results in **Table 16** show that there is no significant correlation between accessibility and income level in the Greater Paramaribo Region. Also, when another size and set of sample points were used to test for the volatility of sampling, the results obtained for the correlation between accessibility and income level showed that there is still no significant correlation between them.

Table 16: Correlation between overall accessibility and income level

First sample points set		Income level
Accessibility to UGS	Spearman's rho Correlation Coefficient	0.04
	Sig. (2-tailed)	0.670
	N	106
Second sample points set		
Accessibility to UGS	Spearman's rho Correlation Coefficient	-0.07
	Sig. (2-tailed)	0.195
	N	317

4.3.3. Socio-economic groups with the highest and least access to UGS in Greater Paramaribo

This section looks at the socio-economic groups with the highest and least access to green spaces. When accessibility to UGS within 5 minutes' walk of randomly selected residential houses (**Figure 39** and **Table 17**), elderly homes (**Figure 37** and **Table 14**), and schools (**Figure 36** and **Table 13**) are compared, it is observed that the residential houses only 22% of the houses have access to agriculture as compared to 41.7% for schools and 90% for elderly homes. For forest, 14% residential houses have access as compared to the 40.4% for schools and 80% for the elderly homes. 2% of the residential houses have access to green squares whereas 19.2% and 30% of schools and elderly homes have access to green squares respectively. With the green buffers, 80% of the elderly homes have access and 67.8% of schools 3% for residential houses. Also, more schools have access to sports field/ playgrounds than elderly homes and residential houses. There is also more elderly homes and schools having access to public parks and private gardens than residential houses.

When all the types of UGS are considered, the elderly homes and schools have more access than the residential houses. This is complemented with the correlation results where there is no significant correlation between accessibility and Age (0-14) and Age 60 and above. This shows that the socio-economic groups Age (0-14) and Age 60 and above which is the children and elderly ones respectively are not the least marginalized when it comes to access to UGS.

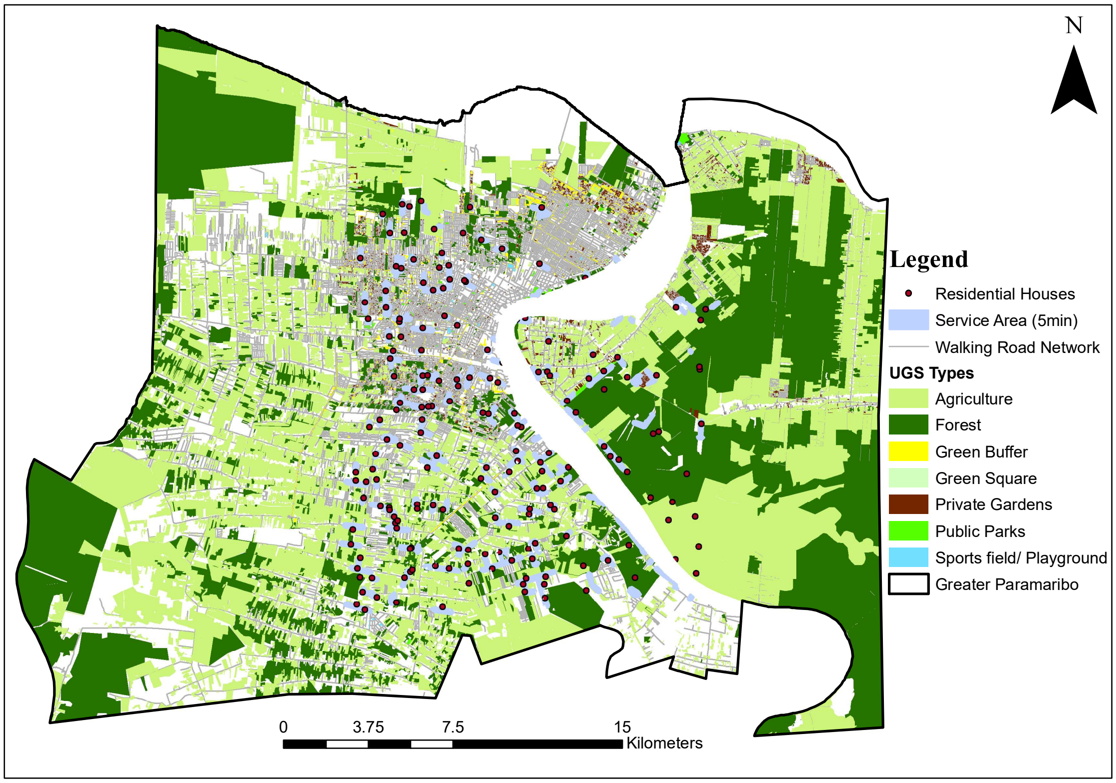


Figure 39: Accessibility to UGS within 5 minutes' walk of randomly selected residential houses

Table 17: UGS types and residential houses within 5 minutes' walk service area of residential houses in the Greater Paramaribo Region

UGS Type	Number of UGS patches	Area (ha)	Number of residential houses	Percentage (%)
Forest	290	2121.5	28	14
Agriculture	957	2248.9	44	22
Green Square	15	7.5	4	2
Green Buffer	219	53.4	6	3
Sports field/ playground	8	3.1	2	1
Public park	50	54.4	8	4
Private Gardens	432	92.5	12	6

5. DISCUSSION

This chapter discusses the study's findings and compares it with findings from other research in Sections 5.1 to 5.3 according to the research objectives. Section 5.4 presents a reflection on the study concerning the data used and the chosen methods. It also gives some strengths and limitations of the study and areas for further studies.

5.1. UGS Types, Distribution, and Patterns

The study's first objective is to investigate the spatial distribution of green spaces in the Greater Paramaribo Region. The result of the study indicates there are seven UGS classes in the Greater Paramaribo Region. There is about 48246.7 ha of green spaces in the whole of Greater Paramaribo which according to the findings of these studies not evenly distributed. The study also shows that agricultural lands occupy most of the UGS and are concentrated in the north, west, eastern, with little pieces spread within the central part. This might be because the Region is known to have agriculture as a dominant land use (Weidum, 2014) especially in the outskirts of the Greater Paramaribo Region. It can then be said that the people in the central area of the Greater Paramaribo Region have limited access to agricultural lands since it is dominated by built-up.

The findings of this research indicate most of the forest/forest fragments are found at the outskirts of the region with a few spreads out within the central parts of the region. This might be because they are usually found outside built-up areas. Forests are also the second most dominant UGS in the Greater Paramaribo Region. The public park and green squares are mostly accessible to areas within the central parts of the Greater Paramaribo Region according to this study. The same can be said about sports fields and playgrounds in the Greater Paramaribo Region since this type of UGS is found in the central areas and southern areas.

There is a concentration of private gardens in areas where there is residential houses in the Greater Paramaribo Region. Private gardens were found in most houses within the central areas and not just the high end residential houses. Also, few private gardens were in the outskirts of the Greater Paramaribo Region, this might be because most of the land is used for agriculture. Most of the green buffers are also found in the central and northern areas of the region according to this study. This might be because they are found along the roads and there are a lot of developed roads available in the central and northern areas of the region than the other areas of Greater Paramaribo.

Regarding the composition of UGS, as observed in this current research, some studies found that the different types of UGS are not evenly distributed across cities. Studies done by Czembrowski & Kronenberg (2016) in Lodz found different UGS types are unevenly distributed across the city, and various neighbourhoods that are essentially identical have varying UGS availability. They found out that forests was the UGS most abundant in the city, with parks, allotment gardens and cemeteries accounting for the rest. Similar findings were observed by Graça et al. (2018) where they realised that UGS types such as public parks, household gardens are varied and influences their effectiveness in terms of delivering benefits to society. The research of Graça et al. (2018), conducted in Porto, Portugal showed that the UGS types consisted of private gardens & backyards and parks, public gardens & forests with vacant lots & wastelands having the most coverage in the city and the city centre having the lowest proportion of UGS.

In this current study vacant lots & wastelands (public or private permeable unbuilt areas with no evident use) were found but not included since only UGS with evident use were investigated.

The findings of this research are also evident in the results from the landscape metrics. As stated by Xu, You, Li, & Yu (2016) the spatial pattern of UGS influence their impact on the services or value they provide people therefore the spatial arrangement matters. The landscape metrics show that there are forest and agriculture patches spread in the outer ressort with few in the central area of Greater Paramaribo as seen in **Figure 16** and **Figure 17**. The landscape metrics in **Figure 20** also indicates that sports field/ playground has high patch densities in the city centres which indicates that there exist more patches of sports field/ playground in the central area of the Greater Paramaribo Region than in the outskirts.

Green buffers have a wide range of aggregation indexes indicating that they are evenly dispersed as shown in **Figure 18** that they are distributed well in the few ressorts that they are found in. The study also shows that green squares and the public parks are clustered around each other in all the areas they are present which is mostly in the city centres. The metrics for private gardens indicate that there are many patches of it in the centre of Greater Paramaribo with few in the outskirts.

Through this study, it can be said that people in the central parts of the Greater Paramaribo Region have different types of UGS although most of the patches are smaller in size than the outskirts. This is because there is more variation of the types of UGS available in those areas as opposed to the south, east, and west sides of the Region which is dominated by forest and agricultural lands. Graça et al., (2018) observed that contrary to the findings of the current study, the composition of UGS in western and southwestern areas of Porto were varied and in abundant than the central areas. Overall, it can be said that the distribution of UGS types varies across geographical areas, and some areas might have more variations than others.

5.2. Different Sizes of UGS and Modes of Transportation affecting Accessibility

The second objective, to assess the level of accessibility to green spaces in Greater Paramaribo Region is discussed in this section. In the context of the current study using the English Nature (2003) rules, the findings demonstrate that the distribution and access to parks of all sizes are varied and might be improved. In general, most of the residential houses have access to small-sized UGS (≥ 2ha) than medium-sized UGS (≥ 20ha) and large-sized UGS (≥ 100ha; ≥ 500ha). Overall, the results of the analysis showed that a larger share of residential houses in the Greater Paramaribo Region have access to UGS by cycling than walking and driving.

The result from the study shows that most of the residential houses (66.2 %) have access to UGS ≥ 2ha by cycling at 300m distance (**Figure 24**). With regards to walking 55.4 % of the residential houses have access to UGS ≥ 2ha (**Figure 23**) and driving (**Figure 25**) 56% of the residential houses have access to UGS ≥ 2ha at 300m distance. This shows an improvement in cycling infrastructure in the area with less barrier in accessing UGS.

The accessibility analysis results showed that UGS ≥ 20ha within a 2km distance from residential houses are more accessible by cycling than walking and driving in Greater Paramaribo Region. It can be said 2km is far from homes and this makes it hard to access the UGS ≥ 20ha by walking as opposed to cycling and driving. The study also showed that the residential houses in Greater Paramaribo Region have access to UGS ≥ 100ha within a 5km distance mostly by cycling. The studies showed that within a 5km distance, 21.2 % of the total number of residential houses have access by cycling, 21.1 % by driving and 16.1% by walking to UGS ≥ 100ha. This could be attributed to poor road connectivity where there are inadequate access roads to available UGS in the area. Hence, restricting easy access to the available UGS.

It was observed from the accessibility analysis results that only 1 residential house in the Greater Paramaribo Region have access to UGS ≥ 500ha within 10km considering walking, cycling, and driving and thus the biggest UGS is totally inaccessible to the Greater Paramaribo residents. This might be due to the UGS data being utilized, which included multiple small UGS polygons rather than bigger ones.

