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Just Development or Just *Development*?

A Spatial Justice Approach to Urban Green Space in Padova

Supervisor: Prof. Silvia Piovan

Candidate: Antonia Sophia von Buttlar

Registration number: 2007106

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Student's signature

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ABSTRACT

Cities constitute increasingly important spaces for development. Based on the premise that there is a fundamental nexus between urban green space and sustainable local development, this research investigates intra-urban socio-spatial inequalities in the accessibility of urban greenery. Based on a theoretical framework on urban spatial justice comprising socio-spatial and environmental justice conceptions, related patterns of park accessibility in the city of Padova are investigated in terms of socio-spatial differences, and assessed in terms of their consequences for development. By adopting a two-step measurement approach on accessibility and justice patterns, and through the utilization of spatial multi-criteria assessment tools by which the three key accessibility factors - quantity, proximity and quality - are integrated, Padova's urban green space accessibility patterns and their meaning are analyzed with geospatial GIS methodology. Findings show not only an overall lack of sufficiently accessible green space across the urban space, but also significant socio-spatial accessibility differences among the city's administrative units. By exemplifying this world-wide issue on a local case, the account given by this research contributes to the generation of a better understanding of both, the interrelation of green space and local development, and the need of adopting a spatial justice approach in related urban planning.

Keywords: local development, urban green space, spatial justice, GIS analysis, Padova

ABSTRACT IN ITALIANO

Le città costituiscono spazi di sviluppo sempre più importanti. Partendo dal presupposto che esiste un nesso fondamentale tra spazio verde urbano e sviluppo locale sostenibile, questa ricerca indaga le disuguaglianze socio-spaziali intra-urbane relative all'accessibilità del verde urbano. Sulla base di un quadro teorico sulla giustizia spaziale urbana che comprende concezioni di giustizia socio-spaziale e ambientale, i relativi modelli di accessibilità dei parchi nella città di Padova sono studiati in termini di differenze socio-spaziali e valutati in termini di conseguenze per lo sviluppo. Adottando un approccio di misurazione in due fasi sui modelli di accessibilità e giustizia, e attraverso l'utilizzo di strumenti di valutazione spaziale multi-criterio mediante i quali sono integrati i tre fattori chiave di accessibilità - quantità, prossimità e qualità -, i modelli di accessibilità degli spazi verdi urbani di Padova e il loro significato sono analizzati in questa ricerca con metodologia GIS geospaziale. I dati raccolti mostrano, non solo una generale mancanza di spazio verde sufficientemente accessibile in tutto lo spazio urbano, ma anche significative differenze di accessibilità socio-spaziale tra le unità amministrative della città. Esemplificando questo problema mondiale su un caso locale, i risultati forniti da questa ricerca contribuiscono a generare una migliore comprensione sia dell'interrelazione tra spazio verde e sviluppo locale, sia della necessità di adottare un approccio di giustizia spaziale nei relativi problemi di pianificazione urbana.

Keywords: sviluppo locale, spazio verde urbano, giustizia spaziale, analisi GIS, Padova

ACRONYMS AND ABBREVIATIONS

AFA	Addition of factors approach
CRS	Coordinate Reference System
GIS	Geographic Information System
MCA	Multi-criteria analysis
MCDA	Multi-criteria decision analysis
MCDM	Multi-criteria decision making
NUA	New Urban Agenda
NGP	Nominal Group Process
OSM	Open Street Map
PD	Padova (province)
PdV	Piano del Verde
PGS	Public green space
QGIS	Quantum Geographic Information System
SDGs	Sustainable Development Goals
SES	Socioeconomic status
SMCA	Spatial multi-criteria analysis
UGS	Urban Green Space(s)
UN	United Nations
UNDESA	UN Department of Economic and Social Affairs
WHO	World Health Organization
WLC	Weighted linear combination
ZIP	Zona Industriale Padova

LIST OF FIGURES

Figure 1: Sustainable development matrix. 8
Figure 2: Sustainable local development matrix. 10
Figure 3: Nexus between sustainable development and UGS. 14
Figure 4: UGS accessibility located within the sustainability matrix. 24
Figure 5: Theoretical framework and coverage. 26
Figure 6: Padova's geographic context. 28
Figure 7: Padova's administrative division. 30
Figure 8: Padova’s population density per consulta. 31
Figure 9: UGS in Padova. 34
Figure 10: Three factors of UGS accessibility. 45
Figure 11: Socio-spatial justice items. 47
Figure 12: Two-step measurement approach. 48
Figure 13: MCA logic. 51
Figure 14: MCA logic in this research. 62
Figure 15: Example of F1 computation based on field statistics tool (here: consulta 1). 70
Figure 16: Example of F2 computation based on PdV network analysis (here: consulta 6B). 71
Figure 17: Example of F3 computation based on park quality data (here: consulta 5B). 72
Figure 18: Parks across the neighborhoods. 76
Figure 19: F1 results: park quantity. 78
Figure 20: F2 results: park proximity. 80
Figure 21: F3 results: park quality. 82
Figure 22: MCA logic of integration 83
Figure 23: MCA WLC results: park accessibility. 84
Figure 24: Population density 87
Figure 25: Demographics. 89
Figure 26: Spatial accessibility patterns. 90
Figure 27: Comparison of spatial factor patterns. 91
Figure 28: Zoom-in of proximity analysis specificities. 97
Figure 29: Distribution of frequencies among the fulfilled quality features. 98
Figure 30: Figure 30: Zoom-in of spatial particularities. 103

LIST OF TABLES

Table 1: Operationalization of concepts into measures. 48
Table 2: MCA matrix for quantity (F1). 54
Table 3: MCA matrix for proximity (F2). 57
Table 4: MCA matrix for quality (F3). 60
Table 5: MCA matrix for UGS accessibility in Padova. 62
Table 6: QGIS attribute field codes and meaning (UGS accessibility results). 73
Table 7: QGIS attribute field codes and meaning (socio-spatial demographics). 74
Table 8: Computational UGS accessibility results of F1. 77
Table 9: Computational UGS accessibility results of F2. 79
Table 10: Computational UGS accessibility results of F3. 81
Table 11: Computational UGS accessibility outputs of WLC MCA integration. 83
Table 12: Demographics for justice assessment. 86

GLOSSARY OF ITALIAN VOCABULARY

Centro	Center
Città	City
Comitato per lo sviluppo del verde pubblico	Committee for the Development of Public Green
Comune/i	Municipality/ies
Consulta/e	Councils, here: neighborhoods
Est	East
Euganean hills	Colli Euganei
Giardini	Gardens
Centesimento delle Aree Verdi	Census of green areas
Il Piano del Verde	The Green Plan
L'area metropolitana di Patreve	Metropolitan Area "PaTreVe"
Laguna di Venezia	Venetian Lagoon
Linee guida per la gestione del verde urbano e prime	Guidelines for the Management of UGS and Sustainable
Nord	North
Norme per lo sviluppo degli spazi verdi urbani	Norms on the Development of Urban Green Spaces
Ovest	West
Padova	City of Padua
Padova in Cifre	Padova in numbers. Statistical report.
Parchi	Parks
Parchi gioco ed aree gioco/verde degli impianti sportivi	Parks with playgrounds and sports areas
Percorso partecipato di Agenda 21 sul Piano del verde	Participatory Process of Agenda 21 on the Green Plan
Percorso partecipo	Participatory process
Piano d'azione per l'energia sostenibile e il clima	Action plan for sustainable energy and the climate
Pianura Padana	Po Valley
Prealpi Venete	Venetian Prealps
Provinca/e	Province/s
Quartiere/i	Neighborhood/s
Regione/i	Region/s
Settore Verde, Parchi e Agricoltura Urbana	Sector for Green, Parks and Agriculture
Strategia Parchi e accessibilità	Strategy Parks and Accessibility
Sud	South
Ufficio Gestione verde pubblico	Office of the Management of Public Green
Unità urbana/e	Urban unit/s
Verde di prossimità	Proximity green - here: neighborhood park terminology

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION ... 1
1.1 CITIES, GREEN SPACE AND DEVELOPMENT ... 1
1.2 RESEARCH CONTEXT ... 2
1.3 RESEARCH PARAMETERS ... 3
1.4 CHAPTER OUTLINE ... 5
CHAPTER 2: THEORETICAL FRAMEWORK ... 7
2.1 SPACES OF SUSTAINABLE DEVELOPMENT ... 7
2.1.1 LOCAL SPACE ... 9
2.1.2 Urban Space ... 10
2.1.3 Urban Green Space ... 12
2.2 SOCIO-SPATIAL EQUALITY AND GREEN SPACE ACCESSIBILITY ... 14
2.2.1 Socio-Spatial Justice ... 15
2.2.2 Environmental Justice ... 20
2.3 THEORY: A SPATIAL JUSTICE APPROACH ... 25
CHAPTER 3: CASE STUDY ... 27
3.1 SOCIO-SPATIAL CONTEXT ... 27
3.1.1 Spatial Environment ... 27
3.1.2 Social Structures ... 30
3.2 URBAN DEVELOPMENT PLANNING ... 32
3.2.1 Sustainable Development Approach ... 32
3.2.2 Urban Green Space Planning ... 33
CHAPTER 4: METHODOLOGICAL APPROACH ... 37
4.1 MEASURES ... 37
4.1.1 Neighborhood Parks ... 38
4.1.2 Three Factors of Accessibility ... 40
4.1.3 Justice Items ... 46
4.1.4 Two-Step Measurement Approach ... 48

4.2 ASSESSMENT FRAMEWORK 49
4.2.1 Multi-Criteria Analysis 49
4.2.2 Accessibility Standards 52
4.2.3 MCA Assessment Matrix 61
4.3 GEOSPATIAL METHODS 63
4.3.1 GIS Equity Mapping 63
4.3.2 Data 65
4.3.3 Workflow 67
CHAPTER 5: RESULTS 75
5.1 PADOVA'S PARKS 75
5.2 PARK (IN)ACCESSIBILITY PATTERNS 77
5.2.1 Park Quantity 77
5.2.2 Park Proximity 79
5.2.3 Park Quality 80
5.2.4 Integrated Accessibility Results 82
5.3 SOCIO-SPATIAL (IN)JUSTICE PATTERNS 84
5.3.1 Social (In)Equality 85
5.3.2 Spatial (In)Equality 89
CHAPTER 6: DISCUSSION 93
6.1 UNDERSTANDING THE ANALYTICAL FINDINGS 93
6.1.1 Accessibility Results Evaluation 94
6.1.2 Inequality Results Evaluation 100
6.2 CONSEQUENCES OF THE FINDINGS 104
6.2.1 Local Development Implications 104
6.2.2 Urban Planning Implications 106
CHAPTER 7: CONCLUSION 109
BIBLIOGRAPHY & WEBLIOGRAPHY **111**

CHAPTER 1: INTRODUCTION

1.1 CITIES, GREEN SPACE AND DEVELOPMENT

"The future of humanity is undoubtedly urban" – in a nutshell, this statement by the current World Cities Report (UN Habitat, 2022, p.2) sums up the great contemporary importance of urban space for human life on earth. With most of the world population residing in cities, a process that is only projected to increase, urban contexts are considered fundamental for human interaction (Ulbrich et al, 2018). The last years have therefore seen a rising interest into the future of cities among actors across societies around the world, made ever more urgent by the implications of the Covid-19 pandemic for urban areas, which resulted in the agreement "that urbanization remains a powerful twenty-first century mega-trend" (UN Habitat, 2022, p.3).

The importance of cities for global development is thus "undisputed" (Ulbrich et al, 2019, p.6): Urban space is explicitly included in the current sustainable development agenda, in which it is proclaimed that cities are "key in finding solutions" for global challenges (UN Habitat, 2018, p.4). Moreover, as United Nations (UN) Secretary-General Antònio Guterres declared, it is increasingly recognized that in this regard, the "local is the space where we connect the dots" of global development aspirations (UN Habitat, 2022).

In this context, the significance of the local urban space for sustainable development is widely acknowledged, and one particular urban space is commonly emphasized for its special developmental benefits, namely urban green space (UGS): Since urban greenery offers a space of human-nature connection, it has been found that it produces a broad range of positive effects for human well-being, social cohesion, and the quality of life of people residing in cities, due to which UGS are considered fundamental for urban sustainable development (e.g. Sun *et al*, 2022, p.1; de Sousa Silva *et al*, 2018, p.1; Venter *et al,* 2020, p.11; Panagopolous *et al*, 2015, p.141).

While cities are spaces with a high potential for sustainable development, they also constitute spaces in which persisting issues are more aggregated. One of the most pressing issues for global sustainable development are growing inequalities, which were found to be even more apparent in urban environments, with detrimental consequences for local development prospects (OECD, 2016, p.3). Moreover, intra-urban inequalities have been found to manifest in the frequent green space accessibility discrepancies across urban space and society (e.g. Panagopolous *et al*, 2015, p.137), thus reducing the positive well-being effects of these spaces. Such urban injustice can thus be understood as impeding on development not only by its harmful nature, but especially since the effects of related inequalities include the hampering of important spaces' development potential, which otherwise might have alleviated it. This research is concerned with this issue of intra-urban socio-spatial inequalities in accessing to urban greenery, and investigates the matter in the Venetian city of Padova, which has recently proclaimed a progressive urban sustainable development approach to local green space planning (Padovanet, D, 2022).

1.2 RESEARCH CONTEXT

The positive connection between cities, green space and development has been approached not only by developmental agencies, policymakers and related civil society organization, but has also increasingly been taken up as a research topic in academic literature. By nature, the research on this multi-faceted subject ranges over a multitude of scholarly disciplines, from land use, urban planning and environmental sciences to sustainability research (Sun *et al*, 2022, pp.2-5). Studies on cities' green spaces were undertaken internationally, from Australia to Bangladesh, from China to Syria, from the US to Ghana, and from Canada to Italy (ibid, p.6). Across these studies, it has been unanimously found that there is, in fact, a global intra-urban inequity in UGS accessibility (ibid, pp.2-5).

However, despite the wide coverage on the topic across international scholarship, there are some significant research gaps that are yet to be comprehensively attended to: first, related to the nexus between green space and development, in regard to which the specific principles of the growing body of local development research were not explicitly included, thus the need to analyze the unique local configurations when considering development matters has not been explicitly included as the theoretical basis for such research. As stated by Sun et al (2022), it is however crucial to review local contextualities in relation to UGS access inequalities in order to obtain a better understanding of the underlying mechanisms of this issue (Sun *et al*, 2022, p.2).

Furthermore, there continue to be research gaps in terms of the provision of comprehensive theoretical justice frameworks serving to base the assessment of socio-spatial UGS-related inequalities: To understand urban injustice patterns, it is vital to connect the analysis of spatial patterns and social inequality to a spatial justice dimension in order to identify their consequences for local development (OECD, 2018, p.3; Han, 2022, p.2).

Apart from these overall research needs, it has been argued that there is, moreover, the necessity of increasing the, currently limited, investigation of particular types of UGS, especially of parks, that were found to be particularly important in terms of providing a space with potential for well-being (Willemse, 2015, p.15; Willemse, 2018, pp.916-918).

Finally, as regards the particular research context to which this study will contribute, research on UGS accessibility in the city of Padova, the case of interest, may likewise be considered to show some significant research gaps: While it has been established that socio-spatial inequalities are a frequent issue in the matter of UGS accessibility, related studies have not included the necessary theoretical justice approach to identify such inequalities across Padova's urban space. Furthermore, from a methodological point of view, accessibility measures of local studies into the matter have yet to comprehensively integrate the various accessibility criteria adopted in state-of-the-art international literature, which may be considered to preclude them from providing a comprehensive picture of the accessibility of green spaces across the city.

1.3 RESEARCH PARAMETERS

The objective of this research is to fill the aforementioned research gaps. Based on the identified research problem of how the nexus between UGS and local sustainable development can be understood from a justice point-of-view, the aim of this study is thus to contribute to the literature on UGS and accessibility by providing a local development, justice dimension, and to the body of research concerned with the nexus of cities and development by providing an account on the importance of UGS, particularly parks, and their equal accessibility.

More specifically, the research aims at offering a theory-founded account of the UGS accessibility situation in the city of Padova, based on the development of a state-of-the-art methodological framework designed to comprehensively analyze related urban patterns and thereby identify socio-spatial (in)justices and their development consequences. Accordingly, the research interest underlying this study is two-fold:

Based on a justice approach to the nexus of sustainable local development and UGS,

1. ***what are the intra-urban socio-spatial patterns of park accessibility in the city of Padova,…***
2. ***…and how can these patterns be understood?***

Accordingly, the objectives of this research to conclusively answer this two-part question are the following: first, to establish the nexus of UGS and sustainable development from a spatial local development perspective, second, to provide a theoretical framework on intra-urban socio-spatial justice in relation to this nexus, third, to provide the specific contextual particularities as a background to the local case study in line with the requirements of local development research, fourth, to develop a comprehensive methodological approach that enables the identification of Padova's socio-spatial UGS accessibility patterns, and finally, to produce, assess and discuss the results in relation to the research question.

It is hypothesized that, in line with the aforementioned globally found inequality in this regard, the undertaken analysis will exemplify global trends in their local particularity and show significant socio-spatial differences in park accessibility across the city. While the urban planning bodies of the city of Padova proclaimed a sustainable development agenda in accordance with international principles, findings in line with this hypothesis would suggest that the existing state of local development cannot be considered *just* but rather a form of *development* that lacks a comprehensive UGS-related justice dimension, with the risk of decreasing prospects for sustainability in the future.

Based on the delineated research parameters, this study is therefore designed to contribute to the relevant research context by providing a theoretical framework that is exemplified on a local case study and extents existing theoretical accounts, and by integrating state-of-the-art methodology into a comprehensive framework that may be useful beyond the realm of this study. Overall, the findings shall allow for conclusions to be made on the local conditions in terms of the relation of UGS accessibility patterns and sustainable development, which may eventually add to a better understanding of the mechanisms underlying UGS-related patterns of intra-urban inequality.

1.4 CHAPTER OUTLINE

The following chapter (chapter 2) will provide the theoretical framework to be underlying this study, based on the review of relevant state-of-the-art literature: First, it will introduce the nexus of sustainable development and UGS through a spatial account of the significance of local, urban, and green space (2.1). Second, socio-spatial equality and green space accessibility are introduced based on socio-spatial and environmental justice theory (2.2), and third, a spatial justice approach is proposed as the basis for the understanding underlying the following analysis (2.3). Thereby, the first part of the research question, namely the basic underlying understanding of a ***justice approach to the nexus of sustainable local development and UGS***, is established. After the theory, the case context of Padova is introduced (chapter 3): first, the local spatial environment as well as some notable socio-demographic structures are discussed (3.1), after which local urban development planning approaches in relation to sustainability and green space are presented (3.2). Based on these foundations, the methodological approach through which the case is analyzed is comprehensively developed (chapter 4): after operationalizing the key theoretical concepts into a two-step measurement approach consisting of accessibility and equality factors (4.1), multi-criteria analysis (MCA) is introduced as providing the tools to assessing and integrating accessibility criteria by means of an MCA assessment matrix (4.2), and finally, the practical geospatial methods as well as data used for the implementation of the analysis are presented, as well as the geospatial workflow that was conducted (4.3). Chapter 5 finally presents the analytical results on Padova's parks (5.1), park (in)accessibility patterns (5.2), as well as socio-spatial (in)justice patterns (5.3), thus providing the results on the ***intra-urban socio-spatial patterns of park accessibility in the city of Padova***, followed by the discussion of the meaning (6.1) as well as consequences (6.2.1) of the findings for local development in chapter 6, which establishes ***how the found patterns can be understood***. The last chapter (chapter 7) summarizes the conducted research, conclusively answers the research question, and gives an outlook onto the meaning and significance of the research beyond its scope.

CHAPTER 2: THEORETICAL FRAMEWORK

In order to provide the conceptual understanding upon which the research into UGS accessibility in the city of Padova will be based, this chapter introduces the main premises of a development-focused justice approach to this particular urban space. This is undertaken by the establishment and discussion of, and reliance on, the review of related state-of-the-art conceptions offered by academic literature as well as international sustainable development entities, as they set the standards for associated urban development planning and implementation practices and can thereby be considered to influence current local UGS accessibility patterns and their meaning.

To do so, the first part of this chapter introduces the main premise underscoring the relevance of this research for local development scholarship, namely the nexus between urban green space and sustainable local development by providing a spatial account that constitutes a zoom-in into the spaces of sustainable development in question – the local, the urban, and the urban green space (2.1). On this basis, the second part (2.2) offers the theoretical foundation of the spatial justice approach adopted in this research through the establishment of a comprehensive understanding of socio-spatial and environmental justice concepts related to green space accessibility, and their meaning for development. This generates the overall theoretical framework underlying this thesis, which is presented in the last part of this chapter (2.3). Thereby, the main premise of this research, namely the ***spatial justice approach to the nexus of local development and urban green space***, is established in accordance with the first part of the research question, based on which the subsequent chapters are concerned with the empirical case study on Padova.

2.1 SPACES OF SUSTAINABLE DEVELOPMENT

"Green space" is defined as an "area of grass, trees, or other vegetation […] in an otherwise urban environment" (Oxford Languages, 2022). The consequent implication of a surrounding urban context complementing this space, entailed in the term itself, thereby points at the inherent interconnection of two types of surfaces: hard ones, like roads, pavements, buildings or squares, and soft ones, namely green spaces, including grass, soil, trees, and open spaces (Willemse, 2015, p.15). The latter type is commonly understood as a surface with elements supporting “both ecological and social activities and processes” (Venter *et al*, 2020, p.2), which indicates its relevance for human activity.

As stated before, the main premise of this research is the understanding that with its specific features, green space is inherently connected to sustainable urban development. Development itself is the multidimensional “process of providing the conditions that offer opportunities for improving the quality of life” of all people (Pallipedia, 2022; see also: A/RES/51/240). When speaking of development today, and when attempting to provide an understanding of the connection between development processes and specific spaces, scholars, politicians and development organizations contemporarily rely on the principle of sustainability. Sustainable development has been defined most prominently as a process that “meets the needs of the current without compromising the ability of future generations to meet their own needs” (UN SDGs). More specifically, the UN Sustainable Development Agenda has been mainstreaming the perception that this process “harmonize[s] three core elements: economic growth, social inclusion and environmental protection [which are] interconnected and […] crucial for the well-being of individuals and societies” (ibid). Those elements can also be understood as the dimensions in which development processes take place, or as the pillars supporting sustainability (see **Figure 1**):

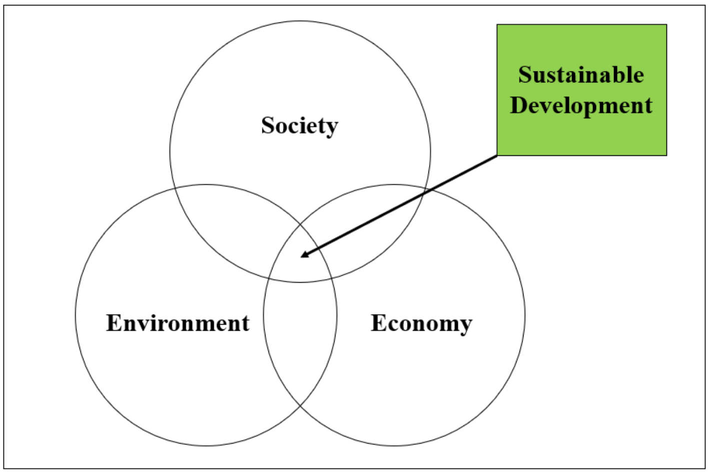


Figure 1: Sustainable development matrix.

While the principles of sustainable development were designed to be universally applicable to, and implementable in, any spatial context, it is widely agreed that there is the need to consider the specificities of the spatial contexts of any sustainable development policy, measure or analysis. Since this research is concerned with UGS as a very particular development space, the following sections zoom into this space and thereby provide the premises upon which this space can be approached. Accordingly, three key spaces[1] for sustainable development are introduced: First, local space will be established as the spatial lens and research approach adopted in this research (2.1.1). Subsequently, the given understanding will be applied to the urban spatial context (2.1.2), which sets the basis for the final introduction of urban green space in its relation and functions regarding sustainable development (2.1.3). Thereby, this chapter will generate a conception of the interrelation between the concrete spaces of interest for this thesis – green space and urban space, aggregated in the concept of local UGS– in their relation to development, when development is understood as sustainable and local.

2.1.1 Local Space

As a first spatial specification, local space as the context of particular interest for this thesis: As stated, it was proclaimed that before the background of global development aspirations, the "local is the space where we connect the dots" (Antonio Guterres in UN Habitat, 2022).

This recent recognition of the importance of the local space by international development entities needs to be understood in the context of the considerable critique by scholars and activists on the premises of global applicability and explicit universality underlying mainstream development discourse: Considering the complexities of global differences, it is argued that development processes cannot be adequately understood through 'one-size-fits-all' models which disregard or neglect local spatial specificities, cultural characteristics and social configurations tied to historical and territorial particularities (e.g. Pike *et al*, 2007) . Rather, to understand development and its spaces, endogenous social, spatial, cultural, economic and environmental resources of given places need to be approached and understood as providing unique contextual realms for sustainable development processes (see *inter alia* Milán-García *et al*, 2019, p.1; Mempel-Sniezyk, 2013, p.11; Pike *et al*, 2007, p.1259). Thus, the sustainable

[1] It should be noted that when the notion "space" is used in this research, the main underlying understanding adopted from the body of literature theorizing socio-spatial relations is based on Jessop *et al* (2008)'s essay, in which they discuss spatial 'turns' within critical social science and argue for a "polymorphy" in which spatial notions like territories, places, scales and networks are seen as interconnected. Thus, when "space" is mentioned in this research, neither of these notions is precluded; rather, space should be understood contextually and in its four-dimensional complexity. Apart from that, "space" in this research is mostly referred to in its geographic place/territory form, i.e. in terms of delimiting the urban context of interest, and the specific place within it that is in focus – namely, green space, as defined in the literature discussed in this chapter.

development matrix is analytically understood at the local level, in the sense that processes in social, economic and environmental sphere are understood before local contextual particularities, as presented by the figure (**Figure 2**) below.

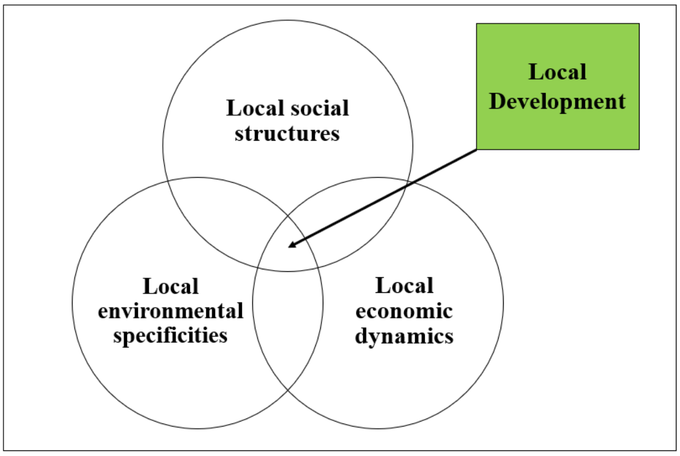


Figure 2: Sustainable local development matrix.

Accordingly, research concerned on particular spaces of development, such as urban green space in the case of this thesis, thus require a local sustainable development lens in order to effectively provide understanding of potentialities or barriers to development processes inherent in it. While the following theoretical sub-sections provide a more general understanding of the connection between urban green space accessibility and sustainable development, the subsequent analysis of the local case of Padova will provide a place-based, contextualized and local evaluation. It should hence be emphasized that when speaking of development in this research, this will always be understood from a sustainable local development perspective.

2.1.2 Urban Space

Urban space can be considered the second spatial focus of this research. The following section provides a conception of how this space is understood as related to sustainable local development, to provide the basis for considering the importance of green spaces in the particular context of cities.

With half the world population residing in cities or urban areas since 2007, a process projected to increase by about 70% by 2050 (Sun *et al*, 2022, p.1; UN Habitat, 2018, p.8), urban contexts can be considered the most important realm for human interaction today, as mentioned before. As such, they are stressed to be vital “places of opportunity”, by providing crucial economic services as well as proximity to others, which facilitates social contact (OECD, 2018, p.3). On the other hand, urban spaces may also constitute areas of vulnerability for their inhabitants, due to the complexities of the “multiple interacting ecological, social and technological drivers of urban expansion” (Sun *et al*, 2022, p.1).

Cities are thereby spaces that can be said to comprise both advantages and dangers for development processes. The projections of further acceleration in urbanization gave incentive for the explicit inclusion of related considerations in the current agenda for sustainable development: As highlighted by UN Habitat (2018), urbanization, a “transformative process capable of galvanizing momentum for many aspects of global development” (UN Habitat, 2018, p.3), makes the importance of cities for development “undisputed” (Ulbrich *et al*, 2018, p.6). Accordingly, the UN recognizes the need for “a world where human habitats are safe, resilient and sustainable”, as established by SGD 11 of Agenda 2030 (A/RES/70/1, pp.4 & 21-22), and states that a majority of SDG targets contain an urban component due to the fact that “cities are well positioned to take lead in addressing many of the persisting global challenges” (UN Habitat, 2018, p.3) and are indeed “key in finding solutions” (ibid, p.4). This role is reaffirmed in various other internationally recognized development agendas, from the New Urban Agenda (NUA) to the Paris Agreement on Climate Change (ibid, pp.4&16-17).

There is thus wide agreement on the importance of urban contexts for sustainable development processes and the understanding of their mechanisms in space. From a local development perspective, it must be highlighted that naturally, cities vary considerably in their characteristics and potentialities regarding development, as well as their related intra-urban spatial configurations. This will become visible when looking at the particular intra-urban structures of Padova as the urban context of interest for this thesis.

2.1.3 Urban Green Space

While the previous sections provided an understanding of sustainable local development and of the importance of the urban context for it, the focus of this study is not only the urban space but in one particular component of (most) urban contexts: green spaces.

As mentioned before, one of the main advantages of cities for human well-being and development is the provision of access to high-level services (OECD, 2018, p.3). Green areas are usually considered among these services. As previously mentioned, UGS are considered to support "both ecological and social activities and processes" (Venter *et al*, 2020, p.2), and belong to the class of "soft surfaces" as compared to "hard" ones like roads or buildings which dominate the urban environment (Willemse, 2015, p.15). The persisting scarcity of such "soft" surfaces in cities furthermore already indicates the need for their equal accessibility, as discussed in the next part of this theoretical framework, considering the many benefits provided by them: By belonging to the larger group of ecosystem services, UGS have been found to deliver a range of sub-services that can be considered vital for development:

1. Provisioning services (providing resources like food or wood)
2. Regulating services (regulating e.g. air quality or climate)
3. Cultural services (delivering non-material benefits, such as "spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences" with resulting social benefits, like mental health improvement, stress reduction and relaxation)
4. Supporting services (contributing e.g. to soil formation and photosynthesis).

(da Sousa Silva *et al*, 2018, p.3, also: Panagopoulos *et al*, 2015).

