

Faculty of Engineering

Doctoral Program in Spatial Planning

THE POWER OF PLOT SYSTEMS

A MULTIFACETED APPROACH TO URBAN THEORY AND
PRACTICE

Lais Caroline Bertolino de Almeida

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REPÚBLICA
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For Mário, with all my love.

Man's most successful attempt to remake the world he lives in more after his heart's desire. But, if the city is the world which man created, it is the world in which he is henceforth condemned to live. Thus, indirectly, and without any clear sense of the nature of his task, in making the city man has remade himself (Robert Park).

Declaration of authorship

I, Lais Caroline Bertolino de Almeida, declared that this thesis titled ‘The power of plot systems: a multifaceted approach to urban theory and practice’ and the work presented here is my own. I confirm that this thesis comprises of my original work towards the Doctor of Spatial Planning degree.

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Building a PhD isn't just a 3- or 4-years period that begins with an application. The decisions made throughout life and the professors who are part of our learning process have a significant impact on how we get to this point. In university, you first need to complete an undergraduate degree, which in Brazil takes 5 years. Then, a 2-year master's degree. Only then can you start thinking about pursuing a doctorate, which on average lasts 3 to 4 years. Throughout this time, the support of professionals in the field (especially supervising professors), friends, and family is very important. Therefore, thank you to everyone who has had a great impact on my academic and professional life.

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Preface

The trajectory of this research began with the proposal for a thesis entitled: *The plot system from a tripartite perspective: morphological, legal and economic*. The initial objective was to develop a theoretical-conceptual understanding and a spatial analytical method for the plot system, which could understand the plot system from these three approaches (the proposal submitted to FCT). However, throughout the research, it became evident that this tripartite structure was insufficient to capture the complexity of the topic. The in-depth theoretical review revealed that plots not only shape the urban structure but also interact with different dimensions of life in cities based on their varied characteristics. This finding led to the reformulation of the scope of the study, integrating the multidimensional and multicharacteristic nature of the plot system into the theoretical-conceptual analysis and the method developed, culminating in the final research entitled *The Power of Plot Systems: A Multifaceted Approach to Urban Theory and Practice*.

Plot systems play a central role in the territorial organization and structuring of cities, directly influencing land use and various aspects of urban life. In addition to the morphological, legal and economic dimensions, their strong relationships with social, environmental and institutional aspects are critical. They reflect belonging and identity, impact the real estate market, influence the urban microclimate and are regulated by a complex legal and institutional framework. To understand this multiplicity, a spatial analytical method was developed, of a quantitative and qualitative nature, which allows both detailed analyses on a local scale and a comprehensive view of the structure and dynamics of plots in a city. The objective is to develop a theoretical and practical approach that integrates the different meanings of plots in a unified analysis that can expand the scientific field and support more coherent and well-founded planning decisions.

During my PhD research, I had the opportunity to deepen my knowledge in different academic contexts. In 2022, I participated in two significant events: the Business Models for Evidence-Based Urban Practices - KAEBUP course, held at the University of Cyprus, Nicosia, Cyprus, from April 26 to 29, and the Business Models Workshop - KAEBUP, held at the University of Porto, Portugal, from July 26 to 29. Both courses were essential to broaden my understanding of evidence-based urban practices and their implications for urban planning.

In the same year, I participated in the first edition of the International School on Urban Morphology - ISUM, organized by *Sapienza Università di Roma*, Italy, from June 20 to 28. This course deepened my understanding of the theoretical bases of urban morphology and its implications for the structuring of Italian cities, being an important milestone in the theoretical formation of the thesis work.

In 2024, I completed an exchange program at New York University in New York City, United States. This exchange program was of great importance for validate the empirical application the proposed research methodology and applying the analysis to the city's plot system at the local scale. This period was essential for consolidating the empirical bases of the work, allowing me to test the method in a complex urban environment highly regulated by private property. In addition, I participated in scientific events of great relevance for urban morphology: the conferences of the Portuguese-language Network of Urban Morphology - PNUM in Belém, in the state of Pará, Brazil, and the International Seminar on Urban Form - ISUF in São Paulo, Brazil, as a presenter of a scientific paper and as part of the organization commission of these two events in 2024.

In 2025, I participated in the second edition of the International School on Urban Morphology, in Hangzhou, China. It was a unique opportunity to explore urban morphology in a political, socioeconomic, environmental and cultural context that differs profoundly from my reality. This contrast was especially relevant for my research, since the plot systems assumes specific contours in the Chinese context, which contrasts with most cases on a global scale, as there is no concept of private land ownership. In addition, in this course, I had the opportunity to present my research and receive contributions from international experts in the field. This exchange of ideas provided new perspectives, contributing significantly to the final structure of the thesis. In this same year, I participated as a part of organization of the PNUM conference 2025, in Porto, Portugal; and I participated too in the ISUF conference, in Torino, Italy, both events took place in June 2025.

Thus, the courses, events, and exchange program held throughout the thesis were unique training opportunities and spaces for knowledge advancement that were integral to the research journey. They enabled the consolidation of international academic networks, dialogue with different theoretical traditions and urban contexts, and the empirical application of the proposed methodology. This combination of experiences lent greater scientific robustness to the work, granting it a more critical perspective on the method to encompass different contexts. Furthermore, this journey allowed for the integration of diverse perspectives on the plot system, strengthening the proposal for a multifaceted approach capable of expanding the theoretical field and supporting the practice of urban planning.

The result of this research seeks to fill a gap in the urban planning literature and practice by proposing an analytical method that highlights the role of plots in the configuration and transformation of cities. Along the way, I learned that each decision made at the plot scale not only reflects the existing urban dynamics but also has the potential and intensity to reconfigure the territory in multiple dimensions over time. I hope that this work can contribute to a deeper understanding of plot systems and its application in urban planning, promoting more equitable, sustainable and well-structured cities to people.

Abstract

Plots play a central role in the organization and structure of cities; they are the minimum unit of land designated for occupation. The plot system is related to several fundamental dimensions of urban life, such as the *social* - belonging and identity; the *economic* - real estate and productive activities; the *environmental* - impact on the urban microclimate; the *morphological* - spatial configuration; the *legal* - property rights; and the *institutional/planning* - planning and use of strategic and structural options. Plots also possess fundamental characteristics: *transformation* - physical, economic, legal (etc.) changes over time; *location* - position in the urban system; *occupation* - spatial and three-dimensional use of land; *control* - area of ownership; and *function* - activities carried out. Despite the importance of the plot system in structuring human settlements, directly influencing the built environment, land uses, and various aspects of urban life, plots often receive limited attention in urban science and planning practice. This thesis aims to broaden the understanding of the multifaceted nature of plot systems. To this end, this study proposes the construction of a theoretical and conceptual basis for building a typology of the plot system; and a taxonomy, to empirically analyse, through a spatial analytical method, capable of quantifying the different types of plots in the system. The method seeks to analyse specific aspects of the plot (at the local and plot scales), as well as to understand the patterns of the structure and dynamics of plots in a city (at the city scale). Finally, the method offers a multifaceted view of the plots system. Each decision made at the plot scale, in the different dimensions of urban life, impacts the urban system in different ways, shaping real estate dynamics, land use, spatial structure, identity, and environmental balance. The method is applied to New York City.

Keywords: plots, urban morphology, urban planning, New York.

Resumo

As parcelas desempenham um papel central na organização e estrutura das cidades; elas são a unidade mínima de solo designada para ocupação. O sistema de parcelas está relacionado a diversas dimensões fundamentais da vida urbana, como a social - pertencimento e identidade; a econômica - imóveis e atividades produtivas; a ambiental - impacto no microclima urbano; a morfológica - configuração espacial; a legal - direitos de propriedade; e a institucional/planejamento - planejamento e uso de opções estratégicas e estruturais. As parcelas também possuem características fundamentais: transformação - mudanças físicas, econômicas, legais (etc.) ao longo do tempo; localização - posição no sistema urbano; ocupação - uso espacial e tridimensional do solo; controle - área de propriedade; e função - atividades realizadas. Apesar da importância do sistema de parcelas na estruturação dos assentamentos humanos, influenciando diretamente o ambiente construído, os usos do solo e vários aspectos da vida urbana, as parcelas frequentemente recebem atenção limitada na ciência urbana e na prática do planejamento. Esta tese tem como propósito ampliar a compreensão da natureza multifacetada dos sistemas de parcelas. Para isso, propõe-se a construção de uma base teórico conceitual para a construção da tipologia do sistema de parcelas; e uma taxonomia, para analisar de forma empírica por meio de um método analítico espacial capaz de quantificar os diferentes tipos do sistema de parcelas. O método busca analisar aspectos específicos das parcelas (em escala local e na escala da parcela), bem como compreender os padrões da estrutura e dinâmica das parcelas em uma cidade (escala da cidade). Por fim, o método oferece uma visão multifacetada do sistema de parcelas. Cada decisão tomada na escala da parcela, nas diferentes características e dimensões da vida urbana, impacta o sistema urbano de maneiras diferentes, moldando a dinâmica imobiliária, o uso do solo, a estrutura espacial, a identidade e o equilíbrio ambiental. O método é aplicado na cidade de Nova Iorque.

Palavras-chave: parcelas, morfologia urbana, planejamento urbano, Nova Iorque.

List of abbreviations

ACRIS - Automated City Register Information System
ASSOCIATION - Community, religious, or non-profit organizations
AP – Area of the plot
AO – Average plot area for each owner
BD - Building density
CIAM - *Congrès Internationaux d'Architecture Moderne*
CORPORATION - Large companies, often multinationals, with shareholders
CAS - land use coefficient
COS - land occupation coefficient
CIS - impermeability coefficient
CPC - City Planning Commission
DOF - New York City Department of Finance
DEP - Department of Environmental Protection
DCP - Department of City Planning
DUAT - Right of Use and Exploitation of Land
EAP – Number of economic activities
FCT - Foundation for Science and Technology
FP – Number of functions it accommodates
GIS – Geographic System Information
ISUM - International Summer School in Urban Morphology
ISUF - International Seminar on Urban Form
IPTU - Progressive Property Tax
IBGE – Brazilian Institute of Geography and Statistic
IPUF - Florianópolis Urban Planning Institute
KAEBUP - Business Models for Evidence-Based Urban Practices
LCP - Department of Municipal Administrative Services
LLC – Limited Liability Companies
LADM - Land Administration Domain Model
LOT - Land Subdivision Law
LVP – Plot value
NYU - New York University
NYC Planning - New York City Department of City Planning
OTI - Office of Technology and Innovation
OSM – OpenStreetMap
OP – Total number of owners
PósArq/UFSC - Postgraduate Program in Architecture and Urban Planning at the Federal University of Santa Catarina
PBU - Parcel-Based Urbanism
PLUTO – Primary Land Use Tax
PNUM - Lusophone Network of Urban Morphology

PLOTTER - Method for analysing the parcels system for urban planning practice
PTP – Number of property transfers
PEUMM - Maputo Urban Structure Plan
PA – Permeable area
PDT – Distance of attraction
PD – Plot density
SF – Size of the façade
TRUST - Trust structures for the benefit of third parties
UFMS - Federal University of Mato Grosso do Sul
UFSC – LABTRAS - Transportation Laboratory of Federal University of Santa Catarina
UOP – Users who are owners
UOPG - Operational Planning and Management Units
URP – Plot utilization rate
VA – Variation in plot area
VPT – Variation in property transfers
VLV – Variation in land value over time
ZEIS - Special Zones of Social Interest

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1 INTRODUCTION

I Introduction

One of the ways that planning can be understood is as the organisation of strategies and actions to achieve a number of key goals. Broadly speaking, it is a process of reflection, of bringing together important ideas for the reorganisation of the present and future. In essence, it can represent the concrete process of idealisation with various decision-making procedures. In this sense it is ‘a conscious attempt to integrate decisions in different areas’ (Mintzberg, 1981, p. 321).

In the ‘urban’ realm, planning has evolved significantly over time, keeping pace with the social, economic, environmental and spatial transformations of cities. Planning theory has developed from a variety of perspectives, taking approaches from ‘conventional’ and modern urbanism, systems and rationality theory, incremental planning, approaches from Marxist streams, pragmatism, neoliberalism, postmodern thinking, the collaborative approach, new urbanism and more (Taylor, 1998; Ellis, 2002; Allmendinger, 2017). The variety of theories that have been developed over decades to explain, and attempt to change, the urban space demonstrates the complexity of this task.

The state of the art in planning exposes the resurgence of urban form as a centrepiece, driven by concerns about sustainability, the field of urban design, and innovative approaches such as New Urbanism. There is a renewed interest in cities designed for a human scale, centred on the neighbourhood, pedestrians, mixed spaces, and different types of employment, housing, and leisure. Important thinkers such as Kevin Lynch (1964), Jane Jacobs (1961), and Christopher Alexander (1965, 2003), among others, have long advocated new approaches to the city at the local scale, articulating the physical form of the city with socio-economic and environmental conditions. Despite the existence of theories and practices that indicate paths towards what are understood as ‘good cities’ - fairer and more sustainable, there are several real difficulties in their implementation.

In urban morphology, the science that studies the physical form of cities (Oliveira [2016] 2022), there is a vast field of theory with different approaches of a descriptive and explanatory (Conzen, 1960; Whitehand, 1987), prescriptive (Muratori, 1959; Caniggia and Maffei, 1979) and normative (Lynch, 1964; Alexander, 1965) nature. This discipline has gained an important foothold in other fields of knowledge, such as the environmental, social, economic, and legal sciences, etc. However, one of the most important elements of the physical form of cities has been undervalued in the urban literature and practice, supposedly because of its highly complex nature: urban plots.

Despite the importance of plots, and their interdisciplinary nature, having been identified in a seminal book in the historical-geographical approach to urban morphology (Conzen, 1960),

subsequent studies on the plot have been developed piecemeal, leaving important gaps over time. The plot systems have been characterized as complex, linked to the notions of ‘ownership’, ‘land use’, ‘construction’, ‘economic’, ‘social’, ‘environmental’ and ‘legal opportunities’. These characteristics are strictly different depending on the institutional frameworks for regulating land use and control, and the historical and cultural aspects of each city and/or country. This implies that plots play a role in territorial organization that can influence different aspects of urban life over time, depending on how the shape and physical boundaries of each plot within the urban system are managed. While this hypothesis has been partially identified in some studies in the literature, a study that comprehensively addresses the multifaceted nature of the plot system has yet to be explored. Thus, this research aims to fill this gap, constituting the plot as multifaceted unit of urban land organization.

1.1 Motivation

The city is one of the most difficult human inventions to understand, yet incredibly functional. Cities are home to most of humanity’s constructed history and culture, represented by distinct urban landscapes that are transformed over time. The city is also the space where daily economic exchanges take place, a shelter for native peoples, migrants, and visitors, a stage for artistic and cultural expressions (theatres, music, exhibitions), and the setting for social interactions, coexistence, leisure, and family relationships. It is also the place where the main services that sustain urban life are organized (health, education, commerce, mobility and supply) and the convergence point of rural and industrial activities. More than physical agglomeration, the city is the synthesis of the relationships between society and nature, between time and space, between identity and memory. It is the way human beings have found to collectively respond to their fundamental needs and ambitions.

However, the city is also a space of contrasts and inequalities. Historically, social inequality manifests itself in economic, spatial, and political dimensions, reflected in the distribution of public and private investments and the opportunities available to different social groups. While some enjoy the development conditions, others remain excluded from basic resources and fundamental rights. The unequal distribution of opportunities in urban space (such as employment, housing, mobility, education, and health) has patterns of socio-spatial segregation widely documented in the literature, both in contexts of the global North (Dunford, 2016; Lelo *et al.*, 2019; Venter *et al.*, 2023), and the global South (Miraftab, 2015; Unceta *et al.*, 2020; Ogunmiloro *et al.*, 2022; Netto *et al.*, 2022). This inequality is associated with structural problems such as the housing deficit, precarious infrastructure, socioeconomic vulnerabilities, environmental risks, and limited access to quality public services and spaces.