In general, the central areas have little access to UGS of all sizes and through all the modes of transportation considered in this study. This might be because UGS with areas ≤ 2ha were not considered in this study and those are in abundance in the central area of Greater Paramaribo. Wen et al., (2020) in a study done on Hannover, Germany realised that the city centre have limited access to green space and additionally, many of the city's green spaces were small and scattered (Wen, Albert, & Von Haaren, 2020) as observed in this current study. The quantity and size of UGS were varied across Greater Paramaribo, same is observed in research conducted by Abercrombie et al. (2008).

5.3. Social Inequality associated with Accessibility to UGS

To assess the level of social inequality associated with the accessibility to UGS in Greater Paramaribo Region, the current study analysed the access of the population using socio-economic status which are age, ethnicity, and income status. This present study found that statistical there is no proof that the elderly have limited access to UGS through the correlation. This is in line with the findings of Wen, Albert, & Von Haaren (2020) conducted. Also, there was no significant evidence in the current research showing that the children (0-14) have little access to UGS, contrary to the studies of Wen et al. (2020).

Nevertheless, with regards to the locations of schools and elderly homes, the current study showed schools and elderly homes have more access to UGS in the Greater Paramaribo Region than the average resident. When the preference for specific type of UGS for the elderly people is taken into consideration, it can be said that about 50% of the elderly homes have access to UGS which offer areas for gatherings and have walking paths and seating (green squares and public parks). This might be because these type of UGS are not in abundance in the region and the few available are not within accessible range of the elderly homes. For schools, when UGS preferences for children are considered, UGS that provide avenue for exploring, running, sliding, and meeting others, or opportunity to learn new things such as sports field/ playgrounds, public park, green square are accessible to about 20% of schools. The findings of this study is in line with a study done by Sikorska et al., 2020 where they found out UGS types such as public parks and recreational areas were not available to children.

The findings of this research also indicated that some of the ethnic groups have good access to UGS whiles others have limited access to UGS. From the correlation results, it can be said that the ressorts with high percentages of Javanese have the most access to UGS in Paramaribo. This might be because they are concentrated in the eastern parts which have a lot of UGS. Just like the Javanese, the ressorts with high percentages of Hindustani group also have high accessibility to UGS because they are mostly found in the outskirts of the Region which has more areas of UGS.

There is evidence that the ressorts with high percentages of Creoles have the least access to UGS in the Greater Paramaribo Region. This is shown in the correlation between UGS accessibility and the percentage of Creoles. This might be because the Creoles inhabit the very central part of the Greater Paramaribo Region, which is characterised by small sized UGS. The Natives ethnic group also have very limited access to UGS in Greater Paramaribo, this could be because they make up 0.5 to 3 percent of the population and are concentrated in the central areas of the Region. Also, it might be because the study omits very small UGS which is usually found in the central urban areas. This is later discussed in Section 5.4 as a limitation of the study.

Just as suggested by the recent research other studies also observed UGS are unevenly accessed depending on ethnicity. A study within South Africa by Venter, Shackleton, Van Staden, Selomane, & Masterson (2020) observed that UGS is unevenly distributed among the different races and ethnicities. Wen, Zhang, Harris, Holt, & Croft (2011) and Powell et al. (2004) discovered that in the USA, when it comes to race and ethnicity, communities with greater concentrations of minority races were marginalised in access to UGS, corroborating the widely held belief that disadvantaged communities lacked UGS.

The present study shows that statistically there is no significant proof of the ressorts with higher percentages of Maroons and Mixed ethnic groups having limited access to the UGS in the Greater Paramaribo Region. This might be because these ethnic groups are spread throughout the Greater Paramaribo Region as shown in their distribution in **Appendix 4b and 4c**. In contrast with the results obtained in this recent study, research performed in the U.S by Carlson, Brooks, Brown, & Buchner (2010) showed that the majority of the population had access to a community park, and this number did not vary by race or ethnicity.

For the income status of the residents, there was also no significant correlation between it and accessibility to UGS. In line with the current analysis, findings from studies done in Maryland by Abercrombie et al. (2008) showed there was no evidence of limited access to recreation facilities in low income and high-minority neighbourhoods. Timperio, Ball, Salmon, Roberts, & Crawford (2007) also in a study done on Melbourne in Australia proved that the hypothesis that UGS is less in low socio-economic neighbourhoods than high socio-economic neighbourhoods did not hold true and that UGS was dispersed evenly between communities.

In contrast to the recent research, some studies observed that low income neighbourhoods had less access to UGS (Crawford et al., 2008; Estabrooks et al., 2003) whiles others observed low income neighbourhoods had high access to UGS (Moore et al., 2008). Venter, Shackleton, Van Staden, Selomane, & Masterson (2020) discovered that high income areas had more accessible UGS than in low-income areas. Moore et al. (2008) observed parks were generally available in minority and low-income neighbourhoods than in high income ones in Baltimore city.

Other researches also in contrast to recent study had mixed results on income and accessibility. Wen, Zhang, Harris, Holt, & Croft (2011) discovered that in the USA there was mixed findings where some higher income tracts had more access to UGS, and others didn't. Markevych et al. (2017) observed in a study conducted in Munich, Leipzig, Bad Honnef and Wesel that high income families lived in greener areas in Munich and Leipzig areas whereas the opposite was observed for Bad Honnef and Wesel where lower income families lived in greener neighbourhoods. It can be said that the relationship between accessibility and income is not predictable, it varies depending on the geographical area.

All these findings are complimented with the results from the Gini coefficient which shows that there is a relative inequality in UGS distribution in the Greater Paramaribo Region with a value of 0.4. This is evident in the fact that some of the chosen socio-economic factors have high access to UGS and others have limited access to UGS.

5.4. Reflections on the Study

5.4.1. Reflection on Methods and Data

The study used different approaches to achieve the specific research objectives through answering the research questions. For the research question which identifies the types of UGS in Greater Paramaribo Region, OSM data was used. There were a lot of small polygons in the OSM data, which might explain why there were few large UGS. There might have been an underestimation of access to large size UGS due to smaller polygons which might belong to the same UGS not being merged together. With the income data obtained being derived from characterising residences, this might have resulted in the correlation between income and accessibility insignificant.

A manual classification was done by visually interpreting what class a UGS belongs to. This might have resulted in overestimation and underestimation of UGS types than they actually are in reality and the method is time consuming. A supervised classification and high-resolution satellite could have been used for the classification of UGS, if sample and reference data of UGS are available. For the distribution of UGS in the Greater Paramaribo Region, landscape metrics were used. This made it easier to know the types of UGS are spread around the various ressort. The Green Index method (Gupta et al., 2012) is another option of method that could have been used since it considers the area of the ressorts. The network analysis was used in this research for assessing the accessibility to UGS. The length was used as impedance, which resulted in UGS being at long distances being accessible but in reality, people might not want to travel for long period to access UGS. A survey could have also been conducted and this would have solicited for the opinions of residents on the size, number, and their preferences for UGS. The 2SFCA method (Hu et al., 2020; Wei, 2017; Zheng et al., 2019) could have been used if the relationships between available resources and population needs were of importance. The exclusion of UGS less than 2ha in the study might have resulted in the underestimation of accessibility in the central area of Greater Paramaribo.

5.4.2. Strengths and Limitations of Study

This research included a few limitations. Classifying the UGS types manually and using a decision tree, makes it easy to interpret and ends in one output but this method of classification is prone to the judgement of the person performing it and might require some local knowledge on identifying the UGS. The study excluded UGS with areas less than 2ha because they were not included in the English Nature (2003) rules. This might have affected the assessment of accessibility in the central parts of the Greater Paramaribo Region since these areas are dominated by UGS less than 2ha area and densely populated as shown in **Figure 23-34.**

In accessing the relationship between income and accessibility to UGS the income was sampled. A second sampling was made to verify the stability of results, which showed through the correlation produced similar results as the first sample. Also, the income data used is derived from classifying the residential urban areas based on the housing type, spatial features, and land sizes for the income status of residents. This might not be the best way of knowing the income status of residents.

Using the network analysis in accessibility, it considers the effect of the way people move in an urban area. However, this method, as accurate as it may be, has its own flaws, since inhabitants do not always prefer to visit the nearby UGS, but instead to other UGS types available depending on their preferences or use a specific mode of transportation in a particular situation.

The results of aggregating the accessibility to UGS to the 22 ressorts made it hard to distinguish whether the source of low accessibility is due to sizes of UGS or the modes of transport. The use of aggregated values led to some spatial lost, thereby obscuring crucial dynamics in a method and might lead to loss of information(Clark & Avery, 1976). The Gini coefficient for the whole Greater Paramaribo Region was calculated, this showed a relative inequality in distribution of UGS among inhabitant in the Greater Paramaribo Region however this makes it difficult to find individual ressorts that are marginalised considering how diverse the region is.

The socio-economic data obtained was at the ressort level, which is a high spatial level (low spatial resolution), this in effect does not show variation within the ressorts. This therefore generalizes results obtained and made it hard to have detailed patterns that would have been observed if finely grained data was used. Analysing the income and overall accessibility at the pixel level allowed understanding the relationship between them at a finer spatial level.

Despite the fact that these findings give new information about the availability and accessibility of UGS across the ressorts and socio-economic groups, there are certain limitations to the study's scope that is acknowledged. In the various ressorts, there might be additional social and physical structural elements such as safety, the presence of amenities (washrooms, seating, playing facilities etc) and payment to use UGS that may be linked to UGS accessibility however, they were not the study's aims. Residents' active participation, as well as that of urban and environmental planners and policy makers, would be helpful in developing strategies that would help alleviate social inequality and increase fair access to UGS.

From the findings of this research some areas can be suggested for further studies as follows:

- The study used Network analysis for the assessment of the level of accessibility of UGS in the Greater Paramaribo Region. It is suggested that another method such as the 2SFCA be used since it puts into consideration the fact that residents do not always make use of UGS near their residences.
- It is recommended that fragments of UGS belonging to the same UGS be merged together to prevent underestimation of access to large size UGS.
- The sizes and distances of UGS were used in the assessment of accessibility, this can further be improved by conducting interviews in which the needs, uses, or preferences of residents are considered in the accessibility assessment.
- The presences of amenities such as seating, etc can be taken into consideration when studies on accessibility to UGS is being conducted to find marginalized or vulnerable neighbourhoods.
- A more detailed spatial level analysis such as a neighbourhood-level evaluations should be made to better understand the processes behind these observed results, and more study should be done to understand the relationship between accessibility to UGS and socio-economic factors.
- Development of accessibility rules specifically tailored to the needs of countries in the Global South should be considered in research. This is because there are social, political, and cultural differences that varies patterns in terms of access to UGS for developing countries when compared to developed countries (Wei, 2017).

6. CONCLUSION

This chapter summarizes the findings in the study (**Appendix 1**). This includes the methods used to achieve the research objectives, the results obtained, and concludes and recommends actions that can be taken from the results in this research.

Green areas serve a critical role in urban populations' environmental and social well-being. This is because they have many benefits ranging from recreational activities, air quality, reduction in noise pollution to mitigating floods, protecting biodiversity as well as source of livelihood for residents (Lepczyk et al., 2017). Their value has been recognized and thus it's necessary that everyone has easy access to UGS. Therefore, there was the need to investigate how various social groups have access to it. The main objective of the study is to explore the accessibility and issues of social inequality, that is the relationship between accessibility and the socio-economic factors related to UGS in the Greater Paramaribo Region. The study looked at the types of UGS available by classifying them into seven types using a visual interpretation based on aerial images and looking at the distribution of the UGS types. The accessibility to UGS was then done using the sizes of UGS and different modes of transportation with the network analysis. The study also looked at the disparities in the spatial distribution of UGS in the Greater Paramaribo Region. The study finally looked at how UGS accessibility differed across various socio-economic groups by finding the correlation between accessibility and socio-economic factors.