Furthermore, specific focus in UGS-related literature has been put on the importance of UGS for human well-being in the urban context: First, it may be stressed that the provision of all the above classes of services can be said to contribute to well-being, quality of life and urban sustainable development. Venter *et al* (2020) stress, moreover, the positive relationship between urban greenery and well-being particularly in terms of indirect social benefits like the physical and mental health included under the term "cultural services" above, as well as positive impacts on social cohesion and sense of place generated through green spaces (Venter *et al*, 2020, p.1; also: La Rosa, 2013, p.122; Nasri & Hoseini, 2021). Sun *et al* (2022) and de Sousa Silva *et al* (2018) further emphasize the role of UGS as critical connection points between nature and humans (Sun *et al*, 2022, p.1; de Sousa Silva *et al*, 2018, p.1), and Willemse (2015) assigned UGS three main attributes related to their value: a functional one, related to people's ability to fulfil their recreational needs, an aesthetic one, through the provision of a space in which relaxation is possible, and an ecological one, related to the sustainable use of environmental resources (Willemse, 2015, p.15).

There is, hence, wide agreement on the interconnection between UGS and human well-being, which points at the inherent relevance of UGS for sustainable local development. This is expressed by Venter *et al* (2020) who state that the "ecosystem services derived from green infrastructure are fundamental for […] development and general human well-being" (Venter *et al*, 2020, p.11). Panagopoulos *et al* (2015) confirm this relevance by reaffirming the desire of urban residents for contact with nature, thereby concluding that the presence of natural areas is an important contributor for urban life quality which, in their understanding, can be conceived as synonymous for livability and sustainability (Panagopoulos *et al*, 2015, p.141).

The link of UGS and sustainability, based on the well-being related benefits of green spaces, has correspondingly been acknowledged by the UN Sustainable Development Agenda, incorporating the need for equal access to green spaces in target 11.7 of SDG 11 on urban contexts (UN Habitat, 2018, p.85; Ulbrich *et al*, 2018, pp. 2 & 11). Green space can thus be considered a distinct realm for sustainable urban development based on the understanding provided in this chapter.

This section has hereby introduced the nexus of sustainable development and urban greenery by discussing three distinct spaces of sustainable development: First, local space with its contextual particularities, second, urban space as a local space of particular importance for development and the one that hosts the third, most vital space: urban green space, which is the key unit of interest in this research. The figure below (**Figure 3**) summarizes this phenomenon by providing the zoom-in of the three development spaces of interest, the potential of UGS to produce benefits for, among others, human well-being and social cohesion, and the way in which these benefits may be understood to function as the mediator between the connection of UGS and sustainable development by contributing to the latter.

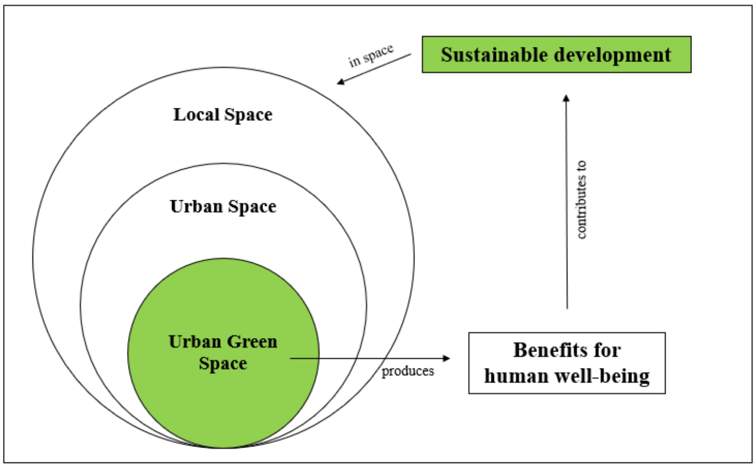


Figure 3: Nexus between sustainable development and UGS.

2.2 SOCIO-SPATIAL EQUALITY AND UGS ACCESSIBILITY

The previous section established the premise that there is a nexus between green space and development based on the understanding that both, urban space in general, and UGS in specific, constitute local spaces that can be considered vital for development in terms of their specific benefits for opportunities and well-being. However, green space accessibility is frequently uneven among different social groups within the urban environment, a fact that must be regarded problematic considering this importance. How UGS inaccessibility, or unequal accessibility, can thus be regarded a development issue will be established in the following sections, which propose a spatial justice approach to development as the necessary theoretical perspective to consider the matter.

The following sections will accordingly first provide a state-of-the-art justice conception of socio-spatial inequality, and particularly intra-urban socio-spatial inequality, in its relationship with sustainable local development (2.2.1). This is followed by the introduction of UGS (in)accessibility as a realm in which this issue is frequently expressed, which is likewise connected to the way in which this may be understood from a development perspective, now by including related conceptions of environmental justice (2.2.2). By doing so, green space is problematized through a justice approach that provides the basis for understanding the research problem throughout the following case study.

2.2.1 Socio-Spatial Justice

In order to provide this basis, inequality and social justice conceptions will be introduced and connected to their specific socio-spatial dimension, followed by the discussion of urban manifestations of such socio-spatial inequality as well as related development consequences. By providing a comprehensive literature review on the matter, socio-spatial justice theory is discussed in relation to the research interest of this thesis.

Inequality

Inequality can be defined as the "state of not being equal, especially in status, rights, and opportunities" (UNDESA, 2015, p.1). As such, the concept has different meanings, focusing on different areas of inequality, such as for instance economic income-based, or rights-based inequality (ibid). Two streams of inequality theory may be stressed as particularly noteworthy: On the one hand, research focusing on the inequality of outcomes has been understood as closely related to development theory, since it is concerned with inequality associated with factors of living standards, such as income or wealth, education, health and nutrition (ibid). On the other hand, inequality has also been understood in relation to opportunities: As Amartya Sen has prominently suggested, equality can also be measured through "functionings" - the "beings and doings valued by people" -, and "capabilities" - the ability to choose and act on one's choice (Sen, 1999; UNDESA, 2015, p.1). He highlights that equality is conditioned by the personal and social circumstances of each individual (ibid). This is reaffirmed by Frances Steward, who introduced "horizontal inequalities" as those inequalities existing predominantly in the inter-personal sphere, when individuals are discriminated, marginalized or disadvantaged due to the social groups they belong to, or identify with (Steward, 2002; UNDESA, 2015).

Inequality is thus at the heart of social justice theory, and while some of the aspects of equality remain contested[2], there is consensus among international development agencies and

[2] Controversial aspects of justice theory in relation to equality include the question to what degree equality equals fairness, and in relation thereto, whether one aspires to achieve equality or rather equity – equality as the equal chance of all people to, for instance, access the same services, thus having the same opportunities and ultimately, the same outcomes, and equity as the recognition of all individuals as different in their outcome needs and capabilities, thus some requiring more positive action to achieve their outcomes than others, rather than the same. Likewise, in international literature on development, there is controversy as to what degree the same values of, for instance, human rights should be strived for across countries – cosmopolitan universalist philosophy is here opposing the camp of cultural relativist theory. While the discussion of these controversies exceeds the scope of this thesis, it should be noted that while adopting a local development stance that focuses on the need of looking at particular local contexts with particular socio-cultural settings, aspirations of justice in terms of the need of urban residents to have equal access to vital spaces will be the underlying justice approach, in line with the common sustainable development agenda. This conception is understood as non-contradictory to the simultaneous affirmation of the fact that some groups might have more needs or less capabilities in accessing such fundamental spaces or services. However, it is argued that as a starting point, there should not be an unevenness in accessibility, but rather equality: if that is given, affirmative action to better include every individual is possible – and necessary.

development literature that the proclaimed objective of sustainable development entails the aim of equal opportunities for everyone, without which potential life outcomes would be compromised (Paes de Barros *et al*, 2009; UNDESA, 2015, p.2). Therefore, the understanding of inequality, or injustice, adopted in this research is based on the on a combination the two streams of inequality literature, viewing it as defined by the existence of an equality in outcome and opportunities – the former of which will be conceptualized as the ultimate objective of development and well-being, the latter as degree to which vital services, like UGS, are provided.

Socio-spatial inequality

This research is concerned with a specific dimension of justice, namely socio-spatial justice, or equality. Based on the given understanding of inequality as an issue of justice, an understanding of how socio-spatial inequality can be considered a challenge for sustainable local development requires the establishment of what is meant by its components: the social and spatial forms of inequality.

Social inequality can be understood as closely related to the previously given conception that outcomes and capabilities are frequently affected by external circumstances or factors interfering with human activities, such as the unfair distribution of opportunities, resources, and power (Sen, 1992; Han, 2022, p.2). Literature concerning social inequality accordingly commonly emphasizes the role of social categories like age, class, gender, cultural or ethnic identification, as well as family composition or nationality as influencing factors for such distributional discrimination.

Spatial inequality can be understood in relation to social inequality. Simply put, spatial inequality is the manifestation of overall inequality in space, such as across different geographical units like countries, regions, or neighborhoods (Bansal, 2021, p.369). Thereby, the spatial dimension of inequality may be a dimension of any inequality, and can be understood as the phenomenon of the alignment of spatial variations in opportunities and outcomes with occurring social tensions within a given spatial unit (Kanbur & Venables, 2005). Accordingly, spatial inequality research stresses the need to look at the local spatial context when considering any type of inequality, since, as it has been argued, spatial inequalities are growing, and already make out a third of total inequalities (Venables *et al*, 2005, p.9; Lessmann, 2013, p.35). As a result of this growth, social inequalities may also become increasingly more visible, once they are manifested in space.

While spatial divisions might be attributed to inequalities not only in social relations, but also to geographic factors such as natural features and disparities in environmental potentialities, the interest of this research is mainly focused on the realm of those spatial polarizations that are interconnected with social polarizations. Based on the previous definitions of social and spatial inequalities, socio-spatial inequalities will henceforth be understood as the manifestation of social inequalities in spatial patterns (Han, 2022, p.2). Among such manifestations one might for instance think of mobility inequalities across spatial units like neighborhoods (e.g. Hidayati *et al*, 2021, pp.492-492), income inequalities across neighborhoods with different demographic configurations (e.g. Reardon *et al*, 2015), or inequalities in the accessibility of spaces that are important for development and well-being, the latter of which is the issue in focus of this research.

Moreover, socio-spatial inequalities can be understood, in line with the literature on inequality, as a matter of justice, whereas social justice can be understood as “the objective of creating a fair and equal society in which each individual matters” (Oxford reference, 2022), which is complemented by a critical spatial perspective stressing the spatiality and the geographies of such justice (see Soja, 2010). Inequalities in the social and spatial realm, from this point of view, must be considered as critical in terms of their adverse effects on outcomes and opportunities, and ultimately, on development.

Inequality in the urban space

As introduced, the key space in which inequality will be considered in this research is the urban environment, which, concurrent to its previously shown advantages for development, exhibits socio-spatial inequalities more than any other space (OECD, 2016 pp.3 & 11-12). There is an extensive body of research on the occurrence of inequalities in cities, from which an understanding of its particular intra-urban features can be drawn.

Cities bring together a variety of people with diverse backgrounds. While this is part of why cities are recognized such important spaces for development, this feature simultaneously produces challenges for development, since these diverse social groups are commonly living in separation from others, which frequently leads to urban spatial segregation and social division

(OECD, 2018, p.11). The frequency of socio-spatial inequalities in urban space has given rise to a large body of development research and policies concerned specifically with this phenomenon (Lelo *et al,* 2019, p.1). While the roots and causes of urban spatial segregation are not conclusively clarified, it is presumed to be an outcome of a process involving both, personal preferences as well as rent abilities (OECD, 2018, p.11). Urban spatial segregation does not necessarily have to be a negative matter, for instance when people are voluntarily choosing to live in proximity to others that are sharing the same social characteristics (ibid). However, what can be regarded problematic is the commonly resulting inequality in terms of opportunities, eventually visible in disparities of development outcomes (ibid, pp. 3&11). The production of exclusive spaces and the "concentration of disadvantage" in accessing high-level services and opportunities has been connected to the polarization dynamics in urban environments, resulting in the socio-spatial marginalization and peripheralization of the most socially disadvantaged groups (ibid; Han, 2022, p.2; Kühn, 2013). Related to this process is the common intra-urban core-periphery distribution of factors of life quality (Han, 2022, pp.3-4), whereby urban livability disparities across neighborhoods can be understood to reflect the socio-demographic composition thereof (ibid, p.8).

This intra-urban socio-spatial inequality is usually understood as three-dimensional, with local variations in terms of which dimension is most dominant: the first dimension is one related to income, whereby social groups are spatially clustered and inhibit differences in economic performance based on this clustering (OECD, 2018, pp.13-15). The second dimension is usually one related to nationality, citizenship, or ethnic group belonging, whereby the clustering is based on ethnic differences with the result of segregation across these lines (ibid, p.16; Kilroy, 2009, pp.7-8). The third dimension finally relates to an access divide, which focuses on the outcomes produced by segregation in terms of inequalities in the accessibility of services (OECD, 2018, p.17). This third dimension is the focus of this study, as it includes the accessibility of vital urban spaces as fundamental services, and thus the inequality in utilizing such services as opportunities for enhanced development outcomes.

Furthermore, the processes and dynamics underlying the spatial segregation of social groups in these dimensions, as well as the socio-spatial inequalities exhibited in the urban realm, have been discussed by Kühn (2013), who provided an in-depth account thereof. Based on his argumentation, the phenomenon can be understood in close relation to a socio-spatial conception of marginality, namely the multidimensional process by which social groups are simultaneously put on the fringes of society and urban space (Kühn, 2013, pp.369 & 371-372).

This process is understood through the power dynamics between those groups at the social and spatial center, in possession of social and political power, and those at the margins, which lack power and thus are at risk of being dependent on the center (ibid, pp.372-373). Their peripheralization can be seen through the notion that social relations have spatial implications, whereby a periphery understanding might suggest that vice versa, spaces have social implications (ibid, p.369). His conceptualization of peripheralization in the urban realm is thereby in line with the previously proposed understanding of socio-spatial inequalities.

A last feature of socio-spatial inequalities in the urban space that can be considered pertinent for the proposal of their relevance for development processes is the conclusion in related scholarship that these inequalities bear the danger of constituting a spatial poverty trap: As pointed out by Kilroy (2009) and Bansal (2021), spatial segregation of social groups, visible in geographic concentration of resources and services, leads to a lack in inter-group and inter-spatial interaction as well as a decrease in the access to vital services, and ultimately results in the perpetuation of opportunity inequalities transmitted to the next generations living in these spaces (Kilroy, 2009, pp.2-16; Bansal, 2021, p.369). This risk underlines the challenges for human well-being produced in urban spaces in terms of the discussed inequalities.

Consequences for development

Based on the provided understanding of inequality as a challenge in terms of resulting disparities in outcomes, capabilities and opportunities necessary for human well-being, and underlined by the specific socio-spatial justice issues arising in the urban realm that cumulate in spatial segregation, marginalization, peripheralization and culminating in potential poverty traps, there is wide consensus on the relevance of socio-spatial inequalities for development. As Kilroy (2009) states, "when [social] inequalities are expressed spatially, they are likely to coincide with spatial inequalities in welfare and human development" (Kilroy, 2009, p.17). While Lessmann (2013) argues that spatial inequalities should be considered a temporal phenomenon that diminishes over time, he also problematizes the fact that their occurrence might be "harmful for the development process itself" when they remain unchallenged[3], which poses the inherent risk for self-perpetuation.

[3] The reason for a lack of challenging persisting inequalities might be the "tunnel effect" based on which people tend to accept inequalities as long as they believe they will vanish over time (Lessmann, 2013, p.46). Further reasons might be related to other well-studied psychological phenomena, such as system justification or the self-perpetuating mode of hierarchies based on disparities in power and resources (Pfiff *et al*, 2018).

The issue is accordingly recognized by development literature and constitutes an explicit part of the sustainable development agenda. The related UN declaration specifically affirms the need to "combat inequalities within and among countries" by declaring that "no one will be left behind" (A/RES/70/1, p.3, §3&4) and puts particular emphasis on the right for everyone of "equal opportunity permitting the full realization of human potential" (ibid, p.4, §8). SDG 10 is specifically concerned with the objective to reduce inequalities and reaffirms the target of providing equal opportunities (ibid, p.15). Furthermore, SDG11, which is concerned with the urban space, was likewise linked to this objective: As UN Habitat (2018) reiterates, inequalities are particularly prevalent and complex in cities, which underscores the need to "address social, political, economic, ethic, racial and other inequalities playing out in urban areas" (UN Habitat, 2018, p.13).

This concern with intra-urban socio-spatial inequalities by development agencies thus supports the claim that they are indeed a particular challenge for sustainable local development.

2.2.2 Environmental Justice

Based on the understanding of intra-urban socio-spatial inequality given in the previous section, the following pages will connect this conception to the specific urban space of interest in this research: urban green space (UGS). To provide this account, it must be established how the accessibility to a particular urban space, here the green one, relates to the preceding conception of intra-urban socio-spatial inequality and justice. This will be done by complementing it with an environmental justice dimension.

First, it is noteworthy to understand that accessibility is considered a "broad and flexible concept that can be defined according to the field of interest" (La Rosa, 2014, p.122). According to La Rosa (2014), it is important not to confuse the term with the concept of mobility, but rather understand accessibility as an "attribute of people" which relates to an "integrated system of facilities/services and users from the user viewpoint" (ibid, p.123). While accessibility can be defined as the "quality of being able to be reached or entered […] or use[d]" (Oxford Languages, 2022), the focus on the user requires the understanding that what is important is not the character of the service *per se,* but rather the availability of the service to be effectively used by the user.

An accessible space can therefore be understood as closely related to the socially equitable ability to reach or enter it, and to make use of its services. Thereby, accessibility directly relates to the requirement of equal opportunities – namely, the opportunity to access a space – for equal development outcomes (UNDESA, 2015). Furthermore, as established before, one of the commonly identified dimensions of intra-urban socio-spatial inequalities is the accessibility of services (OECD, 2018, p.17), which, if unequal, is considered problematic in terms of the aforementioned potential of inequality perpetuation: When socio-spatially marginalized groups lack accessibility to a space that provides vital services for well-being, this may lead to the further deepening of development issues. Thus, when looking at the issue of UGS accessibility in the following sections, its conceptual location within the dynamics of intra-urban socio-spatial inequalities cannot be underestimated in terms of the related detrimental effects.

UGS Accessibility

Urban green space has been introduced as a space with benefits for human well-being through the delivery of vital sub-services that relate to quality of life and development. Overall, the need of accessible UGS for all urban residents is thus widely acknowledged, however, what is meant by that can be understood and conceptualized in several ways as will be introduced in the methodological framework of this research (chapter 4, especially 4.1). Some of the main features of UGS accessibility can nevertheless briefly be summarized here, to provide a better understanding of what is meant when talking about the issue of UGS inaccessibility as a barrier for development in the following pages.

First, it should be stated that accessibility is not synonymous with availability, since accessibility emphasizes the specific spatial or geographical dimension in which something, such as UGS and its services, is reachable and usable, whereas availability can be understood as an overall usability of something beyond the spatial realm (Oxford Languages, 2022). Since this research has a concrete interest in the spatial variations of UGS usability across the city of Padova, the notion of UGS accessibility is adopted as the main terminology to understand the concept.

Next, there are various different understandings of how this reachability and usability - thus, the accessibility - of UGS can be understood. On the one hand, literature around this topic includes accessibility as one aspect of a larger catalogue of features based on which UGS can be analyzed in their function for urban residents (e.g. de Sousa Silva *et al*, 2018, p.4; Fan *et al*, 2017; Nasri Roodsari & Hoseini, 2021, p.4). On the other hand, literature concerned specifically with UGS accessibility stresses various factors of the concept itself: some scholars concentrate more on the structural-general features of UGS, such as its existence and size, others emphasize the mobility aspect related to the vicinity of UGS, and yet another stream of literature is more concerned with the qualitative value creation potential of the services provided by UGS (de Sousa Silva, 2018, p.4). In the methodological framework of this research, these different options of accessibility understandings will be discussed more in-depth, and the specific operationalization choices adopted in this research are presented.

What needs to be emphasized at this point is that in this thesis, the main concern with accessibility is the focus on its *equal* accessibility. Hence, no matter how accessibility is conceptualized and operationalized concretely, or which aspects are ultimately focused upon, the premise in relation to accessibility is the requirement that UGS need to be equally accessible for all urban residents of all social groups across the urban territory, due to the established general value of this space for sustainable local development and the adverse effects of socio-spatial inequality. Whenever UGS exist, its quantity, proximity and quality should therefore be equally distributed in space and society.

UGS inaccessibility

Considering the previously introduced vulnerability of urban spaces to overall inequalities, it is not surprising that UGS accessibility was likewise found to exhibit features of socio-spatial inequity: As pointed out by Panagopoulos *et al* (2015), UGS within "aggressive" urban habitats may be poorly distributed across space and among social groups (Panagopoulos *et al*, 2015, p.137; also: de Sousa Silva, 2018, p.2). In fact, the issue of UGS accessibility has been taken up by an increasing number of scholars from a multitude of disciplines, ranging from land use, urban planning and environmental science to sustainability research, with a unanimous finding: namely that there is global inequality in the accessibility of UGS (Sun *et al*, 2022, pp.2-5).

This accessibility injustice has been found to be expressed in the common patterns of socio-spatial inequality: As Venter *et al* (2020) state, uneven patterns of urban greenery are potentially predictable in their accessibility, in the sense that those areas or population groups with least access are also usually those that are most disadvantaged (Venter *et al,* 2020). This finding was confirmed by Nasri Roodsari and Hoseini (2021), who point out that the heterogeneous distribution of UGS correlates with the social status and the development level of urban districts (Roodsari and Hoseini, 2021). De Sousa Silva *et al* (2018) likewise conclude that low UGS accessibility is usually most occurrent in specific areas of cities or for specific demographic groups, for instance related to the ethnicity of the inhabitants (de Sousa Silva *et al*, 2018, pp.2&18). Thus, the common patterns of UGS (in)accessibility can be understood as a manifestation of the issue of intra-urban socio-spatial inequality introduced before, and thus relates directly to the field of socio-spatial justice.

More specifically, however, the issue of uneven UGS accessibility across space and social groups can be considered to fall into the realm of environmental justice: Traditionally, environmental justice is defined as the "fair treatment and meaningful involvement of all people [...] with respect to development, implementation and enforcement of environmental laws, regulations and policies" (Koprowska, 2019, p.143) or as the "right of the entire population to be protected against environmental pollution and to live in a clean and healthful environment" (de Sousa Silva *et al,* 2018, p.3). Thereby, the concept "brings together social and ecological justice questions" and hence extends the concern with the natural environment to also include its interaction with populated areas (Koprowska, 2019, p.142).

However, there has been a recent shift in the way in which environmental justice is understood, which includes, apart from procedural justice and interactional justice, also the distributive dimension of environmental justice, namely the equity or fairness in the distribution of environmental benefits (ibid, p.143; also: Willemse, 2015, p.16; de Sousa Silva *et al*, 2018, pp.2-3; OECD, 2016, p.135). According to this understanding, environmental justice "occurs when green [space] is equally distributed, without discrimination, within a city" (de Sousa Silva *et al*, 2018, p.2). This last definition thereby includes the specific focus on the urban environment and on UGS as unevenly distributed across urban space (see also Koprowska, 2019, p.142). UGS accessibility, from an environmental justice perspective, thus constitutes an issue when its environmental benefits are unequally distributed across social and spatial lines (ibid, p.143). Therefore, the socio-spatial justice dimension of intra-urban inequalities, manifested in the uneven accessibility of UGS, can be extended to an environmental justice dimension (see also: Nasri Roodsari & Hoseini, 2021).

UGS (in)accessibility and development

Having established that unequal accessibility of UGS constitutes an issue of environmental justice and a manifestation of intra-urban socio-spatial inequalities, the link to sustainable local development becomes apparent: As previously mentioned, the issue falls within the spatial nexus of social and environmental justice, which touches upon two of the three sustainability pillars, defining its location within the sustainable development matrix (**Figure 4**):

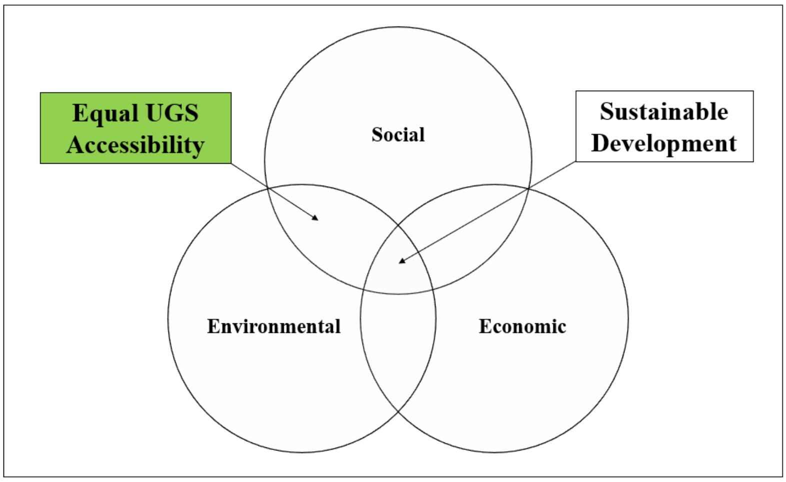


Figure 4: UGS accessibility located within the sustainability matrix.

This is reaffirmed by de Sousa Silva *et al* (2018), who locate the principle of environmental justice itself within the sustainability matrix (de Sousa Silva *et al*, 2018, p.3) and by Willemse (2015), who states that UGS are key components of sustainable development due to their connection to quality of life provided they are accessible (Willemse, 2015, p.15). Moreover, Panagopoulos *et al* (2015) reiterate that UGS accessibility is crucial for the provision of a space of interconnection between society and environment, which they relate directly to urban livability and, by extension, to sustainable development (Panagopoulos *et al*, 2015, p.139).

Accessible UGS, and specifically, equally accessible UGS, are accordingly also part of the current sustainable development agenda: The OECD (2016) declares that the specific spatial environmental disparities related to the accessibility to natural goods and services, like green spaces, directly relate to development disparities (OECD, 2016, p.135). This understanding is incorporated in the UN SDGs, where the target 11.7 on the goal on urban spaces spates the specific need to "provide universal *access* to safe, inclusive and *accessible* green and public spaces" (Ulbrich *et al*, 2018, p.11; de Sousa Silva *et al,* 2018, p.14). Thereby, environmental and social justice, related to UGS, are brought into immediate connection with sustainable development (Koprowska, 2019, p.143).

What is more, the matter of UGS accessibility has also been stressed as one that is particularly related to the local space and a local development understanding: Since the environmental justice movement had taken an interest into the improvement of related issues specifically for local communities (Koprowska, 2019, p.148), local place-based particularities of the way in which accessibility can be understood in each context are emphasized when considering the degree to which it can be considered equitable. The local development lens adopted in this research is therefore of concrete importance for the evaluation of UGS accessibility issues.

2.3 THEORY: A SPATIAL JUSTICE APPROACH

The preceding chapter has provided a state-of-the-art conceptualization of the way in which urban green spaces and their equal accessibility relate to development: first, by the introduction of urban and green spaces as relevant to development processes due to their particular benefits for human well-being, and secondly, by the generation of an understanding of the way in which intra-urban socio-spatial inequalities and their manifestation in unequal UGS accessibility constitute an issue for development.

Thereby, a ***justice approach to the nexus of sustainable local development and UGS*** has been presented. The figure (**Figure 5**) below therefore summarizes the logic underlying this research as well as its coverage throughout the research organization of this thesis:

Accordingly, while the previous chapter has provided the comprehensive theoretical understanding of the greater nexus of local development, urban justice, and urban green space accessibility, the following chapters will turn towards the empirical analysis of the given theoretical complex and thus towards the analysis of UGS accessibility across space and society within the urban context of the city of Padova.

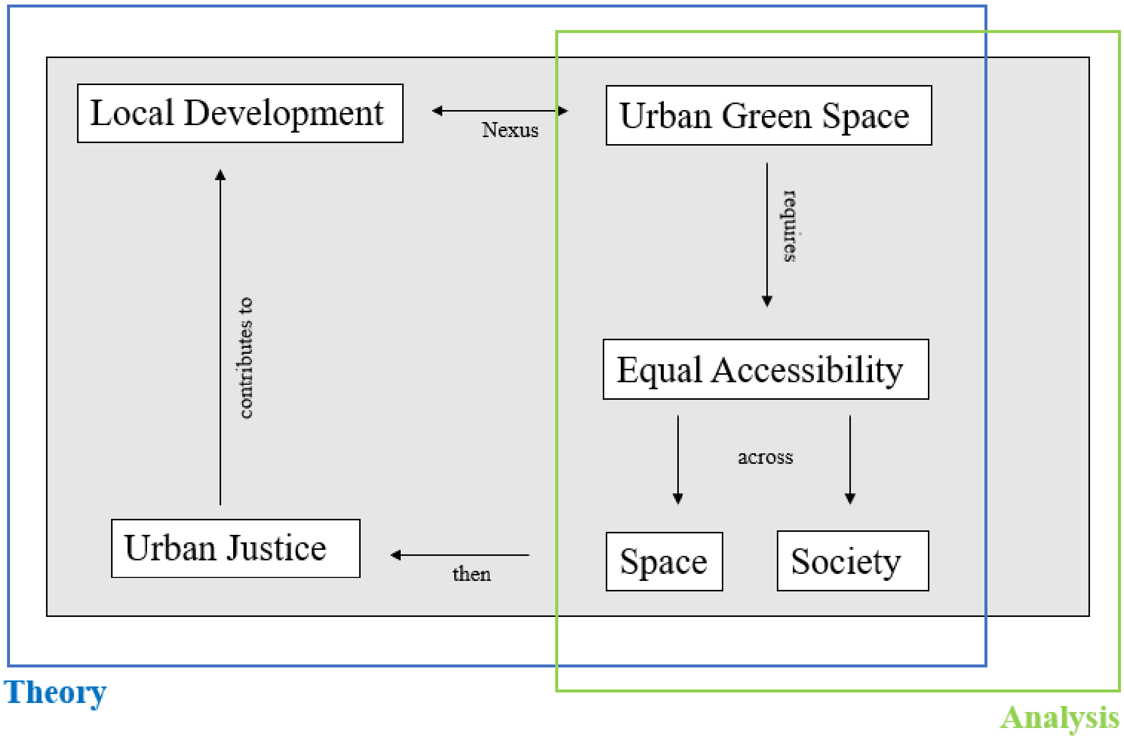


Figure 5: Theoretical framework and coverage.

CHAPTER 3: CASE STUDY

Having provided a theoretical framework on both, the understanding that there is a nexus between development and UGS, as well as the provision of a socio-spatial environmental justice approach with which the (in)accessibility of this space must be considered, the following pages will introduce the particular local context in which this research is undertaken: the city of Padova[4], Italy. In line with the previous stipulation, the necessity to focus development-related research on a specific local case arises from the given location of this thesis within the field of local development, which recognizes the value of considering aspects of development more deeply in relation to local territorial specificities and contextualities to generate a profound analytical understanding of a situation or phenomenon. Accordingly, this chapter provides the contextual foundation upon which the analysis and assessment of UGS (in)accessibility in Padova will be based.

The following paragraphs will hence introduce the socio-spatial context of the city (3.1), complemented by relevant development planning approaches (3.2), thereby introducing the context for the critical analytical aspects of this research – sustainable urban development approaches, socio-spatial dynamics, and related green space planning - within the local environment.

3.1 SOCIO-SPATIAL CONTEXT

In order to identify the specific local contextual features of Padova consistent with the framework of socio-spatial urban justice theory, the following sections will briefly introduce the spatial environment in which the case is located, as well as the overall social situation before which the following analysis of justice in UGS accessibility is to be understood.