Although this work does not directly address socio-spatial inequality, the search for more just and sustainable cities motivates this research, both scientifically and personally. Academic research, while lacking direct power to transform space, constitutes an essential tool for critical elucidation, capable of influencing how planning professionals, public decision-makers, and communities understand and transform the city. It is in this context that urban morphology was chosen as the central field of this research. Understanding the physical form of the city is comprehending the material expression of the historical, cultural, socioeconomic, legal, and

environmental forces that shape it. Urban morphology, together with the main disciplines of urban life, allows to decipher how space is organized and evolves, revealing patterns and dynamics that can guide more equitable and sustainable urban policies.

This research, therefore, is dedicated to the in-depth and interdisciplinary study of one of the structuring elements of urban form: the plot. In literature, plots are recognized as one of the most complex components of urban form due to their conceptual ambiguity (Conzen, 1960; Scheer, 2018; Kropf, 2018; Bobkova, 2019). This research argues that plots have a multifaceted nature, simultaneously representing morphological, legal, economic, environmental, institutional, and social entities. When analysed collectively, this multifaceted nature of plots allows to determine patterns of urban complexity, which directly influences how cities transform. The organization and evolution of plots over time have direct implications for urban dynamics, with positive or negative impacts on the city. If these transformations are not studied and monitored, the ability to understand urban processes in depth and guide more conscious development of cities is lost. By recognizing the plot as a multifaceted unit of urban land organization, the aim is to demonstrate that its configuration and development constitute determining factors in the structuring, resilience and justice of contemporary cities.

1.2 Research problem and thesis

Despite the central role of plot systems in structuring cities, influencing everything from the physical form of human settlements to economic, social, and environmental aspects, planning often neglects their strategic importance. This neglect is partly rooted in the conceptual ambiguity surrounding the term *plots*.

The plot can be understood as a physical and spatial unit of urban transformation, permanence, and diversity. It embodies an area of land, often with buildings, representing a stable base on which local forms, identities, and dynamics are constructed (Conzen, 1960; Oliveira, [2016] 2022). It is simultaneously an urban artefact and a social and environmental convention, defined by collectively accepted boundaries and capable of reflecting different patterns of behaviour, use, and control (Scheer, 2018; Kropf, 2018). Its form and function are shaped by historical processes of adaptation and negotiation, which give it both resistances to change and flexibility to accommodate multiple typologies and uses (Ersland, 2009; Bobkova, 2019; Tumturk *et al.*, 2022).

The plot can also be seen as a territorial unit with added value and defined boundaries associated with land ownership or use. It may be privately owned (Alchian and Demsetz, 1973; Webster and Lai, 2003), publicly owned (Chau *et al.*, 2018; Kantarek *et al.*, 2022), or be the result of social recognition through occupation and claim practices (Scheer, 2018; Zazyki *et al.*, 2022). In all cases, it plays a crucial role in land allocation, in the distribution of benefits and burdens and in defining the possibilities of state intervention (Vejchodská *et al.*, 2022).

The plot is also widely treated as an economic asset. It is the object of appreciation and speculation by real estate market agents, often involved in concessions and negotiations with the public authorities (Humphrey, 2020; Li *et al.*, 2022). Furthermore, it constitutes the functional space where productive activities take place - commercial, residential, industrial, or

service - and is therefore fundamental to understanding the dynamics of urban development. These activities are related to transaction costs (Webster and Lai, 2003; O'Sullivan, 2003) and the logic of land occupation based on efficiency and adaptation, as defended by theories such as natural occupation (Marcus, 2010; Bobkova, 2019). However, despite such relevance in various areas of urban life, the land structure of cities often lacks complete and organized data, compromising its effective use as an urban management tool (Slomska-Przech and Slomski, 2022). Plots can be important not only because they are a fundamental component of the urban structure, but also because they mediate essential urban processes.

The thesis seeks to answer the following research question: **How can the whole complexity of the plot system, in its interaction with urban development, be captured?** This implies identifying the qualities of urban plots, the indicators that define their multiple faces, and how these data can be combined to form representative profiles that allow for a comprehensive and refined reading of the plot system.

The central thesis that this research is: **It is argued that the complexity of the plot system can be captured by a comprehensive analytical framework and measured using an innovative method that integrates critical urban dimensions and plot characteristics.**

By bringing together, in each plot unit, this characteristics and dimensions, the plot systems assume a structural role in the organization of the territory, constituting a multifaceted, measurable and manipulable element. It is precisely this inseparable fusion between the delimitation of the plot and its multifaceted character that gives it the structural capacity to influence and impact urban development.

This study proposes to reveal an integrated theoretical-conceptual framework on the different meanings of plot systems in various areas of urban life and to develop a spatial analytical method capable of quantifying this complexity.

To this end, six specific questions structure the research process:

1. What are the different qualities and main meanings of a plot system?¹
2. What are the main indicators that can be used to define the main meanings of the plot systems?
3. How can different indicators be combined to build representative profiles for the multiple faces of the plot system?
4. How can the integration of profiles generate a multifaceted view of the plot system?
5. What are the interrelationships between the multiple faces of the plot system and how do they cooperate with urban structure and dynamics?
6. How can the results of this study be incorporated into planning practice to guide strategic decisions on the development and management of cities?

¹ The meanings of plot systems are related to the sense, the purpose that each plots represents; the qualities are associated with the attributes or indicators that allow to explain these meanings.

The first specific objective of the thesis is to build a theoretical and conceptual basis on the plot system through a literature review, seeking to understand the main particularities of plots and their interactions in the urban space. The aim is to develop this review including the main areas of knowledge that are representative of plots, such as legal, economic, environmental, institutional and social sciences. The realization of this objective implies the formation of an essential theoretical-conceptual basis of knowledge about the multifaceted nature of the plot system. The second specific objective consists of constructing a spatial analytical method capable of identifying the plot's main singularities through the urban plan. The method is structured from the scale of the plot itself, considering its different meanings in an integrated way, to capture its influence on urban dynamics over time. The third specific objective is to demonstrate the relevance of this method to planning practice. The aim is to build a conceptual and practical approach that fills the gap in the interdisciplinary nature of the land structure. The aim is to demonstrate the relevance of the plot system and identify how this system can be integrated into planning.

1.3 Thesis Structure

The thesis is divided into ten chapters (Figure 1). Chapter 1 is the introduction to the research. It includes a discussion of the research motivation, the research problem and question, describing the central goal and specific objectives, the thesis structure and research procedures. Chapters 2, 3, 4 and 5 are the three parts of the literature review². The second chapter addresses plots. It introduces the ideas of different meanings of a plot and its multifaceted nature, and presents the different terminologies for plots. The third chapter focuses on the main methods and examples for studying and analysing the plot system in different dimensions of urban life. The fourth chapter focuses on the main methods and examples for studying and analysing the characteristics of the plot system. The fifth chapter reviews the literature on plots in planning practice in cities across different continents.

Chapter 6 presents the research method. This chapter is in seven subsections addressing the different steps of the investigation (6.1): the plot system typology (6.2), the *Plotter method* (6.3), the selection of the case study (6.4), the data management and development of geospatial databases (6.5), the process of analysing and implementing the plot system as a central framework for urban planning (6.6), and the strengths and limitations of the method (6.7). Chapter 7 develops the application of the method to New York, analysing the multifaceted nature of plots at three scales of analysis: the city, local (or neighbourhood), and the plot scale.

Chapter 8 argues for the importance of the plot system as a central framework for planning practice in the case study. To this end, it is developed in three fundamental subsections: an analysis of the main current urban plan that regulates plots in the city; a case for the *Plotter method* as a complementary tool for urban development in the city; and the *Plotter method* as an interactive tool for analysing and monitoring the plot system. Chapter 9 discusses the *power*

² While most of the literature review includes studies where plots have a central focus, others address it indirectly (in some cases by the selecting it as the level of disaggregation).

of plot systems, based on the findings of this work. Finally, Chapter 10 includes the main conclusions and recommendations for future research.

PhD THESIS STRUCTURE	CHAPTER 1	Introduction	Introduction Motivation Research problema and thesis Thesis structure
	CHAPTER 2	Literature review	What are the plots? The multifaceted nature of urban plots Plots terminology
	CHAPTER 3		The main dimensions of urban plots Social, economic, environmental, morphological, legal and planning/institutional
	CHAPTER 4		The main characteristics of urban plots Transformation, location, occupation, control, function
	CHAPTER 5		The plots system in different planning practices
	CHAPTER 6	Research method	Research method steps Plot systems typology The Plotter method Case study selection Data management and development of geospatial databases Plot systems as the central structure of urban planning Strengths and limitation of the method
	CHAPTER 7	Case study – New York	Brief description of the historical evolution of urban planning in New York City scale analysis Local scale analysis Plot scale analysis
	CHAPTER 8		NYC Zoning Resolution and Department of City Planning The Plotter Method as a central tool for city planning The Plotter Method as na interactive analysis and monitoring tool for planning practice
	CHAPTER 9	Discussion	Plots as multifaceted elements The application of the Plotter method in New York The importance of the plot system for urban science and planning practice
	CHAPTER 10	Conclusions	Conclusion

Figure 1 - PhD Thesis Structure

2 WHAT ARE PLOTS?

2 What are plots?

The plot is a piece of land, with physical or behavioural boundaries, used to organize the city's functions. The plot can be a rural or urban element. In rural areas, plots have usually areas, widths and lengths, designated for agricultural and/or livestock production and, in some cases, for the installation of small and medium-sized industries. In urban areas, they have varying dimensions that can reach a smaller, minimum unit of land capable of housing one or more functions, such as economic activities (productive or buying and selling), services, housing, or other activities. Although this is a simple and straightforward definition - the organization of the city's functions - over the years, the term *plot* has acquired a plurality of meanings closely linked to this genesis.

The organization of the modern city is not an *invention* in itself, but an *evolution* of human coexistence processes. In the past, even when humans were nomadic, upon settling temporarily, they structured the territory according to rules of behaviour that ensured survival and security. Studies on the emergence of planning and architecture highlight that the first spatial organizations, even in camps, were dictated by function and security. Urban and architectural space was the result of behavioural and relational patterns. The rules of behaviour defined the distance between bonfires and shelters, establishing the invisible boundary of the family plot, separating it from the production plots (hunting and gathering) and the leisure and ceremony plots (common space) (Alexander *et al.*, 1977; Lamas, 1993). The boundary of the plot was initially behavioural. The first spatial delimitations were expressions of social use and meaning that transformed into stable morphological elements over time (Rossi, 1966).

With the emergence of the first civilizations, land division ceased to be merely a socially definition and evolved into a physical structure. In Uruk, around 3500 BC, in Mesopotamia (present-day Iraq), land was delimited for different functions, such as temples, storage facilities, and housing, reflecting a social organization spatially marked by the emergence of different types of labour and the production of agricultural surpluses. In the cities of Mahenjo-daro and Harappa, in the Indus Valley Civilization, 2600 BC (present-day Pakistan/India), a more structured grid standardized residences and infrastructure. In Ancient Egypt (2000 BC), settlements such as Kahoun featured uniform residential areas separated from administrative areas (Morris, 1972).

The Roman Empire, however, was one of the first to delimit a system of plots pragmatically and on a large scale, through the *Centuriazione*, developed from the century II BC. This method divided several territories into uniform and orthogonal plots for agrarian colonization and land allocation to veterans, establishing stricter territorial control (Chevallier, 1961). Much later, with the Enlightenment and the rise of the bourgeoisie, the plot ceased to represent merely a

unit of spatial organization and began to assume an economic role, associated with individual value, private property, and the social power derived from land ownership (Locke, 2002).

Today, the plot constitutes one of the most regulated elements of the world's urban structure. This regulation, however, varies according to the cultural, political, and legal context of each country. Over time, the plot has developed along two distinct paths, reflecting different ways of producing and organizing urban space. On one hand, the plot is consolidated as a formal model, characterized by the institutionalization of legal, technical, and cadastral norms that guide land division and use. On the other hand, it is established as a non-formal model, resulting from social and cultural practices that shape the territory spontaneously and incrementally; or linked to state governments, where plots exist not as physical and legal boundaries, but as norms of coexistence determined by the state.

Formal plots represent the most common and institutionalized form of territorial division, being the fundamental land unit for the development of cities, especially in capitalist systems. In this model, plots involve legal demarcations recorded in documents and cadastral maps, where they have an exchange value associated with their specific characteristics. They are often the result of a formal planning process, governed by technical and legal standards; institutionalized by public agencies; generally developed by planners, who define rules for zoning, density, infrastructure, land use, etc. (the institutional/planning dimension). Often, plots are materialized by rigid physical elements (walls, fences, landmarks). The most distinctive aspect of this plots model is its constitution formed by land boundaries (the physical dimension), property boundaries (the legal dimension), and the associated value (the economic dimension). This interconnection expands the meaning of the plot, which was initially described as an element of organization of the city functions, to be also a product of the real estate market (examples of formal plots in Figure 2, a, b and c).

On the other hand, *non-formal plots* lack the tripartite structure that *formal plots* possess. In this model, the right to use space prevails over property rights. Plots do not exist as property rights, but as rights of possession or usufruct, or simply use (in the literal sense of the word) - whether established by law or by social consensus. In informal settlements, for example, plots are parts of land divided and distributed among people spontaneously and incrementally, through rules and agreements of social behaviour. In traditional communities, plots manifest as an invisible element in the organization of activities based on cultural principles, which can change according to each culture and context. In communist countries, plots manifest as an invisible organization by the State for land use. When they have physical boundaries, these exist solely to optimize land use. In these different types of community, the most distinctive aspect of *non-formal plots* lies in their primary constituent formed by land use (the physical dimension) and social agreements (or by the state, in the disposition of the common good) for the organization of the land (the institutional/planning dimension), reinforcing the meaning of the plots as an element of use value (the social dimension), with the social function of the territory prevailing, in contrast to the exchange value that predominates in the formal land system (examples of *non-formal plots* in Figure 2, d, e and f).