The results from this study corroborate our prediction that UGS are not evenly distributed in the Greater Paramaribo Region. The findings of the study show that most of the residential houses have access to small sizes of UGS within shorter travel distances than large UGS sizes at long distances in the Greater Paramaribo Region. In terms of the prior assumptions made by this study that the minority and low income communities are marginalised, the patterns shown by the research are mixed. While there is significant evidence through correlation that some ethnic groups such as the Natives and Creoles (black descendants) have little access to UGS, there is no correlation showing that children (0-14) and elderly (60 and above) have low access to UGS. However, when the UGS types are considered, the elderly has little access to UGS which offer areas for gatherings and have walking paths and seating (green squares and public parks) and children have little access to UGS that provide avenue for exploring, running, sliding, and meeting others, or opportunity to learn new things such as sports field/ playgrounds, public park, green square. Also, the findings show that access to UGS is not based on the income level of residents. This is also shown in research by Wen et al. (2011) where they realise race and social class are significant influences for access to UGS, but they may not always work in predictable ways. The findings of the evaluation revealed that UGS are few in locations around the city centre, necessitating the expansion of UGS distribution in these locations.

In conclusion there is more variation of the types of UGS available to the residents of the central part of the Greater Paramaribo Region even though there is not much of it. Residents in the outskirts of the Region have more areas of UGS but less in variations. Also, the elderly, and children in the Greater Paramaribo Region are not marginalised when it comes to accessibility to UGS and that the most marginalised groups are the Natives and Creoles. Also, income level of the residents does not influence their accessibility to UGS.

A detailed examination of the availability and accessibility of UGS in Greater Paramaribo is one of the study's strengths. The study has provided a strong example of a research in the Global South that addresses social inequality against minority groups in the society. Furthermore, these findings contribute to a wider discussion about the effects of uneven access to UGS. The research adds to the international conversation on urbanization and the importance of UGS to help mitigate the effects urbanisation has on the society. The study has identified specific areas in the Greater Paramaribo Region were authorities need to pay attention to when it comes to UGS distribution, this will help bridge the gap created by non-uniform UGS distribution.

It is recommended the data may be passed on to policymakers who can utilize the maps and other results of the study to know where UGS are required, particularly in the ressorts. There should be a concentrated effort to increase greenness in disadvantaged ressorts to alleviate the negative impacts of lack of UGS. Given that there are correlations between UGS accessibility and some socio-economic factors, they should be considered in greening cities and planning policies. There might be the need for the integration of residents' accessibility preferences in these policies and greening efforts. The study also found that boosting the mobility of the residents by provision of good roads for the various modes of transportation can somewhat compensate for access issues, allowing them to access large size UGS that are further/distant from their homes.

LIST OF REFERENCES

Abbasi, A., Alalouch, C., & Bramley, G. (2016). Open Space Quality in Deprived Urban Areas: User Perspective and Use Pattern. *Procedia - Social and Behavioral Sciences*, *216*(October 2015), 194–205. https://doi.org/10.1016/j.sbspro.2015.12.028

Abercrombie, L. C., Sallis, J. F., Conway, T. L., Frank, L. D., Saelens, B. E., & Chapman, J. E. (2008). Income and Racial Disparities in Access to Public Parks and Private Recreation Facilities. *American Journal of Preventive Medicine*, *34*(1), 9–15. https://doi.org/10.1016/j.amepre.2007.09.030

Abu Kasim, J., Mohd Yusof, M. J., & Mohd Shafri, H. Z. (2019). The Many Benefits of Urban Green Spaces. *CSID Journal of Infrastructure Development*, *2*(1), 103. https://doi.org/10.32783/csid-jid.v2i1.47

Adebowale, M. (2008). Social justice and public policy: Seeking fairness in diverse societies. In G. Craig, T. Burchardt, & D. Gordon (Eds.), *Social Justice and Public Policy: Seeking Fairness in Diverse Societies* (pp. 251–275). https://doi.org/10.1111/j.1365-2524.2009.00898_5.x

Agarwal, R. (2019). Environmental impacts of urban green space. *Van Sangyan* , *6*(11), 37–40.

Akpinar, A. (2017). Urban green spaces for children: A cross-sectional study of associations with distance, physical activity, screen time, general health, and overweight. *Urban Forestry and Urban Greening*, *25*(March 2016), 66–73. https://doi.org/10.1016/j.ufug.2017.05.006

Algemeen Bureau voor de Statistiek. (2013). *Resultaten Achtste (8e) Volks- en Woningtelling in Suriname (Volume I) : Demografische en Sociale Karakteristieken en Migratie*. *1*(294), 102.

Algemeen Bureau voor de Statistiek. (2014). *Resultaten Achtste (8e) Volks- en Woningtelling in Suriname (Volume II): Onderwijs , Werkgelegenheid en Vervoer Vruchtbaarheid en Sterfte Gezondheid en Sport*. *2*(299), 215.

Almohamad, H., Knaack, A. L., & Habib, B. M. (2018). Assessing Spatial Equity and Accessibility of Public Green Spaces in Aleppo City , Syria. *Forests*, (2016), 1–22. https://doi.org/10.3390/f9110706

Amorim Maia, A. T., Calcagni, F., Connolly, J. J. T., Anguelovski, I., & Langemeyer, J. (2020). Hidden drivers of social injustice: uncovering unequal cultural ecosystem services behind green gentrification. *Environmental Science and Policy*, Vol. 112, pp. 254–263. https://doi.org/10.1016/j.envsci.2020.05.021

Anderson, C., Jackson, K., Egger, S., Chapman, K., & Rock, V. (2014). Shade in urban playgrounds in Sydney and inequities in availability for those living in lower socioeconomic areas. *Australian and New Zealand Journal of Public Health*, *38*(1), 49–53. https://doi.org/10.1111/1753-6405.12130

Arnberger, A., Allex, B., Eder, R., Ebenberger, M., Wanka, A., Kolland, F., … Hutter, H. P. (2017). Elderly resident's uses of and preferences for urban green spaces during heat periods. *Urban Forestry and Urban Greening*, *21*, 102–115. https://doi.org/10.1016/j.ufug.2016.11.012

Ayala-Azcárraga, C., Diaz, D., & Zambrano, L. (2019). Characteristics of urban parks and their relation to user well-being. *Landscape and Urban Planning*, *189*(February), 27–35. https://doi.org/10.1016/j.landurbplan.2019.04.005

Badiu, D. L., IojĂ, C. I., PĂtroescu, M., Breuste, J., Artmann, M., NiţĂ, M. R., … Onose, D. A. (2016). Is urban green space per capita a valuable target to achieve cities' sustainability goals? Romania as a case study. *Ecological Indicators*, *70*, 53–66. https://doi.org/10.1016/j.ecolind.2016.05.044

Barbosa, O., Tratalos, J. A., Armsworth, P. R., Davies, R. G., Fuller, R. A., Johnson, P., & Gaston, K. J. (2007). Who benefits from access to green space? A case study from Sheffield, UK. *Landscape and Urban Planning*, *83*(2–3), 187–195. https://doi.org/10.1016/j.landurbplan.2007.04.004

Biernacka, M., & Kronenberg, J. (2019). Urban Green Space Availability, Accessibility and Attractiveness, and the Delivery of Ecosystem Services. *Cities and the Environment (CATE)*, *12*(1), 5.

Byrne, J., Wolch, J., & Zhang, J. (2009). Planning for environmental justice in an urban national park. *Journal of Environmental Planning and Management*, *52*(3), 365–392. https://doi.org/10.1080/09640560802703256

Carlson, S. A., Brooks, J. D., Brown, D. R., & Buchner, D. M. (2010). Racial/ethnic differences in perceived access, environmental barriers to use, and use of community parks. *Preventing Chronic Disease*, *7*(3).

Çay, R. D., & Aşilioğlu, F. (2016). Benefits of Urban Green Spaces for Citizens : Ankara Case Study. *Ecology of Urban Areas 2014*, (April), 1–8.

Cetin, M. (2015). Using GIS analysis to assess urban green space in terms of accessibility: Case study in

Kutahya. *International Journal of Sustainable Development and World Ecology*, *22*(5), 420–424. https://doi.org/10.1080/13504509.2015.1061066

Chen, Q., Wang, C., Lou, G., Zhang, M., & Wu, S. (2019). Measurement of urban park accessibility from the quasi-public goods perspective. *Sustainability (Switzerland)*, *11*(17), 1–17. https://doi.org/10.3390/su11174573

Chen, W., Huang, H., Dong, J., Zhang, Y., Tian, Y., & Yang, Z. (2018). Social functional mapping of urban green space using remote sensing and social sensing data. *ISPRS Journal of Photogrammetry and Remote Sensing*, *146*(September), 436–452. https://doi.org/10.1016/j.isprsjprs.2018.10.010

Clark, W. A. V, & Avery, K. L. (1976). The Effects of Data Aggregation in Statistical Analysis. *Geographical Analysis*, *VIII*(October).

Commewijne District - Wikipedia. (n.d.).

Crawford, D., Timperio, A., Giles-Corti, B., Ball, K., Hume, C., Roberts, R., … Salmon, J. (2008). Do features of public open spaces vary according to neighbourhood socio-economic status? *Health and Place*, *14*(4), 889–893. https://doi.org/10.1016/j.healthplace.2007.11.002

Czembrowski, P., & Kronenberg, J. (2016). Hedonic pricing and different urban green space types and sizes: Insights into the discussion on valuing ecosystem services. *Landscape and Urban Planning*, Vol. 146, pp. 11–19. https://doi.org/10.1016/j.landurbplan.2015.10.005

Dai, D. (2011). Racial/ethnic and socioeconomic disparities in urban green space accessibility: Where to intervene? *Landscape and Urban Planning*, *102*(4), 234–244. https://doi.org/10.1016/j.landurbplan.2011.05.002

De Ridder, K., Adamec, V., Bañuelos, A., Bruse, M., Bürger, M., Damsgaard, O., … Weber, C. (2004). An integrated methodology to assess the benefits of urban green space. *Science of the Total Environment*, *334–335*, 489–497. https://doi.org/10.1016/j.scitotenv.2004.04.054

Derkzen, M. L., van Teeffelen, A. J., Nagendra, H., & Verburg, P. H. (2017). Shifting roles of urban green space in the context of urban development and global change. *Current Opinion in Environmental Sustainability*, *29*, 32–39. https://doi.org/10.1016/j.cosust.2017.10.001

Dooling, S. (2009). Ecological gentrification: A Research agenda exploring justice in the city. *International Journal of Urban and Regional Research*, Vol. 33, pp. 621–639. https://doi.org/10.1111/j.1468-2427.2009.00860.x

Dwyer, J. F., McPherson, E. G., Schroeder, H. W., & Rowntree, R. A. (1992). Assessing the benefits and costs of the urban forest. *Journal of Arboriculture*, *18*(5), 227–234. https://doi.org/10.1016/0160-7383(93)90095-K

Ekkel, E. D., & de Vries, S. (2017). Nearby green space and human health: Evaluating accessibility metrics. *Landscape and Urban Planning*, *157*, 214–220. https://doi.org/10.1016/j.landurbplan.2016.06.008

English Nature. (2003). *Providing Accessible Natural Greenspace in Towns and Cities*.

Estabrooks, P. A., Lee, R. E., & Gyurcsik, N. C. (2003). Resources for physical activity participation: Does availability and accessibility differ by neighborhood socioeconomic status? *Annals of Behavioral Medicine*, *25*(2), 100–104. https://doi.org/10.1207/S15324796ABM2502_05

Fan, P., Xu, L., Yue, W., & Chen, J. (2017). Accessibility of public urban green space in an urban periphery: The case of Shanghai. *Landscape and Urban Planning*, *165*, 177–192. https://doi.org/10.1016/j.landurbplan.2016.11.007

Feng, S., Chen, L., Sun, R., Feng, Z., Li, J., Khan, M. S., & Jing, Y. (2019). The distribution and accessibility of urban parks in Beijing, China: Implications of social equity. *International Journal of Environmental Research and Public Health*, *16*(24), 1–14. https://doi.org/10.3390/ijerph16244894

Fung-Loy, K., & Rompaey, A. Van. (2017). Detection and Simulation of Urban Sprawl and Social Segregation in Paramaribo , Suriname (1987-2030). *Belgian Geography Day*, (2), 1. Liège, Belgium.