3.1.1 Spatial Environment

Since this research is interested in the urban space, the spatial features of the city of Padova will henceforth be provided in order for the methodological choices and the assessments of

[4] Padova and all other cities will henceforth be written in accordance with their Italian name, not the English translation (in this case, “Padua”). Further, all translations of Italian terms into English were undertaken by the author of this thesis.

analytical findings to be well-grounded in their local contextualities. What is to be understood as “spatial context” in the following paragraphs are characteristics related to two spheres: on the one hand, natural or physical geographical spatial features related to properties of the natural environment, and on the other hand, human or anthropogeographical features related to the characteristics of the administrative spatial organization.

Turning first towards the natural or physical aspects (see also **Figure 6** below), the city of Padova is geographically located in the northeast of the Italian peninsula. It is situated in the south of the Venetian Prealps (*Prealpi Venete*) and northeast to the Euganean hills (*Colli Euganei*), as well as at the eastern end of the Po Valley (Pianura Padana) and west to the Venetian Lagoon (Laguna di Venezia) (Figure 6). As part of the Po Valley, also called Po Plain (the literal translation of Pianura Padana), Padova is characterized through 93 km² of entirely flat territory. Further territorial features include the prevalence of sandy soil with a high rate of impermeability (Cortinovis et al, 2021, p.169), as well as the influential role of water on the formation of the city. Regarding the latter, the changes of riverways over the years has considerably influenced the shape of the city, especially those of the Brenta and Bacchiglione rivers (Comune di Padova, Assessorato al Commercio e al Turismo, 2004). Moreover, the city’s municipal territory is highly urbanized: with 49,3%, Padova has the highest share of built surface in the region, and among the highest in Italy (Cortinovis et al, 2021, p. 169).

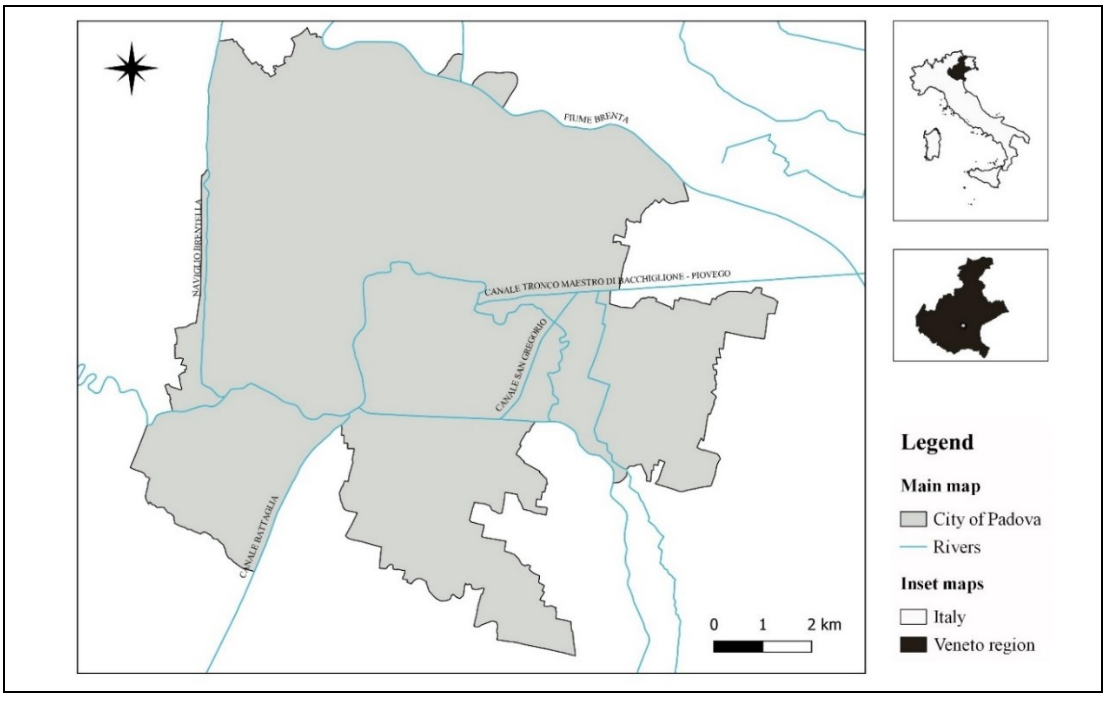


Figure 6: Padova's geographic context.

Having thus established some of the main features of the natural environment of Padova, the second dimension of the spatial context is the human, or anthropogeographical setting of the urban space, which will be provided through a brief overview of administrative location and division of the city to introduce the way in which its space is organized by human activity and, more specifically, public management.

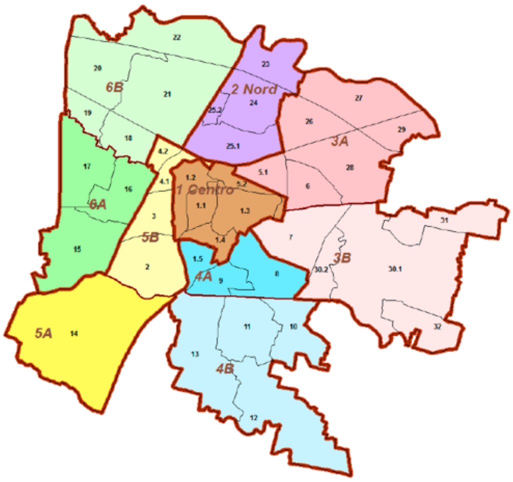
This research is concerned with the urban space, thus with Padova in its dimension as a city, which, in the Italian administrative context, is equivalent to the unit of a *comune* – the local territorial administrative division similar to a municipality. *Comuni* are autonomous entities with own statutes, powers and functions according to the Italian constitution (Ministero dell'Interno, Dipartimento per gli Affari Interni e Territoriali, 2022).

Within the national administrative structures that are organized hierarchically according to unit size and powers, Padova municipality is located at the third-level division, below provinces (*province*) on the second level and regions (*regioni)* on the first. At the same time as being a city, Padova is also the capital of the eponymous province Padova (PD) and is located within the region of Veneto. Furthermore, the city is sometimes included within the Padova-Treviso-Venezia Metropolitan Area "PaTreVe" (*l'area metropolitana di Patreve)*, the aggregation of the main urban zones of the Veneto region which are physically and economically connected by a specific regional planning initiative (Maria de Fanis, 2003).

When zooming into the administrative organization within urban space, the territory of Padova is divided into six neighborhoods (*quartieri*), named after their intra-urban location, with different sizes:

- Quartiere 1: *Centro* (5.2 km²)
- Quartiere 2: *Nord* (6.71 km²)
- Quartiere 3: *Est* (28.02 km²)
- Quartiere 4: *Sud-Est* (17.58 km²)
- Quartiere 5: *Sud-Ovest* (14.05 km²)
- Quartiere 6: *Ovest* (21.88 km²)

As stated by the municipality (2022), the *quartieri* are the "soul" (*l'anima)* of the city and constitute the core units of division for urban development planning (Padovanet, 2022A). They are further subdivided into *consulte* (councils) and then into *unità urbane* (urban units) (see **Figure 7**):



Quartiere	Consulta	Unità Urbana
1 Centro	1 Centro	1.1 Piazze
		1.2 Savonarola
		1.3 Santo - Portello
		1.4 Prato della Valle
		5.2 Stazione Ferroviaria
2 Nord	2 Nord	23 Pontevigodarzere
		24 San Carlo
		25.1 Arcella
		25.2 San Bellino
3 Est	3A	5.1 Fiera
		6 Stanga
		26 Mortise
		27 Torre
		28 San Lazzaro
		29 Ponte di Brenta
	3B	7 Forcellini
		30.1 Zona Industriale
		30.2 Isola di Terranegra
		31 Camin
		32 Granze
4 Sud-Est	4A	1.5 Città Giardino
		8 Sant' Osvaldo
		9 Madonna Pellegrina
	4B	10 Voltabarozzo
		11 SS. Crocefisso
		12 Salboro
		13 Guizza
5 Sud-Ovest	5A	14 Mandria
	5B	2 Sacra Famiglia
		3 San Giuseppe
		4.1 Porta Trento Sud
		4.2 Porta Trento Nord
6 Ovest	6A	15 Brusegana
		16 Cave
		17 Brentelle
	6B	18 Sant'Ignazio
		19 Montà
		20 Ponterotto
		21 Sacro Cuore
		22 Altichiero

Figure 7: Padova's administrative division.

(Data source: Padovanet, 2022B, p.57)

3.1.2 Social Structures

Apart from the given spatial features of the urban context of Padova, the assessment of equality in UGS accessibility requires the provision of a basic understanding of the social structures within the local environment of interest. The following paragraphs therefore introduce some of the main socio-demographic characteristics of Padova on the one hand, and their spatial distribution across the administrative units on the other hand.

Regarding the former, the following city-wide social demographic features provide a first idea of the social structures within Padova: As of 31st July 2022, a total of 209 655 people are registered to live in Padova (Comune di Padova, Settore Programmazione Controllo e Statistica, 2022). The following key numbers are published in the city's 2021 statistical report "*Padova in Cifre*" (Padova in numbers) (Padovanet, 2022B): the average age of the population is 47.39 (male: 45.24; female: 49.34), the birth rate (number of births per year/1000 residents) is 6.67 and the mortality rate (number of deaths/1000 residents) is 13.22.

While these demographics give some insight on the overall character and social composition of the population in Padova, the spatial distribution thereof may provide a more comprehensive impression on the social structures within the urban space.

The density of the population, the concentration of inhabitants within space, give a first idea of the spatial demographic patterns of a city. Padova, as calculated in the statistical report, has an overall density of 2 248 inhabitants per km² (Padovanet, 2022B, p.57). This density, however, varies significantly across the different administrative units, as indicated in the following map[5] (**Figure 8**):

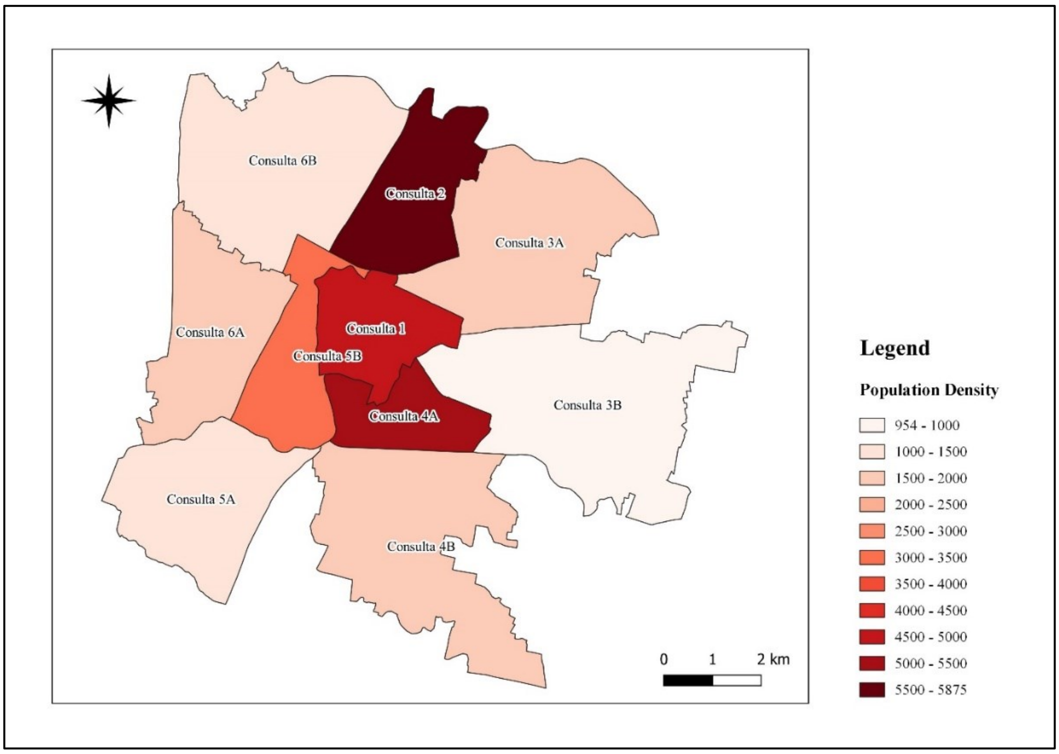


Figure 8: Padova's population density per consulta.

(Data source: Padovanet 2022B. Elaboration by the author.)

The highest spatial population density can thus be seen in the areas of *consulta 2, consulta 1, consulta 4A* and *consulta 5B*. More visualizations of the socio-spatial distribution of demographic data like age, gender, nationality, and family numerosity will be provided in the results chapter (chapter 5), in which related patterns are discussed in connection with the findings on UGS accessibility within the city.

[5] These patterns are going to be provided in a more developed design in the results chapter as well.

3.2 URBAN DEVELOPMENT PLANNING

To complement the socio-spatial context of Padova given before, the following pages will introduce the main urban planning approaches and tools adopted by the city. Specifically, those strategies related to local sustainable development and green spaces will be identified within the policy-making context and the related existent situation, in order to provide a contextual framework within which the analysis of this research is located.

3.2.1 Sustainable Development Approach

The following paragraphs will identify the overall context of sustainable development policymaking, as well as the approach of the city of Padova in relation thereto, in order to offer the background before which green space planning can be understood, as well as the proclaimed objectives based on which the results of this research related to the equality UGS accessibility of the city will be considered.

To give a brief idea of the sustainable development policymaking, it seems relevant to locate Padova within the national and international context, in which the city's planning decisions necessarily fall and before which such approaches may be understood. As a country, Italy belongs to both major international informal governance groups, G7 and G20, and has been holding the presidency of the latter in 2021(ASviS, 2021, p.14). As such, the development-related policy-making approaches of Italian cities need to be in line with G20 priorities, such as the focus put explicitly on the three sustainable development pillars of "planet, people, prosperity" as well as the emphasis of urban solutions relating climate change and issues around social inclusion (ibid).

Furthermore, as a European and EU member state, Italy subscribed to aiming at contributing to the Agenda 2030 goals by aligning development-related policies on each level of governance to the European Green Deal as well as the other priority-setting instruments put forward by the European Commission, that specifically relate to the global SDGs (ibid, pp. 36-39). Italy's overall performance with respect to Agenda 2030 has been found to be problematic: Recent data reveals that whereas there were slight improvements on some SDGs, the majority of goal indicators deteriorated, including regarding goal 11, the goal concerned with urban development (ibid). However, what is noteworthy is that within the national performance on goal 11, the percentage of UGS related to the total urbanized area of cities has improved, indicating that there has been an increase in related priority-setting and action-taking with regard to green spaces within Italy, and that a certain change in thoughts on the matter has taken place within the country.

When turning towards the local sustainable development planning of the city of Padova, it first must be recognized that Agenda 2030 and the SDGs are explicitly included as key aspects in the municipal planning approach: With explicit reference to their global ratification, the city states to take them into account in all decision-making processes and relates all actions taken the respective SDGs (Padovanet, 2022C). In fact, the municipal website "Padovanet" is designed in such way that it is possible to filter all contents by SDG of interest (ibid). This is also true for local development strategies and planning tools, in terms of which the city for instance adopted an SDG-based participatory process (*percorso partecipo*) (Padovanet, 2022D).

This voluntary attribution of the respective SDGs to the local urban planning on sustainable development is thereby providing the basis to consider the requirements of the global sustainable development agenda in the analytical assessment of the local case of Padova, as the city itself proclaims the necessity of its local decision-making to be consistent with the global goals.

3.2.2 Urban Green Space Planning

Within the given framework of local approaches to sustainable development in the urban space of Padova, the following sections will provide the state of, and specific planning context on, urban greenery, the main unit of interest for this research. This is to generate an understanding of the city's context and planning approach to UGS, based on which the existing situation of UGS (in)accessibility is subsequently analyzed and evaluated in terms of whether or not urban justice, has sufficiently been considered in that current approach.

Looking at the current state of Padova's urban green, 56 % of the territory – around 52.23km² – constitute green surfaces, of which most green is private (80.38%), thus only 20% are available to the general public (Pristeri *et al*, 2021, p.13). Much of the non-built space in the outer areas is, moreover, occupied by agricultural use (ibid) as visible in the figure below. (**Figure 9**) below.

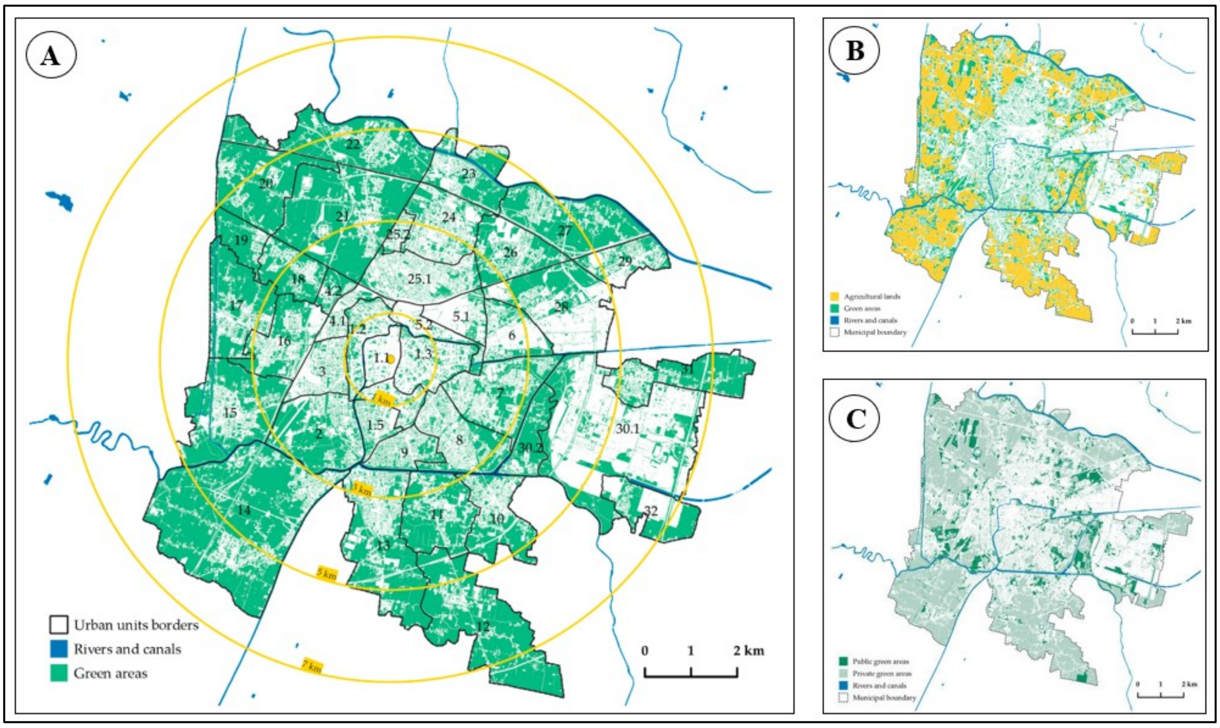


Figure 9: UGS in Padova. A: total UGS, B: rural/non-rural UGS, C: public/private UGS.

(Data source: Pristeri et al, 2021, pp. 14-16)

When it comes to the local planning and sustainable development strategies on the green space in Padova, the city proclaimed a new and innovative era of UGS management recognizing the complexity of interactions between ecosystem and human activity in the anthropocene (Padovanet, 2021). Within the public administrative structures, the main responsible organ is the *Settore Verde, Parchi e Agricoltura Urbana* (Sector for Green, Parks and Agriculture), whose offices are managing the green space in various ways and according to their competences (ibid). Overall, UGS management is based on the principle of horizontal stakeholder cooperation (termed *il verde horizontale*), thereby entailing public-private partnerships and agreements with relevant local associations (ibid). Through the census of green areas (*il Centesimento delle Aree Verdi)*, which is the main instrument underlying UGS management, the relevant entities are able to monitor, categorize and maintain all urban surfaces through geospatial data collection, and are obliged to visualize and share their approaches to the general public (ibid). In their presentation of UGS planning approaches, the city moreover refers explicitly to the following SDGs: SDG 3 on health and well-being, SDG 11 on sustainable cities and communities, SDG 13 on climate action, SDG 15 on life on land (Padovanet, 2022E).

Apart from the general approach of the city in relation UGS, Padova has recently proposed a specific new strategic instrument on green space planning, namely *Il Piano del Verde* (PdV) (the Green Plan), which is proclaimed as directly connected to the international and European sustainable development politics: Through the Italian law regarding public green, titled "Norms on the Development of Urban Green Spaces" (*Norme per lo sviluppo degli spazi verdi urbani)*, the related Committee (*Comitato per lo sviluppo del verde pubblico*) had been providing guidelines for the management of UGS and sustainable planning (*"Linee guida per la gestione del verde urbano e prime indicazioni per una pianificazione sostenibile"*) which includes the suggestion to draft a *Piano del Verde* to be guiding urban local transformation and choices on UGS matters and management strategies (Padovanet, 2022E). Thereby, a *Piano del Verde* is a voluntary strategic tool complementary to the general urban planning approach of the local unit (ibid).

Padova's *Piano del Verde* has been developed before this background. The process of drafting began as the "Participatory Process of Agenda 21 on the Green Plan" (*percorso partecipato di Agenda 21 sul Piano del verde*) in May 2021 and included different phases of stakeholder involvement with the goal of drafting a solid UGS strategy (Padovanet, 2022D). The objectives of the plan – and planning – can be summarizes as follows: To improve the territorial conditions from an ecosystem services point of view, to analyze public and private open spaces and green areas as a basis for new planning, to identify the connection between natural and urbanized areas to mitigate gray infrastructures, to plan and manage public green areas to increase biodiversity, to provide new green areas to mitigate the impact of the anthropocene, and to promote the topic and involve stakeholders for a participatory and inclusive co-management of the green areas (Padovanet, 2022E).

Following the process of stakeholder consulting, analysis and drafting, the newly developed *Piano del Verde* for Padova was eventually published in February 2022 (Padovanet, 2022E). The extensive document comprises eleven chapters and various annexes, entailing contents from analytical results on history, characteristics and biodiversity of the green infrastructures of Padova, water and heat management, biodiversity state, ecosystem services, parks and green areas, and agricultural use, to strategies forwarded for UGS management including one on "parks and accessibility" (*Strategia "Parchi e accessibilità"*). Complemented by good practices and monitoring criteria, Padova's *Piano del Verde* hence constitutes the main local development planning document on UGS. Thereby, the urban green planning and local development context of the city provides the basis for discussion of the findings of this analysis on the (in)accessibility of UGS in Padova from an urban justice perspective.

CHAPTER 4: METHODOLOGICAL APPROACH

Based on the preceding chapters providing the theoretical substantiation of the research interest through the establishment of a framework on sustainable development and urban justice, as well as the contextual background of the empirical local case of interest through the delineation of the relevant socio-spatial and develop planning approaches, this chapter introduces the methodological parameters of the spatial justice research conducted in the case study. It thereby provides an understanding of how the empirical research interest was analytically approached.

The following sub-chapters will accordingly present *what is analyzed, how it is analyzed, and how it is assessed* in this study, based on the operationalization of the theoretical concepts into measurable units with a two-step measurement approach (4.1), the assessment matrix developed through a multi-criteria analysis (MCA) design (4.2), and the operational premises of GIS equity mapping and the geospatial methods and data used to conduct the analysis (4.3). This is done by providing an extensive discussion of existing approaches in related research, as well as an evaluation of methodological risks and limitations as well as their potential alleviation. Thereby, a novel methodological approach to analyze UGS accessibility is proposed.

4.1 MEASURES

To establish the understanding of *what* exactly is analyzed in this research, the following sections will introduce the operationalization choices made when transforming the key conceptual research parameters, introduced by the theoretical framework, into measurable entities based on which an empirical analysis is possible. These choices and the two-step measurement framework to be presented were made based on the identification of common measures of UGS accessibility in state-of-the-art literature, as well as the consideration of the previously introduced contextual features and related urban planning approaches within the context of Padova.

To re-emphasize the basis for the operationalization provided within the next sections: The overall theory underlying the research is based on the need of spatial justice for local development, and, or more specifically, of UGS accessibility as a decisive factor in this regard, due to the nexus of urban greenery and sustainable development. The key theoretical components, as conceptualized within the theoretical framework, are therefore UGS, accessibility, and socio-spatial justice, which accordingly are the concepts to be operationalized for the empirical analysis undertaken by this research. Their empirical units and measures will thus be introduced in the following sections, entailing a two-step approach merging the different measures into a utilizable analytical frame.

4.1.1 Neighborhood Parks

This first section will introduce the operationalization of the key concept of interest, namely UGS, into the key unit of measure for this concept. Since UGS can be defined and understood differently, it is necessary to substantiate the unit choice made in this research based on the discussion of other approaches and the contextual features of the case context: as hinted upon when characterizing Padova's green space before, different types of this space were previously identified (i.e., the shown rural/non-rural areas, or private/public greenery). The following paragraphs will hence elaborate on common types and classifications of UGS and present the approach of this research in this context.

Based on the understanding that all forms of UGS together make up the urban system of green infrastructure, and that green space itself is said to be made up by a "system of hubs, links, and sites" in form of a network (de Sousa Silva *et al*, 2018, p.1), related literature commonly refers to the following types of UGS as potential units of measure: urban gardens, parks, forests/woodlands, nature reserves, corridors along waterways, playgrounds, informal green areas, vacant lands, brownfields, and agricultural areas or agricultural pockets (*inter alia* La Rosa, 2013, p.22; Panagopolous *et al*, 2015, pp. 139-140; de Sousa Silva *et al*, 2018; Koprowska, 2019).

These types of UGS are commonly sub-divided by service user and service provider: Firstly, they may be separated into public or private areas, whereby public areas are defined as "green spaces that are accessible to the general public and managed by the local government" (de Sousa Silva *et al*, 2018, p.4). While much of UGS planning and research focuses on public greenery, there has been a recent shift towards the acknowledgement of the importance to include private greenery for instance into calculations or projections of carbon emissions (Pristeri *et al*, 2021, p.2). Secondly, UGS may be separated by ownership into municipal versus non-municipal areas, which may be important to distinguish in order to detect whether or not local city planning offices have the authority or responsibility to directly manage these spaces or whether this falls outside their direct mandates (ibid, pp. 7 & 24).

In this research, the unit of measure for UGS is the unit of public neighborhood parks. The decision to focus on public green space (also: PGS) derives from the main premises upon which this thesis is built: One the one hand, on the focus on UGS not in terms of its environmental benefits but rather in its well-being benefits. Thus, while the inclusion of private greenery, like gardens, may be necessary to analyze the former benefits, well-being is argued to be more related to have accessible UGS for all. This relates to the other relevant premise, namely the interest into UGS as a local development service provision that requires equal accessibility and thereby equal well-being opportunities and outcomes among and for all inhabitants of the local urban space, which can only be provided in public space, since private space inherently restricts public accessibility through its exclusive ownership and character. Since parks are usually public property owned and managed by the local municipality (de Sousa Silva *et al*, 2018, p.4), their choice provides the basis for critically considering the state of UGS (in)accessibility in their justice dimension.

Within UGS literature, parks are in fact emphasized as particularly important UGS measurement unit, due to their inherent advantages for well-being: The body of so-called "park literature" (Willemse, 2018) stresses the benefits of parks in their design as leisure-time areas, which provide not only related recreational advantages, but also an open and inclusive space for all citizens, which may contribute to social encounter and, ultimately, social cohesion (Panagopolous *et al*, 2015, pp.139-140; Willemse, 2015, pp.15-16; Koprowska, 2019, p.144). For that reason, and because the main understanding of the nexus between sustainable local development and UGS derives from exactly this well-being and cohesion potential, parks are the unit of measure for UGS in this research.

More specifically, parks are commonly classified into different typologies based on aspects like size or function, such as metropolitan, district, neighborhood or community parks (Willemse, 2018, pp. 919-920; Willemse, 2015, p.19). Whether or not a UGS is considered a type of park or, for instance, rather a forest or even vacant land may depend on the national, regional or local classifications (ibid). Therefore, the classification of what will be considered as a park and thereby unit of measure in this research is going to be based both, on the categorization by Padova's *Ufficio Gestione verde pubblico* (Office of the Management of Public Green), as well as on the academic literature concerned with Padova's public greenery.

According to the UGS typologies of Padova, which are based on type, intensity of use and equipment, parks are considered a key category together with public gardens (*giardini*), complemented beyond this category by quality specifications like playgrounds or sports options (*parchi gioco ed aree gioco/verde degli impianti sportivi*) (Padovanet, 2021). Moreover, parks in the Padova context are classified in relation to the category "proximity green" or *"verde di prossimità*", by which all municipally owned and freely accessible and usable green areas are meant that are designed for relaxation, sports, play and socialization and comprise more than 500m² (PdV, 2022, chapter 6). What is excluded from the category of "proximity green" are thus other green areas like street greenery, residual green or private green (ibid). Based on the applicability of the stated character of "proximity green" onto the category of public neighborhood parks – both categories are understood as designed for public recreational purposes and thereby entail an accessibility requirement -, "proximity green" is adopted as a specific local kind of neighborhood park in Padova and thereby constitutes the unit of measure in this research. The adoption of this understanding, which deviates partly from the classification by the local green sector[6], was further made due to the specific focus on "proximity" that is entailed in the local classification of "proximity green", which underscores the accessibility requirement of this type of UGS and thereby constitutes a useful subject for analysis in this research.

Thereby, the local classifications of public green space are adopted as presented above, which provides the basis to enable a locally relevant assessment of accessibility justice in Padova's urban planning and organization. This choice is, moreover, in line with the recent research of Semenzato *et al* (2022)[7], who likewise interpreted Padova's "proximity green" as neighborhood parks. "Proximity green", understood as the local parks distributed across Padova's administrative units (here: *consulte*) are thus the key unit of measure for UGS in this research.

4.1.2 Three Factors of Accessibility

Having identified the key unit of measure, the following sections will introduce the operationalization choices of the measures themselves. This part will focus on the concept of accessibility, which is the key measure of interest in this research.

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[6] Within the category "proximity green", parks are a sub-category rather than understood as the equivalent to it. Accordingly, *Il Piano del Verde* classifies parks as particularly valuable spaces (labelling them *"valenza paesaggistica"*/ "valued landscapes"), which aligns with the aforementioned literature emphasis on their well-being functions, and sub-divides them geographically and characteristically into five groups: parks within the historical city center (*parchi all'interno della cinta muraria cinquecentesca, nel tessuto storico della città*), those close to the historical center (*parchi a ridosso delle mura cinquentesche*) urban parks (*parchi urbani della città*), agricultural parks (*parchi agricoli*) and river parks (*parchi fluviali*) (ibid). In this research, however, parks as "proximity green" are understood to be interchangeable terms, a decision that is also based on the available data with which the analysis was conducted, see chapter 4.3.

[7] It must be noted that the reference to this research was done despite the fact that it has yet to be peer-reviewed might thus still be subject to change. This is because the research provides an extensive account on the same topic within the same case context, and is therefore highly relevant when considering the current state-of-the-art in the development of the research design of this thesis. Whether or not it was used as a reference was still subject to careful consideration and review in connection to the analytical findings of this study.