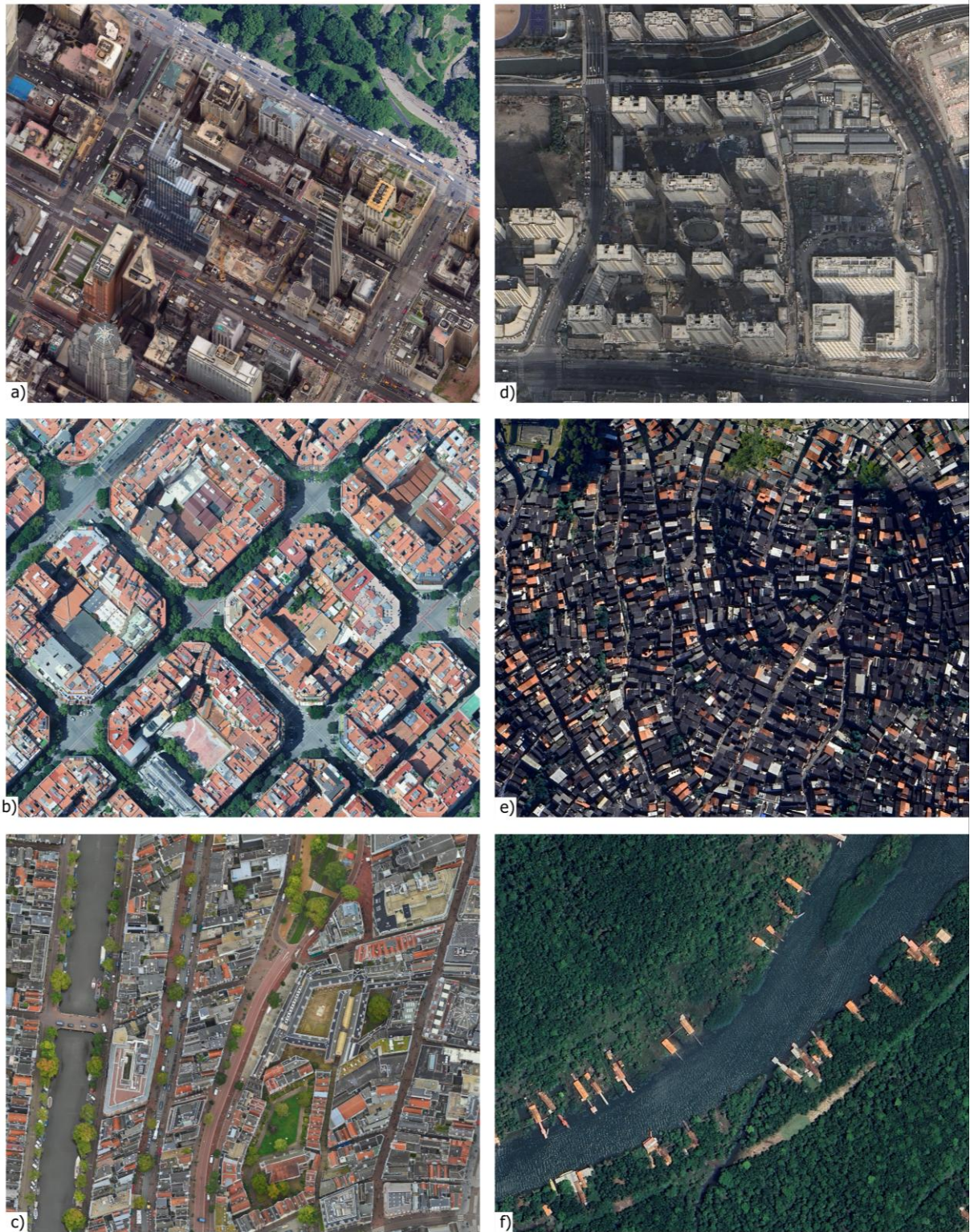


Figure 2 - Examples of formal and non-formal plots – scale 1:5.000. Formal plots: a) New York, US; b) Barcelona, ES; and c) Amsterdam, NL. Non-formal plots: d) Hangzhou, CN; e) Salvador, BR³; and f) Região Tocantina, BR⁴. Source: Google Earth (2025).

³ For information on informal plots, see Spolaor (2023).

⁴ For information on plots in traditional communities, see Pinho *et al.* (2021).

Although the two plots' models present distinct strengths, both express different dimensions of urban life that are intrinsically related to plots configuration (whether *formal* or *non-formal*). The physical (or morphological) dimension refers to the limits of land organization into plots through shape, size, types of occupation, etc. Even if the plot is not strictly delimited in space, it is perceived by the arrangement of activities and the extent of access, without invading the privacy of others. The legal dimension concerns the types and rights of property established by law; the behavioural agreements and social consensus that have the word as a foundation or the rules established by the state. The economic dimension refers to the plot as a product, the land market; but also, as a space for economic activities - whether for the production or exchange of goods (such as commerce, services, industry, agriculture, livestock, etc.). The social dimension encompasses daily practices, identity, belonging, and the mode of appropriation. The institutional and planning dimension refers to the forms and norms of organization, how each plot is organized and distributed in space, the types of activities, the established density of occupation, etc. These dimensions coexist, albeit in different proportions, in the different forms of human settlements and in all types of subdivision.

However, it is also important to recognize that the plot originates with an inherent environmental dimension, as the act of subdividing involves transforming and organizing parts of the natural space for human activities. From its inception, the plot is directly linked to the natural environment, whether through the removal of vegetation and modification of the relief for the site's development, or through adaptation to specific conditions, as occurs in wetlands or on suspended structures such as stilt houses. Thus, the plot's environmental dimension corresponds to a set of interactions between the urban land and natural elements - land, relief, water, vegetation, and climate - conditioning both the form of occupation and the territory's environmental quality and sustainability.

This conceptual ambiguity in the meaning of plots is a crucial problem for urban planning, as it directly affects how territory is understood and, consequently, how it is planned and transformed. After all, *what are plots?* In different contexts, the term plot takes on different meanings: it can be understood as a physical unit of land, an invisible unit that guides social behaviour, a unit of property, a unit of economic value for the development of activities and property transfers, a social unit, a unit of identity and belonging, a piece of natural land, or a technical instrument of territorial planning. However, as seen previously, the plot is not limited to any of these meanings in isolation. From its origins, the plot emerged as a form of behavioural and spatial organization, created to organize the different functions permitted by collective life - inhabiting, producing, moving around, coexisting. Over time, this concept has expanded and incorporated new layers of meaning. Today, it can be stated that plots take on a multifaceted character, constituting a structuring cell of urban life that converges as physical/morphological, legal, economic, social, environmental, and institutional/planning dimensions, revealing the complexity and interdependence of the plot systems in urban space. Although this concept is complex, its understanding is fundamental to urban planning, as the successful performance of decisions made about the city depends directly on how these units are interpreted and managed.

2.1 The multifaceted nature of urban plots

In the field of urban morphology, many authors have discussed the ambiguous nature of plots. In this field, plots are widely recognized as fundamental units in the organization of urban space, integrating land use, property, and built form (Conzen, 1960; Moudon, 1986; Whitehand *et al.*, 2016; Kropf, 2019). In his seminal work in urban morphology, Conzen (1960) defined the plot as a physically delimited piece of land, representing a unit of use and ownership, and developed the concept of the *burgage cycle*, showing how transformations within plots reflect historical processes of intensification. In another crucial work in the field, Caniggia and Maffei (1979) further analysed the role of the plot within the city's typological structure. For them, the plot is the morphogenetic cell of the urban fabric, the starting point for the formation of the block and, subsequently, the urban fabric. The process of plot construction (described by the authors) shows how the relationship between the building and the plot shapes the typological identity of historic Italian cities.

Close to Conzen (1960), Slater (1981) argues that plots are an invisible structure that guide the development and transformation of cities, highlighting them as the smallest morphological units endowed with historical and social significance. Moudon (1986) discussed the plot as a module of the urban fabric, whose shape and boundaries influence the organization of buildings and the spatial configuration of a neighbourhood. In a comprehensive international review of the morphological field in the late 1980s, Merlin *et al.* (1988) described the plot as an element divided into small parts of the ground; the size and how these plots are arranged for the construction of any buildings has a decisive effect on the form which the building in question may assume. For the author, the plot is the starting point for understanding urban growth patterns, considering political, economic and legal decisions.

For Kropf (1997), established in the relationships between the historic-geographical and process typological approaches⁵, the physical plot must be understood as a unit of occupation and control, an area of land over which a person or group has control and access to activities. It is also considered the smallest expression of undivided ownership and decision-making within the urban area (Tarbatt, 2012). Kropf (2018) reinforces that understanding, stating that the plot is fundamentally ambiguous. For the author, the concept of a plot cannot be reduced to a single dimension (whether physical, legal or functional), as the plot simultaneously involves spatial, social, and behavioural relationships. Starting from the distinction between physical form, ownership and control, the author shows that the plot's boundary is, above all, a social and behavioural construction, a collective agreement that defines restrictions and permissions over space. Thus, the plot ceases to be merely a delimited physical unit and comes to be understood as an expression of urban interactions with territory.

On the other hand, Scheer (2018) proposes a conceptual advance by seeking a minimal and universal definition of the plot, highlighting that, beyond its cultural and legal dimensions, it

⁵ The integration between these two approaches was strongly developed in the 1990s. The most visible expression of this integration is the creation of the most important scientific society in the field, the International Seminar on Urban Form in 1994 (Moudon, 1997; Oliveira, 2024).

must be recognized as a physical and measurable datum, existing in any urban context. By decoupling the plot from the categories of ownership, use or behaviour, Scheer argues that its morphological existence, as a piece of land delimited by measurable and locatable vectors, is the starting point for any subsequent analysis.

Bobkova (2019) argues that the plot is a physical entity that takes shape in different types in urban space and is considered a powerful instrument for the process of concentration and diversification of spatial activities and built form. For Tümtürk (2022), plots are structuring units of the urban fabric, whose physical configuration, composition, and boundaries influence the use and adaptation of the city over time. For him, plots are elements that condition the persistence or transformation of the urban form.

Most urban morphology scholars agree that the plot, in addition to being a physical unit of land, also represents a unit of ownership and control, and that plots can significantly influence urban development. Based on Conzen's (1960) studies, which identified the plot as a unit capable of reflecting historical processes of intensification, subdivision, and merger, most morphologists recognize that its physical boundaries embody social, economic, and legal dimensions. This understanding is fundamental to establishing the plot as a multifaceted element of the city. To strengthen this foundation, it is necessary to create space to understand and integrate what other disciplines, directly linked to the plot, say about its nature.

In the field of law, property rights and land laws are fundamental tools for understanding the meaning of a plot. The first formulations on the nature of plots ownership were developed by authors such as Hohfeld (1917), who emphasized that land is not merely a physical good, but a set of different legal relations that regulate the use, control, and transfer of resources. Alchian (1965) and Alchian and Demsetz (1973) linked that forms and types of property can define or identify different forms of competition, discrimination, or behaviour characteristics of society. For these authors, a plot corresponds to two types of rights: the right of use and the right of possession. The classical legal system presents three main types of property (Demsetz, 1967). Private property implies that the community recognizes the right of property to exclude others from exercising their private property rights. State ownership implies that the state can exclude anyone from the right to possess and use a plot of land, provided the state follows specific policies. Communal ownership means that the community denies the state or its citizens the right to interfere with anyone carrying out any activity within those plots. Demsetz emphasized that property rights are an instrument of society and owe their significance to the fact that they help shape each person's expectations of others.

Dale and McLaughlin (1988) defined the plot as the elementary legal unit that integrates cadastre, registration, and land planning systems. For Akbar (1988), the land plot corresponds to a unit of control based on the concept of claim, which is based on the 'plurality of using, possessing, or controlling an object' (Akbar, 1988, p. 19). For Bromley (1991), the right to use a portion of land allows for the exclusion of others. The author argued that the critical characteristic of land ownership is not the relationship between the owner and possession, as assumed in the classical view of property rights, but rather the relationship between an owner and other owners, because property rights allow control over who has access to a given plot. Dixon (1994) argued that land may exist either within the system of registered land - where title

and interests are recorded in the land register - or within the older system of unregistered land, where ownership is proved by title deeds and equitable doctrines. For Kaufmann and Steudler (1998), a plot is understood as a continuous portion of space, where a unique set of rights and restrictions is associated with a titleholder.

Payne (2001) reviewed land tenure types in different countries and specified them as follows: 'zero legality' (homeless), a certain degree of legality (unregulated tenant, tenant in authorized subdivisions, and regularized landowner), and, finally, fully legal (landowner with legal possession and authorized construction, tenant with a lease agreement, and freeholder). This work supports the importance of household tenure security as a legal status for equity and well-being. The author reported that the spatial distribution of tenure types of influences levels of security and the innovative nature of public policies, which are determinants of urban transformation. Needham (2006) noted that land ownership, in most cases, is governed by land law. In some countries, the law governing land rights is a consequence of a general property law (as, for example, in Western Europe), while in other countries, there is a specific law for land ownership (as, for example, in England and the United States). The author argues that property rights clearly provide (or should provide) certainty and stability in relationships between people regarding a given product. In this case, land is the product, and land rights can promote security and stability for an individual and/or a society. Dixon (2009) argued that specific plots of land ownership patterns and that understanding urban land ownership patterns can affect the urban form for new developments. Cole and Wilson (2016) argued that to understand what an urban land plot is, one must understand the types of boundaries that exist. These boundaries are lines that limit and separate property and can be between i. adjacent private land, ii. adjacent public and private land, and iii. adjacent public land. For the authors, boundaries must be permanent, recognizable, and unambiguous. The systematic division of land into plots, for the authors, is essential for the organization of urban space.

In more recent approaches, the land plot in the field of law has evolved from a traditional view, restricted to the land surface and cadastral records, to a more complex legal and spatial entity. Bradshaw and Leonard (2020) introduce the concept of virtual plots, referring to legal boundaries that regulate rights to resources such as land, water, air, or energy. Paasch and Paulsson (2021) propose the idea of a three-dimensional cadastre, noting that plots can encompass subsoil and airspace, with rights, restrictions, and responsibilities. Cozzolino and Moroni (2021) argue for the existence of a spatial dimension of property, which corresponds to the boundaries of urban plots. The authors argue that the distribution of property types in space can influence the growth of cities. In this study, property types were classified as: simple ownership (a single owner); hybrid ownership (typical ownership of condominiums, homeowners' associations, and co-housing units); and collective ownership (a group of individuals sharing responsibility for present and future uses). Orr *et al.* (2022) studied the weakening of the physical property structure in cities, arguing that this has led to a movement toward fragmentation between plots and property, due, for example, to financial institutions linking land ownership to real estate funds. Çağdaş *et al.* (2023) developed important work by analysing how different civil law jurisdictions define and determine plot boundaries. This work highlights the heterogeneity in the determination and recognition of property boundaries across countries.

Although an extremely challenging task, the attempt to internationally standardize the concepts of property and land plots was consolidated with the creation of ISO 19152:2012 – *Land Administration Domain Model (LADM)*, which establishes a common conceptual model for representing information about plots, rights, and spatial boundaries. The standard defines a plot as a continuous physical or virtual space associated with a specific set of rights, restrictions, and responsibilities, which may include subsoil and airspace. This standard understands property as a system of legal and social relationships between individuals and plots, with rules governing rights, restrictions, and responsibilities.

In general, legal scholars, along with urban morphology academics, agree that the plot expresses the embodiment of property rights (although with specific laws and rules that restrict them in each country), serving as a basis for the control, use, and transfer of land, and serving as a link between the individual, the state, and urban space. Beyond a piece of land with physical boundaries, the plot consolidates itself as an invisible space (associated with visible space) of legal security and social and economic stability.

In economics, land plots are a product of the land market and a recipient of economic activity. Classical economists, such as Adam Smith (1776), identified land as one of the three essential factors of production, alongside labour and capital, and defined ground rent as the compensation received by the landowner for the productive use of a limited resource. David Ricardo (1817) deepened the understanding of the economic character of land plots by formulating the theory of differential rent, according to which land value is influenced by location and productivity. Marx (1887) differentiated between absolute rent⁶ and differential rent⁷, arguing that private land ownership is a central instrument in capital accumulation and the reproduction of urban inequalities.

Shortly thereafter, George (1879) proposed an alternative interpretation of the ground rent problem, arguing that the value of land plots is primarily due to collective activity and urban growth, not just the individual effort of the landowner. In his theory of the single land value tax, George argued that ground rent should be captured by the state, since the increase in land value is a social product. This idea contributed to fiscal policies and debates about distributive justice in modern cities.

In the following decades, urban economics began to analyse in detail the relationship between location, value, and land use. Alonso (1964), well-known for his theory of the monocentric model of the city, demonstrated that the price of urban land decreases as distance from the city centre increases, influencing the distribution of economic activities within the city. This theory was later developed by Muth (1969) and Mills (1979), who incorporated variations such as density, transportation, and residential preferences. Fujita, in 1989, modified the notion of

⁶ Absolute rent arises from the monopoly of private ownership of land, which prevents the rate of profit in agriculture from levelling to the general level and allows the landowner to demand a share of social surplus value as a tribute (Marx, *Capital*, Book III, chapter 45).

⁷ Differential rent arises from differences in natural fertility or location between plots of land, or from supplementary capital investments that increase productivity (Marx, *Capital*, Book III, chapters 37-40).

agglomeration economies, explaining how the concentration of economic activities increases the value of more accessible and centrally located land.