Fung-Loy, K., & Rompaey, A. Van. (2021). Socio-economic and Ethnic Segregation in the Greater Paramaribo Region, Suriname. In M. van Ham, T. Tammaru, R. Ubarevičienė, & H. Janssen (Eds.), *Urban Socio-Economic Segregation and Income Inequality* (The Urban, pp. 487–501). https://doi.org/https://doi.org/10.1007/978-3-030-64569-4

Fung-Loy, K., Van Rompaey, A., & Hemerijckx, L. M. (2019). Detection and Simulation of Urban Expansion and Socioeconomic Segregation in the Greater Paramaribo Region, Suriname. *Tijdschrift Voor Economische En Sociale Geografie*, *110*(3), 339–358. https://doi.org/10.1111/tesg.12350

Garcia, C. S. G., Paiva, P. D. de O., Brück, J., & Sousa, R. de B. (2020). Distribution of urban green spaces: Comparative analysis between cities in different countries. *Ornamental Horticulture*, *27*(1), 8–19. https://doi.org/10.1590/2447-536X.V27I1.2151

Geurs, K. T., & van Wee, B. (2004). Accessibility evaluation of land-use and transport strategies: Review and research directions. *Journal of Transport Geography*, *12*(2), 127–140. https://doi.org/10.1016/j.jtrangeo.2003.10.005

Graça, M., Alves, P., Gonçalves, J., Nowak, D. J., Hoehn, R., Farinha-Marques, P., & Cunha, M. (2018). Assessing how green space types affect ecosystem services delivery in Porto, Portugal. *Landscape and Urban Planning*, Vol. 170, pp. 195–208. https://doi.org/10.1016/j.landurbplan.2017.10.007

Gupta, K., Kumar, P., Pathan, S. K., & Sharma, K. P. (2012). Urban Neighborhood Green Index - A measure of green spaces in urban areas. *Landscape and Urban Planning*, *105*(3), 325–335. https://doi.org/10.1016/j.landurbplan.2012.01.003

Haase, D., Kabisch, S., Haase, A., Andersson, E., Banzhaf, E., Baró, F., … Wolff, M. (2017). Greening cities – To be socially inclusive? About the alleged paradox of society and ecology in cities. *Habitat International*, *64*, 41–48. https://doi.org/10.1016/j.habitatint.2017.04.005

Heidt, V., & Neef, M. (2007). Benefits of Urban Green Space for Improving Urban Climate. *Ecology, Planning, and Management of Urban Forests*, 84–96. https://doi.org/10.1007/978-0-387-71425-7_6

Hepcan, Ş. (2013). Analyzing the pattern and connectivity of urban green spaces: A case study of Izmir, Turkey. *Urban Ecosystems*, *16*(2), 279–293. https://doi.org/10.1007/s11252-012-0271-2

Heynen, N., Perkins, H. A., & Roy, P. (2006). The political ecology of uneven urban green space: The impact of political economy on race and ethnicity in producing environmental inequality in Milwaukee. *Urban Affairs Review*, *42*(1), 3–25. https://doi.org/10.1177/1078087406290729

History of OpenStreetMap - OpenStreetMap Wiki. (n.d.). Retrieved November 27, 2021, from wiki.openstreetmap.org website: https://wiki.openstreetmap.org/wiki/History_of_OpenStreetMap

Hu, S., Song, W., Li, C., & Lu, J. (2020). A multi-mode Gaussian-based two-step floating catchment area method for measuring accessibility of urban parks. *Cities*, *105*(June), 102815. https://doi.org/10.1016/j.cities.2020.102815

Jafri, A. M. S., & Rajaullah, A. M. (2018). Evaluating the Urban Green Spaces: Benefits and Issues. *International Journal of Engineering Research*, *7*(special3), 269. https://doi.org/10.5958/2319-6890.2018.00074.0

Jansson, M., Sundevall, E., & Wales, M. (2016). The role of green spaces and their management in a child-friendly urban village. *Urban Forestry and Urban Greening*, *18*, 228–236. https://doi.org/10.1016/j.ufug.2016.06.014

Jennings, V., Johnson Gaither, C., & Gragg, R. S. (2012). Promoting environmental justice through urban green space access: A synopsis. *Environmental Justice*, *5*(1), 1–7. https://doi.org/10.1089/env.2011.0007

Jennings, V., Larson, L., & Yun, J. (2016). Advancing sustainability through urban green space: Cultural ecosystem services, equity, and social determinants of health. *International Journal of Environmental Research and Public Health*, *13*(2). https://doi.org/10.3390/ijerph13020196

Jim, C. Y., & Chen, S. S. (2003). Comprehensive greenspace planning based on landscape ecology principles in compact Nanjing city, China. *Landscape and Urban Planning*, *65*(3), 95–116. https://doi.org/10.1016/S0169-2046(02)00244-X

Jo, H. (2002). Impacts of urban greenspace on offsetting carbon emissions for middle Korea. *Journal of Environmental Management*, 115–126. https://doi.org/10.1006/jema.2001.0491

Johnston, R., Poulsen, M., & Forrest, J. (2007). Ethnic and racial segregation in U.S. metropolitan areas, 1980-2000: The dimensions of segregation revisited. *Urban Affairs Review*, *42*(4), 479–504. https://doi.org/10.1177/1078087406292701

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

Kabisch, N., Qureshi, S., & Haase, D. (2015). Human-environment interactions in urban green spaces - A systematic review of contemporary issues and prospects for future research. *Environmental Impact Assessment Review*, *50*, 25–34. https://doi.org/10.1016/j.eiar.2014.08.007

Kechebour, B. El. (2015). Modelling of Assessment of the Green Space in the Urban Composition. *Procedia - Social and Behavioral Sciences*, *195*, 2326–2335. https://doi.org/10.1016/j.sbspro.2015.06.187

Kendal, D., Lee, K., Ramalho, C., Bowen, K., Bush, J., Melbourne, T. U. of, & Australian Government's Department!of the Environment. (2016). *Benefits of urban green space in the Australian context: A synthesis*

review for the Clean Air and Urban Landscapes Hub.
Kong, F., Yin, H., James, P., Hutyra, L. R., & He, H. S. (2014). Effects of spatial pattern of greenspace on urban cooling in a large metropolitan area of eastern China. *Landscape and Urban Planning*, *128*, 35–47. https://doi.org/10.1016/j.landurbplan.2014.04.018
Kupfer, J. A. (2012). Landscape ecology and biogeography: Rethinking landscape metrics in a post-FRAGSTATS landscape. *Progress in Physical Geography*, *36*(3), 400–420. https://doi.org/10.1177/0309133312439594
Kuta, A. A., Odumosu, J. O., Gbenga Ajayi, O., Zitta, N. Z., Samail-Ija, H. A., & Adesina, A. E. (2014). Using a GIS-Based Network Analysis to Determine Urban Greenspace Accessibility for Different Socio Economic Groups, Specifically Related to Deprivation in Leicester, UK. *Civil and Environmental Research*, *6*(9), 12–21.
Łaszkiewicz, E., Kronenberg, J., & Marcińczak, S. (2018). Attached to or bound to a place? The impact of green space availability on residential duration: The environmental justice perspective. *Ecosystem Services*, Vol. 30, pp. 309–317. https://doi.org/10.1016/j.ecoser.2017.10.002
Lee, A. C. K., & Maheswaran, R. (2011). The health benefits of urban green spaces: A review of the evidence. *Journal of Public Health*, *33*(2), 212–222. https://doi.org/10.1093/pubmed/fdq068
Lepczyk, C. A., Aronson, M. F. J., Evans, K. L., Goddard, M. A., Lerman, S. B., & Macivor, J. S. (2017). Biodiversity in the City: Fundamental Questions for Understanding the Ecology of Urban Green Spaces for Biodiversity Conservation. *BioScience*, *67*(9), 799–807. https://doi.org/10.1093/biosci/bix079
Li, L., Du, Q., Ren, F., & Ma, X. (2019). Assessing spatial accessibility to hierarchical urban parks by multi-types of travel distance in Shenzhen, China. *International Journal of Environmental Research and Public Health*, *16*(6). https://doi.org/10.3390/ijerph16061038
Li, X., Zhang, C., Li, W., Kuzovkina, Y. A., & Weiner, D. (2015). Who lives in greener neighborhoods? The distribution of street greenery and its association with residents' socioeconomic conditions in Hartford, Connecticut, USA. *Urban Forestry and Urban Greening*, Vol. 14, pp. 751–759. https://doi.org/10.1016/j.ufug.2015.07.006
Lin, Y.-P., Chu, H.-J., & Wu, C.-F. (2010). Spatial pattern analysis of landslide using landscape metrics and logistic regression: a case study in Central Taiwan. *Hydrology and Earth System Sciences Discussions*, *7*(3), 3423–3451. https://doi.org/10.5194/hessd-7-3423-2010
Ma, F. (2020). Spatial equity analysis of urban green space based on spatial design network analysis (sDNA): A case study of central Jinan, China. *Sustainable Cities and Society*, *60*(August 2019), 102256. https://doi.org/10.1016/j.scs.2020.102256
Markevych, I., Maier, W., Fuertes, E., Lehmann, I., von Berg, A., Bauer, C. P., … Heinrich, J. (2017). Neighbourhood greenness and income of occupants in four German areas: GINIplus and LISAplus. *Urban Forestry and Urban Greening*, Vol. 21, pp. 88–95. https://doi.org/10.1016/j.ufug.2016.11.011
Markevych, I., Tiesler, C. M. T., Fuertes, E., Romanos, M., Dadvand, P., Nieuwenhuijsen, M. J., … Heinrich, J. (2014). Access to urban green spaces and behavioural problems in children: Results from the GINIplus and LISAplus studies. *Environment International*, *71*, 29–35. https://doi.org/10.1016/j.envint.2014.06.002
McGarigal, K., Cushman, S. A., Neel, M. C., & Ene, E. (2002). FRAGSTATS: Spatial Pattern Analysis Program for Categorical Maps. *Analysis*, *3.3*(2007), The following citation is recommended by the autho.
Moore, L. V., Roux, A. V. D., Evenson, K. R., McGinn, A. P., & Brines, S. J. (2008). Availability of Recreational Resources in Minority and Low Socioeconomic Status Areas. *American Journal of Preventive Medicine*, *23*(1), 1–7. https://doi.org/10.1016/j.amepre.2007.09.021
Morancho, A. B. (2003). A hedonic valuation of urban green areas. *Landscape and Urban Planning*, *66*(1), 35–41. https://doi.org/10.1016/S0169-2046(03)00093-8
Morar, T., Radoslav, R., Spiridon, L. C., & Păcurar, L. (2014). Assessing Pedestrian Accessibility to Green Space Using GIS. *Transylvanian Review of Administrative Sciences*, (42), 116–139.
Moseley, D., Marzano, M., Chetcuti, J., & Watts, K. (2013). Green networks for people: Application of a functional approach to support the planning and management of greenspace. *Landscape and Urban Planning*, *116*, 1–12. https://doi.org/10.1016/j.landurbplan.2013.04.004
Naipal, S., & Tas, A. (2009). Promotion of sustainable livelihood within the coastal zone of Suriname, with emphasis on Greater Paramaribo and Wanica. *The Adaptation Continuum: Groundwork for the Future*,