What can be noted first is that while the previous classifications of public green space and parks, as understood in urban planning approaches and international literature, may already include the notion of "accessibility" as a typological precondition, what is understood by accessibility and how to measure it can vary considerably. Likewise, the above classifications frequently already entail the presumption of some qualitative and quantitative elements, such as sports equipment or the requirement of a certain size in order for a UGS to count as a park, both of which will here be introduced and discussed as parts of the accessibility measures.

As provided in the theoretical framework, since there is "no existence of a single index to measure environmental inequality" (de Sousa *Silva et al*, 2018, p.4), UGS accessibility was identified as a valid starting point for the evaluation of the state of urban justice in this regard. As stated, research on accessibility might focus on structural-general, mobility-related, or usability/functionality-related aspects. More specifically, UGS accessibility is commonly defined through the following main features (de Sousa Silva *et al,* 2018, .p.4*,* 2018; Sun *et al,* 2022, p.1; Willemse, 2018, p.918; Willemse, 2015, p.18; Koprowska, 2019, p.144; Nasri Roodsari & Hoseini, 2021, p.4; La Rosa, 2013, p.123):

a) **Quantity**: Area/size of available amount of the UGS,
b) **Proximity**: Distance/time to reach the UGS,
c) **Quality**: Value/worth of the features and functional services provided by the UGS.

These three factors are hence the most common operationalizations of the concept of UGS into commensurable measures (Rigolon, 2016; Sun et al, 2022, p.1; Nasri Roodsari & Hoseini, 2021, p.4; Venter et al, 2020). The utility of including the three accessibility measures was affirmed within local planning in Padova, where the rules for accessibility analysis include notions relating to all of them (PdV, 2022, chaper 6, annex 3, p.202). In addition to that, research usually defines some preconditions for considering UGS accessibility in the first place, such as basic requirements like whether there even is any green space – if not, this necessarily implies green space inaccessibility – or a minimum acreage of the considered areas (Koprowska, 2019, p.144; de Sousa Silva *et al*, 2018, p.4; Semenzato *et al,* 2022, p.4).

Before this research context and the adoption of related analytical rules in Padova, the three factors will be introduced and discussed in their benefits and limits for UGS measurement, and a comprehensive three-factor measure for accessibility will be proposed. The main precondition for considering accessibility in the first place will be the classification of the area as a "neighborhood park", or "proximity green", as provided in the previous section.

a) Quantity

The first, and most straightforward, accessibility measure utilized by much of the related international research is the assessment of the UGS unit's area in terms of its quantity or size (*inter alia* Koprowska, 2019, p.144). There are different ways in which the available UGS amount may be measured methodologically, i.e. either in terms of the area in km², or only in terms of the number of existing UGS units (Semenzato *et al*, 2022, p.2). Furthermore, quantity approaches commonly relate the size of UGS to its spatial occurrence: The area may either be summed as the total amount (i.e., the total number of UGS units or the total km²) of UGS in a given urban space, or as the amount within a spatial unit (i.e., the number of UGS per district, or the km² per district). This accessibility measure is usually termed "container approach", since it simply relies on the comparison of the numbers or total areas of UGS within spatial units as "containers" (ibid).

Frequently, this basic quantity measure, particularly when undertaken through the calculation of the total UGS area in km², is further complemented by a relation to the population distribution across the urban space and expressed as per capita UGS, or UGS area per inhabitant (done *inter alia* by Willemse, 2018; de Sousa Silva *et al*, 2018; Nasri Roodsari & Hoseini, 2021; Pristeri *et al*, 2021). The advantage of including a per capita approach may be to generate an understanding not only of UGS supply, but the relation of UGS supply and demand, whereby the demand is given by the mere number of people living in the area.

Another way of measuring the relation of supply and demand may be a spatial measure of quantity, in which the total area of UGS is related to the total available are of an urban administrative unit in order to arrive at a conclusion on the overall quantitative ratio of parks or greenery relative to the total urban space (UN SDSN, 2022). In this case, supply may be understood as the provided park area, whereas demand may be read from certain standards on the necessary quantity ratio of UGS to the total area. Accessibility, then, is measured through the proportion of available park area relative to total area per spatial unit.

Since container-based measures like the park ratio, however, are limited in terms of their lack of consideration of the interactions between service users and UGS across administrative boundaries, and the failure to take into account instances where there might e.g. be a large UGS within a large district that may produce a good ratio, however might not easily be reachable by those residents living at the other side of the district, quantity is not always the best accessibility measure (Semenzato, 2022, p.2). The next paragraphs discuss proximity and quality as common alternatives or supplements.

b) Proximity

Proximity, or the distance to reach a UGS, is the most commonly adopted accessibility measure within related UGS research (Sun *et al*, 2022, p.7). There are two popular proximity indicators and ways of measure, namely either in spatial or in temporal units: On the one hand, proximity in space is the physical distance to reach a UGS, for instance given by the average meters from the residential buildings and could be given *inter alia* by the average linear distance. On the other hand, proximity in time is the consideration of the time it takes for residents within a given spatial unit to arrive at a UGS from their homes, which may be given by the average minutes of walking to arrive at a UGS. The latter can be understood as relating more to the real-life opportunities for UGS users to access the UGS services: While the linear distance in meters might be short based on a straight-line calculation, it could take much longer to arrive at a UGS via the available road networks due to its routing or internal barriers. However, an average time is much more user-specific and can thereby also vary considerably based on resident's individual physical capabilities to cross certain distances.

Overall, proximity measures are agreed to be an important accessibility measure since it was found that the willingness, or ability, of individuals to actually make use of the provided UGS and to thereby attain the recreational benefits of this space is closely linked to distance: the longer the distance and the more time spent to reach a UGS, the less likely it will be accessed or used at all (Willemse, 2018, p.919).

In proximity approaches, accessibility is thereby understood through proximity, or the spatio-temporal possibility of reaching a green space like a park (Sun *et al*, 2022, p.7). However, while this measure focuses on the demand-side – the serviced population – of UGS, and the potential to reach a UGS easily and within an acceptable expenditure of time, it has limits in relation to scenarios such as the following: for instance, there may be many very small UGS providing nothing but some grass, that are spread across a spatial unit, and which are thereby very near to all residents and easily accessible in terms of spatial and temporal proximity, however insufficient in size and the quality they offer (see also Semenzato *et al*, 2022, p.3). For such cases, quantity measures or quality measures are more useful, the latter of which will be introduced in the following section.

c) Quality

Whereas the previous two accessibility measures can be defined quantitatively, in numbers – i.e., number of existing parks in a neighborhood, total area of UGS in km^2, km^2/capita km^2/total area, and average distance in meters or minutes -, internal UGS features may provide a valuable additional qualitative approach: Without a certain quality that provides the value creation potential of UGS in terms of its benefits for well-being, one might argue that there is not much value in determining whether or not an area is close by or large enough. Or in other words, without the UGS offering a certain quality standard through its internal features, one may consider its quantity or proximity irrelevant, since the main value function for local sustainable development is arguably not likely to be given. As pointed out by Sun *et al* (2022), the supply-demand model of accessibility assumed by the previous two measures does not apply when a certain quality is lacking, since the willingness of residents to access and utilize UGS is considerably influenced by its quality (Sun *et al*, 2022, p.10).

Therefore, the need for research into UGS quality has been stressed based on the related limitations of the other two measures, as quality might have a considerable additional impact for the determination of UGS accessibility (Semenzato *et al*, 2022, p.2). Despite this impact, there remains, however, a research gap in the inclusion of quality measures in contemporary UGS accessibility literature (Sun *et al*, 2022, p.8).

When looking at different ways of measuring quality, there is a variety of features that may be subject to assessment, ranging from ratings of general aspects of aesthetic satisfaction to the evaluation of internal features like natural characteristics, leisure time equipment or management services (Willemse, 2018, p.918; PdV, 2022, chapter 6). Accessibility, through quality measures, is thus determined by the value creation potential of a UGS that is given through its internal features.

A Three-factor Accessibility Measure

Due to the different benefits and shortcomings of each of the three introduced key accessibility measures, a combination of more than one measure to usefully operationalize UGS for empirical research can be concluded to provide a better basis for the actual understanding of the state of accessibility within a local context, and for the assessment of spatial and demographic differences in that regard (also: Semenzato, 2022, p.11). Therefore, the three factors are aggregated into the following three-factor accessibility measure:

Firstly, a “park ratio” for each urban administrative unit (*consulte*) is developed as a first indicator to measure accessibility in terms of UGS quantity, based on established standards of the average proportion of UGS relative to the total area of a neighborhood that should be available in order for the UGS-related well-being benefits to be obtainable, which will be introduced in the comprehensive MCA matrix provided in the next methodological chapter (chapter 4.2).

Secondly, the average walkability distance, or rather, the amount of household that can be reached within an acceptable distance, of existing UGS in each administrative unit is determined through related spatial and temporal distance measures, the thresholds for which are likewise going to be established in the MCA matrix.

And finally, the value creation potential of the existing UGS within each unit is determined by the determination of a relevant catalogue of quality features to be presented in the assessment framework as well.

Thereby, accessibility is to be understood as given when UGS is sufficiently large, nearby and high-quality. The theoretical concept of accessibility was hence operationalized and aggregated into a 3-factor measure (see **Figure 10**):

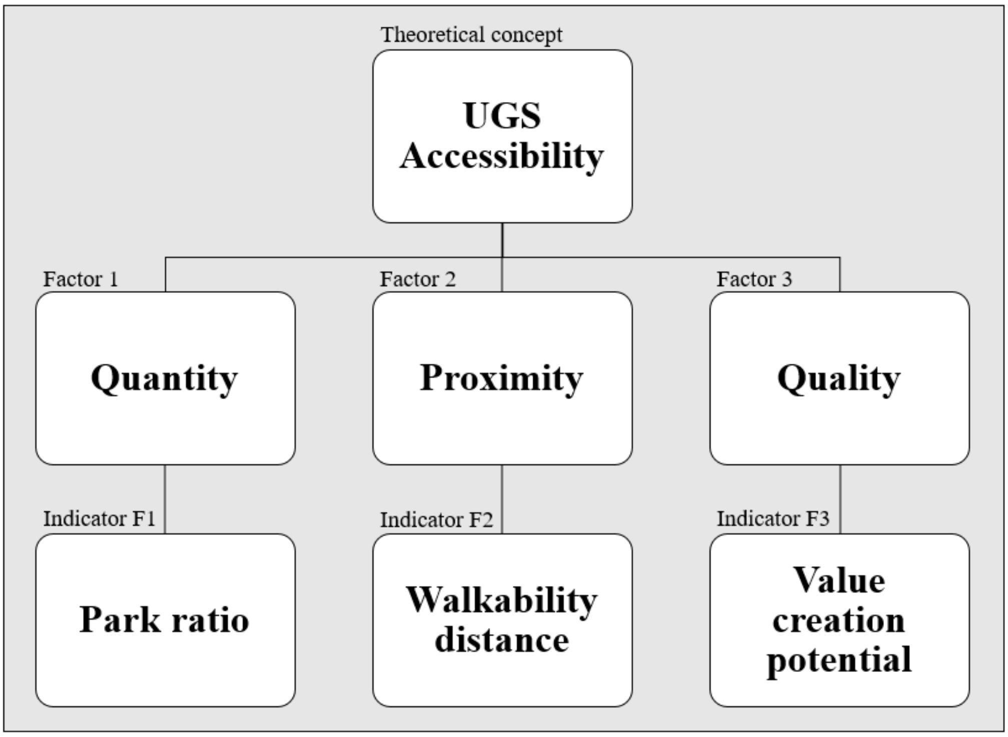

Figure 10: Three factors of UGS accessibility.

4.1.3 Justice Items

Having introduced the operationalization of UGS and accessibility, and thereby the established measures for the key unit, urban public neighborhood parks, and the key measure, accessibility in its three factors, the last theoretical component to be operationalized is the concept of socio-spatial equality, so the measure that will make this research a spatial justice approach.

Generating and utilizing a justice measure will thereby be important for the analysis of whether there are ***equal*** opportunities in accessing sufficiently large, nearby and high-quality parks for different social groups and across the examined local space, or whether there are socio-spatial differences in this regard and thus potentially unequal development outcomes across space and society. The measures for socio-spatial equality can therefore be understood as complementary in their purpose and function for the research: related items constitute the basis to assess given accessibility results on parks in terms of socio-spatial justice, so they serve as a means of spatial and social comparison.

In terms of social equality, social justice approaches to UGS accessibility commonly rely on demographics related to income, or rather socio-economic status (SES), as well as ethnicity, since these are understood to be the social categories that most frequently differentiated in terms of the availability of accessible environmental services (Sun *et al*, 2022, pp.2-4; Nasri Roodsari & Hoseini, 2021, p.4): People with lower SES were commonly found to live in more densely populated areas with less accessible greenery, and people belonging to marginalized or socially discriminated ethnic groups were commonly found to belong to those with less resources and therefore, inevitably, to those that are at risk of being neglected in UGS-related local development planning (ibid). Moreover, these groups usually have less private green space available than those that are richer and belong to a non-discriminated group, which is why the accessibility of PGS like parks can be considered even more important (ibid). As identified by Sun *et al* (2022) in their extensive review of literature on socio-spatial UGS inequalities, scholars have found a range of demographic factors to correlate with access inequality by influencing SES (Sun *et* al, 2022, pp. 6-7). Based on their findings, it can be concluded that socio-demographic items such as family structure, age, gender or ethnicity/nationality are among the most useful socio-demographic factors relating to, and potentially predicting, UGS accessibility inequalities.

In this research, the relevant items to determine the related social structures will be derived from the existing demographic data on Padova, as briefly introduced in the previous chapter. As presented before, this data is already divided into the administrative spatial units of the city, which provides the spatial justice measure: For the determination of whether the accessibility varies not only across society but, more particularly, across space, the previously introduced spatial units (*quartieri, consulte, unità urbane*) will constitute the spatial justice measurement items. More specifically, this research will be focused on the *consulte* as the most appropriate urban spatial division: this is because on the one hand, the use of the *consulte* offers a more detailed picture of the specific characteristics of the spatial units than the division into *quartieri* – the population statistics available on the city show significant variations across the different sub-units of the larger *quartieri* (Padovanet, 2022B). On the other hand, other scholars have utilized the divisions of the urban space into the smallest units, the *unità urbane* (e.g. Pristeri *et al,* 2020). However, this division, while offering much more specific comparisons, can also be considered to produce a more scattered picture of the urban space that would make it much more difficult to meaningfully compare the spatial units with each other, and to identify and discuss significant differences in UGS accessibility and social demographics. *Consulte* provide a middle ground between the two administrative extremes, and thus a useful division for comparison. From this point onwards, when it is talked about "neighborhoods" or "districts" or "administrative units" in Padova, what is to be understood is therefore the division of the city into *consulte*, if not explicitly stated differently.

Socio-spatial equality, or socio-spatial justice, is thereby operationalized into socio-spatial demographics as well as administrative divisions as the indicators for social and spatial equality items of the justice measure adopted in this research (**Figure 11**):

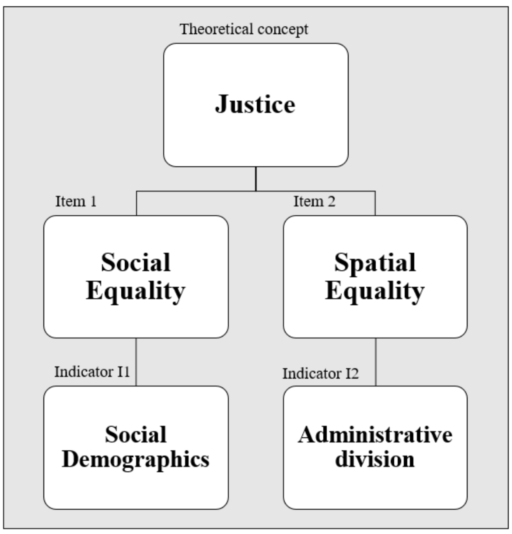

Figure 11: Socio-spatial justice items.

4.1.4 Two-Step Measurement Approach

The previous sections introduced the measures of the methodological framework of this research by presenting and discussing the operationalization choices undertaken for the three main theoretical concepts of interest: UGS, accessibility, and socio-spatial justice (see **Table 1** below).

Theoretical Concept	Measurable Units	Indicators
Urban Green Space	Neighborhood Parks	Proximity Green
Accessibility	Quantity	Park ratio
	Proximity	Walkability distance
	Quality	Value creation potential
Justice	Social structure	Social demographics
	Spatial structure	Spatial administrative units

Table 1: Operationalization of concepts into measures.

Therefore, the key unit of measure, namely parks, is to be subject to two measures: the three-factor accessibility measure to identify the patterns of accessibility in each spatial unit, and the socio-spatial justice items to assess whether the UGS-related patterns can be considered ***just.*** Therefore, the measures of this research follow a two-step logic common in related scholarship (e.g. Nasi Roodsari & Hoseini, 2021, p.4), as visible in the below figure (**Figure 12**):

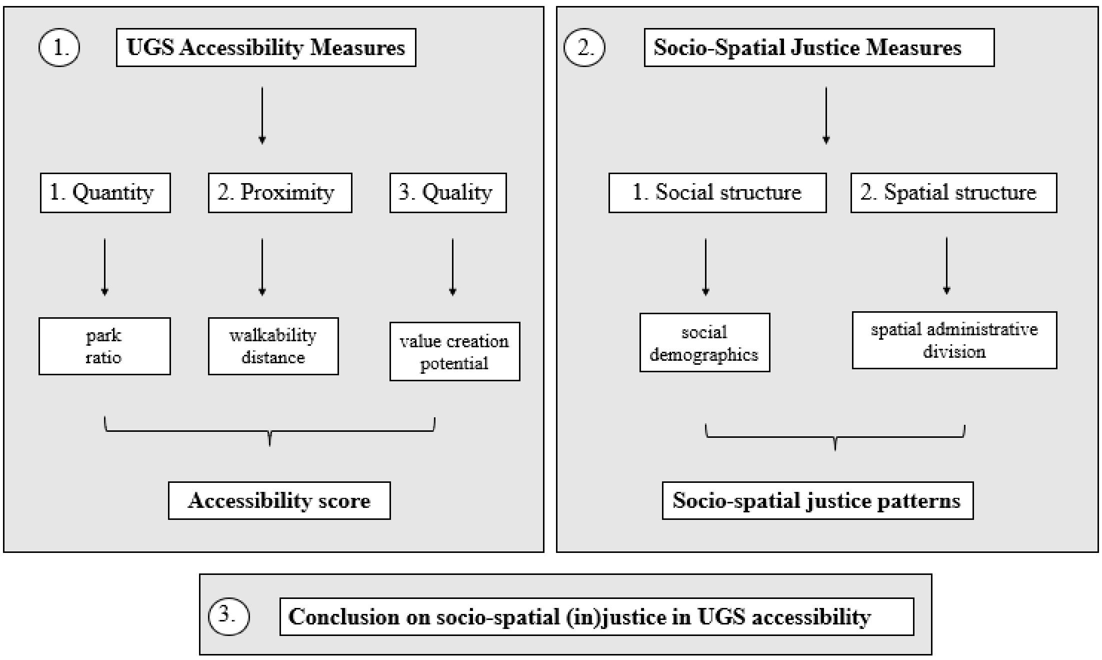

Figure 12: Two-step measurement approach.

4.2 ASSESSMENT FRAMEWORK

Having established *what* is analyzed in this research, namely public neighborhood parks or "proximity green" through a two-step approach measuring accessibility and socio-spatial equality, the following sections will introduce the assessment framework based on which the level of UGS accessibility among the spatial units within Padova is determined. It will thereby be introduced based on which parameters the neighborhoods within the city are categorized as low, medium or high in terms of the level of UGS accessibility within their boundaries, based on the values of the previously introduced indicators of the three accessibility factors quantity, proximity and quality.

This chapter thus provides the assessment basis for the evaluation of the analytical results of the conducted research. Accordingly, the following sections will introduce the assessment framework and the related standards to be adopted to evaluate the UGS accessibility levels within the neighborhoods of Padova, and the matrix to be underlying the analysis.

4.2.1 Multi-Criteria Analysis

In the following paragraphs, multi-criteria analysis (or MCA) will be introduced as the tool for assessing the – presumably varying – levels of UGS accessibility across the urban space of Padova. Since the previous sections identified three factors, or *criteria*, through which accessibility is to be measured, MCA as an approach that, by nature, considers and integrates multiple criteria, will be established as a useful methodological choice for the assessment framework of this research.

By way of introduction, MCA, also known as MCDA (multi-criteria decision analysis), MCDM (multi-criteria decision making), or SMCA (spatial multi-criteria analysis), can be understood as an interdisciplinary method for analyzing, assessing and/or decision-making on complex problems for which multiple criteria are relevant and thus have to be considered. These criteria might either complement each other or stand in conflict with one another, which is why MCA offers tools to integrate them and thereby to approach the issue in question more systematically. Due to this function, MCA is not only employed for academic research purposes, but may, for instance, also be applied to everyday life decision making problems, e.g. in situation where more than one criterion is relevant.

Beyond these applications, the utility of MCA is widely accepted in planning and used to deal with complex decisions, analyses or assessments (e.g. Lelo *et al*, 2019). For instance, one might think of the need to adopt some form of multi-criteria evaluation in the context of local development and spatial planning endeavors: first, because development itself is comprised by multiple factors relating to social, environmental and economic criteria, as introduced in the theoretical framework of this research. Related planning in the local space can thereby be understood as necessarily requiring the consideration of multiple aspects. Furthermore, in the realm of spatial planning, MCA is commonly adopted for the evaluation of the capability or suitability of a given territory or space for specific planning objectives, or for related risk assessment purposes (e.g. Ottomano Palmisano *et al*, 2016). SMCA specifically relates to spatial analyses of decision-making based on the integration of multiple criteria (ibid). Most notably, MCA has been adopted as a useful method in service accessibility and equity research, such as for instance by Talei *et al* (2014), who assessed the equity of urban public facilities using SMCA. The tools provided by MCA are thus highly relevant to the related research interest of this thesis.

When considering the practicalities of MCA, different steps need to be undertaken in order to logically integrate the different criteria (see also Lelo *et* al, 2019): First, the exact factors to be considered must be identified. In urban planning, this is usually done for instance by the consultation of stakeholders and experts through a Nominal Group Process (NGP), whereas in this research, it was done by extensively reviewing related international, national and local literature on the topic of UGS accessibility, resulting in the identification of a) the need of including more than one factor, and b) the identification of quantity, proximity and quality as the most useful criteria for assessment. Second, in order to conduct MCA, the technique by which these factors are integrated needs to be chosen. Regarding that, MCA offers different tools: At the heart of the logic of MCA is a ranking, rating, and scoring mechanism by which the criteria of interest are combined. Thus, useful indicators for each factor are identified and thresholds for the evaluation of the indicator outcome values are determined. Then, the resulting rating for each factor is integrated with the others and combined into an overall score. For spatial approaches like the one to be presented in the context of this research, this mechanism relates to the scoring of a spatial unit, whereby the same unit is rated on different factors and then given an overall summary score. The following visualization (**Figure 13**) underscores this logic:

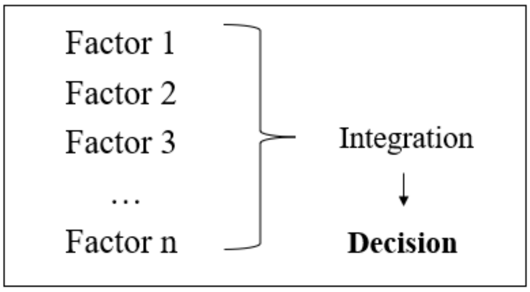

Figure 13: MCA logic.

While there are different integration techniques to summarize the rating of the three factors to an overall score of the spatial units in question, the most common approaches are the pass/fail model, the addition of factors approach (AFA), and the weighted linear combination (WLC) (see Piovan, 2020, pp. 153-155). The pass/fail approach is based on the definition of a minimum threshold value for each factor, through which the integration is undertaken by the multiplication of the passing factors: $Score = (R(F1)) * (R(F2) * \ldots (R(Fn)$, whereby F equals the indicator of the criterion, or factor, in question, and the R is the rate assigned to the value given to the respective indicator result. While this model is the simplest one, it lacks the capacity to produce the more nuanced picture of spatial units as low, medium or high in UGS accessibility of interest for this research, based on which a comparison across the units can be undertaken more meaningfully: $Score = \big(R(F1)\big) + \big(R(F2)\big) + \cdots (R(Fn)$. The two other techniques provide the means to do so by relying on the rating of each factors' indicator value according to different identified value ranges, e.g. thresholds defining low, medium, and high accessibility, on the basis of which they are subsequently integrated by summing the resulting ratings that are related to the respective ranking accordingly. This enables the internal ranking of indicator values and thereby provides the more differentiated consideration of the factors. When complementing the AFA with the WLC, each factor (or rather the indicator value of each factor) can furthermore be attributed a weight in line with its importance relative to the others, which may further deepen the assessment results: $Score = (R(F1) * w(F1)) + (R(F2) * w(F2)) + \cdots (R(Fn) * w(Fn))$ whereby w is the weight of the respective criterion. The latter approach will be adopted in this research, as will be discussed in section 4.2.3.

Having thus introduced the main parameters and logic of MCA approaches, it can be concluded that for this research, MCA will be utilized to assess the accessibility of Padova's neighborhood parks based on the three identified factors. The ultimate aim of the MCA in this research is thus to establish a rating/score matrix based on which each *consulta* can be scored into low, medium and high UGS accessibility, which will serve as a basis for the comparative intra-urban justice assessment to be undertaken in this respect. The next section will accordingly establish the necessary standards by which all three factors can be rated.

4.2.2 Accessibility Standards

Based on the preceding establishment of the logic of MCA approaches, the following sections provide the discussion and identification of the threshold values based on which the indicators for each factor will be evaluated and rated and ranked as low, medium or high. In other words, it will be established how big the park areas within Padova's neighborhoods should be to produce a park ratio that can be considered high enough to contribute to UGS accessibility in the area, how small the average distance has to be for how many residents in the neighborhoods in order for UGS accessibility to be considered high in terms of proximity and walkability, and which, and how many quality features the parks in each neighborhood need to fulfill in order to be considered to have a high value creation potential.

As will be discussed, these aspects were determined by the review of international and local urban sustainability standards, complemented by the retrospect comparison with the actual values after retrieving the local data. This last action was necessary to include in order to circumvent potential issues related to possible local deviations from international norms, which might have otherwise resulted in the rating of all neighborhoods with the same values, making a spatial comparison in the UGS accessibility impossible – for instance, if the local proximity values for all *consulte* would exceed the international thresholds, all would be rated as "high", which would disregard variations among the values. As this research is concerned with the assessment of intra-urban spatial justice, or equality, differences among the *consulte*, no matter how high the values, are the focus of the analysis, and will thus continue to be relevant. Furthermore, this research is part of the research body on local development, thereby aiming at including and focusing on local specificities rather than applying universal models that might not catch the specific local circumstances – relying upon the local data when defining the MCA thresholds can thus be considered of value in itself. This is why the thresholds were chosen by the inclusion of a combination of inductive and deductive standards, leading to more or less externally applicable threshold determinations. Limitations and aspects in this regard will be discussed more in-depth in the following sections, in which the MCA thresholds for a) quantity, b) proximity, and c) quality are introduced.

a) Quantity Standards

As discussed before, quantity is the first accessibility measure, or factor, to be adopted in this research. The determination of standards for thresholds on low, medium or high rankings of a spatial unit in terms of the available UGS quantity is based on the consideration of the question how much supply of UGS area will fulfill the demand of the residual population in order to create well-being and thereby allow for the contribution of urban greenery to local development.

In international literature and urban planning norms, standards around the necessary UGS quantity commonly rely upon the identification of a minimum area to be available, either in total or per capita: Coles & Bussey identify a threshold of 2 ha, van Herzele and Wiedemann state the necessity of 1-10 ha, and Magalhaes argues for the minimum of a 400m² minimum area for public green space (de Sousa Silva *et al*, 2018, p.4). Most importantly, the UN Sustainable Solutions Network (SDSN) suggests specific standards relating to the ideal park ratio for sustainable cities, stating that within public space, which ideally should constitute at least 45% of the urban area, 30% should be comprised by streets and sidewalks, and at least 15% should constitute public green space (UN SDSN, 2022).

In Padova, the key strategic tool on UGS planning, *Il Piano del Verde*, does not include a specification on the park ratio norms for the neighborhoods, but provides that any account of "proximity green", thus all areas to be considered neighborhood parks in this research, needs to have an area of at least 500m² (PdV, 2022, chapter 6). Furthermore, it is specified that in order for a UGS to be valuable, parks should have an area of at least 10 000m² (ibid), thus implying the need for larger greenery.

Based on the consideration of the existing abovementioned international and local standards, the assessment of quantity for this research is based on the definition of thresholds determining low, medium and high ranking of the spatial units in relation to their park ratios. The park ratio itself is calculated by the percentage of park area relative to the total area of each neighborhood:

$$\textbf{Park ratio} = \frac{\textbf{Total area of UGS in km}^2}{\textbf{Total area of consulta in km}^2} \textbf{ x 100}$$

When determining the thresholds for the value ranges ranking the outcomes into low, medium and high ratings, the ideal way to do so would be to start from the given SDSN value of a 15%

minimum UGS ratio, signifying for instance the thresholds for a low rating of a district when it shows a public park ratio of less than 15%. However, based on the inductive integration of the existing local circumstances, which serves to test the applicability of such a threshold to a comparative analysis of spatial inequalities within the local context, it becomes apparent that in the case of Padova, the ideal threshold of 15%, signifying a sustainable urban environment, cannot be utilized: For the city as a whole, the ratio of UGS – here, the ratio of public "proximity green", constitutes as mere 2.3%, showing that Padova scores extremely low overall in terms of this first accessibility factor. Since it is therefore more than unlikely for any of the single districts to fulfill the 15% standard at all, the thresholds defined to signify low, medium and high quantity values were adapted to the city's average ratio: A low quantity value is determined to be one of less than 2.5%, a medium value one of 2.5% - 5%, and a high value one of more than 5%. The overall city-wide insufficiency of UGS quantity was thereby still somewhat included in the rating matrix, namely by defining the threshold for low values below the urban average. The following table (**Table 2**) thus shows the MCA rating logic of the first factor, which is coded "F1":

FACTOR (F)	INDICATOR	RANKING	THRESHOLDS	RATING (R)	WEIGHT (W)
F1: QUANTITY	Park ratio	Low	< 2.5 %	1	2
		Medium	2.5 - 5 %	2	
		High	> 5 %	3	

Table 2: MCA matrix for quantity (F1).

Districts with park ratios with low rankings of their values within the defined value range are thereby rated with 1, those with medium rankings are rated with 2, and those with high rankings are rated with 3.