For Harvey (1985), a plot can be a rental unit, subject to daily payment from a user to the owner, or a unit of land used by the owner. A plot is a real property in the urban space, a particular type of asset characterized by land and/or resources incorporated into the land. This element is a product of the real estate market for the exchange of properties between different owners and tenants and receives a set of property rights established by exchange agreements. In the case of purchase and sale, the conditional rules on property rights are more flexible, as buyers retain the right to the plot (except for zoning restrictions and parameters established by urban policies). On the other hand, when property rights are transferred to a tenant by assigning the right of possession, the restrictions on these rights are established by a series of authorizations defined in a contract between the parties. The location of the plot is a condition of real property and places its owner in a position of economic advantage and, possibly, a monopoly (Harvey, 1996).

The plot is also a product of the informal land market. The ease of unrestricted negotiations allows for a diverse range of actors involved in land sales, impacting the social and spatial structures of the city (Fernandes, 2011; Smit, 2021; Luteranya *et al.*, 2023). This occurs because prices in informal markets tend to be considerably lower than those of equivalent formal properties (Smolka, 2003; Mottelson, 2020). Urban land and plots are considered commodities, used as a resource for economic exchange through the use or as a means of production of these spaces. The existence of the plot is a condition for any capitalist activity and a source of capital accumulation through land rent (Harvey, 1985; Jäger, 2003), with accessibility and the rapid growth of cities determining the value of the plot. In high-growth cities, land values and plot rents can easily increase (Capozza and Helsley, 1987).

O'Sullivan (1996) stated that a plot is an element of economic value aggregation conditioned by its accessibility to other activities. The median location of a plot between points of interest has the minimum travel cost and the maximum rental cost; it also serves as a unit for tax purposes through urban land taxes, under different rules according to different political contexts. The plot promotes the generation of positive and/or negative externalities; plots in urban centres are predominantly recipients of economic activities and job creation. For Webster and Lai (2003) cities present individuals with a map of 'agglomeration of economies', with different transaction cost opportunities. One of the reasons for the formation of plots next to each other (forming a series of plots and, on a large scale, the plot systems) is transaction costs⁸. Different ways of structuring land property rights result in different transportation costs, which impact planning decisions and what will or will not be implemented in each location (Webster and Lai, 2003; Needham, 2006). This perspective, inspired by Coase (1960) and North (1990), shows that different ways of defining and protecting land rights produce levels of efficiency in individual markets.

⁸ Transaction cost - generally divided into information costs, trading costs, and execution costs (Needham, 2006).

Economists have recognized the plot as a fundamental unit of articulation between land and the dynamics of production, circulation, and capital accumulation. Since the classical era, land plots have been understood as scarce assets, valued for their location, productivity, and ability to generate land rent. However, this value is not established solely by physical or economic conditions, but also by social factors, since the occupation, use, and valuation of the plot are deeply linked to daily practices, community networks, and the power relations structured within the territory.

In the field of sociology, the social dimension of space is understood as the result of human interactions, power structures, and the forms of organization that shape the city. From the nineteenth century onwards, several authors sought to understand how the social structure materialized in physical space and how space, in turn, conditioned social relations. Durkheim (1893) analysed how the division of labour structured the cohesion of traditional societies, distinguishing between mechanical and organic solidarity. Mechanical solidarity was characterized by traditional societies, in which cohesion derived from the similarity between individuals, without members of society having similar functions and little differentiation between social roles. Organic solidarity was typical of modern societies, in which social cohesion depended on the functional interdependence between individuals and groups, each performing distinct functions within society. Although Durkheim did not directly address urban space and plots, his ideas provided an interpretative basis for understanding how the specialization of human activities could be reflected in the functional differentiation of urban spaces.

Simmel (1903) analysed the then modern urban life, showing how the city directly influences social experience. He argued that population density and the fast pace of metropolises shape individual behaviours, sociability styles, and forms of interaction between people. The Chicago School, in the 1920s and 1930s, brought a systematic approach to the relationship between society and space. Park (1925), Burgess (1925) and Wirth (1938) analysed the city as a social ecosystem, in which different groups compete, adapt, and distribute themselves spatially according to their economic and cultural conditions. For this group, cities could be understood as concentric zones, reflecting economic status and social power. Castells (1972) expanded the approach to the social role in space from a critical perspective, emphasizing that the city is the product of relations of production and power. For the author, urban space is not just a reflection of society, but a space with economic and political structures that determine who has access to certain resources and how they are protected.

Lefebvre (1974) developed the idea that urban space is socially produced, the result of social practices, political decisions, and power relations. For him, the form of the city embodies social inequalities, but it is also vivid, experienced, and transformed by its inhabitants. He proposed a spatial triad composed of three interrelated dimensions: conceived space, which corresponds to the representations of space by planners, architects, and authorities; perceived space, which manifests itself in physical forms, land organization, and observable practices; and vivid space, which is the everyday experience of individuals, their practices, meanings, and interpretations of the urban environment. Qadeer (1981) explicitly addressed the role of the urban plot as a unit of social and economic analysis. He argued that the use of one plot influences the usability of other nearby plots, making urban land a community resource. For Qadeer, the system of

ownership and use of plots is supported by the social structure, highlighting how the organization of urban space is intrinsically linked to social relations.

Bourdieu (1986) linked the appropriation of urban space to the accumulation of different forms of capital. Economic capital refers to financial and material resources; social capital refers to networks of relationships and social bonds that provide access to opportunities; cultural capital, linked to knowledge, education, and socially valued skills; and symbolic capital, which involves prestige, recognition, and social legitimacy. For Bourdieu, the use and possession of space reflect these different forms of capital, shaping social positions, status, and power. Based on these ideas, Marcus (2007) developed the concept of spatial capital, integrating Bourdieu's perspective into the analysis of urban space. For Marcus, spatial capital refers to an urban area's capacity to generate accessibility, social diversity, and opportunities for interaction. He argued that urban form and the configuration of plots directly influence social life, facilitating or restricting mobility, access to resources, and interaction between different groups. In his later work, Marcus (2025) further expands this concept by framing the built environment itself as a form of capital capable of reinforcing or amplifying other forms of capital, particularly social and economic, through the spatial organisation of land and urban form.

This brief analysis of the social dimension allows to verify that the condition of urban space is a crucial factor in sociological research. From this perspective, it is possible to infer, although not explicitly stated by most authors, that the social structure of space is manifested by the formal and informal structure of the subdivision system, as a materialized mechanism of social relations. Each plot, in addition to organizing urban land, creates conditions for interactions, power networks, appropriations, and social inequalities. It is important to emphasize that all these dynamics occur on land, which, although often overlooked, constitutes a natural space of the environment. Each plot of land corresponds to a portion that is often designated for construction, depriving much of its environmental quality. The larger the area occupied by urban construction plots, the smaller the amount of permeable and green land. If care is not taken in the way urban lots are occupied, environmental quality within the urban territory tends to deteriorate.

In the environmental field, urban land is considered a scarce resource that plays a crucial role in the sustainability of cities. In his central work, Geddes (1915) presented the city as an organism that must be understood in interaction with its natural environment. He discussed the importance of topography, land, drainage, and vegetation as factors that determine urban occupation, and argued that planning must consider these natural characteristics for a city to function. McHarg (1969) argued that a detailed analysis of land, planning, reduction, and land demand should guide decisions on urban occupation, infrastructure, and zoning, so that cities can minimize environmental impacts, prevent natural disasters, and promote greater resilience. Sporn (1984) reinforces the importance of considering urban land and its transformations as part of an ecological system. Sporn highlighted that land impermeability and the lack of integration between the built environment and natural processes exacerbate problems such as flooding, pollution, and heat islands. Forman (1995) integrated landscape ecology into urban studies, arguing that the pattern of occupation, including the process of spatial fragmentation, directly influences ecological connectivity and the flows of energy, water and species in the urban environment.

Benedict and McMahon (2006) highlighted the importance of green infrastructure as a network of urban ecological connectivity, arguing that land subdivision and use should integrate permeable soils and ecological corridors. Alberti (2008) developed the concept of urban ecosystems as hybrid systems resulting from the interaction between human and natural processes. The author demonstrates that urban land use and configuration, expressed in patterns of density, fragmentation, impermeability, and connectivity, determine the ecological performance of cities. Salvati and Carlucci (2016) analysed the relationship between land consumption and impermeability in Mediterranean cities, showing that increased urban occupation and paving reduce environmental quality and compromise the capacity for ecological regeneration. Salvati *et al.* (2016) discussed land use efficiency, relating urban density, landscape conservation, and sustainable land use.

Marcus *et al.* (2019) integrated landscape ecology with urban morphology, proposing that form elements, such as plots, buildings, and streets, can be applied analogously to the ecological components of the landscape. The authors demonstrated that the spatial configuration of plots directly influences environmental flows, such as drainage, ventilation, and thermal regulation, playing a structural role in urban sustainability. Hu *et al.* (2021) analysed urban land use efficiency, demonstrating that the form and intensity of spatial occupation directly influence the sustainability of cities. The authors emphasize that inefficient land use, characterized by the expansion and waste of urban areas, compromises ecological efficiency and increases pressure on natural resources. Oliveira (2024, 2025) argues that the density of plots (together with other urban form elements) favours socioeconomic diversity and environmental sustainability. Zhao *et al.* (2023) examined how urban expansion and the replacement of natural surfaces with impervious ones have exacerbated the heat island effect. The study warns that increased imperviousness contributes to higher temperatures.

Discussions about the environmental role of plots converge on understanding land as a structuring element for the sustainability of cities. The way this resource is subdivided, occupied, and modified determines the efficiency of the urban environment, influencing processes such as water infiltration, thermal regulation, ventilation, and biodiversity maintenance. In this context, the urban plots act as a basic unit where the relationships between the natural and built environments are expressed. Each plot functions as an ecological micro territory, whose configuration (in terms of permeability, vegetation, and type of occupation) can mitigate or intensify environmental impacts.

In addition to morphological, legal, economic, social, and environmental dimensions, urban space is also a product of the institutional and planning systems that guide land development. This dimension translates into a set of norms, instruments, and public policies that define permitted land use, occupancy levels, construction parameters, and development guidelines for each plot, and these vary according to each context and urban development objective.

In institutional and planning terms, plots are fundamental elements conditioned by zoning maps and regulations. The shape and behaviour of plots are largely direct results of institutional and political decisions. Urban plans have a considerable impact on urban form, especially because legislation, land use and occupation rules are gradually introduced under different political administrations.

In the first half of the twentieth century, authors such as Geddes (1915) (already mentioned) and Mumford (1938) recognized that the plot system was an expression of the social and economic relations that shape urban territory. Geddes saw parcelling as part of an evolutionary and ecological process of spatial organization, while Mumford understood it as a material synthesis of the productive dynamics and social values of each historical period. With the advancement of modern urbanism, Le Corbusier (1933) and the *Congrès Internationaux d'Architecture Moderne (CIAM)* proposed an extreme rationalization of urban space, in which the plot began to be treated as a technical and functional unit.

In clear opposition, Jane Jacobs (1961) and Kevin Lynch (1964) highlighted the importance of human scale and morphological diversity. For Jacobs, small plots and mixed uses promote economic and social vitality, while large plots and rigid zoning generate monotony and segregation. Alexander (1977) complemented this view by stating that the urban environment is organized into systems of interdependent units, from plots to neighbourhoods, configuring a living and adaptable structure.

In the 1970s and 1980s, planning theory evolved to consider territorial regulation, including control over plots, as an institutional and political process. Davidoff (1965) argued that planning should be advocacy planning, representing multiple and minority interests, rather than applying neutral technocratic rules. Faludi (1973) conceived planning as a rational-comprehensive process, in which the definition of planning rules is part of the attempt to predict and control land use. However, Booth (1989) argued that the urban zoning system does not eliminate uncertainty about the city's future and can even become a political instrument of control and exclusion.

Healey (2007) changed the notion of collaborative planning and relational governance, showing that the configuration and transformation of plots are the result of negotiations between the state, the market, and civil society. In this study, parcelling rules are not only technical but also social and discursive, expressing agreements and disputes over land appropriation. Fainstein (2014) and Friedmann (1987) reinforced this approach, arguing that urban planning must incorporate criteria of justice and equity. Fainstein argues that decisions on land subdivision and zoning should promote a just city, where land is accessible and equitably distributed. Friedmann, in turn, highlights planning as a practice of democratizing decisions about territory.

More recently, studies focusing on urban form and the New Urbanism movement (Calthorpe, 1993) have reinforced the importance of morphological structure, composed of public spaces, street blocks and plots as the basis of urban form and life. Talen (2018) expanded on this discussion, showing that the size, connectivity, and morphology of plots directly influence the environmental and social quality of urban space, potentially fostering urban diversity and vitality. On the other hand, Vaughan (2005), Mehaffy (2015), and Netto (2022) found that the same zoning and subdivision rules can reinforce patterns of segregation, reproducing historical inequalities in access to land and urban infrastructure. In this sense, the design and regulation of urban plots should be understood as instruments of social, not just spatial, structuring.

Operationally, each urban zone establishes a set of restrictions - minimum and maximum plot sizes, occupancy rates, land use ratios, and other aspects - which are applied according to the strategies of landowners, investors, and/or public officials. These specific actions generate

urban dynamics that can either stimulate or restrict sustainability and territorial equity. Recent studies reinforce the political nature of land decisions. Lin *et al.* (2022) revealed that the manipulation of plot ratios is often used to serve private interests, with direct implications for social heritage and the right to the city. Vicuña and Rivas (2022) observed that policies of plot division and amalgamation shape urban transformations, potentially favouring certain social groups and accelerating unequal verticalization. In contrast, AlSadaty (2022) argued that more restrictive rules in historic heritage areas can preserve the original character and morphology, functioning as an instrument of cultural resistance to urban homogenization.

Planning also recognizes that plots are not merely cadastral or geometric units. Plots constitute political instruments for spatial organization, where public and private interests intersect, with different objectives, such as the pursuit of principles of spatial justice or land accumulation strategies.

Throughout the evolution of thought, it has been possible to observe that plots included within the different dimensions of urban life associated with plots (morphological, legal, economic, social, environmental, and institutional/planning) possess a set of key determining characteristics: transformation, location, occupation, control, and function. Transformation, for example, manifests itself in the morphological dimension when discussing the processes of plot reconfiguration (division or amalgamation), expressing the constant adaptation of urban form to market dynamics and public policies. Simultaneously, this transformation assumes relevance in the economic dimension, reflecting rising land values, land rent, and the mechanisms of capital accumulation linked to urban land. In the legal dimension, it materializes in property transfers and changes in land use that redefine the legal and functional status of the plot. In this sense, transformation refers to the physical, specific and legal changes that occur on the plot over time, observed through the union or division of the plot, reflecting the urban dynamics and the new demands of the city and its inhabitants.

Location, for example, appears as a determining factor in morphological and economic dimensions, influencing accessibility, integration with urban infrastructure, proximity to services, and functional centrality. It reflects the strategic role that plots play within the urban system, determining land use and land value, as well as the different development opportunities that exist depending on each plot's position within each urban system. Location refers to the plot's position within the urban system, also considering its proximity to amenities, infrastructure, and economic activities, which influences the value, integration, and connectivity potential of each plot.

Occupation is related to the different forms of occupation and the intensity of construction (density). This characteristic materializes in the built forms, volumetric relations, and dynamics of space use, directly influencing urban vitality and the quality of the built environment. The level of occupation of a plot directly impacts the dimension of its economy. This is reflected in the value attributed to the built environment of each plot and, in cases of buildings with many economic activities associated with a plot, or in cases of many rentals associated with a plot, increases the intensity of this dimension. Furthermore, occupation is highly related to the institutional/planning dimension. Planning rules regulate the intensity and form of occupation of each plot in each area of the city. In this sense, occupation refers to the way land is used and

built, considering the intensity and distribution of uses in terms of density, occupancy rate, and year of construction of buildings.