251–274.
Nations, U. (2020). Home | Sustainable Development.
Nero, B. F. (2017). Urban green space dynamics and socio-environmental inequity: Multi-resolution and spatiotemporal data analysis of kumasi, ghana. *International Journal of Remote Sensing*, *38*(23), 6993–7020. https://doi.org/10.1080/01431161.2017.1370152
Nicholls, S. (2001). Measuring the accessibility and equity of public parks: A case study using GIS. *Managing Leisure*, *6*(4), 201–219. https://doi.org/10.1080/13606710110084651
Oliveira, S., Andrade, H., & Vaz, T. (2011). The cooling effect of green spaces as a contribution to the mitigation of urban heat: A case study in Lisbon. *Building and Environment*, *46*(11), 2186–2194. https://doi.org/10.1016/j.buildenv.2011.04.034
OpenStreetMap. (n.d.). Retrieved November 27, 2021, from https://www.openstreetmap.org/#map=11/5.8213/-55.1768
Pafi, M., Siragusa, A., Ferri, S., & Halkia, M. (2016). Measuring the Accessibility of Urban Green Areas A comparison of the Green four European cities. *JRC Technical Reports*. https://doi.org/10.2788/279663
Panduro, T. E., & Veie, K. L. (2013). Classification and valuation of urban green spaces-A hedonic house price valuation. *Landscape and Urban Planning*, *120*, 119–128. https://doi.org/10.1016/j.landurbplan.2013.08.009
Paramaribo - Wikipedia. (n.d.).
Park, Y. M., & Kwan, M. (2017). Multi-Contextual Segregation and Environmental Justice Research : Toward Fine-Scale Spatiotemporal Approaches. *International Journal of Environmental Research and Public Health*, *14*(1205). https://doi.org/10.3390/ijerph14101205
Petrić, D. (2019). Environmental justice in the European union: A critical reassessment. *Croatian Yearbook of European Law and Policy*, *15*(1), 216–267. https://doi.org/10.3935/cyelp.15.2019.360
Powell, L., Slater, S., & Chaloupka, F. (2004). The relationship between community physical activity settings and race, ethnicity and socioeconomic status. *Evidence-Based Preventive Medicine*, *1*(2), 135–144.
Qin, J., Liu, Y., Yi, D., Sun, S., & Zhang, J. (2020). Spatial accessibility analysis of parks with multiple entrances based on real-time travel: The case study in Beijing. *Sustainability (Switzerland)*, *12*(18). https://doi.org/10.3390/su12187618
Rigolon, A. (2016). A complex landscape of inequity in access to urban parks: A literature review. *Landscape and Urban Planning*, *153*, 160–169. https://doi.org/10.1016/j.landurbplan.2016.05.017
Rigolon, A., Browning, M., Lee, K., & Shin, S. (2018). Access to Urban Green Space in Cities of the Global South: A Systematic Literature Review. *Urban Science*, *2*(3), 67. https://doi.org/10.3390/urbansci2030067
Rigolon, A., & Flohr, T. L. (2014). Access to parks for youth as an environmental justice issue: Access inequalities and possible solutions. *Buildings*, *4*(2), 69–94. https://doi.org/10.3390/buildings4020069
Rutt, R. L., & Gulsrud, N. M. (2016). Green justice in the city: A new agenda for urban green space research in Europe. *Urban Forestry and Urban Greening*, Vol. 19, pp. 123–127. https://doi.org/10.1016/j.ufug.2016.07.004
Sathyakumar, V., Ramsankaran, R. A. A. J., & Bardhan, R. (2019). Linking remotely sensed Urban Green Space (UGS) distribution patterns and Socio-Economic Status (SES) - A multi-scale probabilistic analysis based in Mumbai, India. *GIScience and Remote Sensing*, *56*(5), 645–669. https://doi.org/10.1080/15481603.2018.1549819
Schüle, S. A., Gabriel, K. M. A., & Bolte, G. (2017). Relationship between neighbourhood socioeconomic position and neighbourhood public green space availability: An environmental inequality analysis in a large German city applying generalized linear models. *International Journal of Hygiene and Environmental Health*, Vol. 220, pp. 711–718. https://doi.org/10.1016/j.ijheh.2017.02.006
Shackleton, C. M. (2006). Urban forestry – a cinderella science in South Africa? *Southern African Forestry Journal*, *208*(1), 1–4. https://doi.org/10.2989/10295920609505255
Shackleton, C. M. (2012). Is there no urban forestry in the developing world? *Scientific Research and Essays*, *7*(40), 3329–3335. https://doi.org/10.5897/sre11.1117
Shackleton, C. M., & Blair, A. (2013). Perceptions and use of public green space is influenced by its relative abundance in two small towns in South Africa. *Landscape and Urban Planning*, *113*, 104–112. https://doi.org/10.1016/j.landurbplan.2013.01.011
Shaw, M., Galobardes, B., Lawlor, D. A., Lynch, J., Wheeler, B., & Smith, G. D. (2017). Gini coefficient.

In *The handbook of inequality and socioeconomic position* (pp. 157–159). https://doi.org/10.2307/j.ctt1t892cc.59
Sikorska, D., Łaszkiewicz, E., Krauze, K., & Sikorski, P. (2020). The role of informal green spaces in reducing inequalities in urban green space availability to children and seniors. *Environmental Science and Policy*, *108*(September 2019), 144–154. https://doi.org/10.1016/j.envsci.2020.03.007
Siljeg, Š., Miloševic, R., & Vilic, E. (2020). Multiscale GIS based analysis of urban green spaces (UGS) accessibility: Case study of sisak (Croatia). *GISTAM 2020 - Proceedings of the 6th International Conference on Geographical Information Systems Theory, Applications and Management*, (Gistam), 240–245. https://doi.org/10.5220/0009470802400245
Silva, C. de S., Viegas, I., Panagopoulos, T., & Bell, S. (2018). Environmental justice in accessibility to green infrastructure in two European Cities. *Land*, *7*(4). https://doi.org/10.3390/land7040134
Smoyer-Tomic, K. E., Hewko, J. N., & Hodgson, M. J. (2004). Spatial accessibility and equity of playgrounds in Edmonton, Canada. *Canadian Geographer*, *48*(3), 287–302. https://doi.org/10.1111/j.0008-3658.2004.00061.x
Sun, C., Lin, T., Zhao, Q., Li, X., Ye, H., Zhang, G., … Zhao, Y. (2017). Spatial pattern of urban green spaces in a long-term compact urbanization process—A case study in China. *Ecological Indicators*. https://doi.org/http://dx.doi.org/10.1016/j.ecolind.2017.09.043
Talen, E. (1997). The social equity of urban service distribution: An exploration of park access in pueblo, colorado, and macon, georgia. *Urban Geography*, *18*(6), 521–541. https://doi.org/10.2747/0272-3638.18.6.521
Talk:Key:highway - OpenStreetMap Wiki. (n.d.). Retrieved November 18, 2021, from https://wiki.openstreetmap.org/wiki/Talk:Key:highway
Talk:Key:landuse - OpenStreetMap Wiki. (n.d.). Retrieved November 18, 2021, from https://wiki.openstreetmap.org/wiki/Talk:Key:landuse
Taylor, L., & Hochuli, D. F. (2017a). Defining greenspace_ Multiple uses across multiple disciplines. *Landscape and Urban Planning*, *158*, 25–38. https://doi.org/https://doi.org/10.1016/j.landurbplan.2016.09.024
Taylor, L., & Hochuli, D. F. (2017b). Defining greenspace: Multiple uses across multiple disciplines. *Landscape and Urban Planning*, *158*, 25–38. https://doi.org/10.1016/j.landurbplan.2016.09.024
Texier, M. Le, Schiel, K., & Caruso, G. (2018). The provision of urban green space and its accessibility: Spatial data effects in Brussels. *PLoS ONE*, *13*(10), 1–17. https://doi.org/10.1371/journal.pone.0204684
Timperio, A., Ball, K., Salmon, J., Roberts, R., & Crawford, D. (2007). Is availability of public open space equitable across areas? *Health and Place*, *13*(2), 335–340. https://doi.org/10.1016/j.healthplace.2006.02.003
Tropenbos Suriname. (2019). Groen Paramaribo. https://doi.org/http://www.groenparamaribo.org/
Tzoulas, K., Korpela, K., Venn, S., Yli-Pelkonen, V., Kaźmierczak, A., Niemela, J., & James, P. (2007). Promoting ecosystem and human health in urban areas using Green Infrastructure: A literature review. *Landscape and Urban Planning*, *81*(3), 167–178. https://doi.org/10.1016/j.landurbplan.2007.02.001
Van de Voorde, T. (2017). Spatially explicit urban green indicators for characterizing vegetation cover and public green space proximity: a case study on Brussels, Belgium. *International Journal of Digital Earth*, *10*(8), 798–813. https://doi.org/10.1080/17538947.2016.1252434
Van Herzele, A., & Wiedemann, T. (2003). A monitoring tool for the provision of accessible and attractive urban green spaces. *Landscape and Urban Planning*, *63*(2), 109–126. https://doi.org/10.1016/S0169-2046(02)00192-5
Vaughan, C. A., Cohen, D. A., & Han, B. (2018). How Do Racial/Ethnic Groups Differ in Their Use of Neighborhood Parks? Findings from the National Study of Neighborhood Parks. *Journal of Urban Health*, *95*(5), 739–749. https://doi.org/10.1007/s11524-018-0278-y
Vaughan, K. B., Kaczynski, A. T., Stanis, S. A. W., Besenyi, G. M., Bergstrom, R., & Heinrich, K. M. (2013). Exploring the distribution of park availability, features, and quality across Kansas City, Missouri by income and race/ethnicity: An environmental justice investigation. *Annals of Behavioral Medicine*, *45*(SUPPL.1), 28–38. https://doi.org/10.1007/s12160-012-9425-y
Venter, Z. S., Shackleton, C. M., Van Staden, F., Selomane, O., & Masterson, V. A. (2020). Green Apartheid: Urban green infrastructure remains unequally distributed across income and race

geographies in South Africa. *Landscape and Urban Planning*, Vol. 203. https://doi.org/10.1016/j.landurbplan.2020.103889

Verrest, H. J. L. . (2010). Paramaribo. *Cities*, *27*, 50–60. https://doi.org/https://doi.org/10.1016/j.cities.2009.07.003

Wang, D., Brown, G., Zhong, G., Liu, Y., & Mateo-Babiano, I. (2015). Factors influencing perceived access to urban parks: A comparative study of Brisbane (Australia) and Zhongshan (China). *Habitat International*, *50*, 335–346. https://doi.org/10.1016/j.habitatint.2015.08.032

Ward Thompson, C., Aspinall, P., Roe, J., Robertson, L., & Miller, D. (2016). Mitigating stress and supporting health in deprived urban communities: The importance of green space and the social environment. *International Journal of Environmental Research and Public Health*, *13*(4). https://doi.org/10.3390/ijerph13040440

Wei, F. (2017). Greener urbanization? Changing accessibility to parks in China. *Landscape and Urban Planning*, *157*, 542–552. https://doi.org/10.1016/j.landurbplan.2016.09.004

Weidum, C. (2014). *Urban Sprawl in Paramaribo - The neglected opportunity to sustain communities in the fringe - Case study: Kwatta Region between the Derde and Vierde Rijweg*. Anton de Kom Universiteit van Suriname.