Due to the adaptation of the value range thresholds to the very low local average, the external validity of the above matrix clearly constitutes a limitation of the approach: While it was necessary in order to evaluate internal intra-urban differences, which would be inviable when all districts would have been rightfully rated as "low", the outcomes on quality of the *consulte* need to be considered more carefully, i.e. *consulte* rated with a high score on quantity might not indeed be externally considered as “high”, since this threshold does not even come close to the internationally proclaimed standards for sustainable cities. However, the defined thresholds can nevertheless be considered as internally valid, since this thesis is based on the interest in intra-urban equality to access UGS and a theory on socio-spatial justice, which is why there is an inherent need to identify the differences in quantity across the districts no matter how overall low the ratios are, as stated before. It may, for instance, be argued that based on a justice approach, it does not matter how little everyone has, as long as everyone has equally little – there is, therefore, a difference in the kinds of problems posed: Collectively having equally too little access requires a different kind of solution and creates different problems than when certain districts or social groups are disproportionately disadvantaged relative to others – the difference lies in the interest in total disadvantage of all, or relative disadvantage of others. This discussion will be taken up again in relation to the findings of this analysis; at this point it shall suffice to have recognized the limitations of this choice and presented the considerations based on which they were made.

b) Proximity Standards

The next factor for which the MCA value range thresholds of low, medium and high ratings were defined is proximity. As previously stated, proximity is commonly measured through the requirement that UGS need to be reachable and accessible within walkability distance, however what this concretely means and which distance can be considered sufficiently near and walkable in order for the local residents to reach a neighborhood park is subject to debate, and the rating of spatial units may be conducted based on different threshold values and approaches.

To re-emphasize what was mentioned before, proximity is commonly measures through a combination of temporal and spatial values, which is reflected in the threshold values for UGS proximity proposed by international literature: Nasri Roodsari & Hoseini (2021) define the minimum threshold of 800m or 10min walking, Wolch *et al* mention 400m or 5min, Coles & Bussey 5-10min, and de Sousa Silva *et al* (2018) define a range between 300m relative to 4min and 500m relative to 7min walking (de Sousa Silva *et al*, 2018, p.4). Temporal values are therefore usually combined with spatial values, however what is considered an appropriate walkability distance to the next UGS differs among the accounts of relevant scholarship.

This is why the standards set by urban planning approaches within the local context may give a better indication of proximity understandings and norms within the local space, as the local infrastructure and environmental features might have been included and the related thresholds may thus be more appropriate. In Padova, proximity measures are recognized as important accessibility factor within the realm of *Il Piano del Verde*, in which two related thresholds are defined: on the one hand, a minimum distance of 300m, stated as equivalent to 5mins of walking, is determined as the basis for accessibility (PdV, chapter 6, pp. 202 - 209). Beyond that, the *Piano* defines an 800m/15min threshold for the distance to reach larger parks with more quality features (ibid). Thus, the definition of thresholds and the combination of temporal and spatial values deviate somewhat from international standards; here, 5 minutes of walking are seen as equivalent to 300 meters, instead of 400.

When determining thresholds that may be the basis for attributing each district a rate relative to low, medium or high levels of UGS proximity, it is first important to note that this usually done not in terms of the average meters or minutes for each resident to reach the next UGS, but rather measured through a demand-based approach, whereby it is calculated how many inhabitants may reach the UGS within the defined minimum thresholds. More precisely, the walkability distance indicator adopted in this research is thus based on the calculation of the percentage of the population within a neighborhood out of the total population of that neighborhood that can reach the next UGS within the defined walking distance:

$$\textbf{Walkability distance} = \frac{\textbf{No. of inhabitants within UGS walking distance}}{\textbf{Total no. of inhabitants within consulta}}\ \textbf{x 100}$$

For this research, the locally defined minimum threshold of 300m, equivalent to 5mins, is adopted, since it can be understood as the basic requirement to reach the next local "proximity green" and thus relates proximity with minimum accessibility. Thus relying on the local standard-setting and the analysis conducted in this regard by the city's *Settore Verde* (the green sector), the following thresholds are defined: Since there is an international and local consensus on the need for UGS within 5 minutes of walking distance, it seems appropriate to define a district with less than half of the inhabitants within this distance as low, districts with 50% - 75% of the population in walking distance as medium, and those with over 75% as high in terms of proximity. The following table (**Table 3**) thus shows the MCA matrix for the factor proximity ("F2"):

FACTOR (F)	INDICATOR	RANKING	THRESHOLDS	RATING (R)	WEIGHT (W)
F2: PROXIMITY	Walkability distance	Low	< 50 %	1	2
		Medium	50 - 75 %	2	
		High	> 75 %	3	

Table 3: MCA matrix for proximity (F2).

In relation to the choices underlying this matrix, it may be noteworthy that different to the threshold determinations of F1, quantity, those of proximity were undertaken more deductively and in line with common international standards. This can be interpreted as possible also because Padova itself is a rather small city, and the distances to reach the existing UGS might thereby be generally shorter, making this factor potentially easier to fulfil.

However, there are limitations relating to the choices on the proximity measure as well, relating to the underlying assumptions regarding walkability distance averages, which might vary considerably based on the individual physical and social capacities of the considered inhabitants: Differences in that regard might relate for instance to age, as elderly people or children might have more difficulty crossing a 300m distance by foot and might spend more time doing so, physical health and ability status, as these averages assume the capacities of a healthy and abled persons rather than someone with limited physical mobility, or gender or ethnicity, as these social categories might be the reason why a distance might be perceived as more insecure for individuals belonging to a socially marginalized or discriminated group, members of which might choose a different path than the most direct one to reach a UGS. The adoption of average distance values such as 300m or 5mins thus constitutes a clear limitation in terms of including the specific variations in spatial and temporal walking capabilities, and related results might be distorted in presuming inhabitants to be equally abled in their mobility. While this research nevertheless adopts average walkability values to produce an overall idea of proximity differences among the spatial units that exist even despite disregarding such differences, the aforementioned limitations might be a valuable basis for future research into related mobility and/or infrastructural justice[8].

c) Quality Standards

The final accessibility factor for which the thresholds to rate the districts as low, medium and high are defined is quality. As previously introduced, quality is measured by the value creation potential of a UGS, i.e. it was argued that any neighborhood park needs to fulfill some basic internal features establishing the potential for users to increase their well-being, which needs to be satisfied in order for the UGS to contribute for the local sustainable development.

In international literature around the question of which exact internal features can be considered to increase the quality of an UGS in such a way, different categories are prominently identified: For instance, Semenzato *et al* (2022) emphasize minimum features such as shade, trees, benches, lawns and a pedestrian path (Semenzato *et al*, 2022, p.4) and de Sousa Silva *et al* (2018) identify categories like structural and general aspects, functionality and experience aspects, and management and organization aspects (de Sousa Silva *et al*, 2018, p.4). In her account on park usage, Willemse (2018) furthermore identifies constraints to usage based on structural constraints on the supply side, out of which certain necessary quality features may be read: her findings include *inter alia* the reachability by different means of transport, some equipment, and park management, with aspects such as security measures and the existence of park furniture, play equipment, restrooms and cleaning services, lightning, drinking water and rubbish bins (Willemse, 2018, pp.918 & 926).

Since there is hence an extensive catalogue of possible quality features in international literature based on which one might evaluate and rate UGS, it is relevant to consider the quality standards given by Padova's related planning instruments. In *Il Piano del Verde*, the planning sector entities identify a list of internal features of the areas labelled as "proximity green", based on which an evaluation of the value of these areas is undertaken. The features, or services, are divided into different typologies and comprise the following aspects: first, surface characteristics of the area's size of either 500/10 000m² or more than 10 000m², second, other characteristics of the area with features like the existence of benches, tree shadow, and easily

[8] This limitation thereby touches upon the accounts of Cresswell (2010) and Sheller (2018) on the politics of mobility and mobility justice. While the arguments in that regard exceed the scope of this research, they will be a valuable extension of the justice approach to intra-urban socio-spatial inequalities in further research.

accessible pedestrian paths, third, another set of area characteristics including illumination and water fountains, fourth, the presence of basic services like refreshment services and toilets, or just toilets, fifth, the presence of additional services like playgrounds for children, free sports equipment and areas for dogs, sixth, security features such as fences, and last, the reachability of the UGS including by cycle path, through nearby parking options, and through the existence of a stop for public transport within 300m distance (PdV, chapter 6, p. 195).

In this research, the features identified as quality features by the city of Padova are adopted as the relevant quality features to be underlying the evaluation of the value creation potential of the UGS within each neighborhood, as they can be considered to represent the local planning standards. While not including the first typology of features related to the park size, as the UGS quantity is already covered through the park ratio in this research, the features to be considered to contribute to the value creation of the neighborhood parks are thus the following 14:

1. Benches
2. Tree shadow
3. Pedestrian paths
4. Illumination
5. Fountains
6. Refreshment services
7. Toilets
8. Playgrounds
9. Sports equipment
10. Dog area
11. Fences
12. Cycle path
13. Parking
14. Public transport

For each UGS within the districts, there is therefore a maximum of 14 quality features that may be fulfilled. The interest in the MCA assessment is, however, to develop a basis for assessing the districts of Padova in their quality values relative to each other, which is why the respective threshold values to determine low, medium or high overall UGS quality for each district will relate to the following parameters: Considering the high number of quality features that may be fulfilled, some aspects of which can be considered rather basic (such as the existence of shadow or lawns) and other more advanced ones might be more unlikely for a neighborhood park to have (such as areas for dogs or sports equipment), it is determined that for any park to provide the necessary value creation potential to effect human well-being, at least 50% of the features need to be fulfilled – this would make it necessary for a UGS not only to have the basic features but also some more advanced quality aspects. Based on this definition of a minimum threshold of 50%, which corresponds to more than 7 out of 14 possible features, it will be calculated what percentage of the UGS within a *consulta* out of all UGS within that *consulta* can be considered high enough in quality to provide the necessary value creation potential:

$$\textbf{Value creation potential} = \frac{\textbf{Total number of quality UGS}}{\textbf{Total number of UGS in consulta}} \textbf{ x 100}$$

The outcome value is then ranked and rated in accordance with the MCA logic. For the quality factor, the thresholds defined to determine low, medium and high rankings of the districts has been defined by simply dividing the value ranges into thirds, in line with simple international planning standards: A percentage less or equal as 33.33% of quality UGS therefore corresponds to a low value, one between 33.33% and 66.66% to a medium value rate, and more than 66.66% to a high value. This simple division was chosen over thresholds that are set higher, such as done in relation to proximity that set the lowest threshold at 50%, because the inductive inclusion of the data on Padova shows that quality seems more unlikely to be fulfilled across the urban space, which is why, for previously discussed reasons, it was necessary to find thresholds that would enable the intra-urban comparison among the districts. The following table (**Table 4**) accordingly shows the MCA matrix for the factor quality (F3):

FACTOR (F)	INDICATOR	RANKING	THRESHOLDS	RATING (R)	WEIGHT (W)
F3: QUALITY	Value creation potential	Low	<= 33.33 %	1	1
		Medium	>33.33 - 66.66 %	2	
		High	> 66.66 %	3	

Table 4: MCA matrix for quality (F3).

As in the case of quantity and proximity, the choices made to assess the factor of quality are certainly not ambiguous either. Limitations include, for instance, the fact that the choice of the 14 features is based entirely on the aspects identified by the local planning entities, which relates to the available data and strategies, but might be leading in terms of the risk that only those features that were most likely to be fulfilled were included by these entities. While it might be useful to conduct a field visit and test this hypothesis to gain a better understanding of the reliability and validity of the reported quality data, and the inclusion of further quality features might contribute to a more comprehensive result, the reliance on these 14 aspects in this research shall be understood as a useful starting point to consider the matter within Padova, where scholarship on UGS accessibility has not yet included any quality features. These features are, moreover, sufficiently represented as important in international scholarship, and can thus be adopted as a valuable set to be considered at the local level. Further limitations might relate to the inclusion of some specific features as quality features, such as fences as a feature for security: this can be considered ambiguous, as fences might, for instance, on the one hand contribute to a perception of security by providing an enclosed space, but can on the other hand be considered as, by nature, exclusionary and thereby restricting free accessibility. However, they are usually accepted as a valid security measure in spatial planning, which is apparent in the choice to include this aspect in the quality catalogue developed by the city of Padova, which is why they are adopted in this research. Lastly, the choice to rate each of the 14 features equally might be subject to debate and could lead to limitations in terms of providing a nuanced picture of the quality state within the UGS. Yet as argued before, setting the threshold at 50% already requires the existence of a variety of features, and since the interest of this research is to create a basis for intra-urban comparison, variations among the UGS within the districts are considered of less importance. These aspects will be taken up in the later chapter providing the discussion of the analytical findings (chapter 6).

4.2.3 MCA Assessment Matrix

Based on the preceding definitions, the MCA logic of the accessibility measure conducted within this research is the consideration of three factors – or criteria -, each of which contains a three-level ranking of low, medium and high, according to which the indicator values for each spatial unit are rated.

Moreover, in order to integrate the ratings of the three factors, this research will make use of the WLC technique (see **Figure 14**), and attribute a weight to each one: Quantity and proximity, as the more traditional accessibility measures, are going to be weighted equally more than quality, as this factor does not directly related to accessibility but rather relies on the assumption on the kind of UGS to be accessible, namely one that has the potential to contribute to development.

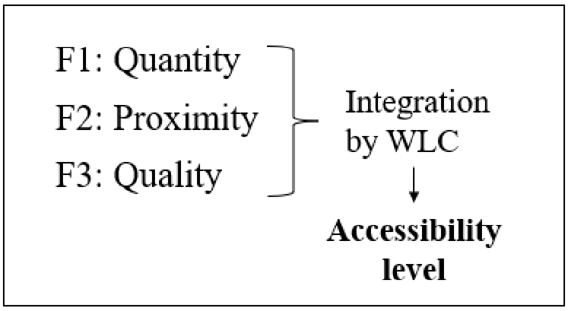

Figure 14: MCA logic in this research.

Thus, the formula below will underlie the integration of the ratings of the factors, where R = the rating, F = the factor: the final accessibility score will thus be calculated by summing the weighted outcome values of each factor, as provided in the summary MCA matrix table (**Table 5**) below. This will be done for each *consulta*, thus providing the basis for comparing the accessibility of UGS, defined by the three integrated factors, across the spatial units of the city.

$$\textbf{WLC Accessibility score} = (\mathbf{R(F1)} * \mathbf{2}) + (\mathbf{R(F2)} * \mathbf{2}) + (\mathbf{R(F3)} * \mathbf{1})$$

FACTOR (F)	INDICATOR	RANKING	THRESHOLDS	RATING (R)	WEIGHT (W)
F1: QUANTITY	Park ratio	Low	< 2.5 %	1	2
		Medium	2.5 - 5 %	2	
		High	> 5 %	3	
F2: PROXIMITY	Walkability distance	Low	< 50 %	1	2
		Medium	50 - 75 %	2	
		High	> 75 %	3	
F3: QUALITY	Value creation potential	Low	<= 33.33 %	1	1
		Medium	>33.33 - 66.66 %	2	
		High	> 66.66 %	3	

Table 5: MCA matrix for UGS accessibility in Padova.

4.3 GEOSPATIAL METHODS

Having provided the measures and assessment framework underlying the accessibility analysis conducted in this research, this last method chapter introduces the practical methodological operations by which the analytical results on the accessibility and related socio-spatial equality patterns on UGS in Padova were obtained, thus *how* the analysis was conducted.

The next sections accordingly present the adopted geospatial methodology, the utilized data sets, and finally provide the description of the geospatial workflow by which the results were obtained.

4.3.1 GIS Equity Mapping

In the following sections, geospatial methodological approaches to UGS accessibility justice will be introduced as the methodological research body in which this thesis is located. Thereby, the overall basis for the specific data and operational choices, to be presented in the subsequent sections, will be established.

Within the research body on UGS accessibility justice, a variety of analytical approaches was identified by Sun *et al* (2022) in their comprehensive literature review: Beyond the use of a multitude of measures, studies were published by scholars from various disciplines, including land use studies, sustainability sciences, public health and environmental sciences (Sun *et al*, 2022, pp. 2 & 7). By nature, research on the topic thus includes both quantitative methodologies and qualitative studies, the latter of which is less common but might include, for instance, the interviewing of local residents related to their perceptions of park quality factors (e.g. Willemse, 2015 & 2018).

Despite the interdisciplinarity and variety in methodological approaches on UGS accessibility, most research on the topic does have one aspect in common: the use of geospatial approaches and the related common utilization of GIS (geographic information system) tools, which enable the use of both quantitative and qualitative spatial data. As established by Piovan (2020), GIS means are used when aiming to "organize, visualize, and analyze spatial and aspatial information" (Piovan, 2020, p.119). GIS is thereby a "fundamental tool in the analysis and mapping of […] geographical processes" by offering the means to approach these processes "in a digital and quantitative manner" and for interdisciplinary purposes (ibid). More specifically, GIS is "an information system used to manipulate, summarize, query, edit and visualize spatial and non-spatial information stored in a computer database" (ibid, p.120). The utility of combining spatial research with cartographic analytical and mapping tools derives from the understanding that maps are powerful means to visualize spatial patterns and communicate spatial phenomena (ibid, pp.40-43). In GIS, mapping constitutes the last phase of operations, in which utilized data and found patterns are visualized (ibid, pp.163). Thereby, GIS software is used not only to compute space-related questions, but also to cartographically display spatial information.

In studies on green space in general, GIS has been adopted for its utility in a variety of ways: "to model new greenspace developments, to quantify the value of different greenspaces, for scenario testing planning models and to quantify the spatial configuration of greenspace elements in the urban landscape" (Comber *et al*, 2008, pp.104-105). More specifically, GIS-related geospatial approaches haven been found to be "widely used to examine the patterns of accessible urban [green spaces]" and the "modelling of accessibility to [green spaces was found to have] evolved substantially, thanks to enhanced GIS features […] and personal computers' computational capabilities" (La Rosa, 2013, p.123). Moreover, UGS accessibility research related to questions of spatial justice, such as the present study, has been identified to fall into the methodological research field of "equity mapping", whereby GIS technology is used to "make the connection between so-called areas of opportunity […] and [socially marginalized] communities" (Sun *et al*, 2022, p.2). As stated by Lelo *et al* (2019), the cartographic visualization of urban inequalities and spatial analyses of such phenomena with GIS tools can be considered valid, as these tools are considered particularly useful for the "addressing [of such] complex, multidimensional problems" (Lelo *et al*, 2019, p.1). The present study can thus be considered to fall into this last research camp, whereby local UGS – namely, neighborhood parks labelled "proximity green" – are understood as "areas of opportunity" for local development, which is connected to an evaluation of the spatial difference in accessing these areas across space and society.

By adopting geospatial GIS methods, combined with the previously introduced two-step measurement approach and the MCA assessment matrix, the methodological approach of this research can be considered to contribute to the methodological research body related to UGS accessibility justice by bringing together the three aspects in a novel way, as already hinted upon in the introduction of this research: First, since the combination of MCA and GIS is uncommon in related literature (Taleai *et al*, 2014), and second, since the recent related studies concerned with UGS in Padova (e.g. Pristeri *et al*, 2021; Semenzato *et al*, 2022) neither adopt a comprehensive MCA assessment, nor socio-spatial justice approach. This study thus aids this methodological research gap and thereby provides novel results on the state of UGS accessibility justice in the local space.

4.3.2 Data

Having established the utility of GIS technology for the spatial analysis of UGS accessibility justice, the following paragraphs will present and discuss the data underlying this approach in the current research. By nature, data models used in GIS need to be geo-relational, thus relating geographical spatial features stored in graphic filed to attribute data stored in a relational database (Piovan, 2020, p.125). For the purposes of this study, the specific data format for the utilized spatial and attribute data was chosen to be the shapefile (shp) format for vector data, as opposed to raster data forms, due to its advantages in terms of accessibility, visualization simplicity, and the possible emphasized representation of spatial data by the primitives of points, polylines, and polygons. The latter constitutes the primitive used to represent the administrative area divisions in Padova, thus the unit of research, as well as the key unit of interest, namely neighborhood parks.

The following data was sampled and, when necessary, transformed in order to be usable by GIS technology:

1. To establish the basic administrative boundaries in Italy and the location of Padova within the regional and national context: Vector polygons (shp) retrieved from the regional and national geodata portals (Il Geoportale della Regione del Veneto & Istituto Nazionale di Statistica Istat),
2. To establish the overall UGS context in Padova: Vector polygon (shp) provided by Prof. Daniele Codato, containing data collected and developed in the research of Pristeri *et al* (2021),
3. To establish the key unit of interest, namely the spatial and non-spatial features of neighborhood parks: Vector polygon (shp) of what is termed "proximity green" in *Il Piano del* Verde, made for the city's urban planning and released by dott. Degl'Innocenti (head of Padova's *Settore Verde*), and provided by Prof. Paolo

Semenzato who used the same data for "neighborhood parks" in his study (Semenzato *et al*, 2022),

4. To establish the socio-spatial demographic patterns of the city for the social equality measure: Statistical demographic data extracted from the publication "*Padova in Cifre"*, the annual statistical report published by the municipality of Padova (Padovanet, 2022B),
5. To establish and draw from the already conducted proximity analysis findings conducted in the context of the drafting of *Il Piano del Verde*: Output tables on the proximity results, retrieved from the municipal publication of the *Piano* (PdV, chapter 6, p.205).

For supplementary and comparative purposes, further data included Open Street Maps (OSM) services and satellite imagery (here: use of "orthophoto2018_Veneto"), both available through the QGIS interface, as well as civic house points (shp) within the city, retrieved from the available urban geodata portal.

As regards the attributes, or in other words, the information contained in the original and non-manipulated layers, the following aspects were available through the datasets of the key layers, namely those relating to UGS in Padova: In the shapefile on overall UGS provided by Prof. Codato, attribute information is based on the urban subdivision into the smallest local administrative unit, namely *unità urbane*, and includes the respective coding, the number of inhabitants, its area in m^2 and km^2, the area of different types of UGS in m^2 (agricultural/non-agricultural, municipal/non-municipal, private/public), the total area of UGS in m^2 and ha, and the population density. In the shapefile on neighborhood parks released by the municipality, the available attributes data is based on the area polygons of the local UGS and includes the names of the parks where existent[9], the classification of the typology of "proximity green" related to the internal features of the UGS, the attribution to a *quartiere* where possible, the information on whether or not the area is considered a social garden when applicable, the information whether or not the abovementioned 14 quality features are fulfilled, the area of the UGS in m^2, km^2 and ha, and the city's rating of the UGS in their own quality assessment.

[9] Attribute data "where existent ", "where possible", or "when applicable" relates to those attributes that might be more ambiguous in this regard. For instance, some of the polygons that were included in the dataset to signify "proximity green" do not have names despite fulfilling the basic park criteria, for instance in the case of greenery alongside rivers or waterways, as well as the city walls. These ambiguous cases are signified by "NULL" within the attribute tables of the dataset. Thus, a particularity of this dataset is that it includes some fields with no data when the attribution of the respective feature was decided not to be applicable or relevant.

When considering the sources of the utilized data, a note on the use of secondary data seems necessary: Based on the understanding that primary, or direct, data is “based on the intent to collect data specifically for the purpose of the research question”, whereas secondary, or indirect, data are those “originally collected for another purpose” (Piovan, 2020, p.30), it should be noted that the data utilized in this research is primarily secondary data that was not collected and developed by the researcher but taken from existing other data sources. This might raise questions in terms of the validity of using these datasets and hence the reliability of the data sources. While some of the data sources can be considered more trustworthy, such as the quantitative and spatial data on areas, administrative boundaries, and overall demographics, as they are collected by official entities and may be considered less ambiguous, and academic data sources such as the general UGS data provided by Prof. Codato can be considered sufficiently reliable since the data was part of a research published in a peer-reviewed academic journal, other data sources are more ambiguous: Using the data underlying the *Piano del Verde,* developed by the urban green planning entities of the municipality of Padova, might raise some reliability issues in terms of possible bias towards publishing better quality and proximity results than the actual UGS situation, in order to report are more positive UGS situation and thus not adopting less radical policy approaches in this respect. In order to minimize the risks in this regards, future analysis should either include fieldwork elements to provide a real-life visual impression of the local manifestation of the features, or own data collections in this regard. The results of this study shall thereby provide a first idea of existing issues, to be taken up as a starting point in further research on the matter.

4.3.3 Workflow

Based on the preceding establishment of the used data and the adoption of a geospatial GIS equity mapping approach, the following section will describe the exact methodological operations performed on the data to produce the results on UGS accessibility and related intra-urban socio-spatial (in)equality in Padova. It may be noted that these operations follow a mixed-methods design based on the output requirements of the respective indicators of the measures of interest, within an overall geospatial approach.

Before describing the operations conducted to perform the two key measures, accessibility and socio-spatial justice, the main underlying GIS parameters of this research can briefly be summarized as the following: The analysis was conducted with the open-source GIS software

QGIS (version 3.14.16). In accordance with cartographic fundamentals, the setting of the appropriate coordinate reference system (CRS) is key in order to precisely define the positions of a location (Piovan, 2020, p.66). For this research, the appropriate CRS was identified in correspondence with the geographic location of Padova and set to be the projected Monte Mario Italy zone 1 CRS, set through the QGIS ID EPSG:3003, which is the Gauss-Boaga system adopting the Roma40 datum, thus the international ellipsoid oriented in Monte Mario, Rome[10].

In order to conduct the accessibility and equality analysis, the available datasets had to be cleaned, transformed and manipulated in such a way that they could be utilized for the purposes of this study. The following basic operations on the previously presented shapefiles were performed: First, since the research interest is the spatial administrative division of the city into *consulte*, the shapefile containing the spatial division into the smaller unit of *unità urbane* was subjected to a spatial query in which, through the selection by cursor and based on the comparison to the administrative divisions in Padova, separate layers for each *consulta* were created.

Second, the geoprocessing tool was used to "dissolve" the polygons of the *consulte*, so that the subdivision into *unità urbane* was removed. As the resulting layers only included the attribute information of one of the included *unità urbane*, the attribute tables were thereby also usefully cleaned from the previously contained information on general UGS in Padova, which merely served to generate a contextual understanding in this study but does not relate to the analysis of neighborhood parks as the specific UGS type of interest. To attain a better idea of the latter, the shapefile containing the information on neighborhood parks was likewise subjected to a spatial query in which separate layers containing the parks in each *consulta* were created by using the "select by location" tool, by which the parks in the parks layer were selected and, based on the geometric predicate "intersect", connected with each newly created layer containing the area and location of the *consulte*. Other basic operations included the fixing of invalid geometries of one of the layers (*consulta 3B*), and solving the issue of a park transmitting the administrative boundaries of *consulta 3B* and *consulta 4A* by attributing it to the latter, as more than 50% of its area was within the territory of *consulta 4A*.

Lastly, to provide the basis for visualizing the analytical results of the accessibility and equality measures as well as the MCA assessment, a new layer was created, in which the attribute table is organized based on the spatial division of the urban space into *consulte*. This was done by

[10] However it needs to be noted that Padova is located just at the border of the Monte Mario Italy zone 1 EPSG:3003 and the zone 2 EPSG:26591 CRS, which is why there might be a risk of slight referential distortions in the created maps.

utilizing the “toggle editing” tool to copy and paste the separate layers of the *consulte* into the newly created layer. Then, the attribute table was filled with new fields containing the necessary analytical information relevant to the findings of the analysis. This process was repeated twice, in order to create three main analytical findings layers: first, for analytical aspects and findings related to the accessibility measure, second, for aspects related to the equality measure, and third, city-wide related averages on both. Based on these transformations, it was possible to conduct the geospatial operations to of accessibility and equality analysis and assessment.

A) Accessibility Measure

In order to measure UGS accessibility across the city and enable the MCA scoring of the level of accessibility in each of the *consulte*, related values of the three accessibility factors had to be established, based on which the MCA accessibility assessment could be conducted. The following sections summarize the operational steps that were performed.

a) Quantity (F1)

In order to measure the park ratio indicating the quantity aspect for each neighborhood, the analysis was conducted based on the following calculations (see **Figure 15** below):

1. Calculation of the total park area in km² of each *consulta* using the “basic statistics for fields” analysis tool,
2. Calculation of the total area in km² of each *consulta* using the same analysis tool,
3. Calculation of the park ratio in % of each *consulta* using the formula introduced above (chapter 4.2.2*a*),
4. Identification of the value range of the outcoming results based on the defined MCA thresholds, and ranking and rating of each *consulta* in accordance with the MCA matrix rules for F1,
5. Inserting of the key values and MCA rating results as new fields into the UGS accessibility results layer, using the QGIS “toggle editing” tool.

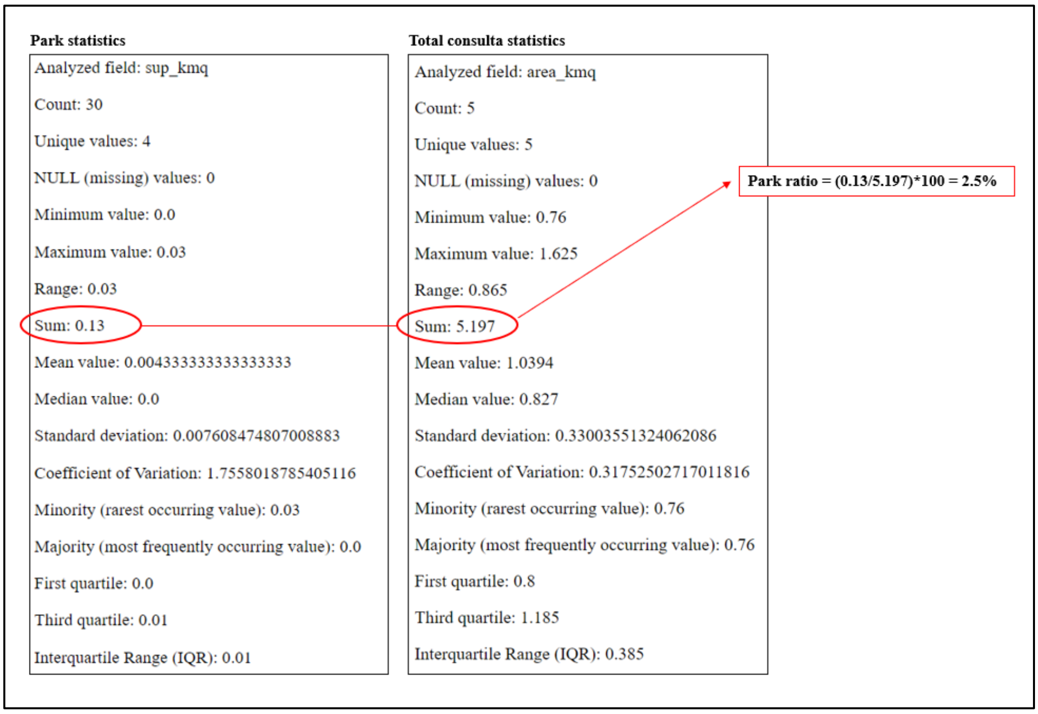

Figure 15: Example of F1 computation based on field statistics tool (here: consulta 1).

b) Proximity (F2)

In order to measure the walkability distance indicating the proximity aspect for each neighborhood, the analysis (example see **Figure 16** below) was conducted based on the reliance on the related results of the proximity study by the municipality, available through *Il Piano del Verde*:

1. Review of the results of the network analysis[11] conducted by the municipality and following the rule of a 300m/5min distance to the next neighborhood park,
2. Identification of the number of inhabitants found within this distance as well as the total number of inhabitants within each *consulta*,
3. Calculation of the walkability distance indicator using the formula provided above (figure 12), (chapter 4.2.2*b*)

[11] Network analyses are the computation of the cost (time/space) to reach a goal via the movement along a network (usually road networks). By buffering around the point of the goal using a set distance threshold, it is possible to identify catchment/service areas for the point (see also: Piovan, 2020, pp. 151-153). In PdV of the city of Padova, the goal points were set as the “proximity green” polygons, and by use of the road network polylines it was calculated how many people could be reached setting the walking distance threshold of 5mins/300m.