Control is reflected in institutional and legal dimensions, encompassing legal aspects of property, tenure rights, and land management mechanisms. This characteristic defines the degree of autonomy, intervention, and transformation possible on each plot, while also revealing the power, negotiation, and governance relationships between the State, the market, and civil society in territorial regulation. This characteristic refers to the extent of the area under a landowner's legal control, which defines the level of intervention power, autonomy, and decision-making capacity over the plot. In plots with considerably large areas, the level of power is greater and concentrated in a single agent, while in smaller plots, a single agent more easily facilitates appropriate interventions.

Finally, the plot's functional characteristic is expressed primarily in both the social and economic dimensions, by developing the role played by each plot in the urban fabric, determining the diversity of uses, local dynamics, and urban vitality. This characteristic refers to the set of uses attributed to the plot, which may be economic, national, institutional, service-related, etc., determining the functional role and diversity of occupations that structure urban life.

From these reflections, it becomes clear that the urban plot is an entity that represents different dimensions and characteristics of urban life, whose complexity goes beyond its organizational definition. This observation resonates with Kropf's (1997) questions, in which he problematizes the meaning of the plot, noting that, in urban morphology, there is no consensus on what it truly represents - whether it is a morphological unit, a unit of property, or an element of spatial organization. For the author, this ambiguity is revealed: the plot is at once an object and a relationship, a physical structure and a social construction, and it is precisely this dual nature that gives it centrality in the understanding of urban form. Convergingly, Scheer (2018) reinforces that plots are the persistent foundation of urban structure, positioned as a meeting point between built form, legal control, and social practices of land use and appropriation. These authors' questions, along with this theoretical construction on the meaning of plots, demonstrate that conceptual uncertainty is not a weakness, but an essential aspect of the plot's very nature, an element situated between tangible space and intangible structures. Thus, considering the findings developed in this work, it becomes possible to affirm that the plot should be understood as an intrinsically multifaceted entity, a fundamental unit of the city's structure that converges as the main dimensions of urban life and its inherent characteristics. Each plot structures and influences urban development, thus constituting a formal or informal basis for how the city is produced, transformed, and lived.

In this research, the term adopted to designate this spatial reference unit is the *plot*. Based on the reflection on the meaning of term, and although there are some unclear differences in the various terminologies, the term *plot* will be understood as a unit of territorial organization, a piece of urban land, of any size, that serves as the basis for the structuring and development of the city. The *plot*, in this research, is understood here as a multifaceted entity, simultaneously integrating the physical/morphological, legal, economic, social, environmental, and institutional/planning dimensions, and the characteristics of transformation, location,

occupation, control, and function. A *plot* is an area with boundaries that support urban buildings, a property boundary, an element of composition and organization of the urban fabric, and a concrete expression of the historical and regulatory processes that shape urban space. The plot, in addition to its spatial organization component, also constitutes an operational and analytical component that allows for the understanding of urban development patterns and processes (Figure 3).

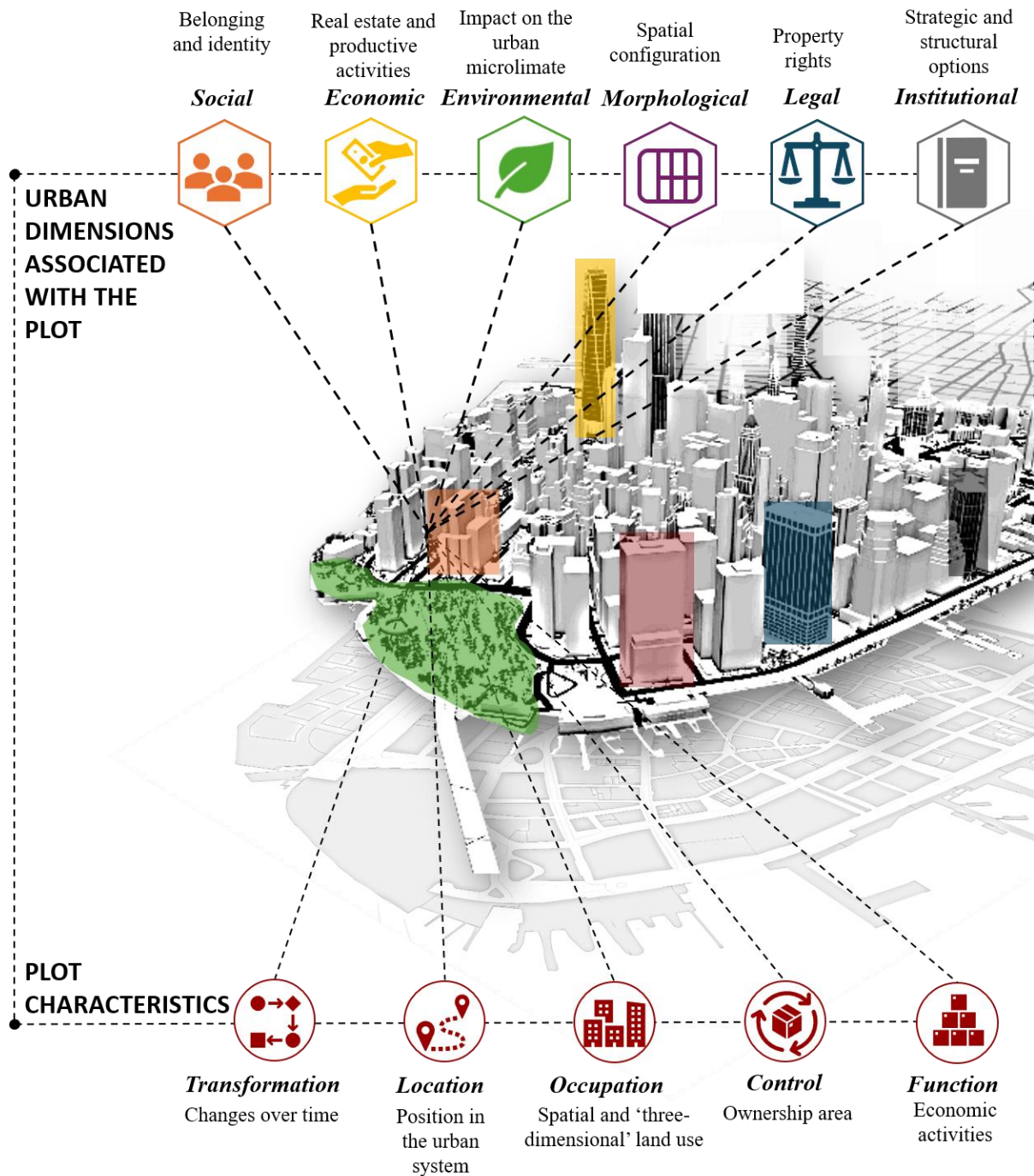


Figure 3 – Multifaceted nature of the plot system

2.2 Plots terminology

Considering terminology, the term *plot* does not have a single, universal meaning; it can also be called a parcel, lot, land subdivision, subdivision, etc. (see appendix 1). Although there was an attempt to standardize the term *parcel* through the ISO 19152 (LADM) standard, the term varies according to the disciplinary field, legal system, and technical tradition of each country. In some countries and regulatory systems, the term *plot* is understood primarily as a cadastral and legal unit, linked to property rights and legal restrictions, while in others it assumes a morphological and functional connotation, related to urban form and land use dynamics (Dale and McLaughlin, 1988; Kropf, 1997; Kaufmann and Steudler, 1998; Scheer, 2015).

In the United States, the most used term is *lot*. In the New York state and city (the focus of Chapter 6), the term *parcel* refers to a parcel of land that can be subdivided into *lots* for sale, transfer, or development. In Texas, the Local Government Code (n.232.001) establishes that any landowner wishing to subdivide a portion of land located outside the urban limits must prepare a *plat* (a formal subdivision map or plan) for approval by the local authority. The law establishes this requirement when a piece of land is divided into one or more parts for the purpose of creating *lots* intended for sale, transfer of ownership, or real estate development. In California *parcel* is a legal and cadastral term that designates any unit of land registered or identified by a cadastral number. *Lot* is the most common term in urban planning and development, referring to a legally recognized and buildable unit of land delimited on an approved map. In Canada, the province of Alberta designates the term *lot* as specific units within a larger parcel. In the province of Quebec, the term *parcel* refers to a registered unit of land, and the term *lot* refers to a specific subdivision within that unit. In Brazil, for example, the Federal Law n. 6.766/1979 distinguishes the division of land between the term *gleba* (a parcel of land not subdivided for urban development purposes, without the approved subdivision process), and the term *lote* (a parcel of land resulting from the urban subdivision process, served by minimal occasional infrastructure).

In Europe, the term varies significantly depending on the language. In Portugal, the terms *parcela* and *lote* differ somewhat. A *lote* is understood as the smallest unit designated for use within approved subdivisions, while the term *parcela* can refer to larger portions or units with different legal use statuses. In France, the term used is *parcelle cadastrale*, meaning a minimum unit of land registration, defined by the *Code Général de la Propriété des Personnes Publiques*. The term means a legal and fiscal unit, essential for tax administration and urban planning. In Germany, two terms are used to describe plots. *Flurstück* is a geometric unit representing a plot of land with defined boundaries, and *Grundstück* is a legal unit of ownership, which may consist of one or more *Flurstück*. In the United Kingdom, a *parcel land* is a unit registered in Her Majesty's Land Registry, used for legal and tax purposes. A *plot* is a morphological building unit, often used in urban planning to designate an area designated for a building or development. In Spain, a *parcela* is a unit of land registered in the land registry, used for tax and legal purposes. The *parcela* is the smallest buildable unit, generally associated with urban areas and designated for construction. In the Netherlands, a plot is called a *kadasterperceel*, a unit of land

registered in the land registry, with defined boundaries and identified by a unique number. In Switzerland the term changes to *parzelle*, with the same meaning as in the Netherlands.

In South Africa, a plot is known as a *lot*, *plot*, *land*, or *erf*. Erf is the legal term for any piece of land registered as a lot, plot, or stand in a deed's registry. The term is used to describe the parcel in deeds and title records. In Kenya, the Ministry of Lands uses the term *parcel* as a technical term. For them, a *parcel* refers to a separate area of land delineated on the cadastral map and regulates the *parcels plans* and subdivisions.

In Morocco, the department responsible for cadastre, titling, and cartography (*Agence Nationale de la Conservation Foncière, du Cadastre et de la Cartographie*) manages the cadastral plan and the parcel registry. The cadastral unit is shown on the *parcelle cadastrale* map, and the official term used is *parcelle*.

In Australia, the most used terms are *lot* and land *parcel*. In Australian cadastral systems, a *lot* or *land parcel* is a legal geometric unit represented on a survey plan and linked to destination records. The cadastral record contains the boundaries, the parcel identifier, and legal data. In New Zealand, the basic unit of land is the *lot*, a term used in survey plans planned and registered with LINZ (*Land Information New Zealand*). Each *lot* represents a legally delimited parcel of land, an area with regionally defined boundaries and an approved unit of land registration.

In general, an analysis of the terminology related to land division shows that there is no universal consensus on the meaning and use of the different terms associated with plot, the most commonly used being *parcel*, *lot*, and *plot*, and that variations are determined by the legal, cadastral, and technical systems of each country. While *parcel* tends to designate a cadastral and legal unit in land records, larger in area and linked to property rights and legal restrictions, *lot* is more common in urban regulation contexts, representing a unit resulting from formal land subdivision processes, intended for construction or urban development. The term *plot*, although less frequently used in legal instruments, plays a central role in morphological and urban approaches, as it is described as the physical and functional cell of the urban structure, the portion of land designated for building purposes.



3 THE MAIN DIMENSIONS OF URBAN PLOTS

3 The main dimensions of urban plots

Understanding *what urban plots are* requires a reading that goes beyond their physical boundaries and recognizes within them a set of dimensions that structure urban life, as argued in the previous chapter. More than just land units, plots constitute basic structures for territorial organization and, therefore, reveal the articulation between daily practices, economic relations, built forms, and institutional regimes, for example. This chapter deepens the analysis of these main dimensions of urban life contained in plots, identifying their attributes, presenting research methods, and theoretical and empirical references that show how different fields of knowledge approach the plot as a structuring element of the city.

This chapter is divided into six subsections corresponding to each main dimension of urban life associated with the plot, as identified in the previous chapter. The first subsection develops an understanding of the social dimension of plots and the existing methods of analysis, discussing how daily practices, bonds of identity and belonging, and neighbourhood relations can materialize in the space of each plot. The second subsection develops the economic dimension, aiming to understand the different types and forms of appropriation of the plot for the generation of economies. In this dimension, the plot is understood as a market asset and as a basis for the exchange and production of commercial, industrial, agricultural, or service activities.

The third subsection develops the environmental character of land plots, identifying the different types and forms of land appropriation that consider environmental quality at this scale, in pursuit of environmental improvements for the entire city. The fourth subsection addresses the morphological dimension of land plots, analysing the shapes, sizes, geometries, and occupation patterns that make up the territorial structure of cities. The fifth subsection develops the legal dimension, understood as the set of norms, rights, and instruments that regulate ownership, possession, usufruct, and property transfers. Finally, the sixth subsection develops the institutional/planning dimension, addressing the policies, norms, and instruments that guide territorial organization and define the role of land plots in the urban structure. In cooperation, these six dimensions broaden the understanding of the meaning of land plots as a system integrated with the main dimensions that make urban life happen.

3.1 Social dimension

“The question of what kind of city we want cannot be divorced from that of what kind of social ties, relationship to nature, lifestyles, technologies and aesthetic values we desire. The right to the city is far more than the individual liberty to access urban resources: it is a right to change ourselves by changing the city.” (Harvey, 2008).

Understanding urban space as a socially produced phenomenon provides the basis for analysing the importance of urban plots in the organization of contemporary cities. As mentioned in the last chapter, from Durkheim (1893), Simmel (1903), and the scholars of the Chicago School, to Lefebvre (1974) and Bourdieu (1986), sociological literature shows that space is not neutral: it reflects power structures, social relations, and forms of appropriation, and directly influences behaviours, interactions, and social cohesion. In this context, urban plots are not limited to physical units of land - they constitute a decisive element in the materialization of social relations, in the promotion of social mix, and in the expression of socio-spatial inequalities, just to mention a few examples. By organizing land use, determining density, access, and urban functions, each plot interferes with opportunities for interaction between individuals and groups, in the perception of belonging, in the distribution of social capital, and in equity in access to urban resources.

The social structure of a city is an essential element for maintaining land tenure systems and for the balanced functioning of settlements, directly influencing the well-being of residents (Castells, 1972; Qadeer, 1981). A sustainable urban society depends on conditions that ensure decent housing, local access to activities, services and infrastructure, and a balanced population density (Jacobs, 1961). Plots play a central role in this process, as they house the fundamental functions of urban life. The social characteristics associated with the distribution of activities on plots are directly related to fundamental issues for the quality of a society, for example, local identity (Tarbatt, 2012), social mix and socio-spatial justice (Soja, 2013).

Local identity refers to the affective and symbolic bond between citizens and the space they inhabit. It is constructed through experience and collective memory, through the perception of similarities and differences that unite a group of individuals to their place (Shao *et al.*, 2017). Shared spaces contribute to the formation of community self-identity, while the built environment constitutes both the raw material and the product of social practices that shape a cultural landscape over time. Culture, architecture, historical events, and local traditions are fundamental elements in the consolidation of the identity (Erickson and Roberts, 1997; Kavaratzis and Ashworth, 2010). In this sense, the plot and the neighbourhood play a decisive role in this process, strengthening the sense of belonging, especially when residents are long-time owners and associate personal experiences, such as births and family ties (Chen and Romice, 2009). Thus, the way plots are organized, as well as the quality of the surrounding

environment, directly influences the creation of cohesive, stable, and vibrant communities (Tarbatt, 2012).

Furthermore, recent studies in urban geography and planning suggest that the shape, size, and density of plots, as well as the quality of the surrounding environment, directly influence social cohesion and the perception of local identity (Gehl, 2013). Environments that offer functional connectivity, diversity of uses, and proximity between residences and services tend to favour regular social interactions, strengthening the community experience and promoting more stable and vibrant neighbourhoods (Marcus, 2007). Local identity is not only a symbolic construct but also a product of the physical organization of urban space.