Wen, C., Albert, C., & Von Haaren, C. (2018). The elderly in green spaces: Exploring requirements and preferences concerning nature-based recreation. *Sustainable Cities and Society*, *38*(July 2017), 582–593. https://doi.org/10.1016/j.scs.2018.01.023

Wen, C., Albert, C., & Von Haaren, C. (2020). Equality in access to urban green spaces: A case study in Hannover, Germany, with a focus on the elderly population. *Urban Forestry and Urban Greening*, *55*(August), 126820. https://doi.org/10.1016/j.ufug.2020.126820

Wen, M., Zhang, X., Harris, C. D., Holt, J. B., & Croft, J. B. (2011). Spatial Disparities in the Distribution of Parks and Green Spaces in the USA. *Annals of Behavioral Medicine*, *23*(1), 1–7. https://doi.org/10.1007/s12160-012-9426-x.Spatial

Wheeler, B. W., Cooper, A. R., Page, A. S., & Jago, R. (2010). Greenspace and children's physical activity: A GPS/GIS analysis of the PEACH project. *Preventive Medicine*, *51*(2), 148–152. https://doi.org/10.1016/j.ypmed.2010.06.001

Wolch, J. R., Byrne, J., & Newell, J. P. (2014). Urban green space, public health, and environmental justice: The challenge of making cities "just green enough." *Landscape and Urban Planning*, *125*, 234–244. https://doi.org/10.1016/j.landurbplan.2014.01.017

World Health Organization. (2017). Urban green spaces: A brief for action. *Regional Office For Europe*, 24.

Wu, J., He, Q., Chen, Y., Lin, J., & Wang, S. (2018). Dismantling the fence for social justice? Evidence based on the inequity of urban green space accessibility in the central urban area of Beijing. *Environment and Planning B: Urban Analytics and City Science*. https://doi.org/10.1177/2399808318793139

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

Xiao, Y., Wang, Z., Li, Z., & Tang, Z. (2017). An assessment of urban park access in Shanghai – Implications for the social equity in urban China. *Landscape and Urban Planning*, Vol. 157, pp. 383–393. https://doi.org/10.1016/j.landurbplan.2016.08.007

Xu, C., Haase, D., Pribadi, D. O., & Pauleit, S. (2018). Spatial variation of green space equity and its relation with urban dynamics: A case study in the region of Munich. *Ecological Indicators*, *93*(May), 512–523. https://doi.org/10.1016/j.ecolind.2018.05.024

Xu, L., You, H., Li, D., & Yu, K. (2016). Urban green spaces, their spatial pattern, and ecosystem service value: The case of Beijing. *Habitat International*, Vol. 56, pp. 84–95. https://doi.org/10.1016/j.habitatint.2016.04.005

Xu, M., Xin, J., Su, S., Weng, M., & Cai, Z. (2017). Social inequalities of park accessibility in Shenzhen, China: The role of park quality, transport modes, and hierarchical socioeconomic characteristics. *Journal of Transport Geography*, *62*(129), 38–50. https://doi.org/10.1016/j.jtrangeo.2017.05.010

Yang, J., Li, C., Li, Y., Xi, J., Ge, Q., & Li, X. (2015). Urban green space, uneven development and accessibility: a case of Dalian's Xigang District. *Chinese Geographical Science*, *25*(5), 644–656. https://doi.org/10.1007/s11769-015-0781-y

You, H. (2016). Characterizing the inequalities in urban public green space provision in Shenzhen, China. *Habitat International*, Vol. 56, pp. 176–180. https://doi.org/10.1016/j.habitatint.2016.05.006

Yuan, Y., Xu, J., & Wang, Z. (2017). Spatial equity measure on urban ecological space layout based on accessibility of socially vulnerable groups-A case study of Changting, China. *Sustainability (Switzerland)*, *9*(9), 1–20. https://doi.org/10.3390/su9091552

Yung, E. H. K., Conejos, S., & Chan, E. H. W. (2016). Public open spaces planning for the elderly: The case of dense urban renewal districts in Hong Kong. *Land Use Policy*, *59*, 1–11. https://doi.org/10.1016/j.landusepol.2016.08.022

Zheng, Q., Zhao, X., & Jin, M. (2019). Spatial accessibility of urban green space based on multiple research scales: A case study of Futian District, Shenzhen. *Ekoloji*, *28*(107), 995–1006.

Zhou, X., & Kim, J. (2013). Social disparities in tree canopy and park accessibility: A case study of six cities in Illinois using GIS and remote sensing. *Urban Forestry and Urban Greening*, *12*(1), 88–97. https://doi.org/10.1016/j.ufug.2012.11.004

Zhou, X., & Rana, M. M. P. (2012). Social benefits of urban green space: A conceptual framework of valuation and accessibility measurements. *Management of Environmental Quality*, *23*(2), 173–189. https://doi.org/10.1108/14777831211204921

Zhou, X., & Wang, Y. C. (2011). Spatial-temporal dynamics of urban green space in response to rapid urbanization and greening policies. *Landscape and Urban Planning*, *100*(3), 268–277. https://doi.org/10.1016/j.landurbplan.2010.12.013

Zuniga-Teran, A. A., & Gerlak, A. K. (2019). A multidisciplinary approach to analyzing questions of justice issues in urban greenspace. *Sustainability (Switzerland)*, *11*(11), 1–22. https://doi.org/10.3390/su11113055

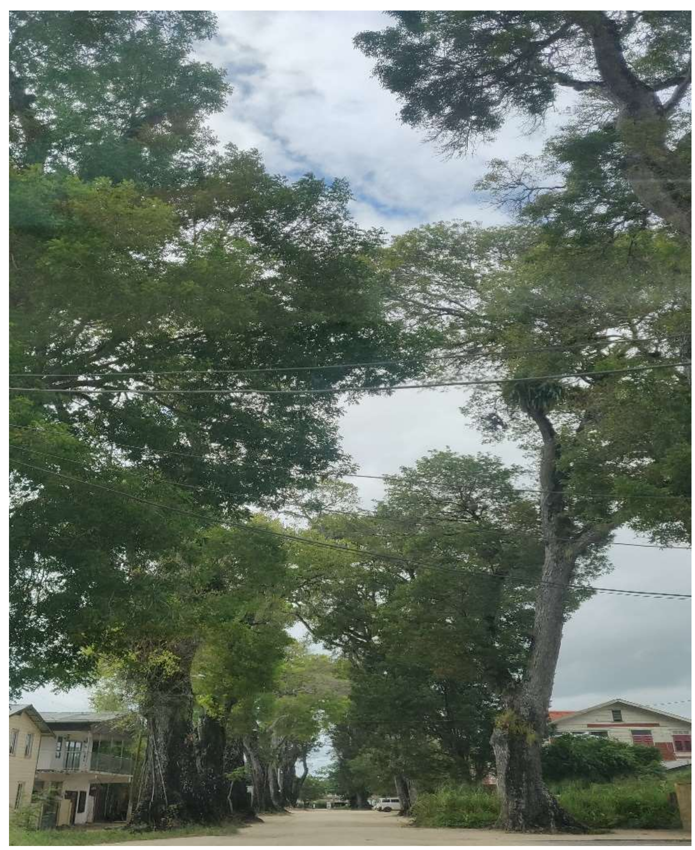
APPENDICES

Appendix 1: Research matrix of the study

Research Questions	Data/Data Collection	Software & Tools	Methods of Data Analysis	Results
Specific Objective 1: To investigate the spatial distribution of green spaces in Greater Paramaribo Region.				
1. What are the types of UGS in Greater Paramaribo?	UGS data from OSM Aerial Image (Google Earth)	ArcGIS	Spatial Analysis (Manual classification) Decision tree	Map of types of UGS in Greater Paramaribo.
2. How are the types of UGS distributed in Greater Paramaribo?	Types of UGS in the Greater Paramaribo Region	ArcGIS	Spatial Analysis (GIS area calculation) Landscape metrics	The area of each type of UGS in ressorts in Greater Paramaribo
3. Does the distribution of UGS in Greater Paramaribo follow a particular pattern?	Types of UGS in the Greater Paramaribo Region	FRAGSTATS Excel	Landscape metrics	Tables and graphs of the landscape metrics showing pattern of UGS in Greater Paramaribo
Specific Objective 2: To assess the level of accessibility to green spaces in Greater Paramaribo Region				
1. What method will be useful for the assessment of the level of accessibility of UGS in Greater Paramaribo?	Scholarly Works	NA	Literature review	A method for the assessment of the level of accessibility of UGS in Greater Paramaribo

2. What is the level of accessibility to UGS in Greater Paramaribo?	OSM data Types of UGS in the Greater Paramaribo Region Transport networks data Administrative boundaries	ArcGIS	Spatial Analysis (Network analysis)	Maps and tables showing accessibility to UGS of different sizes and with different modes of transportation in Greater Paramaribo
3. How many residential houses, schools, and elderly homes in Greater Paramaribo are within accessible ranges of UGS?	Service Areas Residential houses, schools, and elderly homes	ArcGIS	Spatial Analysis (GIS query analysis)	Number of residential houses, schools, and elderly homes in Greater Paramaribo within accessible ranges of UGS
Specific Objective 3: To assess the level of social inequality associated with the accessibility to UGS in Greater Paramaribo Region				
1. What is the level of inequality in UGS distribution in Greater Paramaribo?	UGS Population data	Excel	Gini coefficient	A value showing inequality to UGS distribution in Greater Paramaribo
2. What is the relationship between accessibility of green spaces and socio-economic factors in Greater Paramaribo?	Socio-economic data Overall Accessibility map	RStudio	Pearson correlation Spearman correlation	The relationship between accessibility of UGS and the socio-economic factors in Greater Paramaribo
3. Which socio-economic groups have the highest and least access to green spaces in Greater Paramaribo?	Accessibility results for elderly homes, schools, and random residential houses	ArcGIS	Spatial Analysis	Socio-economic groups with highest and least access to UGS in Greater Paramaribo

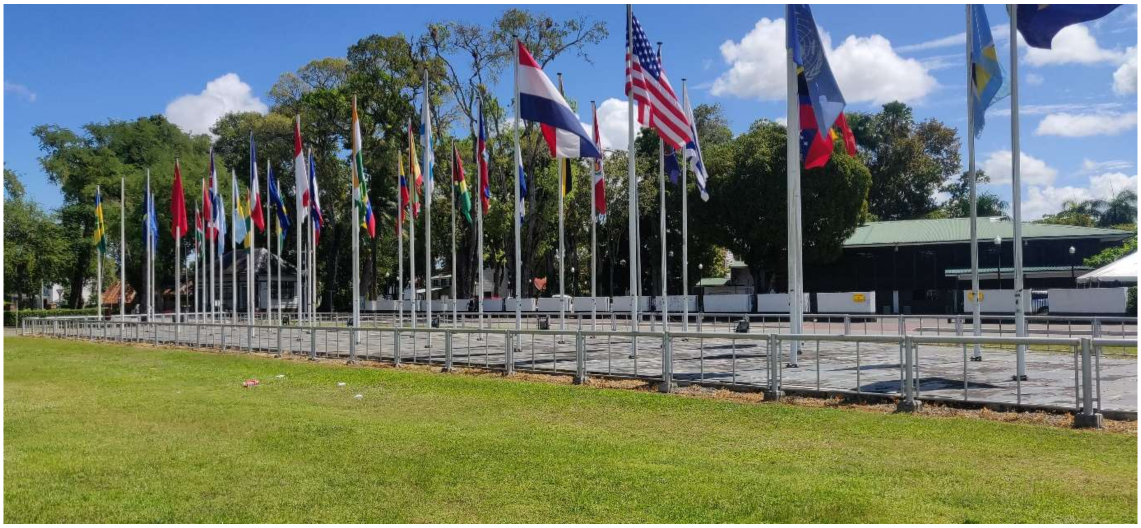
Appendix 2: Examples of UGS in Greater Paramaribo Region



Appendix 2a: Examples of green buffers in Greater Paramaribo Region

Appendix 2b: Examples of forest/forest fragments in Greater Paramaribo Region

Appendix 2c: Examples of playgrounds/ sports field and green squares in Greater Paramaribo Region