4. Identification of the value range of the outcoming results based on the defined MCA thresholds, and ranking and rating of each *consulta* in accordance with the MCA matrix rules for F2,
5. Insertion of the key values and MCA rating results as new fields into the UGS accessibility results layer, using the QGIS "toggle editing" tool.

Walkability distance = e.g. (10 742/16 692)*100 = 64.35%

Population in UGS walking distance

Total population of consulte

Consulta	Regola 1 - 300 metri		Regola 2 - 800 metri		Totale popolazione
	n°. abitanti	%	n°. abitanti	%	
1 CENTRO	15.844	61,59%	20.753	80,67%	25.726
2 NORD	25.188	63,62%	34.950	**88,28%**	39.590
3A	9.305	**42,72%**	11.606	**53,28%**	21.782
3B	10.111	66,26%	12.667	83,01%	15.259
4A	13.999	64,62%	20.138	**92,96%**	21.664
4B	5.364	**21,31%**	12.257	**48,70%**	25.166
5A	8.322	**82,34%**	6.495	64,26%	10.107
5B	8.322	**47,24%**	13.634	77,40%	17.615
6A	9.804	62,46%	11.538	73,51%	15.696
6B	10.742	64,35%	13.754	82,40%	16.692

Figure 16: Example of F2 computation based on PdV network analysis (here: consulta 6B).

Table retrieved from PdV, chapter 6, p. 207.

c) Quality (F3)

In order to measure the value creation potential indicating the quality of the UGS in each neighborhood, the following operations were performed (see **Figure 17**):

1. Export of the attribute information of the park layers for each *consulta* to excel by transforming the shapefiles into MS Office Open XML spreadsheet format (xlsx),
2. Transformation of the categorical data relating to the existence of the 14 quality features, here in form of text ("*si"/"no*") into numerical data; whereby "*si*" =1 and "*no"/"NULL*" =0 for each *consulta*,
3. Calculation of the number of quality features fulfilled for each UGS by summing the "1" in each row for each *consulta*,

4. Identification and sum of the number of UGS fulfilling more than 7 quality features for each *consulta*,
5. Calculation of the value creation potential indicator value based on the abovementioned formula (chapter 4.2.2*c*),
6. Identification of the value range of the outcoming results based on the defined MCA thresholds, and ranking and rating of each *consulta* in accordance with the MCA matrix rules for F3,
7. Insertion of the key values and MCA rating results as new fields into the UGS accessibility results layer, using the QGIS "toggle editing" tool.

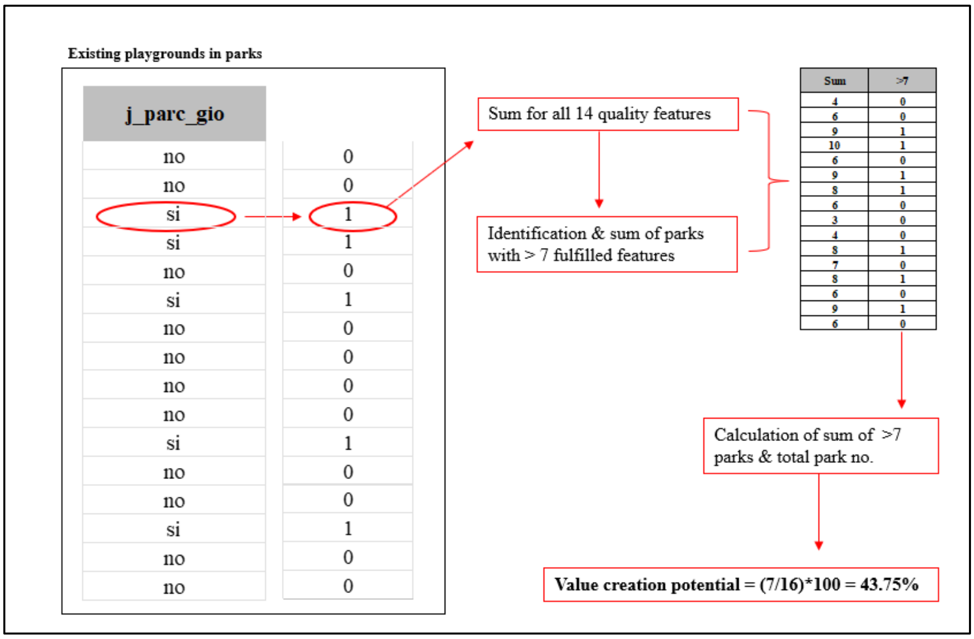

Figure 17: Example of F3 computation based on park quality data (here: consulta 5B).

d) MCA accessibility assessment

The last step in order to establish the key measure on accessibility was the integration of the values of F1, F2 and F3 by means of the MCA assessment matrix and the WLC technique, in order to attribute an overall and weighted accessibility score to each *consulta*, based on which the spatial comparison in accessing local neighborhood parks could be conducted. This was enabled through the following operations:

1. Computation of the MCA accessibility scores for each *consulta,* first in general, by summing the ratings of all factors, and then using the WLC model presented in the above formula (chapter 4.2.3),
2. Insertion of the overall accessibility scores of each *consulta* as new fields into the UGS accessibility results layer, using the QGIS "toggle editing" tool,
3. Visualization of the accessibility patterns and variations across Padova's urban space and mapping the spatial equality results using the QGIS "symbology" and "layout creation" tools.

The final shapefile table on the geospatially obtained results of the conducted analyses for each accessibility factor as well as the MCA assessment comprises the following attributes (see **Table 6**):

QGIS code	Meaning
consulta	number of the consulta
name_consu	name of the consulta
F1_totarea	for F1, total area
F1_UGSarea	for F1, total area of the UGS
F1_ratio%	for F1, park ratio in %
F1_rate	for F1, MCA rating
F1weighted	for F1, weighted MCA rating (*2)
F2_tot_pop	for F2, total population
F2_UGSpop	for F2, population within the defined walking distance to the UGS
F2_prox%	for F2, the % of population within the defined walking distance to the UGS
F2_rate	for F2, MCA rating
F2weighted	for F2, weighted MCA rating (*2)
F3_tot_UGS	for F3, total number of UGS
F3_qualUGS	for F3, number of UGS fulfilling defined number of quality features
F3_qual%	for F3, % of quality UGS out of total UGS
F3_rate	for F3, MCA rating
F3weighted	for F3, weighted MCA rating (*1)
MCA_score	overall MCA score
WLC_score	overall score including weights (weighted linear combination)
Accessible	overall accessibility based on classess of low, medium, high scores

Table 6: QGIS attribute field codes and meaning (UGS accessibility results).

B) Equality Measure

In order to complement the spatial UGS accessibility patterns produced through the reliance on the transformed data into the relevant spatial division into *consulte*, the social equality measure was generated through the registration and transformation of socio-demographic data (of the categories age, gender, nationality, and family numerosity) on the *consulte* into a geo-relational data model. This was done based on the following operational steps:

1. Creation of a new layer organized containing the organization of the urban space into *consulte* and adding new attribute fields for the relevant social demographic categories using the "toggle editing" tool,
2. Insertion of the values of the demographic information provided by the statistical report of the municipality into the related attribute fields for each *consulta*
3. Visualization of the demographic patterns and variations across Padova's urban space using the QGIS "symbology" and "layout creation" tools and analysis and mapping of social and spatial (in)equality in UGS accessibility across the urban space by comparing the outputs to the accessibility maps created by the accessibility measure

The following attributes were included in the final shapefile containing the socio-spatial data relevant for the equality measure (**Table 7**):

QGIS code	Meaning
consulta	number of the consulta
name_consu	name of the consulta
pop_total	total number of population
pop_dens	density of the population
age_index	age index
gen_index	gender index
%_foreig	percentage of foreigners
num_family	family numerosity index

Table 7: QGIS attribute field codes and meaning (socio-spatial demographics).

Based on the methodological framework provided in the preceding pages, the following chapter will present the analytical results of the conducted operations, followed by a discussion of their meaning and significance before the given theoretical understandings and within the realm of the research interest of this thesis.

CHAPTER 5: RESULTS

The following chapter will present the analytical results of the conducted analysis of UGS accessibility and related intra-urban socio-spatial justice patterns in the city of Padova. By providing and describing the produced analytical outputs, both in computational and cartographic form, the findings of the geospatial two-step measurement MCA assessment are comprehensively summarized, based on which the discussion of their meaning in relation to the theoretical, contextual and broader research framework of this thesis is enabled (chapter 6). Thus, the following sections introduce, first, the overall spatial condition of public neighborhood parks within Padova as the key analytical unit for UGS of this research (5.1), second, the (in)accessibility patterns of the UGS as identified by the analysis of the three identified factors including the conducted MCA assessment (5.2), and third, the socio-spatial (in)justice patterns relating to the findings on UGS accessibility across the urban space (5.3). Thereby, the first part of the research question is established, namely the ***intra-urban socio-spatial patterns of park accessibility in the city of Padova.***

5.1 PADOVA'S PARKS

In order for the following presentation of the analytical results on UGS accessibility and socio-spatial justice to be comprehensible, the following paragraphs provide a brief overview on the more general spatial condition and local particularities of neighborhood parks within the context of Padova. Specifically, the geospatial data available on the location of the parks within the urban territory will be presented and some related specificities are be provided.

To introduce the location and spatial context of the parks, the following maps present the overall terrain of the city as visible through the available satellite imagery of Padova, the location of neighborhood parks across the city as visible through the available park polygons. As visible from the satellite image below, the urban context of Padova can be considered to be dominated by "hard surfaces" (concrete/built environment), and contains only a rather limited number "soft surface", thus green spaces that are clearly identifiable from above. Most of the visible UGS seem to be agricultural areas, as previously found by the research of Pristeri *et al* (2020), who identified 28,8km² out of 52.23km² of Padova's UGS as rural (Pristeri *et al*, 2020, p.13). Their findings on the prevalence of private as compared to public greenery (ibid) is further affirmed by the rather scattered impression of the public "proximity green" visible in the below map.

Since the main interest in this research is the comparison of parks across the spatial administrative units of the *consulte*, the following map shows the location of the parks across the urban environment, as divided into the neighborhoods (**Figure 18**):

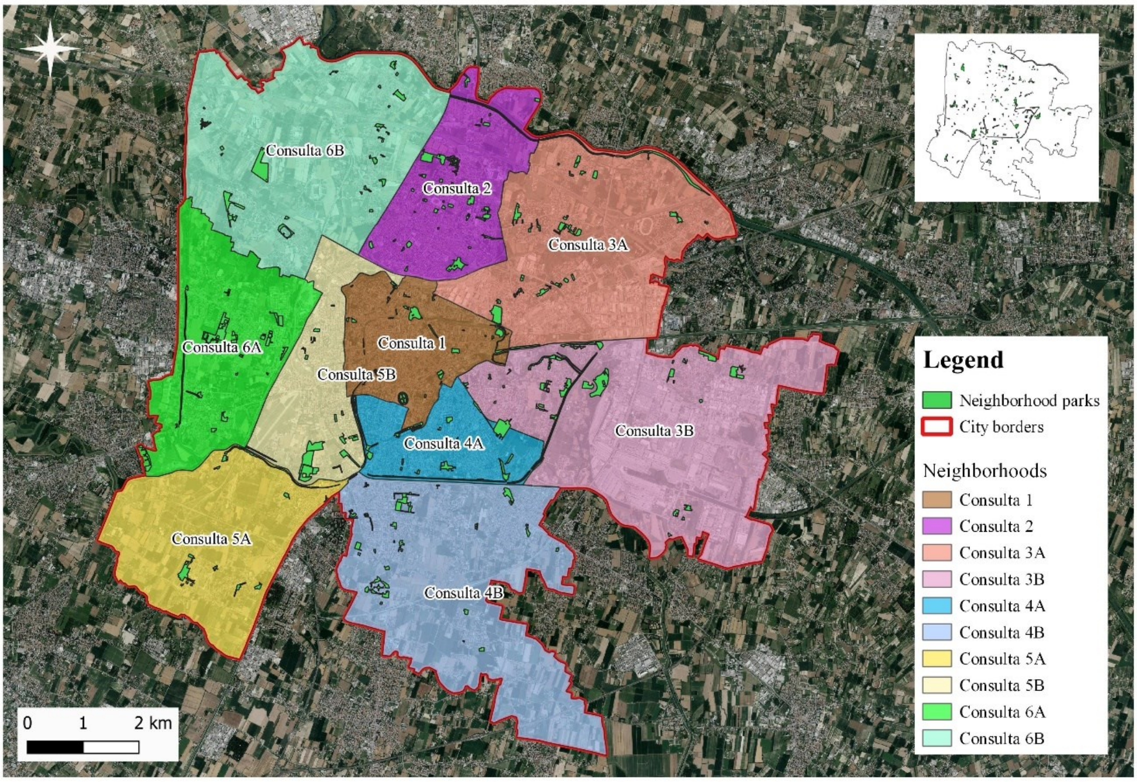

Figure 18: Parks across the neighborhoods.

(Data source: Padova municipality. Elaboration by the author.)

Based on the cartographic visualization, it becomes apparent that the distribution of parks across the neighborhoods is far from being spatially even: For instance, the parks within *consulta 5A* are mainly located in the southern part of the district, with only very small parks in the northern part. While the following accessibility and justice analysis summarizes the park-related numbers for all neighborhoods, thus will concentrate not on the park polygons but summarize related data into the *consulte* polygons, this aspect will be included in the later discussion of the meaning of the results (chapter 6), as the location of the parks might obviously influence results such as the proximity, or the meaning of the park ratios.

Overall, the following general numbers related to the neighborhood parks can be stated: There is a total number of 245 parks across the urban space, all of which make up a total area of 2 189 km² out of Padova's overall area of 93 305km². The following accessibility results will provide the more specific numbers on the parks within each *consulta*.

5.2 PARK (IN)ACCESSIBILITY PATTERNS

In the next sections, the results of the first measurement step, namely the accessibility analysis of UGS in Padova, and with that, the key measure and subject of interest of this research, will be presented. Thus, based on the methodological parameters introduced before, the results on all three accessibility factors and their MCA integration will be provided. This is done by presenting and commenting on the produced cartographic and computational outputs and the identification of the resulting UGS accessibility patterns within Padova's urban space.

5.2.1 Park Quantity

In this first section, the analytical findings on the quantity of neighborhood parks across the urban districts are provided.

Through the calculation of each *consulta's* park ratio, the following computational output was generated as visible in the table below, where the key computational parameters and calculation results are summarized for each neighborhood (**Table 8**):

Consulta	F1_UGSarea	F1_totarea	F1_ratio	F1_ratio%	MCA threshold	MCA ranking	F1_rate	F1weighted
1	0.13	5.20	0.025	2.50	2.5-5%	medium	2	4
2	0.32	6.72	0.048	4.76	2.5-5%	medium	2	4
3A	0.28	12.10	0.023	2.31	< 2.5%	low	1	2
3B	0.27	15.89	0.017	1.70	< 2.5 %	low	1	2
4A	0.25	4.09	0.061	6.11	> 5%	high	3	6
4B	0.17	13.47	0.013	1.26	< 2.5%	low	1	2
5A	0.13	8.92	0.014	1.45	< 2.5%	low	1	2
5B	0.22	5.11	0.043	4.31	2.5-5%	medium	2	4
6A	0.22	8.24	0.027	2.67	2.5-5%	medium	2	4
6B	0.23	13.59	0.017	1.69	< 2.5%	low	1	2

Table 8: Computational UGS accessibility results of F1.

Through the geospatial GIS-methodology utilized for the analysis, the following cartographic outputs were generated to visualize the computational quantity results (see **Figure 19** below): The first inset map shows the patterns in relation to the total area of the districts. It is visible that *consulta 4A* has the smallest total area (4,09km²) followed by *2, 5A, 5B, and 6A*, whereas *consulta 3B* has the largest total area (15,89km²), followed by *3, 4B* and *6B.* These results point at significant variations in the size of the *consulte*, which might influence the accessibility results of this research. The second inset map depicts the patterns in total park area for each district. It becomes visible that *consulta 2* contains the most total park area (0,31km²), followed by *3, 3B* and *4A*, and *consulta 1* and *5A* contain the same least total area (0,13km²), followed by *consulta 4B*.

More importantly, the cartographic outputs of the park ratio and the MCA value range attribution show the analytical results of interest for this first accessibility factor: In the below map, the bigger inset map shows the UGS quantity based on the calculated park ratio for each *consulta*, and the main map provides the classification of the *consulte* into high, medium and low ranks based on their respective ratings related to the former. Based on the park ratio findings, the *consulta* with the highest quantity based on the relation of park and total size is *consulta 4A* (6.11%), followed by *2* and *5B*, whereas the *consulte* with least quantity can be identified as *4B* (1.26%) and *5A, 3B, 6B,* and so on, all of which have similarly low park ratio results. Based on the MCA classification matrix, these results were classified accordingly, and it becomes clear that only *consulta 4A* can be considered of relatively "high" (rating: 3) park quantity, whereas four neighborhoods (*1,2,5B,6A*) are rated as "medium" (rating: 2), and five neighborhoods (*3A,3B,4B,5A,6B*) are classified as "low" (rating: 1).

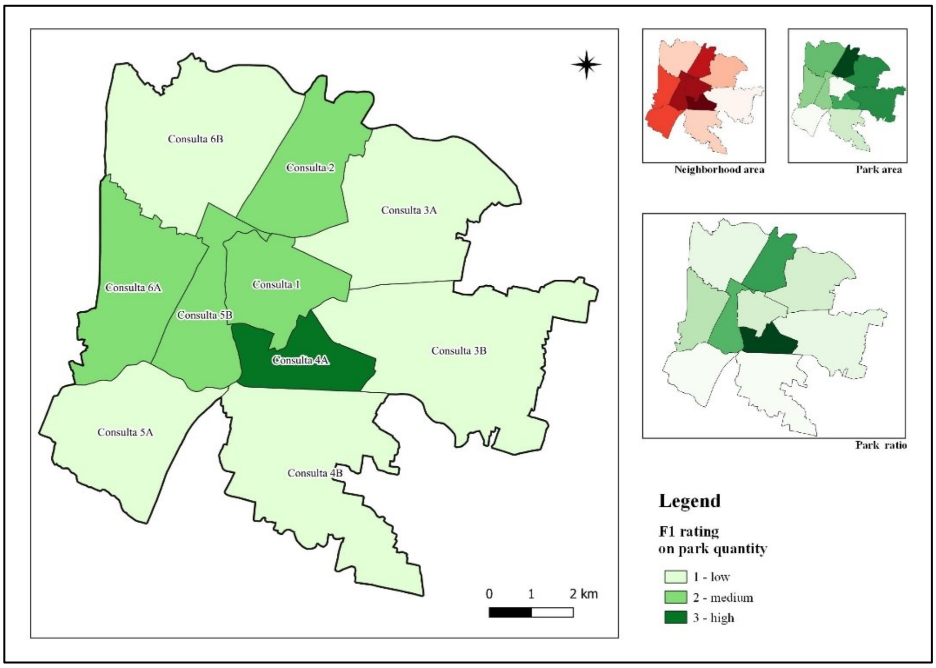

Figure 19: F1 results: park quantity.

5.2.2 Park Proximity

Next, the results on the computation of the second factor, namely UGS proximity, will be presented. These were arrived at through the reliance on the available secondary data retrieved from the municipal document on the network analysis conducted in the context of Padova's urban planning, as stated above (chapter 4.3).

The table below (**Table 9**) constitutes the computational output of the operations conducted based on this data, and describes both the values of the key units of calculation, as well as the analytical results:

Consulta	F2_UGSpop	F2_tot_pop	F2_prox%	MCA threshold	MCA ranking	F2_rate	F2weighted
1	15 844	25 726	61.59%	50-75%	medium	2	4
2	25 188	39 590	63.62%	50-75%	medium	2	4
3A	9 305	21 782	42.72%	< 50%	low	1	2
3B	10 111	15 259	66.26%	50-75%	medium	2	4
4A	13 999	21 664	64.62%	50-75%	medium	2	4
4B	5 364	25 166	21.31%	< 50%	low	1	2
5A	8 322	10 107	82.34%	> 75%	high	3	6
5B	8 322	17 615	47.24%	< 50%	low	1	2
6A	9 804	15 696	62.46%	50-75%	medium	2	4
6B	10 742	16 692	64.35%	50-75%	medium	2	4

Table 9: Computational UGS accessibility results of F2.

As for F1 (quantity), the cartographic outputs of these values were created to provide a better visualization of the intra-urban proximity patterns related to UGS (see **Figure 20**). The two smaller inset maps show the base value patterns of the number of inhabitants for each *consulta* and the number of inhabitants within walking distances. Regarding the former, it is visible that *consulta 2* has the highest total population (39 590), followed by *consulta 1* and *4B*, whereas *consulta 5A* has the lowest number of inhabitants (10 107), together with *6B, 5B, 6A, 3B* which all show similar values (see table). Regarding the latter, it is clear that the neighborhood with the highest number of inhabitants within walking distance to the next park is *consulta 2* (25 188), followed by *consulta 1*, and the neighborhoods with the lowest number of residents who can reach the next park within 300m or 5min are *consulta 4B* (5 364), as well as *5A* and *5B*.

When looking at the results of the proximity indicator calculations (bigger inset map and main map in the output below), a different pattern becomes apparent: The district with the highest percentage of residents within UGS walking distance out of all residents is *consulta 5A* (82.34%), followed by *consulta 3B, 4A,* and *6B*, whereas those neighborhoods with the lowest overall percentages are *consulta 4B* (21.21%), as well as *3A*. Based on the classifications of these results according to the MCA matrix, the proximity patterns across the urban environment are as follows: As in F1, only one district, namely now *consulta 5A*, can be considered of "high" (rating: 3) proximity, six districts (*1,2,4A,3B,6A,6B*) are classified as "medium" (rating: 2), and three districts (*3A,4B,5B*) can be considered "low" (rating:1) in the urban context.

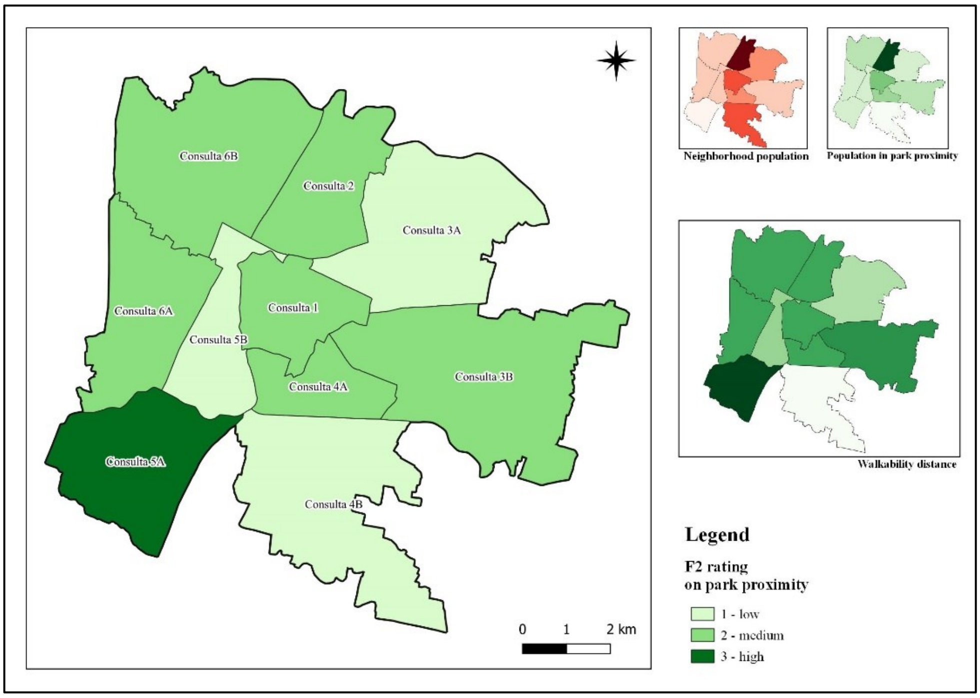

Figure 20: F2 results: park proximity.

5.2.3 Park Quality

Finally, the following sections will present the findings of the third accessibility factor, namely the quality of the UGS in each *consulta*, which were produced through the calculation of the "value creation potential" indicator.

Thus, the following table (**Table 10**) contains both, the key parameter based on which the quality indicator was computed, as well as the computational results both for the neighborhoods:

Consulta	F3_qualUGS	F3_tot_UGS	F3_qual%	MCA threshold	MCA ranking	F3_rate	F3weighted
1	30	11	36.67	>33.33-66.66%	medium	2	2
2	35	12	34.29	>33.33-66.66%	medium	2	2
3A	28	9	32.14	<=33.33%	low	1	1
3B	27	9	33.33	<=33.33%	low	1	1
4A	24	9	37.50	33.33-66.66%	medium	2	2
4B	26	8	30.77	<=33.33%	low	1	1
5A	11	2	18.18	<=33.33%	low	1	1
5B	16	7	43.75	>33.33-66.66%	medium	2	2
6A	22	8	36.36	>33.33-66.66%	medium	2	2
6B	24	8	33.33	<=33.33%	low	1	1

Table 10: Computational UGS accessibility results of F3.

Based on the cartographic utilization of these data, the following map output (**Figure 21**) shows the park quality patterns across the neighborhoods within Padova. The first set of maps (small inset maps), containing the key parameters underlying the computation of the indicator, visualize the total number parks per *consulta* and the total number of quality UGS per *consulta*. On the former, the neighborhoods with the highest overall number of parks are *consulta 2* (35) and *1*, and the least parks can be found in *consulta 5A* (11) and *5B*. On the latter, it can be established that the *consulte* with the most quality parks remain *consulta 2* (12), just as the least quality parks are found in *5A* (2) and *5B*.

After utilizing these values for the calculation of the quality indicator, the key maps (bigger inset map and main map) show the resulting quality patterns across the urban environment: The bigger inset map visualizes the value creation potential of the different *consulte*, whereby the highest value was found for *consulta 5B* (43.75%), followed by *4A*, and the lowest values were found for *consulta 5A* (18.18%), as well as 4B (30.77%). Considering these values, it might be noteworthy to point out that while *consulta 5B* was found among the neighborhoods with the least UGS and least quality UGS before, it has now become the one with the highest value after relating these two aspects. Furthermore, there is a significant jump from the second lowest value (*4B* with 30.77%) to the lowest value (*5A* with 18.18%). When applying the MCA matrix thresholds to identify the ranking and rating of the values according to the value ranges, what is further noteworthy is the lack of any neighborhood in Padova to be considered as “high” in quality UGS, and the rather balanced account of “medium” (5 *consulte*) and “low” (also 5 *consulte*) quality UGS districts.

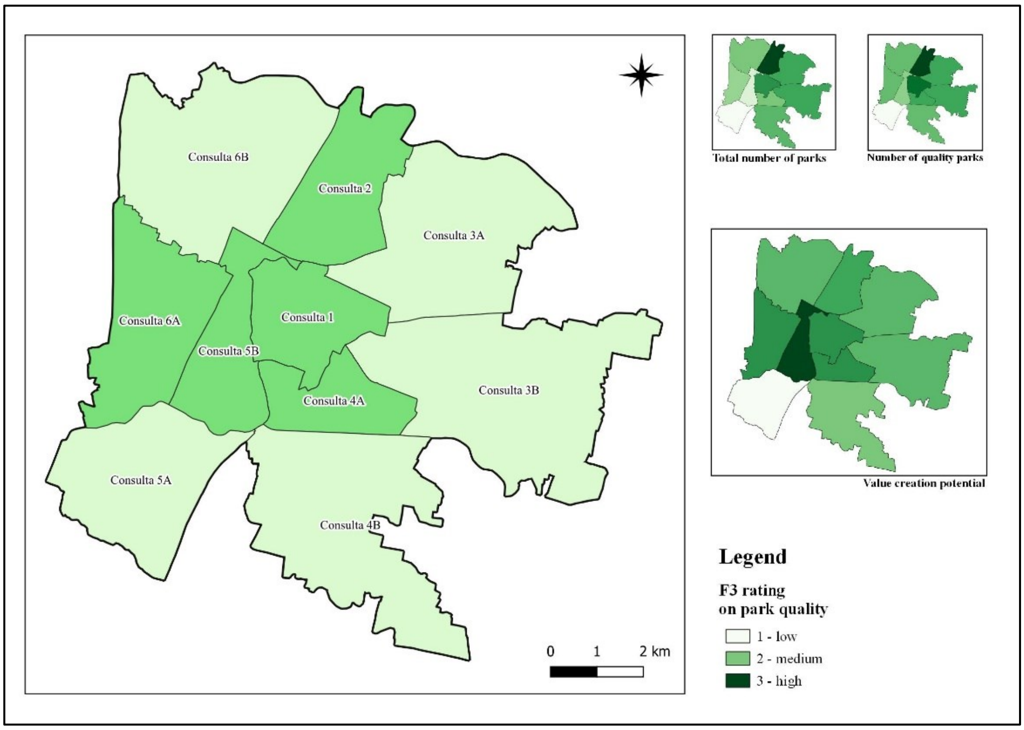

Figure 21: F3 results: park quality.

5.2.4 Integrated Accessibility Results

Based on the computation and cartographic visualization of all three accessibility factors, the following section will provide the integration of the respective results into an overall accessibility score for each neighborhood, in order to enable the summary of these values into a comprehensive result on the UGS accessibility patterns across the urban context of Padova. The results of each of the factors, as presented before, can furthermore be understood to underscore the need to integrate more than one accessibility factor, as their outcomes vary considerably in terms of which of the urban districts can be considered "high", "medium" and "low" in park accessibility: While for the quantity factor F1, *consulta 4A* was found as the highest, the proximity factor F2 points at *consulta 5A*, which is however found to be "low" for the other to factors, and while there is no neighborhood with "high" value creation potential, *consulta 5B* was found to be highest, although being among the lowest scoring neighborhoods for F2. The integration of the three criteria shall thus identify the patterns after summarizing the values for all three aspects, according to the MCA assessment framework.

In accordance with the logic of the MCA assessment matrix (**Figure 22**), the ratings were thus multiplied by the respective weight of each factor, and summarized into an overall accessibility score.

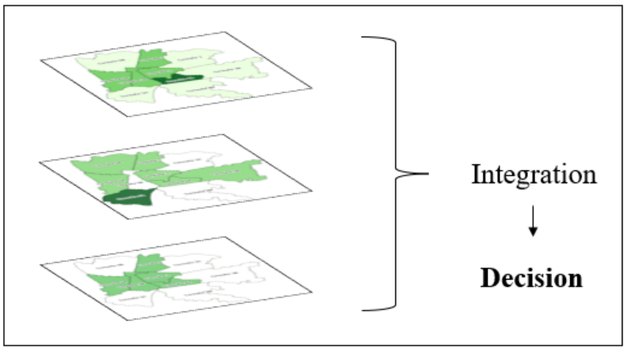

Figure 22: MCA logic of integration of map outputs per factor.