Social mixing is understood as the coexistence of groups with different nationalities, races, colours, and socioeconomic backgrounds in the same neighbourhood of locality, sharing nearby spaces and interacting socially. This concept goes beyond simple cohabitation, involving the construction of social bonds, cultural exchange, and the valuing of diversity as central elements for community cohesion. Several studies demonstrate that socially mixed neighbourhoods tend to exhibit less segregation, greater civic participation, more opportunities for informal learning, and greater social resilience in the face of urban and economic transformations (Bailey *et al.*, 2015; Bican, 2023).

Literature emphasizes that social mixing should be incorporated within urban planning and design, especially in the organization of how public and private spaces are distributed. According to Arthurson (2012), promoting social mixing, particularly through housing ownership, contributes to improving the reputation and vitality of historically disadvantaged neighbourhoods. Lawton (2012) expands on this perspective by proposing that social mixing be incorporated from the urban design process, with guidelines that avoid isolating social groups. This approach is based on theories of social capital (Bourdieu, 1986) and neighbourhood effects (Musterd, 2005; Blokland and Savage, 2016), advocating social mixing as an effective strategy to mitigate urban segregation. Lawton (2012) strongly highlighted that social space constitutes both an implicit and explicit aspect of urban design. In other words, urban design must recognize the relationship between the built environment, especially the way in which plots and social structures are designed, and the structures themselves, incorporating mechanisms from their conception that promote diversity and integration.

Social-spatial justice, in turn, involves principles of democracy, diversity, and equity (Fainstein, 2014), which should guide urban planning practice. Democracy refers to the effective participation of citizens in decision-making processes, ensuring that multiple voices and experiences influence the production of urban space. Diversity highlights the value of recognizing social, cultural, and economic differences, advocating for inclusive cities that embrace different ways of life and avoid spatial homogenization. Equity implies the pursuit of a fair distribution of urban resources and opportunities, requiring the regulation of market processes and public policies that perpetuate territorial inequalities.

Soja (2013) proposes a spatial theory of justice by recognizing that social injustices are intrinsically linked to the spatial organization of cities. The author starts with the notion of unequal geographical development, a concept that highlights how urban space is continuously produced and reproduced by economic and political forces that distribute resources,

opportunities, and rights of access to the territory asymmetrically. For Soja, the omnipresence of geographically unequal development reveals that social inequality is not only a historical or economic product, but is also spatial structured, manifesting itself in the way the territory is divided, planned, and appropriated.

According to Vejchodská *et al.* (2022), land policy is one of the most effective ways for the State to promote socio-spatial justice by intervening in land markets to mitigate environmental, social, and economic problems. Even when not explicitly formulated for this purpose, land use and management policies can incorporate actions aimed at environmental protection, control of urban sprawl, provision of affordable housing and public infrastructure, as well as preventing processes of exclusion and vulnerability in low-income neighbourhoods. The authors also emphasize that the success of land policies depends on the legal and institutional contexts in which they are applied, since different property regimes and legal traditions determine the degree of freedom for State intervention in land markets. This institutional dimension is essential to understanding the real possibilities of promoting spatial justice. Table 1 presents a synthesis of research in the field of urban sociology and planning, in which land plots are directly or indirectly part of the social analysis of urban space. These works address different urban social aspects, such as residential renewal, social cohesion, social mixing, housing displacement, gentrification, and the perception of socio-spatial justice, highlighting how the form, use, and organization of plots can influence social relations, such as local identity and the equitable distribution of resources. Thus, these presented works offer a general perspective on research that demonstrates the relevance of land organization as an element for analysing and understanding the processes of inclusion, diversity, and social justice in cities.

Table 1 - Research about social issues and urban plots

Source	Theme	Synthesis of study	Synthesis of results
Helms (2003)	House renovation and social dynamics from plot to plot.	A plot-level database documenting all residential renovation work in Chicago between 1995 and 2000; statistics on the determinants of residential renovation by plot.	Renovation focuses on plots in better locations and is associated with local market characteristics; changes in plots precede socioeconomic changes in the neighbourhood.
Rutan and Desmond (2022)	Concentration of eviction.	Geocoded plot-level eviction data for the study cities; spatial and statistical analysis of eviction patterns.	Eviction processes are highly associated with specific landowners. The study demonstrates the impact of institutional investments on land ownership.
Loukaitou-Sideris <i>et al.</i> (2019)	Empirical methods for studying gentrification.	It describes mapping protocols and visits to all plots with new constructions and renovations between 2008 and 2013.	It recommends combining plot registration data and administrative data to identify local physical and social changes; it demonstrates the effectiveness of plot scale in detecting micro-level gentrification processes.
Ramiller (2022)	Displacements linked to property turnover prior to rehabilitation.	Use of plot-level records to verify whether evictions occur before redevelopment in each specific plot.	There is evidence that evictions frequently precede the redevelopment of the plot.
Cramer-Greenbaum (2023)	Measures of physical and psychological displacement using urban plot turnover.	Indices based on resident turnover, calculated from plot change data, population replacement maps.	The results demonstrate that social turnover metrics are effective in identifying both forms of physical displacement, linked to the forced or induced departure of resident's due estate appreciation, and psychological displacement, characterized by the loss of identity and community cohesion.

Wang <i>et al.</i> (2023)	The relationship between perception of spatial justice and acceptance of land policies in contexts of land reduction for construction.	This study investigates how the perception of spatial justice influences public acceptance of land reduction policies for construction in urban and peri-urban areas of Shanghai.	The authors identify that citizens who perceive a fairer distribution of spatial benefits and burdens demonstrate greater support for land policies. The research also reveals that variables such as educational level, community participation, size and scale of contracted land, as well as family structure, significantly modulate this acceptance.
Cheng <i>et al.</i> (2024)	Relationship between land plot patterns and urban quality of life.	Morphological analysis of urban plots and blocks and their correlation with urban suitability indicators.	Medium and large blocks with a greater number of plots offer greater comfort in life. The shape and configuration of the plots influence the urban social experience.
Calderon <i>et al.</i> (2024)	Urban settlements of people displaced from rural areas and their territorial markers linked to social status and marginalization.	Participatory mapping, geospatial analysis, and correlations with socioeconomic indicators.	The settlements exhibit distinct spatial patterns: areas with a higher concentration of low-income families tend to have denser and more informal layouts; higher-income settlements have more regular organization and better infrastructure. The spatial configuration directly reflects the social condition and levels of marginalization of the residents.
Andrade Suárez <i>et al.</i> (2025)	Relationship between social cohesion, spatial justice, and sustainability in an urban renaturalization project; residents' perceptions and sociodemographic variables.	Quantitative case study in Pontevedra, analysis of satisfaction surveys, and cluster analysis.	They found significant differences in the valuation of urban spaces according to sociodemographic variables; they highlight the need for citizen participation in urban design to promote territorial equity; they indicate that spatial justice and social cohesion are interconnected.

3.2 Economic dimension

“Cities are spatial manifestations of cooperative acts”
(Webster and Lai, 2003)

Plots represent the physical space and product of the real estate market, a portion of land intended for urban activities that exert economic influence on its surroundings (Qadeer, 1981). The plot is considered not only a product of the real estate market (Harvey, 1985; Ratcliffe *et al.*, 2021), but also an expression of capital accumulation (Jäger, 2003). It is urban space determined by the land rent, market value, or informal market, as well as a unit for tax purposes (O'Sullivan, 1996). Furthermore, the plot is a space with different types of property rights, functionalities, and transformations that result in different market transactions costs (Webster and Lai, 2003; Tarbatt, 2012), to the different forms of agglomeration of urban activities (Webster and Lai, 2003; Needham, 2006), and to positive and negative externalities (Qadeer, 1981; O'Sullivan, 1996).

The role of the plot as a product has been incorporated into the economy through land value and associated tax effects. While land value defines the investment required to obtain land ownership (market value) or the right to use land through a rental unit (land rent), the tax registry is a government activity that records fundamental information about the plot. This platform serves as a benchmark for purchase and sale of real estate, offering the guarantee of title deed, land valuation, and the application of property tax (Cole and Wilson, 2017). However, the plot is also the of the informal land market (Bouwmeester and Hartmann, 2021), developed through different types of negotiations facilitated by a considerably lower price, which impact the social and spatial structures of cities (Leaf, 1992; Lall *et al.*, 2009; Mesgar and Ramirez-Lovering, 2021). In various situations, land use is influenced by planning, positively or negatively (Needham, 2006), through the development of technologies and infrastructures that add value to the urban system and strongly reflect on the value of land ownership (Hoyt, 1960).

Hoyt (1960) analysed the transformation of urban land value patterns and identified that such changes occurred due to political issues and the evolution of new forms of transportation that impacted the physical configuration of cities. According to the author, the peaks in land value indicated the appreciation of the main locations of large global financial entities, governments, and corporate headquarters. His works underlined four main characteristics of urban development that conditioned the increase in land value in the United States: river towns, railroad towns, the automobile, and the convergence of different activities on the same plot. For the author, the first change in land prices came with the emergence of steamboats - river towns began to develop rapidly with the river transport of goods. With the construction of the railroad network, there was a new land value pattern. Railroad towns grew rapidly due to the need for housing, and with the improvements in mass transit lines over the years, the value of land plots and apartments in the vicinity increased. The automobile was the driving force behind radical changes in cities. The ability to travel long distances led to the development of larger urban

areas. In 1946, one year after the end of World War II, shopping centres emerged with ample parking for automobiles and a concentration of activities such as department stores, services and retail, supermarkets, and others. At that time, land values began to increase in line with the increasing size of urban plots. Before this, each plot of land was valued separately and was an independent entity; however, large integrated plots with different activities and owners began to emerge.

Needham (2006) argued that urban planning has a significant influence on land value, stating that ‘The effects of land-use planning on people’s lives go beyond clashing with the strong feelings many people have about land, places, and their own land rights. Land planning can make a person richer or poorer by affecting the value of land-use rights.’ (Needham, 2006, p. 3). Restrictions on land use and the influence of what people can do with their plots mean that defined uses influence their neighbours. The author argued for the need for rigorous studies on the application of land-use regulations so that their effects and functioning have positive and fair impacts on other plots and on society.

According to Lall *et al.* (2009), land value is determined by three characteristics: land use restriction, artificial limitation of urban development, and increased verticalization of the built environment on plots. In terms of land use restriction, the argument was based on the difficulty families and businesses face in acquiring land due to the high regulations applied. For the authors, the restrictions of urban parameters established by city development policies impacted the form of growth and the value of urban land. Cities with rigid restrictions on building heights facilitate the process of urban sprawl, contributing to an increase in the cost of living for economically disadvantaged people. The authors presented the case of Mumbai, whose regulations are restrictive for plot development, resulting in low per capita land use, high land prices, and low city competitiveness. In this situation, economically disadvantaged people had no alternative but to live in slums (such as *favelas*, in South America contexts). In terms of urban development, regulations that limited the size of plots restricted the overall supply of development plots and built spaces, increasing land prices. According to the authors, regulatory spillover effects, in which they identified that an increase in restriction in one community leads to price spillovers in neighbouring communities. ‘Regulations that increase built environment standards or that increase the time required to obtain regulatory approvals increase the costs of land and built developments. These increases are reflected in consumers, with higher prices’ (Lall *et al.*, 2009, p. 25).

The tax registry refers to the registration of land to provide a guarantee of property title, with the main purpose of distributing taxes on urban land. In practice, this system is a file containing information about all plots in a city, including details about the property and various factors related to the land that could affect its value. Two main components make up the tax registry: a property map describing the location of the plot within the jurisdiction and a plot valuation file. This map aims to accurately identify the physical boundaries of the plot and its physical structure. The tax registry also contains a wide variety of information about the plot, such as the property value, the deed reference, the price and date of the last purchase, information about the use of the plot, a description of the size and nature of any improvements the plot provides, and any other information that may attribute and add value. The tax registry is a cartographic component, which, along with the physical boundary registry, includes a table with the

necessary information for the land value tax. Tax registration differs according to political context. In some cases, the system is decentralized; in others, it is concentrated in a centre under municipal power. Recently, all data for tax registration have begun to be developed through Geographic Information Systems - GIS (Cole and Wilson, 2017).

Plots, as fundamental spatial units for the functioning of the urban economy, are associated with economic activities, transaction costs, and externalities. The different ways of structuring and organizing property rights determine not only the efficiency of land markets, but also a city's own capacity to generate economic growth and collective well-being (Webster and Lai, 2003; Bobkova, 2019).

The conditions for the performance of economic activities in urban spaces are deeply related to how land is organized, regulated, and used. According to Jacobs (1961, 1969), the economic vitality of cities depends on the diversity of uses, population density, and functional proximity between different activities, stating that it is in these environments that innovations and opportunities for productive cooperation emerge. For the author, the city is the main engine of the modern economy, since the physical and social proximity between economic agents promotes the emergence of new types of work and products from existing activities. This interpretation converges with Glaeser's theory (2011), which states that density and spatial heterogeneity favour collective learning, the sharing of infrastructure, and the diffusion of knowledge, increasing the productivity and efficiency of urban systems.

Authors in institutional economics, such as Coase (1960) and North (1990), have argued that institutions, including property and land-use regulation systems, reduce transaction costs and allow markets to function more efficiently. In the urban context, plots are precisely the physical support of these institutions, where economic rights and duties materialize. As Coase (1960) observes, a well-defined and transferable property right is an essential condition for the internalization of externalities, a principle that underlies the role of urban planning as an instrument for aligning private incentives and social benefits. Transaction costs are understood as the indirect costs of carrying out a given exchange of market products. Webster and Lai (2003) argued that transaction costs are saved when land and capital owners spatially cluster with property rights close to each other and subdivide to produce economic cooperation. This logic is similar to the theory of agglomeration economies formulated by Marshall (1890) and later expanded by Hoover (1937) and Krugman (1991), according to which spatial proximity between economic agents in adjacent plots generates collective efficiencies and infrastructure sharing.

Webster and Lai (2003) defined five types of urban order: organizational order, which arises when individuals property rights to form businesses; institutional order, which arises as society invents systems of rules and sanctions that reduce the costs of competition; proprietary order, which arises as these institutions allocate property rights to scarce resources; spatial order, which arises as individuals and businesses seek locations that minimize information search costs and balance them with the cost of congestion in crowded cities; and public domain order, which arises as individuals engage in collective action through governments and other agencies to clarify consumer property rights.

Needham (2006) described three types of transaction costs: search costs, negotiation costs, and execution costs.

‘If we buy the building privately, there may be a lot of negotiation involved. If we want to change the land use, we may first need to obtain a planning permit. This costs us time and money, and some state agencies need to pay the costs of making a zoning plan, testing and issuing the planning plan, etc. These are all examples of search costs. If we buy a building under certain conditions, someone will bear the costs of verifying that those conditions are being met. If a planning permit has been granted, the state agency will have to monitor whether it is being followed. These are the enforcement costs.’ (Needham, 2006, p. 59).

The author argued that transaction costs are an important factor in urban dynamics and development because the way land is regulated determines transaction cost dynamics. Different ways of establishing or structuring property rights will result in different transaction costs. In this sense, the author argued that land use planning needs to be regulated and guided by actions that minimize transaction costs. ‘Land use planning used to reduce transaction costs can be very different from planning to reduce market failures’ (Needham, 2006). In this sense, the quality of the local economy has been associated with sustainable development through closely spaced subdivisions, aiming to promote strong business communities in an equitable way, with vitality and diversity of uses and functions (Tarbatt, 2012).

However, planning decisions for urban development generate externalities for society. These effects impact individuals who never had any decision-making power in the resulting action, benefiting at the expense of others. The externalities are associated with the morphology of the plots, such as issues of utilization coefficient, height, and maximum and minimum plot sizes by development zones (Needham 2006, Lall *et al.* 2009).