Appendix 2d: Examples of public parks in Greater Paramaribo Region

Appendix 3: Landscape metrics values for the study

Appendix 3a: Class Area for the various UGS type per ressort

Ressort	Class Area						
	Forest	Agriculture	Green Buffer	Green Square	Sports field/ Playground	Public park	Private Gardens
Alkmaar	2513.94	2204.43	0	0	0	0	26.51
Beekhuizen	3.45	5.43	17.73	3.06	4.19	1.43	6.72
Blauwgrond	325.32	276.85	117.84	1.94	0.84	7.92	95.38
Centrum	3.92	0.64	5.94	3.25	5.76	5.01	7.84
De Nieuwe Grond	260.73	1636.99	17.43	0	0	0	0
Domburg	426.59	466.45	0	0	0	0	0
Flora	3.77	4	14.14	2.25	0	3.17	10.92
Houttuin	1051.97	2401.89	12.96	0	1.77	0	0.25
Koewarasan	1211.81	4018.38	9.09	0	8.75	0	0
Kwatta	2773.15	1899.85	3.39	0	1.72	0	0
Latour	106.81	53.46	34.18	0.89	0	0	25.07
Lelydorp	4907.01	5589.04	2.97	0	3.1	3.32	0
Livorno	165.16	38.77	23.39	0.97	0	0.3	19
Meerzorg	6218.89	5729	0.76	0	0	44.1	133.85
Munder	170.39	188.57	16.42	0.59	0	0	15.34
Nieuw Amsterdam	2333.67	1919.51	2.39	0	2.42	15.56	99.49
Pontbuiten	120.58	82.42	19.36	1.86	0.29	0.78	34.28
Rainville	197.87	275.49	53.76	0.22	6.04	12.21	21.22
Saramaccapolder	316.32	1210.89	0.56	0	0	0	0
Tammenga	50.58	65.38	26.13	1.64	0	9.63	29.34
Weg naar Zee	512.12	1975.26	37.59	0.25	0	0.89	30.08
Welgelegen	39.29	70.9	29.53	1.03	2.99	2.89	33.51

Appendix 3b: Patch density for the various UGS type per ressort

Ressort	Patch Density						
	Forest	Agriculture	Green Buffer	Green Square	Sports field/ Playground	Public park	Private Gardens
Alkmaar	0.548	1.7493	0	0	0	0	1.1802
Beekhuizen	35.7058	4.7608	321.3521	14.2823	9.5215	11.9019	230.8974
Blauwgrond	7.5052	8.1105	109.068	0.3632	0.1211	1.5737	37.163
Centrum	52.534	9.2707	253.3993	30.9023	24.7219	37.0828	448.0841
De Nieuwe Grond	6.7358	12.3228	1.1487	0	0	0	0
Domburg	3.9192	24.299	0	0	0	0	0
Flora	65.3595	31.3725	366.0131	20.915	0	20.915	397.3856
Houttuin	3.4305	3.8918	0.0577	0	0.0288	0	0.0865
Koewarasan	2.7629	4.9923	0.2477	0	0.0191	0	0
Kwatta	0.6199	3.805	0.0428	0	0.0214	0	0
Latour	23.1387	13.1573	76.6753	1.3611	0	0	150.6284
Lelydorp	2.3036	4.6547	0.0095	0	0.0381	0.0095	0
Livorno	8.8857	18.5791	25.8492	0.4039	0	0.4039	33.9271
Meerzorg	0.2639	1.171	0.0495	0	0	0.0082	1.7152
Munder	18.9108	9.1999	21.7219	0.2556	0	0	24.0219
Nieuw Amsterdam	0.7775	2.2867	0.686	0	0.0229	0.0229	3.8417
Pontbuiten	17.7216	12.7133	51.6238	0.7705	0.3853	0.7705	114.0347
Rainville	14.4669	7.5863	28.581	0.8821	0.8821	1.235	19.7597
Saramaccapolder	4.32	7.7891	0.0655	0	0	0	0
Tammenga	20.2518	21.8938	69.5129	2.1894	0	13.1363	143.4045
Weg naar Zee	2.3864	5.5943	5.0857	0	0.0782	0.0391	5.3204
Welgelegen	32.7523	46.0753	97.7018	2.2205	0.5551	1.6654	220.3841

Appendix 3c: Mean Patch Area for the various UGS type per ressort

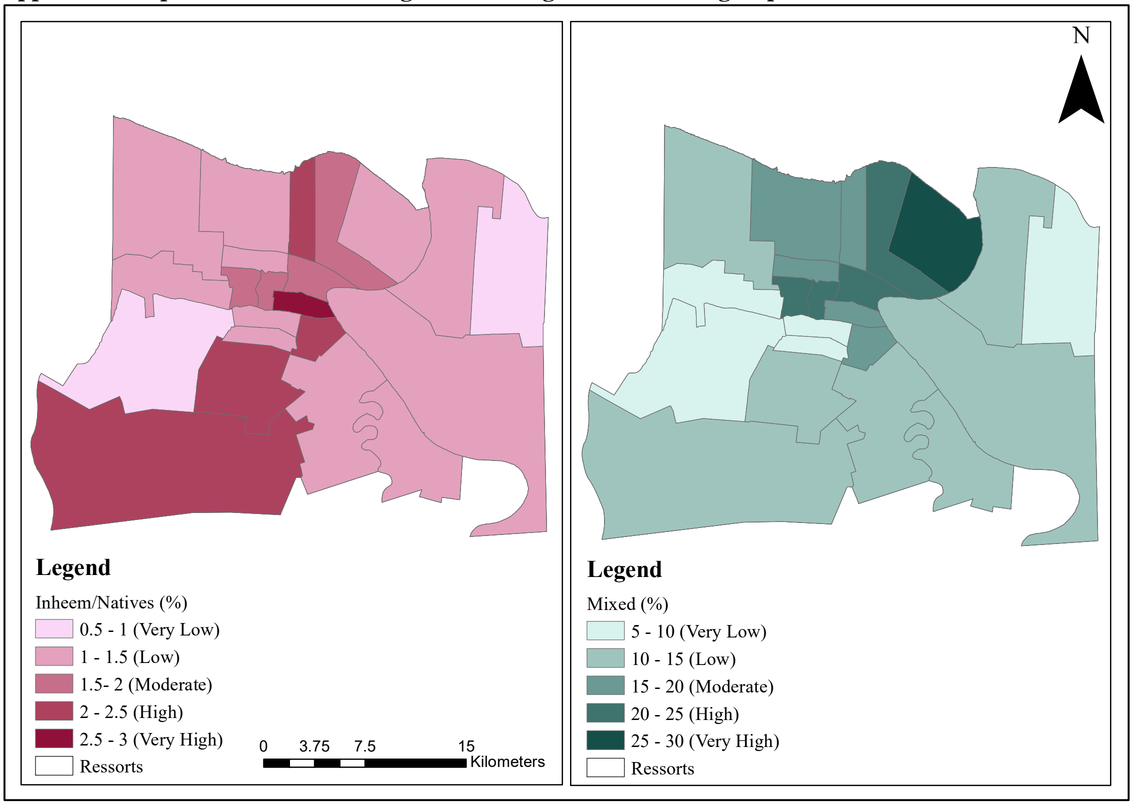
Ressort	Mean Patch Area						
	Forest	Agriculture	Green Buffer	Green Square	Sports field/ Playground	Public park	Private Gardens
Alkmaar	96.69	26.5594	0	0	0	0	0.4734
Beekhuizen	0.23	2.715	0.1313	0.51	1.0475	0.286	0.0693
Blauwgrond	5.2471	4.1321	0.1308	0.6467	0.84	0.6092	0.3107
Centrum	0.2306	0.2133	0.0724	0.325	0.72	0.4175	0.0541
De Nieuwe Grond	2.0212	6.9364	0.7923	0	0	0	0
Domburg	12.1883	2.1495	0	0	0	0	0
Flora	0.1508	0.3333	0.101	0.2813	0	0.3963	0.0718
Houttuin	8.8401	17.7918	6.48	0	1.77	0	0.0833
Koewarasan	8.3573	15.3373	0.6992	0	8.75	0	0
Kwatta	95.6259	10.6733	1.695	0	1.72	0	0
Latour	2.0943	1.8434	0.2022	0.2967	0	0	0.0755
Lelydorp	20.2769	11.4295	2.97	0	0.775	3.32	0
Livorno	7.5073	0.8428	0.3655	0.97	0	0.3	0.2262
Meerzorg	194.3403	40.3451	0.1267	0	0	44.1	0.6435
Munder	2.3026	5.2381	0.1932	0.59	0	0	0.1632
Nieuw Amsterdam	68.6374	19.1951	0.0797	0	2.42	15.56	0.5922
Pontbuiten	2.6213	2.4976	0.1445	0.93	0.29	0.39	0.1158
Rainville	2.413	6.4067	0.3319	0.044	1.208	1.7443	0.1895
Saramaccapolder	4.7927	10.1755	0.56	0	0	0	0
Tammenga	1.367	1.6345	0.2057	0.41	0	0.4013	0.112
Weg naar Zee	8.3954	13.813	0.2892	0.125	0	0.89	0.2212
Welgelegen	0.6659	0.8542	0.1678	0.2575	2.99	0.9633	0.0844

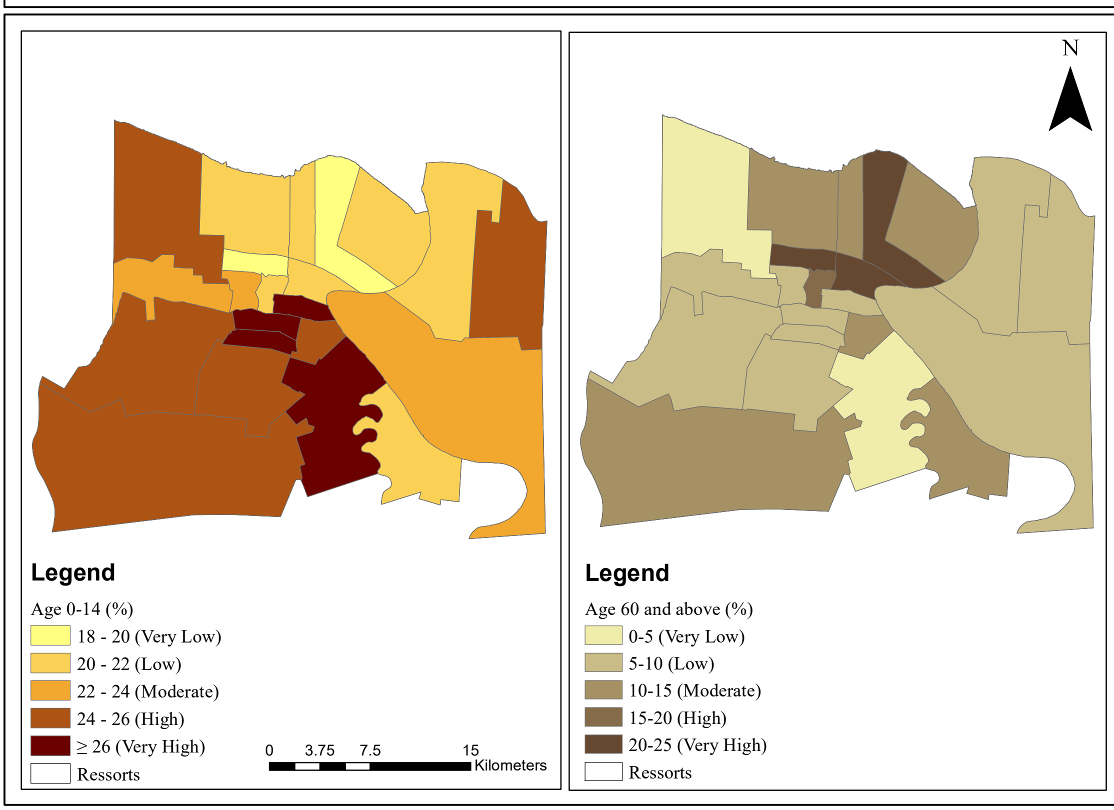
Appendix 3d: Aggregation Index for the various UGS type per ressort