The computational output of this operation is summarized in the table below (**Table 11**), which shows the total and weighted accessibility scores for each *consulta*, as well as the summary of the WLC score into a simplified "low", "medium", "high" ranking score according to the following, deductively generated criteria: 1-7 were considered low, 8-11 medium, and 12-15 high, and rated accordingly:

Consulta	F1	F2	F3	MCA_score	F1weighted	F2weighted	F3weighted	WLC_score	Accessible
1	2	2	2	6	4	4	2	10	medium - 2
2	2	2	2	6	4	4	2	10	medium - 2
3A	1	1	1	3	2	2	1	5	low - 1
3B	1	2	1	4	2	4	1	7	low- 1
4A	3	2	2	7	6	4	2	12	high - 3
4B	1	1	1	3	2	2	1	5	low - 1
5A	1	3	1	5	2	6	1	9	medium - 2
5B	2	1	2	5	4	2	2	8	medium - 2
6A	2	2	2	6	4	4	2	10	medium - 2
6B	1	2	1	4	2	4	1	7	low - 1

Table 11: Computational UGS accessibility outputs of WLC MCA integration.

The following map (**Figure 23**) cartographically visualizes these results: the small inset map shows the results of the overall WLC outputs, and the main map provides the simplified output based on the categorization into low, medium and high accessibility. The cartographic WLC output shows the following patterns: By integrating the three factors, *consulta 4A* (score: 7) can be identified as the neighborhood with the overall highest accessibility of neighborhood parks, followed by *consulte 1, 2,* and *6A*. The lowest identified scores have, on the other hand, *consulta 3A* and *4B* (score: both 3), followed by *consulte 3B* and *6B*. These results thus point at a high relative intra-urban variation in relation to UGS accessibility, and overall medium to low city-wide averages.

After simplifying these scores in order to have an understanding of the neighborhoods as divided into simple low, medium and high hierarchical value thresholds, the following main map in the below output provides a summarized understanding of the patterns across Padova: Only *consulta 4A* can be considered as "high" in this regard, while five *consulte* (*1,2,5A,5B,6A*) can be considered as overall "medium", and four *consulte* (*3A,3B,4B,6B*) can be understood to be low in overall UGS accessibility.

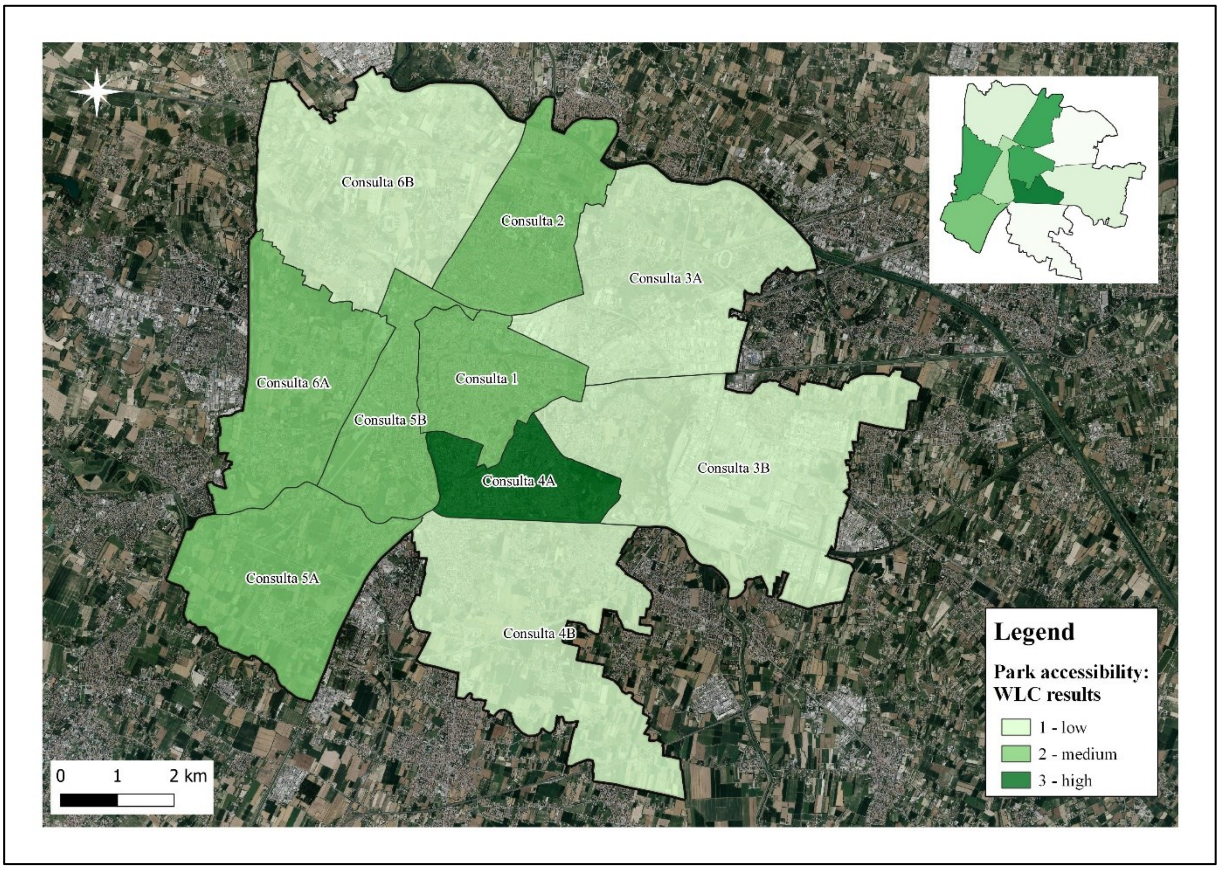

Figure 23: MCA WLC results: park accessibility.

(Data source: Padova municipality. Elaboration by the author.)

5.3 SOCIO-SPATIAL (IN)JUSTICE PATTERNS

Having established the results of the accessibility measure, which comprises the integration of the three factors through the MCA assessment matrix, the following sections will introduce the findings of the equality measure, thus the second step of the two-step measurement approach underlying the undertaken analysis. In accordance with the methodological framework, the found accessibility patterns were thus compared to social and spatial items within the city, in order to identify possible trends and inequalities that might have detrimental development impacts and might points at potential detrimental effects for the residents of certain urban areas or the members of certain social groups. Consequently, the subsequent section will present the findings on social (in)justice patterns, followed by a summary of the spatial (in)justice patterns that can be derived from the previously presented accessibility results.

5.3.1 Social (In)Equality

Based on the comparison of the accessibility scoring output for each neighborhood in Padova with its respective demographic features, the following patterns of disparities in the accessibility of UGS for the different social groups living across the urban environment were identified.

First, it may be re-stated that the following demographic characteristics were included as social equality items for the justice assessment: age, gender, nationality[12], and family numerosity. Based on the available demographic data published by the municipality, the related indices adopted to identify related urban trends can be understood as follows: The age index signifies the relation between the population aged 65 years or more with the population below 15 years (per 100), and thus establishes the degree of aging of the population, whereby values of more than 100 indicate a majority of elderly people as compared to young people (Padovanet, 2022B). The gender index is derived from the city's computation of the "masculinity relation" index, which relates the number of male and female inhabitants (per 100), whereby a value less than 100 indicates that there are less men than women living in the area[13] (ibid). The nationality of the residents within Padova is established through the municipal calculation of the % of foreigners as compared to Italian citizens out of the overall population residing in each area (ibid). Finally, the "family numerosity" index available can be understood as the relation between the number of individuals living in families and the number of families within each area (ibid).

The following table (**Table 12**) presents the demographic data on these four social categories per *consulta*, complemented by the overall population numbers (total and density):

[12] The index for this demographic measure is based on the city's statistical report (Padovanet, 2022B), where it was called the % of foreigners. This statistic is, however, based on the recorded nationality, thus it was called "nationality" in the present research, as some residents might be born in Italy and thus identify not as "foreign" but as Italian, however fall into the "foreigner category" of these data due to their nationality.
[13] It must be noted that the index does not include other gender categories than the male/female binary, which constitutes a clear limitation of this measure. Since this is the only data available in Padova, still adopted, but to be kept in mind that there are other gender categories that may be important to study in this regard in future research, to get a more comprehensive picture of the (in)equality patterns in Padova in this regard.

Consulta	pop_total	pop_dens	age_index	gen_index	%_foreig	num_family
1	25 726	4 982	324.53	83.93	13.33	1.72
2	39 590	5 875	198.70	96.27	29.29	2.00
3A	21 782	1 788	233.31	93.16	19.23	2.05
3B	15 259	954	236.00	89.4	12.31	2.09
4A	21 664	5 265	278.73	84.05	10.21	1.92
4B	25 166	1 859	210.52	90.35	13.04	2.09
5A	10 107	1 127	267.17	90.36	9.35	2.24
5B	17 615	3 451	283.08	86.93	10.31	1.91
6A	15 696	1 902	211.27	91.51	21.85	2.04
6B	16 692	1 223	174.11	95.46	10.51	2.21

Table 12: Demographics for justice assessment.

As with the computational results of the UGS accessibility data, the demographic data were likewise mapped by use of cartographic tools, in order to conduct a meaningful geospatial analysis and to visualize resulting demographic patterns. The maps below provide the demographic trends in Padova, which are compared to the park accessibility results in accordance with the research interest of this study.

First, the overall population characteristics were summarized into the map below (**Figure 24**), which displays the total population within each neighborhood, as well as the density of the population across the available space. As already shown in the previous presentation of the proximity analysis results, *consulta 2* has the highest overall number of residents (39 590), followed by *consulta 1* and *4B*, whereas *consulta 5A* has the lowest number of residents (10 107). However, when considering the density of the populations across the neighborhood areas, a clearer pattern becomes apparent: While *consulta 2* remains the neighborhood with the densest population distribution (5 875/km²), the second highest density is visible in *consulta 4A* (5 265/km²), and only then by *consulta 1* (4 982/km²) and *5B* (3 451/km²). On the other hand, the neighborhoods with least population density are rather similar, with values between 1000 and 3000, while *consulta 3B* is the only neighborhood with less than 1000 inhabitants per square kilometer (954/km²). When comparing these overall population trends to the UGS accessibility findings, it can be noted that the districts with highest population density (*2*: medium*, 4A*: high, *1*: medium, *5B:* medium) score medium to high in terms of accessibility, while those districts with a lower density score medium to, predominantly, low on park accessibility (*3A*: low, *3B*: low, *4B:* low, *5A*: medium, *6A*: medium, *6B*: low).

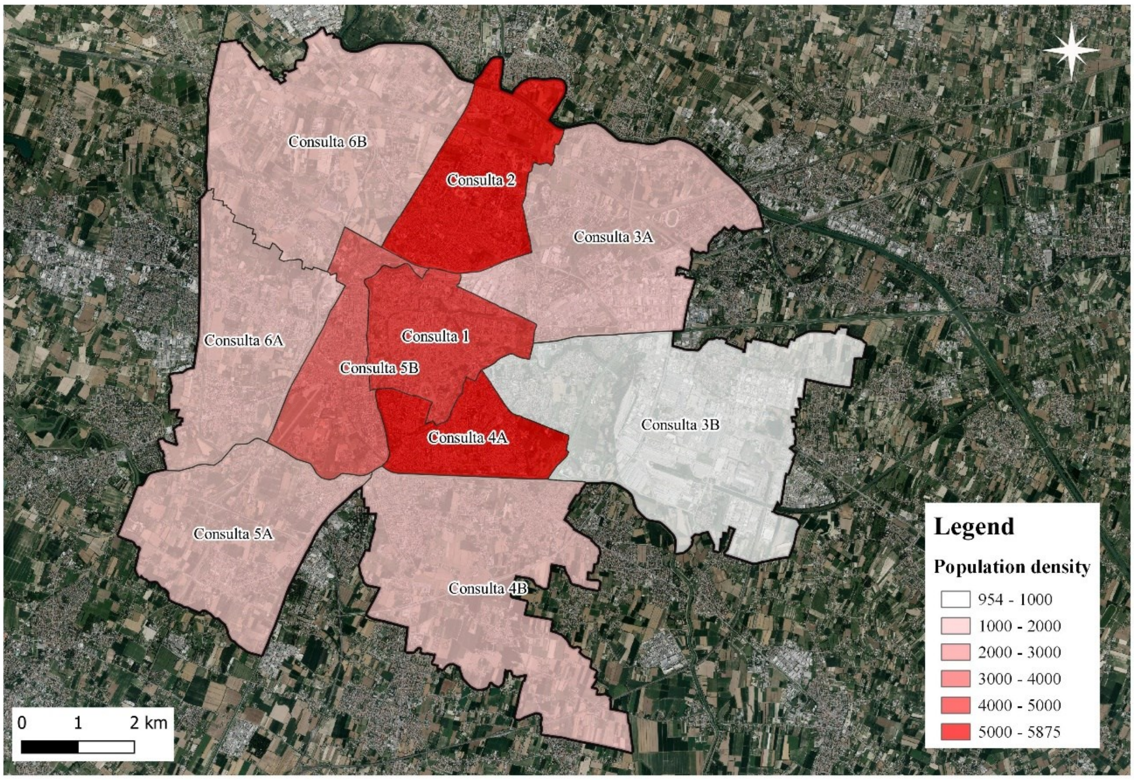

Figure 24: Population density.

(Data source: Padova municipality. Elaboration by the author.)

After the establishment on these overall population patterns, the four social categories used as social equality items were likewise cartographically analyzed in comparison to the previous map output of the accessibility analysis[14]. The spatio-demographic patterns are visible in the figure below (**Figure 25**).

The first map (A) below (**Figure 25)** displays the aging patterns across the *consulte*. Looking at the overall numbers, it can be concluded that all of them are higher than 100, meaning that the majority of the population in each neighborhood is constituted by elderly people as compared to young ones. Despite this overall trend, there are still variations among the districts: *Consulta 1* has the oldest overall residents (index score: 324.53), followed by *consulta 4A, 5A,* and *5B*. On the other hand, the youngest districts are *consulta 6B* (score: 174,11) and *consulta 2*. When comparing these patterns to the UGS accessibility results, the following can be observed: Those districts with the oldest population can be considered as overall medium to

[14] It should be noted that the color coding of the demographics in the output are purposefully chose to not be colorful, to avoid positive-negative associations. Rather, from white to black, the levels of the index values were depicted as low to high. Age: from young to old, gender: from more female to more male, nationality: from more Italian to more "foreign", family numerosity: from least to most.

high in terms of the found UGS accessibility (*1:* medium*, 4A:* high*, 5B:* medium), while those districts with a younger population score medium to low in UGS accessibility (*6B*: low, *2*: medium, *3A*: low, *3B*: low, *4B*: low, *6A*: medium).

When considering the patterns of the gender index (B) (**Figure 25)**, the following trends are visible: first, it can be stated that the values of all districts are below 100, pointing at a female majority of residents in all neighborhoods. Among them, the most female-dominated *consulta* is *consulta 1* (index value: 83.93), followed by *consulta 4A* and *5B* and *3B*, whereas the more neighborhoods with comparatively more male residents are *consulta 2* (index value: 198.70), as well as *6B* and *3A*. When comparing these trends to the UGS accessibility results, it can be concluded that the districts with most female residents show a variation of rather mixed accessibility scores (*1*: medium, *4A*: high, *5B*: medium, *3B*: low), while the more male-dominated districts show medium to low accessibility values (*2*: medium, *6B*: low, *3A*: low, *4B*: low, *5A*: medium, *6A*: medium).

Looking at the nationality index, or rather, the percentage of foreigners registered for each district (C) the following trend becomes visible through the cartographic output below (**Figure 25)**: Most of the districts have a rather low rate of non-Italian residents, and only three districts show numbers of more than 18%: Namely, *consulta 2*, which has by far the highest number of foreign inhabitants (29,29%), as well as *consulta 6A* (21,85%) and *consulta 3A* (19.29%). All other districts are within a range of 10-13%, and only *consulta 5A* has a value below 10% (9.35%) and is thus the district with the least non-Italian citizens. Comparing these trends to the accessibility findings, it can be stated that the three districts with the highest number of registered foreign residents have UGS accessibility scores of medium to low (*2*: medium, *6A*: medium, *3A*: low), whereas the highest accessibility is found among those districts with higher Italian nationality residents (i.e. *4A*), which otherwise vary between medium and low scores in their accounts of park accessibility (*1*: medium, *3B*: low, *4B*: low, *5A*: medium, *5B*: medium, *6B*: low).

Finally, when looking into the demographics related to family numerosity (**Figure 25,** map D), the following patterns are visible: First, it can be stated that most families do not reside in the city center but rather in the urban outskirts. Overall, the highest numbers among the districts can be found in *consulta 5A* and *consulta 6B* (scores: 2.24 & 2.21 respectively), followed by *3B,* and *4B*. Least families, according to the municipal index, reside in *consulta 1* (index score: 1.72), as well as *4A* and *5B*. Comparing these numbers to UGS accessibility, it can be stated that the districts with the highest family numerosity include all neighborhoods that were scored low in terms of UGS accessibility (*5A*: medium, *6B*: low, *3B*: low, *4B*: low, *3A*: low, *6A*: low), whereas the districts with the lowest family indices score medium to high in terms of park accessibility (*1*: medium, *4A*: high, *5B*: medium*,* *2*: medium).

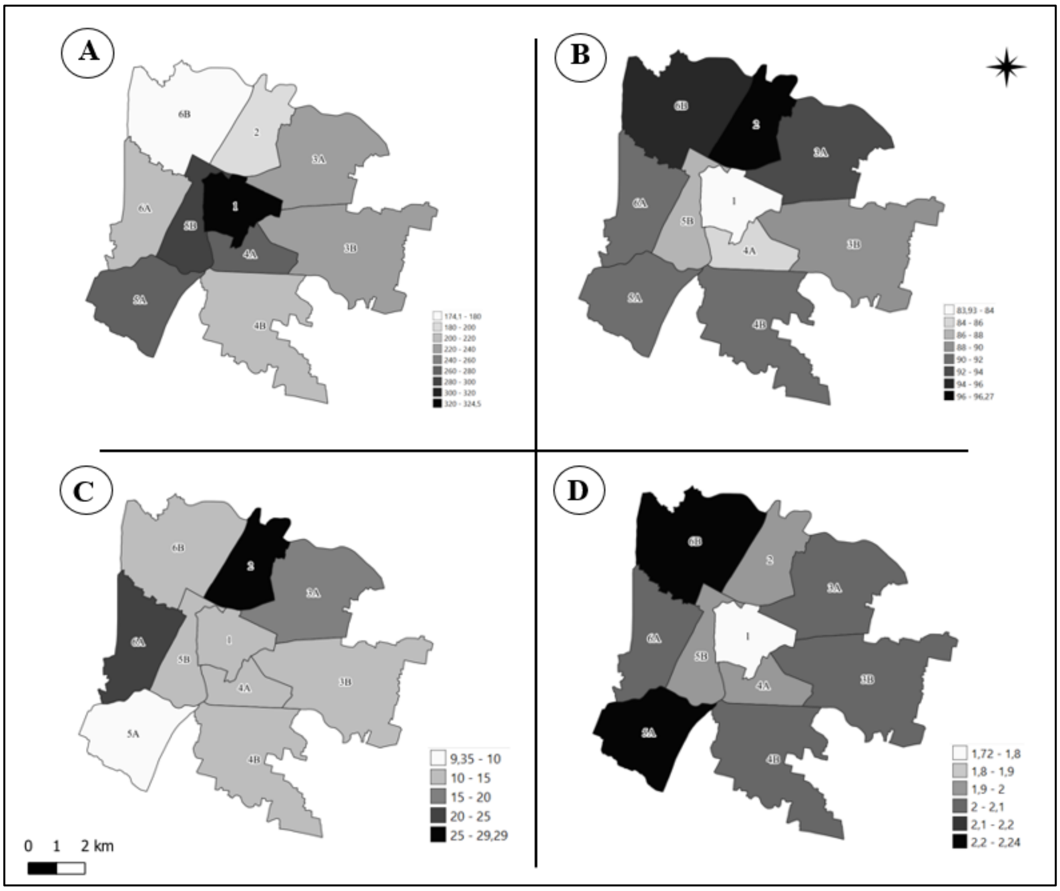

Figure 25: Demographics (A: age, B: gender, C: nationality, D: family numerosity).

In the following chapter (chapter 6) the abovementioned results on the disparities in UGS accessibility among the social categories will be discussed in terms of their consequences for the social justice within the city of Padova.

5.3.2 Spatial (In)Equality

Having thus presented the results of the social equality measure of Padova's demographic patterns in relation to its UGS accessibility patterns, the second socio-spatial justice item to be analyzed is the spatial one, thus the spatial (in)equality patterns in UGS accessibility across the urban context.

These patterns can be considered to already be visible within the results of the UGS accessibility measure itself, as the conducted operations relating to the three factors as well as their MCA assessment were already provided in form of a spatial division based on the administrative units of the *consulte*, which is why the analytical outputs presented on the first measurement step of this research are indicating the spatial disparities in accessing local parks across the urban neighborhoods.

However, beyond that, the following findings can be more explicitly highlighted in order to make the produced account of spatial (in)equality patterns in Padova more tangible: First, it may be stressed that looking at the results, the southern city center is the area with the clearest UGS accessibility. Spatial inequalities in this regard become, however, visible, when looking at the decreasing accessibility scores and the resulting spatial inequality patterns in this regard: As visible in the below figure (**Figure 26**), medium accessibility scores are located in the belt between the city's south-west and north (from *consulta 5A* up to *consulta 2*), whereas low scores were mainly found in the larger belt of southern to north-eastern districts (*consulta 4B* up to *consulta 3A*). As a sort of outlier district, the very north/north-western *consulta 6B* stands out as another low-rated neighborhood in terms of its accessibility to parks.

Figure 26: Spatial accessibility patterns.

Further, there are spatial variations in terms of the different factor analyzed to create the accessibility score, namely quantity (F1), proximity (F2), and quality (F3), as visible in the comparative figure (**Figure 27**) below: First, the overall patterns remain quite equal in terms of a dominance of higher accessibility in the on part of the first (south-west to north) belt, however differ in relation to *consulta 5B*, which is rated low in terms of proximity, and *consulta 5A*, rated low in two accounts (F1 & F3) but high on proximity. The second belt (south to north-west) remains low across F1 and F3, however shows a variation in relation to *consulta 3B* in terms of its medium rating for F2. As regards the high value of *consulta 4A* in the southern center, F2 and F3 are rated as medium, rather than high, differing thus from the final accessibility score visible above. Lastly, the outlier district in the north-west, *consulta 6B*, also varies across the three factors: while eventually scored low, the rating of proximity actually shows a medium value. Thus, the spatial disparities in terms of UGS accessibility must also be understood as different in terms of the different ways in which accessibility might be understood. It can, however, be concluded that no matter the accessibility factor, the southern and eastern part of the city are always worse off than the central and north-western areas, apart from the very north-western district.

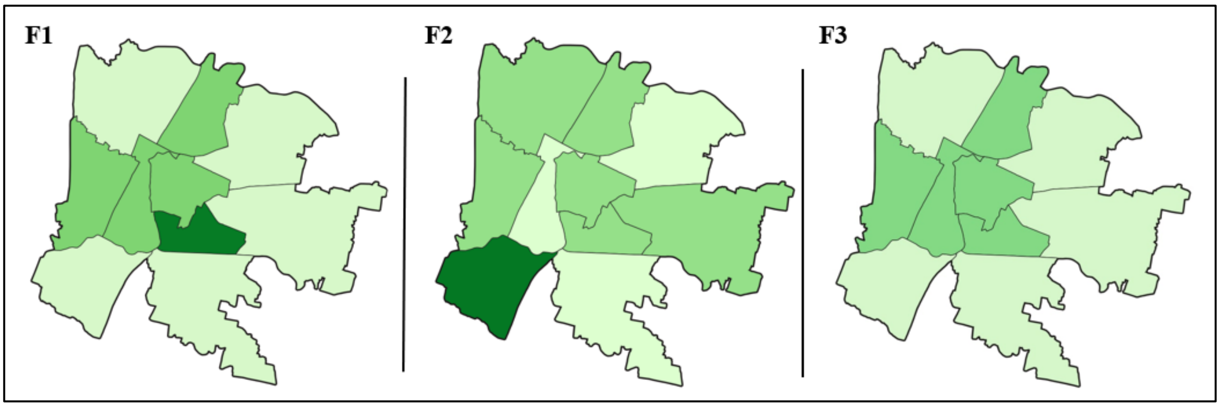

Figure 27: Comparison of spatial factor patterns.

CHAPTER 6: DISCUSSION

In the following pages, the results presented in chapter 5 will be discussed in terms of their meaning based on the theoretical framework of this thesis, the local specificities, and the analytical particularities underlying the approach. Thereby, a more in-depth, comprehensive understanding of the findings of this research will be produced, based on which conclusions on the local development and urban planning consequences of the findings can be made. Accordingly, the first part of this chapter discusses the meaning of the findings on Padova's UGS accessibility and related intra-urban inequalities (6.1), while the second part comprises the suggestion of consequences and takeaways of these findings for future related urban planning (6.2). Before the local urban planning context of Padova and the positive recent progress within Italy, it will thus be discussed whether the city's green space and sustainable development agenda, as introduced before (chapter 3), can be considered to be adequately reflected in the socio-spatial accessibility patterns found in this research. By discussing these aspects, the second part of the research question will be established, namely ***how the socio-spatial UGS accessibility patterns can be understood.***

6.1 UNDERSTANDING THE ANALYTICAL FINDINGS

In order to produce a comprehensive understanding of the consequence of the findings of this research, an overall understanding of their meaning and a discussion of some significant aspects will be provided in the following sections. Thereby, the previously presented results can better be understood in light of the given research framework and the underlying local, theoretical and analytical particularities of the conducted case study. First, the overall accessibility results on neighborhood parks in Padova will be discussed, as they constitute the key measure of analysis. Then, the broader implications of the findings in relation to the justice dimension adopted in this thesis will be discussed, hence the socio-spatial inequality results are considered more in-depth.

6.1.1 Accessibility Results Evaluation

In the following paragraphs, the UGS accessibility outputs produced and presented in the previous chapter are discussed in terms of their meaning and significance, by identifying specific patterns and considering particular aspects that may shed more light onto the related results.

To do so, the importance of UGS for local sustainable development should be re-emphasized: As introduced more comprehensively in the theoretical framework, urban greenery constitutes a vital place for local development processes due to the related benefits of "soft surfaces" for human well-being, and thus the quality of life. UGS, as established, delivers critical services such as provisioning, regulating, cultural and supporting services, which may activate a deeper connection between human activity and the natural environment, provide a place for social interaction comprising potential for enhanced social cohesion, and create relaxation within the loud and hectic urban space (see chapter 2.1.3).

The previously introduced UGS accessibility results in the case context of Padova must be read in consideration of this importance. Based on the cartographic and computational outputs presented in the previous chapter, the following overall patterns related to this important urban space can be concluded to have become apparent: Firstly, the consulted satellite imagery and the overall findings on UGS in Padova confirm the persisting domination of "hard surfaces", thus concrete buildings and built environment, as opposed to "soft surfaces", namely natural and/or green space, as has been previously found by researchers in the area (e.g. Pristeri *et al*, 2020). Secondly, the total values of UGS, particularly neighborhood parks, have been found to be very low for the entire urban average in all three factors: For the whole city, the quantity of "proximity green" – as established through the park ratio – constitutes a mere 2,35%, which must be considered particularly low based on the statement of the SDSN that sustainable cities should have a minimum of 15% of the total area as public greenery (UN SDSN, 2022; see chapter 4.2.2). As stated before, this points at an overall lack of sufficient green area across the urban space.

This quantity-related city average can, furthermore, even be considered "low" within the MCA matrix thresholds, which have already been significantly lowered to enable intra-urban comparison, which must be concluded as a problematic overall result. In regard to proximity, the urban average for inhabitants living in walking distance to neighborhood park is 55,9%, which, while it may be scored "medium" in the assessment framework thresholds chosen for this research, still likewise points at an insufficient urban average, considering that only just above half of the population may reach parks on foot. Lastly, the quality averages for the city are, not surprisingly, likewise rather low: A mere 34,16% of all parks within Padova can be considered to fulfill at least a minimum value creation potential based on the quality features they possess. While this value might correspond to a "medium" score according to the assessment parameters established before, it means that only just above a third of all parks can be considered to have the potential to produce the well-being effects that are so fundamental about UGS and that underlie the nexus between this space and local sustainable development. This rather concerning results on the city as a whole is confirmed by the final cartographic output produced to summarize all accessibility factors: for each factor, there is only one, or even no (F3), *consulta* that shows a high score, despite the setting of thresholds that are mostly below the international standards, which can be understood to indicate city-wide low UGS accessibility.

Despite the urban average, it seems valuable to zoom into the specific factor results to discuss some particular aspects and make an overall conclusion on their meaning. As regards the findings on park **quantity**, it has already been stated that the urban average is particularly low across all *consulte*. Even in relative terms, the majority of neighborhood was rated very low in regard to total park area and park ratio, which is even more significant in total terms, considering that all *consulte*, apart from *consulta 4A*, were found to have values below 5%.

To better understand this result, the following aspects are important to note: First, it may be restated that the result values were calculated based on the summary of the park area into the "containers" of each *consulta*. This means that the distribution of the park polygons, whose area was summarized, was disregarded, thus it needs to be understood that the little area that was found to be available in each neighborhood is actually not equally distributed across the district territory and thus not equally accessible, as shown in the proximity analysis. Secondly, an important aspect for the meaning of the quantity findings is the relation of supply and demand, whereas the demand of UGS area is generated by the inhabitants of each neighborhood. It is thus useful to complement the park ratio with the population density for each *consulta*, which may be understood to generate a higher demand the denser an area is populated, since it may be argued that denser areas produce a higher need for publicly available UGS due to the limited space for other, private, forms of green space. When comparing these two values (see the maps in the results chapter above, it becomes clear that while *consulta 2, 4A, 1,* and *5B* have the most densely populated areas, which would point at a higher need of parks, this demand does not correspond to the park supply, thus the quantity, found in the neighborhoods: While *consulta 1* and *5B* do have a higher park ratio than others, only *consulta 4A* shows a higher ratio and *consulta 1* even has a low one. The quantity results thus point at an insufficient amount of park area across the *consulte*, and an urban account in which the park supply does not fulfill the park demand, which can be understood to lower the human well-being potential for the urban residents in this regard.

When considering the specific meaning of the **proximity** measure, the results suggest a higher overall accessibility account than in respect to the park quantity: Overall, the majority of the *consulte* was classified as “medium” in terms of walkability distance, thus the rule that UGS need to be sufficiently near is fulfilled for the majority of citizens – even if, as discussed before, it must be questioned whether this result can be considered sufficient for a sustainable local development effect. An interesting aspect to consider in relation to this accessibility factor is the finding of two extreme cases among the neighborhoods: Before an urban average where most neighborhoods fall into the value range of around 40%, but mostly even 60% of the population within walking distance to the next park, *consulta 4B*, with a value of 21.21%, scores particularly low, and *consulta 5A*, with 82,34% score particularly high. As the results on proximity were drawn from the municipal network analysis conducted in the context of *Il Piano del Verde*, it is useful to consider the cartographic outputs on the two extreme cases to better understand their meaning.