Externalities can have positive or negative effects. These effects impact people who had no decision-making power in the resulting action, potentially harming some and benefiting others. Needham (2006) argued that urban planners are concerned with certain externalities of a city, such as noise, smell, visual landscape, traffic, and parking, for example. However, other externalities that arise and are related to other areas of knowledge are often not considered, such as market value. Furthermore, another situation that promotes externalities is the scale of the plot and the built environment in relation to other plots. If the plot is considerably large in relation to its building, the externalities of this building may not affect other buildings located on neighbouring plots, which may not happen in cases where the plot is the same size as the building.

‘A very large plot of land can also be used by someone who wants to protect themselves from negative externalities caused by others. The larger your garden, the less inconvenience your neighbor will have. And it is known that very wealthy people buy undeveloped plots of land next to and within sight of their houses to prevent others from using that land in a way that reduces the usability of their homes.’ (Needham, 2006, p.75).

One of the reasons for the existence of land use regulations is externalities. Regulations are applied to address neighbourhood externalities, aiming to improve the economic well-being of those involved. According to Lall *et al.* (2009), the correct way to implement regulations would be to undergo a rigorous understanding of the application site to identify the possible intentional and unintentional effects of each proposed intervention. For example, building height restrictions in an area are based on externalities and adapted to the circumstances of each neighbourhood.

Therefore, the plot constitutes an essential unit of the urban economy. The plot functions as the physical space where productive, commercial, and service activities develop. The plot simultaneously expresses the economic value of the land and the dynamics of land use and occupation in the city, reflecting the relationships between supply, demand, and location, and other related issues such as transaction costs and externalities; in addition to the tax registry that generates savings for the public sector. Table 2 presents a selection of recent empirical studies in the field of economics and planning, in which the plot is used as a unit of analysis.

Table 2 - Research about economic issues and urban plots

Source	Theme	Synthesis of study	Synthesis of results
Berliant <i>et al.</i> (2002)	The relationship between production externalities and urban configuration, such as how the form and density of urban arrangements affect firm productivity and the benefits of externalities.	A theoretical and economic model for firm location that incorporates location-dependent spatial externalities of production. The formal analysis investigates how different urban configurations affect the level of production.	The spatial configuration of productive activities directly affects urban productivity through externalities. Greater proximity and density between productive areas favour the sharing of information and increase aggregate income. Spatial dispersion limits economic efficiency.
Albouy and Ehrlic (2015)	The distribution of urban land values based on market transactions in the US, analysing plot values in different metropolitan areas to understand determinants and variability.	Economic analysis of the relationship between value per acre and variables such as plot size, location (distance from centre), intended use, and regional variables. Examination of the distribution of values and comparison between urban and agricultural plots.	Plot size is a determining factor in value, explaining much of the observed price variation. Distance from urban centres, land use, and location also influence values, but to a lesser extent. Urban and agricultural land markets are interconnected, with land-use conversion costs being a key element in land price formation.
Danenberg <i>et al.</i> (2018)	The study investigates how the scale of plots along main streets in Stockholm influences economic opportunities.	A comparative and empirical approach was used, based on three main streets. All commercial plots and facades along these streets were mapped according to size, shape, and plot subdivision pattern. The relationship between plot scale and type of economic activity was then analysed.	Smaller, subdivided plots on main streets showed a higher number of small retail and food businesses; this suggests that larger plot scales hinder the entry of small businesses and therefore affect economic inclusion.

Ritter <i>et al.</i> (2019)	The relationship between the size of the plot and the price of the property and the land.	Analysis of 80.000 land transactions.	Small plots tend to have a lower price per square meter. Large plots may also have lower unit values due to liquidity limitations, less flexible use, and lower market demand. Intermediate-sized plots have the highest relative prices, reflecting a balance between economies of scale and ease of sale.
Bobkova <i>et al.</i> (2019)	To examine the relationship between the form and structure of the land plot system and the concentration of economic activities.	The study uses cadastral data from London, Amsterdam, and Stockholm to characterize urban plots according to three metrics: size, compactness, and street frontage. Then, it measures the concentration of retail and food service activities in each plot, based on establishment location data.	The study shows that smaller, more compact plots with larger shorelines concentrate significantly more commercial and food service activities. These types of plots are associated with greater urban vitality and functional diversity. Larger, less compact plots tend to house monofunctional uses, such as residences or large-scale services.
Füss <i>et al.</i> (2021)	Estimating land values from residential rentals.	Theoretical modelling and empirical estimation relating residential rents to underlying land values.	The study reinforces that the value of urban land is fundamentally determined by spatial factors, such as accessibility, density, and regulation, and that econometric methods can recover this value from observable variables: rents, prices, ages, and location.
Yuan <i>et al.</i> (2022)	Types of magnitude of transaction costs in urban village redevelopment projects (UVRPs).	A database of 439 projects (UVRPs) in seven Chinese cities; mixed analysis: data identified in projects and semi-structured interviews with <i>stakeholders</i> .	The article found high asset specificity, low frequency, and high uncertainty, which easily results in high transaction costs. These factors increase costs and make the rehabilitation process slower and more unequal. The research also shows that the centralized "top-down" project management model reduces community participation and favours state and private interests, which amplifies conflicts and inequalities.
Ngoc <i>et al.</i> (2024)	Investigation of a plot-based urban land valuation model to estimate the value of urban land in Phung, Dan Phuong, Ha Noi, Vietnam.	The research selects model plots as a basis for comparison to estimate land value in different cities.	It reveals that factors such as plot size, location within the urban area, and zoning parameters significantly influence the estimated value. The article suggests that the method can be applied to support land valuations, property taxation, and urban planning in contexts where there is a lack of land transaction data.

Shulgan and Nikolaichuk (2024)	Modelling the market value of urban land plots using GIS in Rivne, Ukraine. This study examines the role of price-making factors, using a database of plots sales and spatial variables.	A database was constructed containing urban plot transactions, including information on size, location, and comparable characteristics. Multiple regression analysis was used to estimate the value of the plots based on these variables.	The model was able to predict plot values with good accuracy, identifying the most relevant factors for price, such as size and location. The analysis allowed visualization of spatial variations in land value and demonstrated that the use of GIS facilitates the selection of comparable parcels and the interpretation of value patterns in the urban territory.
Efeoglu <i>et al.</i> (2024)	This study investigates how different morphological types of plots are associated with the presence, density, and diversity of retail and food service economic activities.	The study used geospatial data from Helsinki to analyse the relationship between plot morphology and the distribution of economic activities. Plots were classified into six morphological types and clustering techniques. Location data for retail and food establishments were cross-referenced with these plot types.	Smaller, more interconnected plots showed greater density and diversity of retail and food service activities. Larger, less integrated plots concentrated on extensive economic uses, such as supermarkets and warehouses. The study showed that the configuration of the plots directly influences the vitality and intensity of economic activities. More compact and accessible forms favour the presence of street commerce and local services.

3.3 Environmental dimension

*‘Sustainable and resilient urban development depends on adequately planning and ordering the territory to mitigate the impact of human interventions on land resources.’ (Lourenço *et al.*, 2020).*

From its origins, the urban plot carries a specific environmental dimension, as its existence derives from the direct transformation of a natural territory into a physical support for urbanization. Before being an urban and built space, each plot is part of nature, a fragment of land, topography, drainage, and vegetation. This natural dimension precedes and conditions the use of urban land, as Geddes (1915) and McHarg (1969) already observed when arguing that planning must respect the ecological characteristics of the land to guarantee balance and resilience.

In this sense, the environmental dimension of the plot is based on understanding land as an essential and finite natural resource, whose availability is limited in the face of advancing urbanization (Oliveira and Vaz, 2020; Oliveira, 2025). As cities expand, biologically productive land is permanently lost, compromising ecosystems and fundamental environmental services (Marquard *et al.*, 2020; Valente *et al.*, 2023). Land constitutes the support of human life and

the substrate of urbanization (Qadeer, 1981; Gerundo and Grimaldi, 2011; D'Amour *et al.*, 2017), and its organization begins with the division between circulation spaces and spaces intended for basic urban activities, structured in blocks and plots, formal and informal, both built and open. Thus, the way urban land is produced, subdivided, and consumed directly influences the flows of people, goods, and energy, affecting urban metabolism and patterns of emissions and energy consumption (Harvey, 1985; Kennedy *et al.*, 2015).

Literature contains different definitions of land use (Colsaet *et al.*, 2018), frequently equating it with urban occupation or expansion (Couch *et al.*, 2008; Ackerschott *et al.*, 2023). For Siedentop and Fina (2012), land use expresses the degree of urbanization, measured by the ratio between built-up areas and municipal territory. Decoville and Schneider (2016) distinguish three main forms of consumption: occupation by buildings, land impermeabilization, and use of plots for construction. In other studies, the concept includes green areas, leisure spaces, and infrastructure surfaces (Colsaet *et al.*, 2018). Marquard *et al.* (2020) define it as the conversion of natural ecosystems into settlements and infrastructure, while Hu *et al.* (2021) associate it with the relationship between urban morphology and population density. In this context, the plot constitutes the elementary spatial unit of land consumption, the point at which decisions of use, value, and function physically materialize, structuring urban forms and density patterns (Oliveira and Vaz 2020; Oliveira, 2025).

Land consumption manifests itself in two main ways based on the physical boundaries of plots: use in buildable plots and use in plots designated for open spaces. Buildable plots are regulated by urban planning instruments that define parameters such as occupancy rate, utilization coefficient, permeability, and maximum height. However, a significant portion of global urbanization occurs outside formal legality, in informal processes of land division and construction defined by social agreements and adaptive patterns, often in environmentally sensitive areas (Spolaor, 2023). Open space plots, generally public, house essential environmental and social functions, such as recreation, drainage, thermal regulation, and maintenance of urban biodiversity (Langemeyer *et al.*, 2015).

The configuration and distribution of these plots directly influence urban density, land use efficiency, and mobility patterns, affecting both the economic metabolism and the environmental quality of cities (Qadeer, 1981; Oliveira and Vaz, 2020). Land consumption, therefore, is not only a morphological issue, but also an ecological and economic one: it is at the heart of the relationships between space use, urban productivity, and sustainability (Costanza *et al.*, 1997; Ostrom, 1990; NuiSSL and Schroeter-Schlaack, 2009). Thus, land plot and use decisions shape urban diversity (Bobkova, 2019; Oliveira, 2021), ecological resilience, quality of life, and collective well-being, consolidating the plot as the territorial unit where the balance between economic growth, social inclusion, and environmental preservation can be materialized.

The way urban land is consumed demands reflection on how much each plot can contribute to the permeability and environmental balance of cities. Extensive land use through waterproofing reduces water infiltration, exacerbating floods, heat islands, and the degradation of urban ecosystem services. Studies demonstrate that the proportion of permeable surface area in a plot, including green areas, permeable pavements, or vegetation cover, is crucial for regulating the

hydrological cycle and moderating urban temperature (Kazmierczak and Carter, 2010; O’Riordan *et al.*, 2021). At the plot level, interventions such as community gardens, permeable pavements, or green roofs have already demonstrated improvements in the physical characteristics of the land and a reduction in surface runoff (Corrêa *et al.*, 2022). Thus, rethinking land use means not only planning the construction occupation of plots but also recognizing their ecological function as active surfaces in urban metabolism, capable of promoting water, thermal, and climate efficiency.

Energy efficiency is another central aspect of the environmental dimension of plots. The way land is occupied and built upon directly determines the energy consumption of cities. The shape, orientation, and density of plots influence natural ventilation, shading, insolation, and building efficiency, affecting the need for heating, cooling, and lighting (Steemers, 2003; Ratti *et al.*, 2005; Salat, 2011). More compact and integrated plots tend to reduce *per capita* energy demand by favouring active mobility and the collective use of urban infrastructure (Newman and Kenworthy, 1989; Pereira *et al.*, 2022). On the other hand, the dispersion of plots and the increase in land impermeability intensify the use of motorized transport, the consumption of fossil fuels, and carbon emissions (Ewing and Rong, 2008; Creutzig *et al.*, 2015). Thus, urban energy efficiency depends not only on building technology, but also on the morphology of plots and their integration into the urban fabric. Recent literature emphasizes that planning policies that encourage higher density, mixed use, and integration between buildings and open spaces can significantly reduce total energy consumption and increase the climate resilience of cities (Liu *et al.*, 2023). In this sense, the plot constitutes the intersection point between the spatial, environmental, and economic dimensions of energy efficiency, functioning as the unit where individual construction decisions and collective effects on the energy capacity of urban space are articulated.

Table 3 presents a list of empirical studies, providing a synthesis of the method and results on different attributes of the environmental dimension of urban life that are associated with plots.

Table 3 - Research about environmental issues and urban plots

Source	Theme	Synthesis of study	Synthesis of results
Tsirigoto and Bikas (2017)	They investigate how different scales of urban morphology (blocks, city block typologies) relate to the energy efficiency of residential buildings in the context of Greek cities.	Selection of ten typical residential blocks with different shape and density characteristics in cities in Greece. Measurement of physical variables of the urban fabric for each block. Calculation of predicted energy efficiency indicators from these urban morphology variables.	More compact urban blocks, with higher density and a lower external area/volume ratio, have greater energy efficiency. The study highlights that urban planning and urban design interventions should consider the shape and size of the plot and the configuration of the urban fabric to improve energy performance.
Salvati <i>et al.</i> (2018)	This research investigates whether spatial patterns of urbanization and land consumption (urban sprawl, land use) vary according to different socioeconomic contexts in Europe.	The study analysed 155 metropolitan areas in six regions of Europe. Variables on urbanization, land use, population density, and socioeconomic indicators (income, unemployment) were collected. The data were organized on a comparative basis for each metropolis.	Areas with higher rents and lower unemployment tend to use land more efficiently. Less economically developed regions exhibit more extensive and less efficient urban sprawl. Land use is directly associated with the local socioeconomic context.
Ahmadian <i>et al.</i> (2021)	To investigate how urban built form and density influence the energy performance of buildings.	Using empirical data from buildings in an urban district, combining two density metrics with built form variables (height, roof area, building-to-plot ratio); statistics to quantify the relationship between density, urban form, and building energy consumption.	Higher densities and more compact city forms are associated with better energy performance of buildings, with lower consumption per unit area when the building form is efficient. Low-density or dispersed configurations have poor performance due to larger exposed surface area, higher demand for air conditioning and transportation.
Zhang <i>et al.</i> (2022)	This study examines how the density of impermeable surfaces and their spatial patterns affect the urban heat island effect in the built-up area of Xuzhou, China.	Mapping of impervious areas and measuring surface temperature. Impervious areas were classified into five intensity levels. Spatial metrics were calculated to understand distribution and fragmentation. The relationship between these metrics and temperature was analysed.	Impervious areas in Xuzhou increased significantly between 2014 and 2020, mainly in central regions. The higher the density of impervious surfaces, the more intense the urban heat island effect. Large, continuous patches of impervious surfaces raised the temperature more than small, fragmented areas.

Rahimi and Ebrahimian (2024)	Characterization of urban impervious surface cover for rainfall-runoff analysis: impacts of data availability and resolution.	The study used land cover data and satellite imagery to map impervious areas in urban areas. Different spatial resolutions and data availability were tested to verify their effect on impervious cover measurements.	Low-resolution maps underestimate impervious areas and may overestimate or underestimate flows. Detailed data allow for more accurate estimates of the urban impact on runoff. Differences in results show that planning decisions based on coarse data can lead to errors.
Zhao and Jiao (2024)	This study investigates how characteristics of urban plots influence carbon emissions, considering both socioeconomic and morphological factors. The study focuses on non-linear relationships.	Detailed data on urban plots, including socioeconomic (income, population density) and morphological characteristics (occupancy rate, land cover, fractal shape). They correlated these variables with the carbon emissions of each plot. They applied nonlinear models to capture effects that change according to the value of the variables.	The study identified four key factors that influence emissions: economic level, population density, occupancy rate, and plot shape.