Ressort	Aggregation Index						
	Forest	Agriculture	Green Buffer	Green Square	Sports field/ Playground	Public park	Private Gardens
Alkmaar	99.04	96.9135	0	0	0	0	82.1889
Beekhuizen	76.6871	96.5351	65.6458	88.0416	92.4718	81.2977	58.5139
Blauwgrond	95.773	95.1106	63.863	94.7222	93.9597	85.2652	74.5551
Centrum	75.672	80.3571	49.1659	78.7928	86.2319	81.7137	46.0317
De Nieuwe Grond	90.4463	94.3191	60.582	0	0	0	0
Domburg	95.9967	90.2862	0	0	0	0	0
Flora	74.8252	85.2632	68.2413	85.2381	0	84.1137	58.0066
Houttuin	95.5122	95.8402	83.6905	0	96.9419	0	62.5
Koewarasan	94.4378	96.1557	67.5583	0	98.284	0	0
Kwatta	99.5401	97.2566	95.7878	0	98.1073	0	0
Latour	92.0492	90.8677	69.4151	65.4088	0	0	57.5412
Lelydorp	97.5532	95.6955	84.7943	0	86.6438	97.4482	0
Livorno	93.9312	87.0363	77.0574	77.0115	0	91.8367	74.4881
Meerzorg	99.2256	97.9697	38.0597	0	0	96.3048	83.0658
Munder	93.4528	96.135	71.549	89.2157	0	0	73.0679
Nieuw Amsterdam	98.7318	94.1845	38.0313	0	98.6726	98.912	76.1346
Pontbuiten	89.7933	91.9396	69.5296	92.7326	91.4894	90.5797	65.42
Rainville	92.0086	97.7431	79.0193	64.7059	94.8187	91.1467	73.4763
Saramaccapolder	94.999	95.4266	96.9072	0	0	0	0
Tammenga	89.0805	90.6923	69.5101	87.0861	0	77.5094	65.4454
Weg naar Zee	95.5429	96.7584	76.2542	70		97.4843	76.9387
Welgelegen	87.9333	87.9095	71.8303	87.5676	94.849	92.6471	61.9344

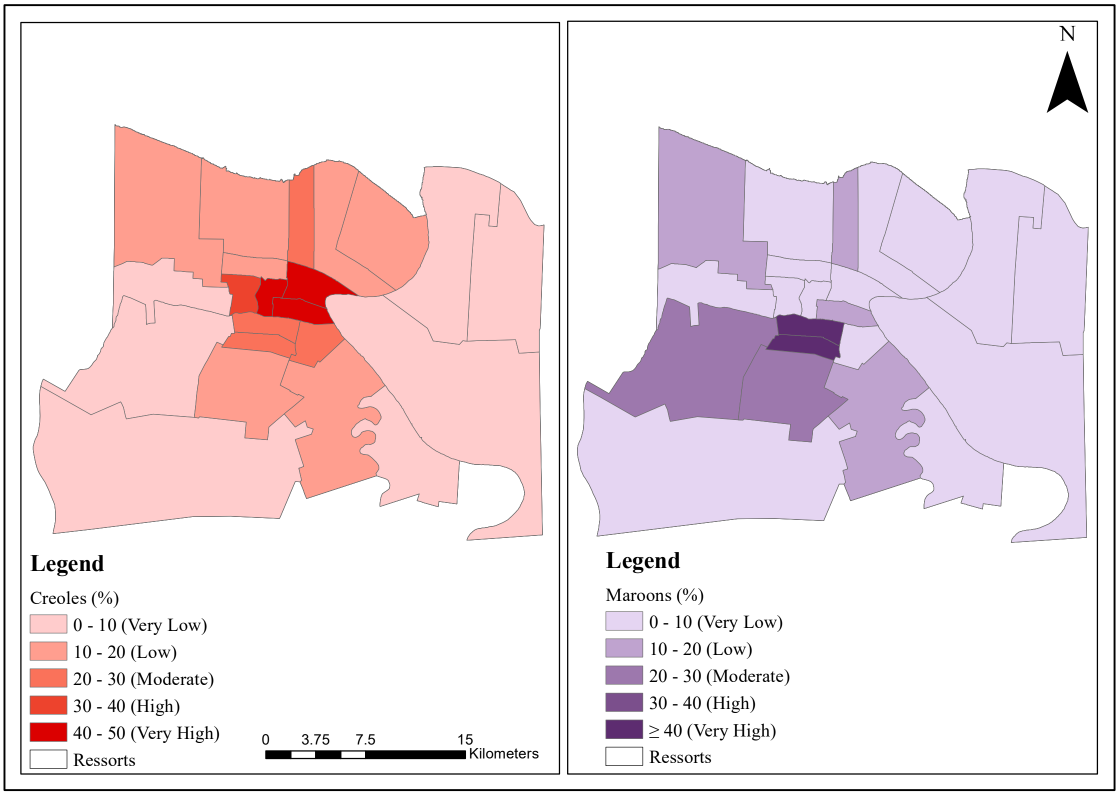
Appendix 4: Visualization of the spatial distribution of socio-economic factors

Appendix 4a: Spatial distribution of Age 0-14 and Age 60 and above groups in Greater Paramaribo

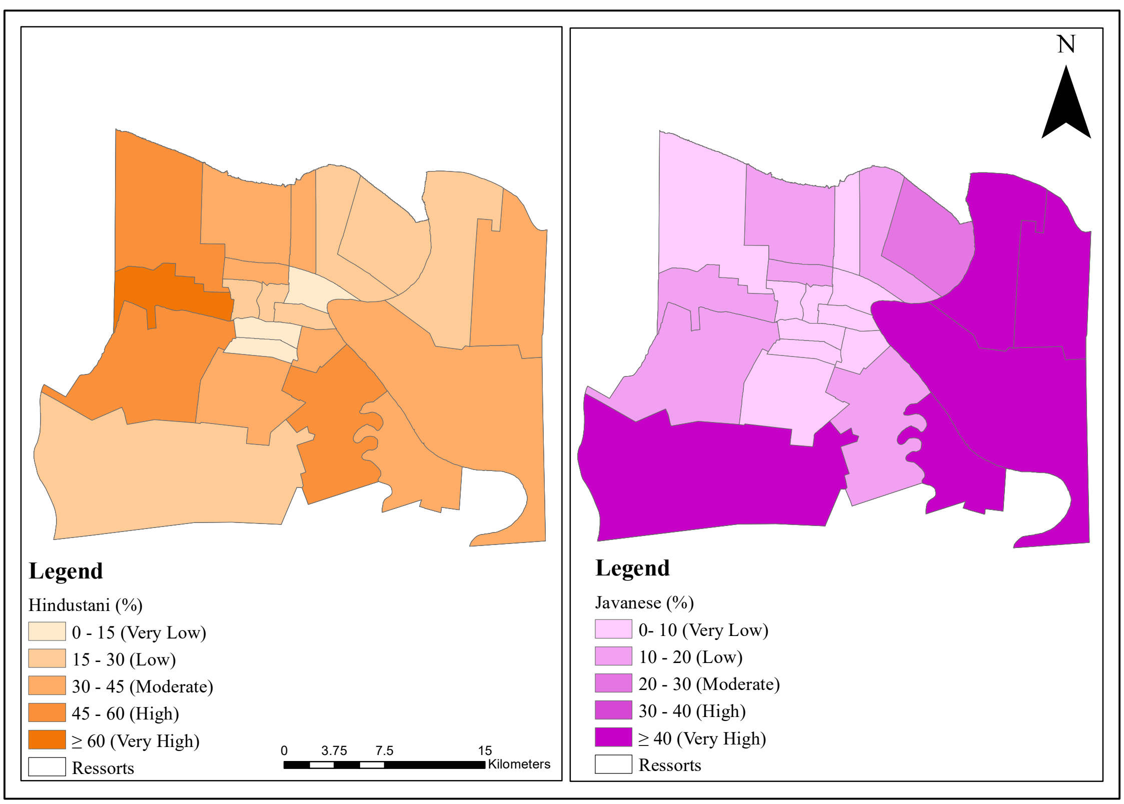




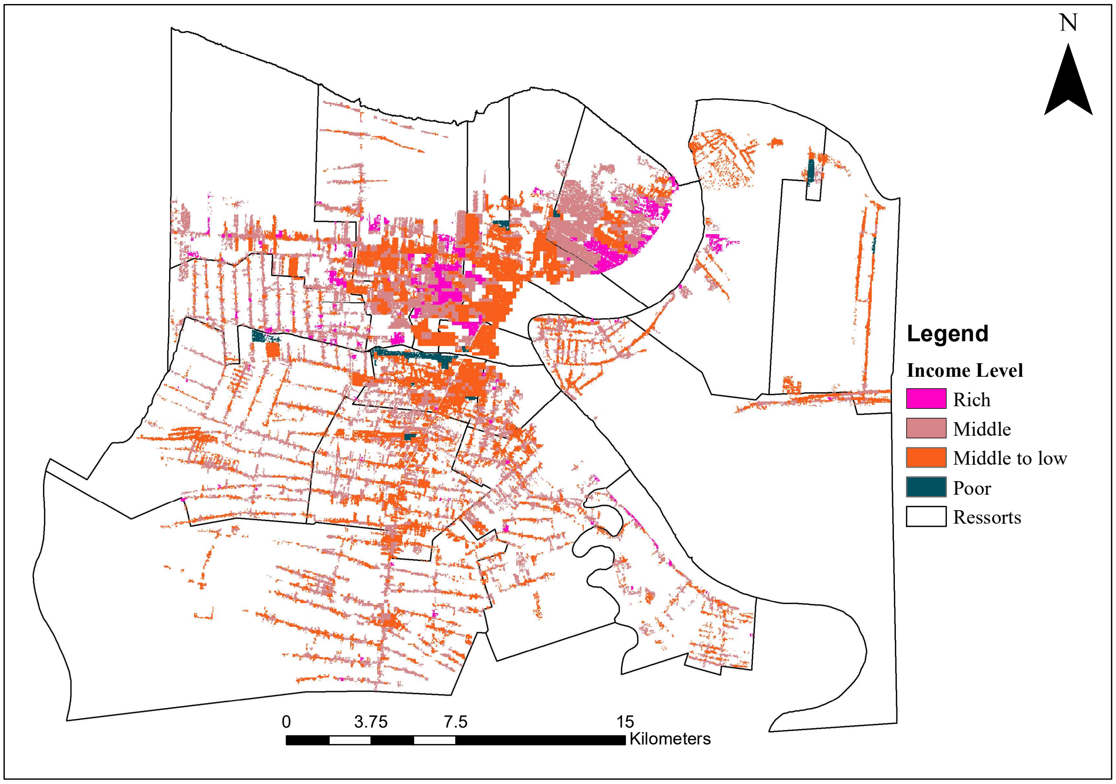
Appendix 4b: Spatial distribution of Natives and Mixed ethnic groups in Greater Paramaribo



Appendix 4c: Spatial distribution of Creoles and Maroons ethnic groups in Greater Paramaribo



Appendix 4d: Spatial distribution of Hindustani and Javanese ethnic groups in Greater Paramaribo



Appendix 4e: Spatial distribution of residential classes in Greater Paramaribo