As visible in the figure below (**Figure 28**), *consulta 5A* shows a particularly uneven distribution of both parks and population across the urban space, whereby much of the area is made up of agricultural acres and most of the residents live in two “hotspots” within the north-east and the south, which is also where the only park areas are located. This may explain the proximity result of over 80%. As regards *consulta 4B*, with the lowest proximity value, the zoom-in into the district shows that here, as well, population and parks are unevenly distributed (likewise **Figure 28**): While the residents predominantly live in the northern part of the *consulta*, and the parks are roughly distributed around the main “hotspots” of the residents, the *consulta* is the second largest of Padova and among those with the highest number of residents, thus the parks, located mostly in the north-west, are not accessible by foot to the many people living across the whole territory into the south.

Thus, the consideration of the extreme values among the proximity results of the neighborhoods shows that the location of the parks and the relationship between park and population distribution across the neighborhoods may significantly influence the analytical outcomes in this regard. Overall, it must be concluded that firstly, proximity thus depends on the spatial characteristics of the area and the location of UGS, and secondly, the overall findings on park proximity are overall low, considering that the rule to have parks near enough is not fulfilled for 44.1% of the population.

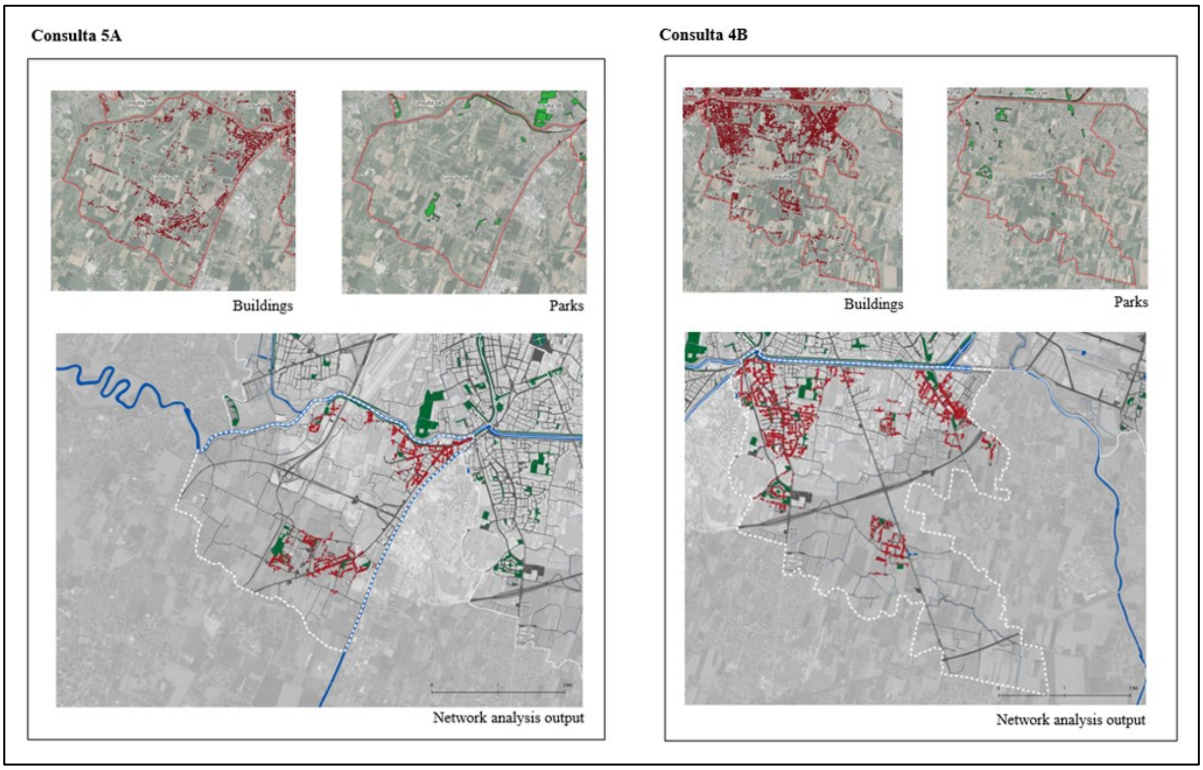

Figure 28: Zoom-in of proximity analysis specificities.

The **quality** results shown before point at an even lower account, as discussed above. While across the neighborhoods the MCA scoring was medium to low, no *consulta* shows a high ranking, which can be understood as showing an overall lack of high-quality, value-creating features across the urban context, diminishing the value creation potential of the existing green areas significantly, even if they were large and nearby, with the result that human well-being is less likely to be produced. Considering the quality results more in-depth, the first aspect to notice is that those parks that were considered "quality parks" were identified by setting a minimum standard of more than 7 out of 14 possible quality features to be fulfilled, thus merely more than half. This means that the given account of quality is based on a rather low, minimum level. If the minimum threshold would have been set at >10, or even >12 features, the result would have been much worse for the entire context of Padova: no *consulta* contains parks that fulfill more than 12 quality features, and only 6 out of 10 neighborhoods have parks with more than 10 features, namely *consulta 1*, with the highest number of 3 parks with more than 10, followed by *consulta 2, 4A,* and *4B* with 2 parks, and *consulta 3A* and *6A* with one. Thus, the number of quality features is at a rather minimum threshold across all parks within Padova. Among those parks that are fulfilling quality features, a second aspect may be interesting to consider to better understand the quality results: The type of quality features that are fulfilled most (and least). As stated before, the 14 features, while considered with equal weight in this study, may actually be considered differently important in their value creation potential: While some are more basic, such as the existence of benches, paths, shadow, or illumination, others might be more important for an advanced value creation, such as playgrounds, sports equipment or water fountains. Based on the conducted calculations, the patterns of which features are fulfilled in parks across the city can be read: Among the total number of fulfilled quality features (signified by "si" in the available dataset") across all parks, the following distribution among the single features became clear (**Figure 29**):

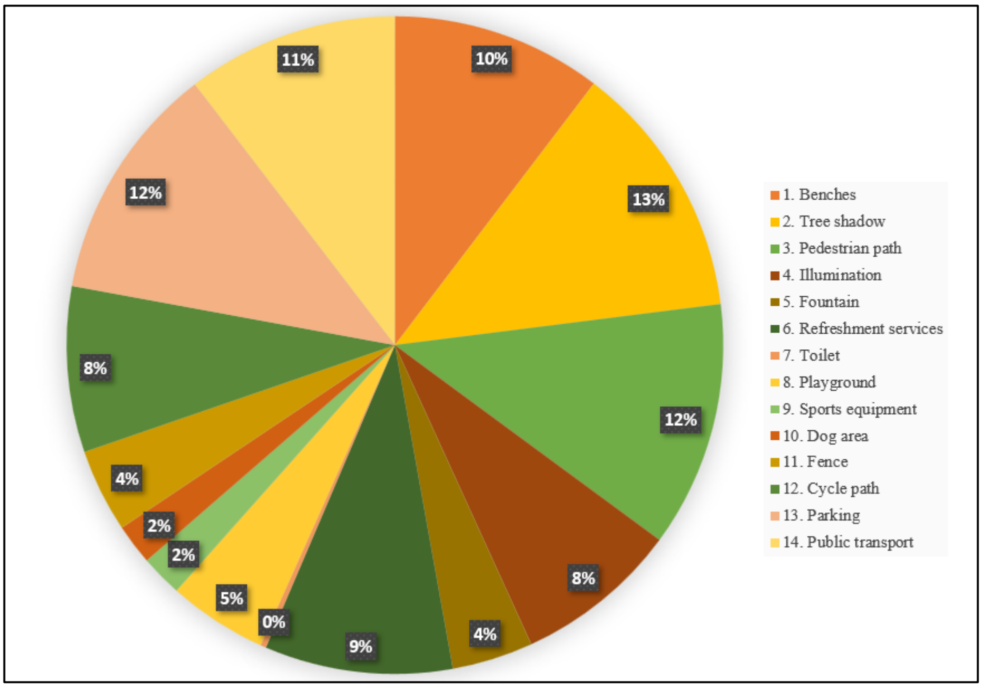

Figure 29: Distribution of frequencies among the fulfilled quality features.

Thus, unsurprisingly, the basic infrastructure such as tree shadow, pedestrian paths, nearby parking, as well as public transport, benches, overall refreshment and cycling are the features that are most commonly fulfilled, whereas those features that may be considered of higher value for user recreational purposes and thus in their well-being effects are sports equipment, playgrounds, fountains and areas for dogs. Considering these characteristics, and the overall value results across the *consulte*, which mainly fall into the value range of 40-30%, it can be concluded that, first, the quality results point at an overall low account, which must be considered problematic in terms of the resulting diminished potential for value creation within the urban parks. Secondly, the results themselves point at a rather basic overall quality as concerns the features that do exist, further diminishing the potential for well-being of the parks. Lastly, it must also be re-emphasized that the data itself was provided by the responsible sector of the municipality (*Settore Verde*) that may have an interest in reporting on a rather high value, which raises questions on the reliability of the data, meaning that the actual situation might be even worse.

Having thus discussed the factor-specific findings and their meanings, a last aspect that might be relevant in the consideration of meaning and significance of the UGS accessibility results of this research is the comparison of the findings that are related only to public neighborhood parks or "proximity green" to the overall UGS characteristics in Padova, thus the other types of greenery that exist. As discussed before (chapter 3), other research has found that the main type of green space in Padova exists at the urban margins and consists of agricultural areas, thus privately owned acres used for economic purposes, complemented by private gardens and green backyards making up most of the greenery in the city center (see below, Pristeri *et al*, 2020). Public green space, with which this research was concerned, is thus the greenery type that is least existent within the urban context, which explains the clear difference in intra-urban patterns when comparing the total green area in general and the total "proximity green" areas (see map in chapter 5.2.4 on UGS accessibility outputs and Pristeri *et al*'s outputs as shown in chapter 3.2.2 of this research). It becomes clear why *consulta 5A* has been found to stand out within the analysis on parks conducted here: In Pristeri *et al*'s research (2020), this is the neighborhood with the highest amount of overall greenery, due to the very high amount of agricultural land. As privately owned and agriculturally used green space is not usually considered as particularly beneficial for human well-being in terms of services for recreation and social activity, and is in this sense thus not connected to local development *per se*[15], this overall context of UGS in Padova reaffirms the findings on a lack of accessible green space in the city.

[15] Agricultural green areas may be related to local development in different other ways, i.e. in relation to their environmental benefits (green space as beneficial in terms of lowering air pollution) or economic terms (agricultural activity as contributing to urban economic growth). These aspects, in the sustainability matrix, are however not located at the social and environmental intersection, which is what this research concentrates on.

Overall, thus, the accessibility results can be understood as pointing at a city-wide lack of UGS accessibility: Neither are parks sufficiently large, not sufficiently near or sufficiently valuable. This result, together with the socio-spatial variations, may have adverse development effects, as will be discussed in the following sections.

6.1.2 Inequality Results Evaluation

As presented in the results chapter, there are significant disparities in the accessibility of parks across social groups and spatial units in Padova. In the following sections, related aspects will be discussed, and the meanings of the findings are concluded based on the reference to the justice framework provided as underlying this research.

To do so, the importance of intra-urban socio-spatial justice in general, and in relation to UGS accessibility, in particular for local sustainable development, needs to be re-emphasized: Social inequality was introduced as the "state of not being equal, especially […] in opportunities" (UNDESA, 2015, p.1; see chapter 2.2.1) and are thus at the heart of social justice theory. As stated, sustainable development is based on the understanding that equality in opportunities is an aim underlying all SDGs, but also an objective in itself. This is specifically related to the opportunity for every individual to access those services that are important for human well-being, such as UGS. Spatial justice, in this regard, has been related to social justice in terms of the common manifestation of social structures in space, or in other words, the alignment of aspatial variations in opportunities and outcomes with occurring social tensions in a given spatial unit, connecting thus spatial with social polarizations (Kanbur & Venables, 2005, see chapter 2.2.1). In the urban space in particular, which is, on the one hand, particularly important for development, but, on the other hand, also particularly vulnerable to such socio-spatial inequalities, it has been found that spatial manifestations of social marginalization are especially frequent. UGS accessibility, in this context, has been argued to be at the intersection of socio-spatial justice and environmental justice, relating directly to the requirements of equal opportunities to access UGS for equal development outcomes. Patterns of socio-spatial UGS accessibility have thus been concluded to be manifestations of persisting intra-urban socio-spatial justice issues, linked inherently with detrimental consequences for sustainable local development. Furthermore, it has been stated that the accessibility of UGS is of particular importance for intra-urban justice, as the beneficial effects of this space entail a potential creation of social cohesion, which might alleviate socio-spatial inequalities and tensions.

Ironically, UGS inaccessibility, conversely, might preclude this potential, possible leading to less social cohesion, and on the other hand, a lack of social cohesions might lead to socio-spatial differences in UGS accessibility - this circle can be understood to make the investigation of UGS accessibility patterns across space and society even more relevant.

When looking at the socio-spatial patterns of UGS accessibility in the case of Padova, as presented in chapter 5, a number of observations and conclusions can be made. Overall, it may be stated that there is a visible relation between social categories and the spatial units, confirming the abovementioned common manifestation of social organization in a local space: Overall, the oldest population in Padova is located in the center and southwest, while the youngest is living more in the north; the most female-dominated areas were found in the center-west part of the city and the relatively more male population mostly in the north; further, most non-Italian residents reside in the north-east and the far west, while the most homogenously Italian population is located in the south-west; and lastly, it was found that most families reside in the outer parts of the city, while the districts in the center-north have the lowest family indices.

Based on the clear spatial patterns of the social groups in the city, social inequality patterns were identified to exist in terms of the accessibility of parks among different social groups within Padova.

Age seems to relate to UGS accessibility in the sense that the districts with the oldest overall populations are those with a higher accessibility score, whereas younger districts were found to be more likely to have medium to low scores (see chapter 5.3.1). This may be considered noteworthy as it could be argued that younger people usually have a higher need for UGS, since they are more active in their leisure time and use parks more frequently (see Willemse, 2018 & 2015), in the context of which it would have to be considered detrimental that the patterns in Padova show the opposite. On the other hand, older populations might also be argued to have a high need for UGS, especially for the health benefits of this vital place, and it might further be argued that they have a higher need for parks in close proximity as mobility might be harder with growing age. A reason for this disparity might, presumably, be income – with growing age, people might have more money and thus live in areas with higher income and high public service provision, which may be ironic, since wealthier individuals might be argued to be more likely to have access to private green space, and thus have a lower need for public parks. Whatever one might argue in relation to the needs of young and old populations, the results show a clear disparity among the age groups, which is problematic from an equality-based justice perspective.

The findings on **gender** suggest that there is no real difference in the accessibility of UGS in terms of whether one is identified as male or female (see chapter 5.3.1): While one might see some patterns in terms of the distribution of the gender groups across space, the comparison thereof to the accessibility results does not show clear patterns. This result can be considered logical, considering that the only possible reason why gender would play a role are differences in location related to income, which might be more related to the differences in service provision.

While much of the UGS-related literature is concerned with UGS-related discrimination based on **nationality** or ethnicity, and related socio-spatial marginalization of minority groups, the findings on the comparison between the percentage of foreigners in each neighborhood and the accessibility results in Padova suggest more moderate patterns (see chapter 5.3.1): While those districts with the highest number of non-Italian citizens do show only low to medium accessibility results, those districts with most homogenously Italian inhabitants vary in this regard. Furthermore, *consulta 2*, which shows the highest percentage of non-Italians, is not among the lowest scoring neighborhoods in terms of the park accessibility measures. On the other hand, *consulta 3A*, also among those districts with higher foreign resident scores, was shown to score very low in terms of accessibility, however this might be due to other characteristics as well, such as the large industrial zone located in this area.

The last demographic category that was put in relation with the accessibility results is the one of **family numerosity**, which can be considered to show the clearest relationship (see chapter 5.3.1): The findings suggest that families, residing predominantly in the outskirts, live in those areas that were scored lowest in terms of UGS accessibility. This can be considered significant, since families are usually agreed upon as a social group with a definite higher need for accessible greenery (e.g. Willemse, 2018), also since they may be less wealthy the larger the family is, which may further increase the need of publicly available parks.

Apart from the more ambiguous findings related to the socio-spatial patterns, the spatial inequality in terms of UGS accessibility has clearly been established and summarized in the previously discussed simplified "belt" graphic (chapter 5.3.2). When considering the spatial inequality patterns, the result that the center has the most accessible parks might not be surprising, as the historical center of cities is commonly most invested into for obvious reasons like tourism, business activity, social interaction and based on the overall commonly centered mobility patterns concentrating there. Considering the local particularities of the urban context of Padova, it is likewise not surprising that the eastern parts of the city are overall scored low: The aforementioned industrial zone (*Zona Industriale Padova ZIP*), expanding over a large part of the area (see zoom-in below), explains why there are less residential areas and thus less investment into leisure services like neighborhood parks. However, the existence of the industrial zone might also be considered to negatively impact those residents that do live in the area, for instance due to noise or air pollution, which may be considered to be deteriorated by the lack of accessible green space, decreasing the quality of life even more. Further spatial inequality particularities are, for instance, the fact that *consulta 6B* falls outside the "belt" simplification by scoring low in terms of UGS accessibility as well, which, looking at the satellite imagery of the area, may be explained by the predominance of agricultural lands – thus, while the *consulta 3A* and *3B* might be considered low predominantly due to the high occurrence of industrial, "hard" surface, the low values of *consulta 6B* (and also *4B*) may be explained by the dominance of rural, but still "soft" surface area (see **Figure 30**). Lastly, the high scoring of *consulta 4A* may be explained by the existence of long riverbanks as well as the green areas around the city wall, providing high proximity from nearly anywhere in the area (see **Figure 30**). Furthermore, parks in this neighborhood show higher quality values, indicating more municipal investments into the equipment and design of the parks in this area.

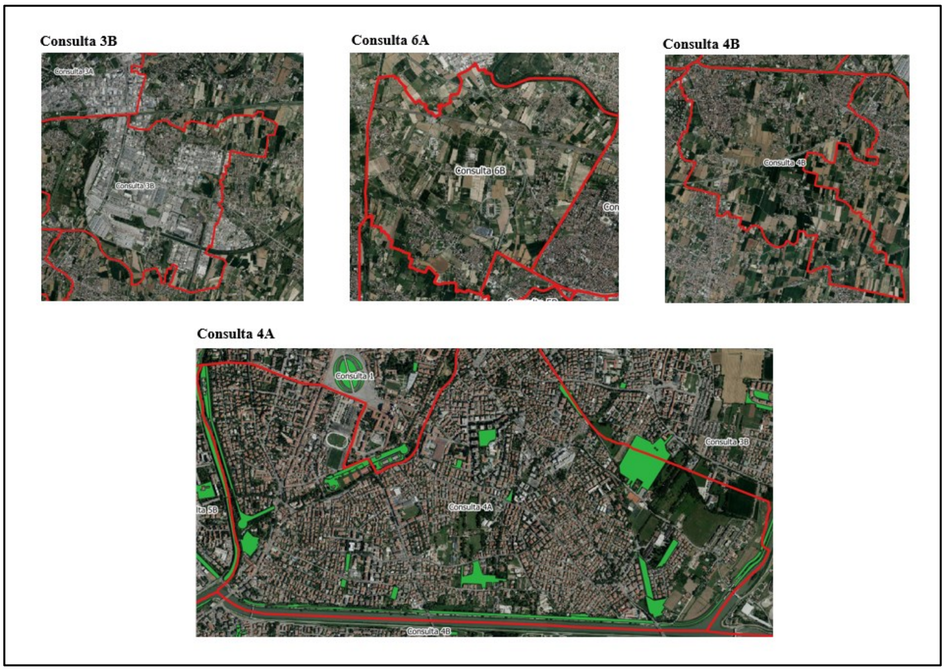

Figure 30: Figure 30: Zoom-in of spatial particularities.

In general, to understand these results, it seems important to re-emphasize the difference of equality versus equity understanding in justice theories: While equity perceptions emphasize that every individual has different circumstances affected by the belonging of different social categories, thus producing different needs, equality perceptions stress the importance of providing the same opportunities for outcomes for everyone as a starting point. While, based on the equity understanding, some social groups might thus have to be allocated more UGS based on higher needs, this thesis adopts the international development standard of the equality perception, thus the understanding that as a basis, everyone needs the same opportunity to access UGS and profit from the related well-being effects. Once this is sufficiently fulfilled, more affirmative action towards the benefits of those in higher need of UGS might be taken. In Padova, as discussed and concluded in the preceding pages, UGS accessibility must be understood as unequal based on social and spatial factors, and lacks an overall standard or level of park availability in the three accessibility factors, which necessitates related action due to the potential detrimental development consequences, as will be shown in the following section.

6.2 CONSEQUENCES OF THE FINDINGS

Based on the preceding discussion of the results of this research regarding UGS accessibility and related intra-urban socio-spatial inequality patterns in Padova, it is possible to make some conclusions on the consequences of these patterns for local development in the city, as well as on respective takeaways for related future planning. This will be done by relying on the theoretical understanding of the subject matter already established and discussed in the previous section, relevant literature on the topic, as well as the current green space planning efforts proposed by the responsible green sector of the municipality of Padova.

6.2.1 Local Development Implications

The following paragraphs will summarize potential consequences on local development in the case context, based on the underlying theoretical understanding of this research derived from sustainability and justice theory.

First, regarding the findings on the accessibility of parks as the measure for UGS in Padova, the city scored overall low in this regard. UGS, as vital for local development, need to be accessible in terms of quantity, proximity, and quality, however in the local case of Padova, it was found that inhabitants of almost all neighborhoods lack enough overall park area, parks they can easily reach on food, and parks that are of a quality sufficient to effect well-being. The consequence of this finding for local development, then, is the lower chances and potential for sustainable development for the city, despite the declared commitment by the municipality to strive to achieve the international sustainability goals. These findings further suggest that the nexus of local development and UGS seems to have been neglected in previous planning efforts, in the sense that this vital urban space seems to not have been considered one producing development. Instead, related structures lead to the conclusion that a focus had previously been put onto the traditional creation of economic opportunities and growth, for instance when thinking of the large industrial zone in the eastern urban belt: this becomes particularly clear when comparing the overall area of the *ZIP* or 10,5km² with the total city-wide park area of only 2,19km². The current situation, as well as the visibility of past decision-making, thus point at detrimental development consequences, which needs to be acknowledged and tackled by future efforts, as will be suggested below.

Second, the intra-urban socio-spatial inequalities in relation to green space accessibility likewise shows some crucial consequences for local development. It was shown that while inequalities and socio-spatial injustice related to UGS as a vital space are contrary to sustainable development, such patterns were found in the realm of Padova, especially across space, but also in relation to social categories. As a consequence, it may be understood that variations in UGS accessibility lead to variations in the urban residents' ability to make use of the well-being related benefits of urban greenery, thus effecting a potential difference in related development outcomes. Furthermore, while UGS, and in particular publicly available park areas, have the potential to alleviate some of the persisting socio-spatial inequalities through their aforementioned cohesion benefits, park accessibility patterns were found to remain unequal, thus potentially further deteriorating lacking social cohesion. Overall, the inequality findings suggest that socio-spatial justice seems not to have been a priority in previous UGS planning, requiring a related in change in the future, and thus, that the developments in Padova must be considered just *development*, instead of *just* development.

6.2.2 Urban Planning Implications

Based on the identification of possible consequences of the findings for sustainable development in Padova, the following paragraphs will discuss potential solutions and risks in relation to previous literature on the topic as well as current municipal approaches, and propose takeaways specifically derived from the analytical results of this research.

There is wide agreement on the need for an adoption of new planning and development solutions regarding greenery in literature on UGS (de Sousa Silva et al, 2018, p.7). The aspect stressed most in regard to this new planning approach is to include participatory measures into the design and implementation of related measure, in order to guarantee the alignment of supply and demand. Specifically, it is suggested to include the needs, preferences and perceptions of local residents as users of UGS or parks as a vital public service based on a benefits-based, bottom-up, participatory management strategy in accordance with the idea of "urban design as a co-creation process" (ibid., Willemse, 2015, pp.18&28; Panagopolous et al, 2015, p.140; Koprowska, 2019, pp.147-151). Based on these principles, it is agreed that UGS should be made more accessible in all three factors (ibid), and access inequality should be mitigated for instance by redeveloping park areas and concentrating on social harmony aspects in their design (Sun et al, 2022, p.6).

Apart from these solution proposals, a common risk discussed in relation to any urban planning measure to improve green spaces is the risk of triggering a green gentrification process: Based on the logic of related theory, this process entails that improved UGS areas attract developers and wealth, leading to higher rent prizes due to more demand and willingness to pay, thereby forcing low income residents to move away from the UGS, which then leads to a persistence of even increase in socio-spatial UGS accessibility differences (see Koprowska, 2019, p.148). In other words, green, or also termed as ecological or environmental, gentrification is the "implementation of an environmental planning agenda related to public green spaces that leads to the displacement or exclusion of the most economically vulnerable human population while exposing an environmental ethic" (Dooling, quoted by Koprowska, 2019, p.148). The risk is therefore that equal UGS accessibility, located between social and environmental sustainability pillar, is subject to a trade-off in regard to the former. According to relevant literature, UGS planning efforts thus need to adopt strategies that preclude this trade-off, for instance by implementing strategies like the "just green enough" strategy that is based specifically on the nexus of social justice and environmental goals (de Sousa Silva et al, 2018, p.6).

When considering the current UGS accessibility approach in place in the city of Padova, the following strategy is proposed through *Il Piano del Verde*: Apart from strategies on the aboreal heritage (*patrimonio arboreo*), water resources (called strategia "*la città spugna*", "the sponge city"), the "recreational-cultural itinerary" ("*itinerario ludico-culturali*") and urban agriculture ("*agricoltura urbana"),* parks and accessibility are specifically targeted through their own strategy ("*parchi e accessibilità*") (PdV, chapter 8). What is focused on in the realm of this strategy is the discussion in particular of those areas that fall outside the conducted proximity analysis, as well as a restructuring of the industrial zone in particular. The goal underlying these strategies is proclaimed to be the promotion of the topic of UGS importance, and the involvement of stakeholders through the previously mentioned participatory process (Padovanet, 2022E). This may be understood as an adoption of some of the abovementioned principles suggested by UGS literature. However, the risk of green gentrification, as well as intra-urban socio-spatial accessibility inequalities beyond the factor of proximity, are not included in Padova's strategic green space planning tool, a fact that must be considered problematic considering the results of this research.

On the basis of the findings and the theoretical justice foundation underlying this thesis, the following specific urban planning focus aspects may be proposed for future approaches, in order for the city's neighborhood parks to be equally accessible and enjoyable, and thus to contribute to the city's local sustainable development:

1. **Increase park accessibility** by

    i. ***Expanding*** the available green space areas by extending their boundaries as much as possible, especially in districts *1, 5A*, and *4B,*
    ii. ***Improving*** the proximity of green areas on foot by providing more equally distributed parks across the areas of the neighborhoods, especially in districts *3A, 4B* and *5B,* and
    iii. ***Valorizing*** existing and future park areas by providing more quality features, especially those related to higher recreational benefits, such as sports equipment, playgrounds, overall but especially for districts *3A, 3B, 4B, 5A*, and *6B,*

2. **Increase socio-spatial** UGS accessibility justice by

   i. ***Expanding*** the available green space areas by extending their boundaries as much as possible, especially in districts *1, 5A,* and *4B,* and

   ii. ***Focusing*** attention on park accessibility, particularly in the south-east and north-western districts, to combat spatial inequalities.

The adoption of the above measures may contribute to the increase in the positive well-being related benefits of UGS, and thus to the prospects of sustainable development in Padova.

CHAPTER 7: CONCLUSION

This thesis set out with the aim of providing an account of ***the intra-urban socio-spatial patterns of park accessibility in the city of Padova, and how they can be understood based on a justice approach to the nexus of sustainable local development and UGS.*** This aim was grounded in the interest of contributing to the body of research concerned with cities, green space and development, by providing a local development perspective that draws from socio-spatial justice theory, and by exemplifying this perspective through the study of the respective green space accessibility patterns in a local case.

Based on the produced, presented, and discussed analytical results, it can be concluded that, in line with the initial research hypothesis and the global account in this regard, there are significant differences in park accessibility across space and society within the local environment of the city of Padova, which constituted the case study of this research: not only has it been found that there are substantial discrepancies in the accessibility to neighborhood parks in terms of quantity, proximity and, quality across the city, but it has also been established that Padova as a whole shows an overall low account of park accessibility and value creation potential for Padova in this regard. Drawing from the understanding of the importance of green spaces like parks for human well-being, urban life quality, and thus local sustainable development, these findings were concluded to be problematic not only for those living in disadvantaged areas or belonging to disadvantaged social groups, but for the prospects of development of the entire city. This diagnosis is based on the adopted, and widely accepted, understanding that services of importance for development need to be equally accessible for everyone and from anywhere within the local environment. The analysis conducted in this study thereby show that local development in the city of Padova might not be regarded *just*, and that the current attempts of the municipality to contribute to the global sustainability agenda may not be directly in line with the latter, as disregarding a justice approach in relation to UGS must be considered as diverging from the proclaimed goal of reducing intra-urban inequalities. The case study thereby exemplifies the common trade-off phenomenon in relation to environmental policies: while environmental measures are a recent focus in related urban planning, there continues to be a lack in effectively adopting social and socio-spatial justice measures in relation to environmental resources and services, such as parks and well-being generating green spaces.

Apart from the context-specific consequences of the findings relating to the prospects of local sustainable development in Padova, the meaning of this research and the adopted research approach can be considered in its external validity and value. First, it may be understood that the study contributes to local development literature in general, by establishing a state-of-the-art account of the nexus of UGS and sustainable development from a spatial local development perspective and by providing a theoretical framework on intra-urban socio-spatial justice in relation to this nexus. Second, it contributes to this research body by applying the theoretical understanding to the local particularities of an urban case, and developing a comprehensive methodological approach enabling the identification of socio-spatial UGS accessibility patterns in the local context. Third, the production, assessment, and discussion of the results in relation to the research interest further exemplifies the utility of applying the framework chosen here to a local case. However, some methodological choices, for instance in terms of the thresholds chosen to rank park accessibility as low, medium, and high, are case-specific, and were determined solely to enable the conclusive identification of intra-urban accessibility differences. Nevertheless, the overall two-step measurement approach of this research, the theoretical foundation, the three-factor accessibility measure, as well as the GIS equity mapping operations, may be considered applicable to other cases and for the identification of intra-urban socio-spatial UGS accessibility injustice in other contexts. Thus, the provided framework was developed in the aspiration to be externally valid and potentially adjustable and applicable to similar research in the field.

To increase the value of such research even more, future studies might further develop the evaluation approach relating to UGS accessibility measures by complementing this studies' service provision-oriented accessibility approach with a user-focused account. For instance, such a focus might identify the needs of local residents in terms of green spaces and their accessibility and provide a more qualitative analysis of actual park usage patterns and the individual capability differences in using UGS. Doing so would increase the value of a quantity, proximity and quality account of park accessibility based on the previously discussed bottom-up urban design principles suggested to increase attempts of alleviated injustices in this matter.

By way of conclusion, it should be re-emphasized that the findings of this research point at the need of more progressive urban policymaking for cities to be able to fulfill the global sustainability goals, especially in the social-environmental sphere of the matrix. It was shown that it is necessary to include a socio-spatial and environmental justice dimension, and the acknowledgement of the nexus between green space and development, for related strategies to enable the unfolding of this vital urban space's full well-being potential. Otherwise, there may be the risk of perpetuating the detrimental effects of urban injustice for local development.

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