3.4 Morphological dimension

‘The plot of land representing a land-use unit defined by boundaries on the ground.’ (Conzen, 1960).

The morphological dimension of the plot is based on its physical character as a spatial configuration for the distribution of activities in cities. The plot is considered a part of the land, a land use unit with physical boundaries on the ground, an element of the urban physical plan (Conzen, 1960) and as an organizing grid of the city (Moudon, 1997). It is considered the smallest expression of undivided property and decision-making within the urban area for construction (Tarbatt, 2012) (among other definitions presented in section 2.1).

The first study on plots as one of the central elements of the urban physical plan was developed in the 1950s and published in 1960 by Conzen, the above-mentioned Alnwick study that would be at the core of the historic-geographical analysis (Whitehand, 1981; Oliveira, 2019). Although this work focuses on the analysis of the city plan, plots were the smallest scale and the basis of analysis that the author chose to develop his study. Conzen conceptualized the plot as a piece of land that represents a land use unit defined by boundaries on the ground (Conzen, 1960). Each plot was understood as a unit of use and a unit of ownership, regardless of its size.

The author classified the plots in different ways: the *bourgeois plot* – an elongated urban plot owned by a bourgeois in a medieval borough, taxed with a fixed annual income as a contribution to the borough treasury or as a community tax; the *original plot* – an initial, or principal, plot from which derived or secondary plots were formed through partitioning; the *derived plot* – a secondary plot formed from an original plot through separation; the *tail end plot* – a derived parcel that occupies the tail end of an original parcel; the *medial plot* – a derived parcel that occupies the middle portion of an elongated original plot; the elongated plot – an elongated, more or less rectangular plot, with one of its narrower boundaries facing the street; and, finally, the *leased plot* – a small, traditional elongated plot that is not owned by the bourgeoisie.

The plot was also characterized as a three-part physical structure: the *head of the plot*, closest to the street and generally the most important part; the *tail of the plot*, the back part and generally less important; and an *accessory of the plot*, relating the plot to a secondary building (Conzen, 1960). The organization of a set of similar plots was defined by Conzen (1960) as a *plot pattern*. A variety of plot patterns in a city's physical plan was defined as a *plot system* (Conzen, 1960). Conzen had a specific focus on the cyclical process of building development on a plot, as a result of the socioeconomic processes that occurred in an old city, which he designated as the *burgage plot cycle* (Figure 4). In addition to the bourgeois plot cycle, Conzen developed two other concepts, with the plot as one of the elements analysed: the fringe belt and the morphological region (see Arat, 2023 and Unlu 2013 for reviews on these concepts) (Table 4).

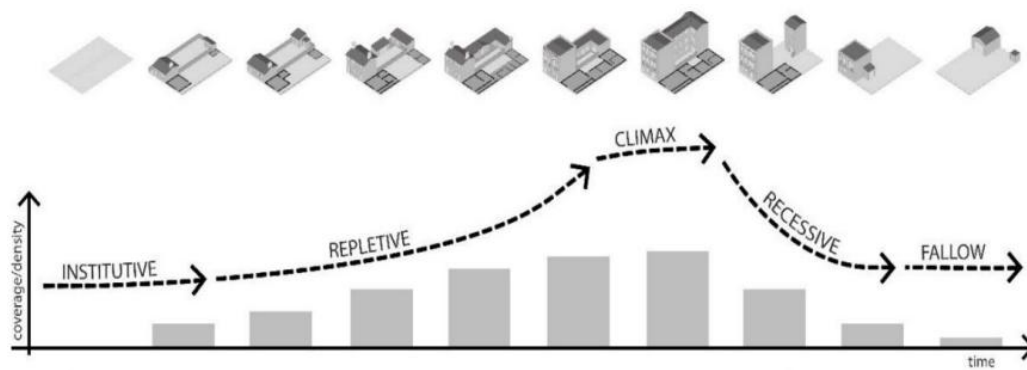


Figure 4 – Burgage cycle of the plot. Source: Feliciotti *et al.* (2018).

Plots have different geometries and sizes, the most common being rectangular or quasi-rectangular. In general, one of the shorter sides of the plot is located as an interface between the plot and the street, the so-called *frontage*. The plot *length*, in most cases, is situated as an interface between two plots, whether private or public. In addition, there are plots *without frontages*; these do not have a direct connection to the street. In these cases, the plots need access through a narrow strip or through rights of way over another plot to connect to the street (Tarbatt, 2012; Bobkova, 2019; Song *et al.*, 2022).

Despite their strong resistance to change, plots can be divided or merged/amalgamated (Conzen, 1960; Tarbatt, 2012; Whitehand *et al.*, 2016). Plots division proceeds from the physical separation of a plot into two or more. Plots merging is its opposite characteristic and consists of the physical joining of two or more plots. Generally, this procedure takes place with the consent of the people involved and the public authorities.

The different geometries of land plots are structured in the city over the years. The urbanization phase known as land subdivision involves a series of decisions, such as the relationship of the plot to the street, the orientation of the plot considering geographic coordinates and topography, its position and proportion within the block, infrastructure, among others (Oliveira, [2016]2022). In some cases, these processes are developed through formal planning, in others, through more spontaneous development (Dovey *et al.* 2020). The decisions that will be made and implemented in the land subdivision phase will determine the future options for building typologies to be constructed and the urban dynamics of the site and the city. The boundaries defined and implemented in the land division remain for long periods of time, spatially structuring the physical plan of cities through different plot patterns. Generally, compact-grain plots exhibit a character of plot patterns that are traditional to urban dynamics on a human scale, characterized by small plots being used in different ways, producing spaces with vitality, adaptability of functions, and social richness (Porta and Romice, 2010; Bobkova *et al.*, 2021). As a rule, smaller plots are located in historical centres, and as they move away from the centre, the size of the plots per block increases towards the peripheral regions of the city (Oliveira, 2016).

From the beginning of plots studies in the field of urban morphology (analysis in the context of formal plot models), the connection of this element with other areas of knowledge has been evident. Conzen (1960) defined the plot as a unit of land use and a unit of property. Slater (1990) defined the plot as the primary cell of urban space with limits of great permanence. For Caniggia and Maffei (1979), the plot is considered a module of the urban aggregate. An element intended to accommodate the largest number of buildings with the minimum of linear development, that is, with narrow plot frontages. Baird (1988) defined the plot as the starting point from which it becomes possible to understand urban growth, from a set of political, economic, and legal viewpoints. Siksna (1998) defined the plot as a constituent element of particular settlements for various owner strategies. Kropf (2018) defined the plot as a limited area of land, an area with buildings, a land use unit, and a property unit. Bobkova (2019) characterized the *plot* as a piece of urban land limited by legally defined boundaries that constitute a basic unit of land control and use, serving as a connection between built space and movement space.

Furthermore, different morphological concepts and methods have been developed to understand the role of the parcel in the urban structure (in isolation, or in conjunction with other elements of the urban form), according to the geographical and political contexts presented in Table 4.

Table 4 - Research about morphological issues and urban plots

Source	Theme	Synthesis of study	Synthesis of results
Caniggia and Maffei (1979)	Morphological structure of the city and evolution of building types; introduction of the concepts of <i>primary cell</i> (minimum building unit) and <i>fascia di pertinenza</i> .	Typological morphological analysis based on a historical reading of urban form and buildings; empirical study of Italian urban fabrics to understand the relationship between building, plot, and urban fabric.	They demonstrate that the process of urban formation is cumulative and continuous, starting from the <i>primary cell</i> , an elementary building associated with a plot of land, which repeats and transforms itself over time. The <i>fascia di pertinenza</i> corresponds to the plot and defines the relationship between the building and the land, being the fundamental unit of the urban fabric.
Marcus (2010)	This study proposes expanding the <i>Space Syntax theory</i> to incorporate broader morphological variables of urban form, specifically accessibility, density, and diversity, under the concept of <i>spatial capital</i> for the analysis of urban morphology.	The author applied spatial syntax analysis to an urban area in Stockholm, measuring integration indices, building and plot density, and land use diversity to examine correlations between these variables.	Three compelling correlations were found: (1) between integration and road traffic, (2) between accessible building density and population, and (3) between accessible plots and land use diversity indices. The study concludes that the combination of accessibility, density, and diversity constitutes the spatial capital that can bridge urban morphology and economic and social activities.

Oliveira (2013)	A method for quantitative evaluation of urban form, considering the street, street block, plot, and building as basic units, with the objective of identifying strengths and weaknesses in the urban morphological structure.	The author defines seven criteria for morphological evaluation and applies them to sample urban units to generate maps and matrices of morphological performance.	The study shows that the morphology of the plots, for example, their dimensions, relationship to the street, alignment of buildings facing the plot, and plot density, has a significant impact on the <i>urbanity</i> of the area, that is, factors such as accessibility, density, and diversity.
Kropf (2014)	This study critically analyses the notion of constructed form in urban morphology, exploring ambiguities in the definition of basic elements, buildings, plots, and streets, and how these relate hierarchically.	Conceptual analysis and comparisons of hierarchical diagrams to examine where ambiguities exist, especially in the role of the plot in the urban structure. Plots are analysed through the concepts of <i>coinflection</i> and <i>coextension</i> .	The author concluded that the plot plays an ambiguous role: it is simultaneously a physical element, a unit of use, and a unit of control. He demonstrates that existing definitions do not adequately accommodate this overlap and that a more robust framework is needed that recognizes plots as an integral part of the hierarchy of urban form.
Wu <i>et al.</i> (2019)	Development of a method for grouping plots based on urban morphology and functional connectivity, aiming at better planning regions.	Use of Beijing plot data: extraction of morphology indicators (line segment similarity, compactness).	The proposed method obtained finer plot groups that were more compatible with human cognition, showing a better union between morphological form and urban function than more traditional methods.
Bobkova (2019)	Natural occupation theory that examines how the structure of plot systems influences urban processes such as economic concentration and diversity of activities.	Develops a method for spatially representing plot systems, identifies three central morphological variables, and classifies plots into types using data-driven statistical techniques.	The thesis presents empirical evidence that there is a direct relationship between the form and structure of land plots systems and economic processes in cities, plots with certain morphologies are associated with greater diversification and intensity of activities.
Freischmann (2020)	The suitability of the plots as a unit of analysis in urban morphometrics and the proposition of an alternative to overcome limitations of cadastral data.	Comparison between cadastral plots data and derived unit data in the city of Zurich, using morphological metrics (geometry and configuration) to test informational similarity.	Morphological tessellation has proven efficient for cadastral data across many metrics, although there are types of information that only cadastral plots can provide. This paves the way for large-scale analyses even where plots data are incomplete.

Liu <i>et al.</i> (2020)	A plot-based strategy for the restoration and regeneration of a historic area in southern Nanjing, focusing on how to subdivide and reorganize plots to balance conservation, density, and modernization.	Historical analysis of maps and plans of the old area with computational modelling to propose different plot division schemes. They developed parcelling scenarios based on criteria.	A <i>smart plot</i> layout that maintains historical integrity while allowing for densification and contemporary use. The suggested divisions allow for the preservation of old streets and typological patterns, but introduce new subdivisions for mixed use (residential, cultural, commercial).
Song <i>et al.</i> (2022)	Investigating the complexity of built form in Chinese cities through the recognition of plot patterns.	Six historical samples from Nanjing were analysed both as physical entities and as formalized land units. Comparison of spatial boundaries of the physical plots and the legal-proprietary boundaries.	The study shows that much of the complexity of the built environment in Nanjing stems from the discontinuity between the physical morphology of the plots and the structure of formalized land use rights.
Arat (2023)	To identify and define urban morphological regions.	The steps involve historical-geographical analysis of the urban form, extraction of morphological variables (such as road network, blocks, plots, building typology) and application in two case studies to delineate morphological regions of different orders.	The morphology of plots varies systematically between different morphological regions, and this variation is closely linked to history, land use type, and urban density. The book presents maps and typologies for regions defined based on plots and blocks, showing that recognizing the plot as a morphological unit allows for a more refined and applicable analysis for urban planning and city design.
Liu and Song (2025)	Automated classification of urban plot morphology using artificial intelligence.	The study applied attentional neural networks to analyse approximately 8.973 plots in the walled city of Nanjing, considering the shape of the buildings, their spatial relationships, and density metrics. The model constructed graphs representing the internal structure of the plots and their connections, allowing the identification of morphological patterns.	Seven distinct plot types were identified. The study showed that parcels with similar density values can have different internal structures, which affects the understanding of urban form. The approach demonstrated potential to support urban planning and regeneration based on more precise and context-sensitive spatial typologies.

3.5 Legal dimension

The legal dimension is one of the most complex of plots because it takes on distinct forms of regulation in different geographical and institutional contexts. In some cases, plots are physical boundaries established by legal boundaries of private property (Alchian and Demsetz, 1973; Webster and Lai, 2003; Cozzolino and Moroni, 2021), in others, they are state property (Chau *et al.*, 2018; Kantarek *et al.*, 2022), or even physical boundaries based on agreements of conduct between individuals (Zazyki *et al.*, 2022). These conditions produce different institutional arrangements, types of tenure, and rights affecting the land.

Needham (2006) explains that land ownership allows the owner to have rights over the land and everything on it: housing, garden, minerals, among others. The author also argued that property rights exist to provide clarity, certainty, and stability in the relationships between people and their association with a particular piece of land. Property rights can promote security and be a source of wealth. For countries that understand land to be private property, existing regulations are still very different. In some cases, land ownership is regulated as a separate land ownership law; in other countries, land ownership is included in general property regulation law. In the Netherlands and some countries in Continental Europe, a general property law was instituted. In these countries, regulations on rights to a material thing, movable or immovable, are regulated separately from rights over *immaterial* things, such as intellectual property rights. In the case of France, a property rights law was created that included both movable and immovable *things*. In this case, the land was considered merely a type of *thing* over which people could have rights. However, Americans treated land separately, with specific property laws. In the Anglo-Saxon tradition, the doctrine of feudal property was a defined interest defended by law; the monarch was the ultimate and sole owner, and people could have a stake in the land. In this sense, land ownership came into existence when a person possessed a certain minimum *package of rights* over a given plot of land (Needham, 2006).

In situations where land is state-owned, as is the case in China, urban land does not have property boundaries; it exists only as an almost invisible spatial division for the placement of buildings. In the study by Song *et al.* (2022), the authors conducted an analysis across three different political periods: before 1949, a period when land ownership was private; between 1949 and 1978, a period of public land ownership in a planned economy; and between 1978 and 1992 – a period of public land ownership in a market economy; and beginning in 1994, a period of public land ownership in a market economy (at a more consistent stage of policy). In each stage, different plot patterns were presented in terms of physical characteristics and behaviour (involving ownership or simply control over space). This allowed them to confirm that the laws affecting land significantly impacted the physical patterns of plots in different ways in each period.

In cases of informal plots, Cole and Wilson (2017) argued that illegal landholdings arise as responses to inadequate laws. Informal property rights lack official recognition and protection. Many of the land tracts colonized by the original settlers of the United States have been informally subdivided over time. This informal subdivision of land can occur with the division of land among heirs to the property or when the owner decides to sell a portion or all of their plot. When such informal subdivision occurs in publicly owned states, the subdivided sectors may take the form of submultiples; or they may be irregular areas within a section delineated by orientation measurements.

According to Demsetz (1967), there are three main types of property: private property, state property, and communal property. Private property implies that the community recognizes the property right to exclude others from exercising their private property rights. State property implies that the state can exclude any person from using a right, provided the state follows accepted policies and procedures for determining who can use state property. Communal property means that the community denies the state or citizens the right to interfere with the exercise of any activity by any person within plots of property with common rights.

Payne (2000) reviewed the types of land tenure in different countries and organized them as follows: habitual tenure, private tenure, public tenure, the religious system of land tenure, and categories of informal tenure. Habitual tenure was given as an example of the form of tenure in most countries in Africa, the Middle East, and North America. In these places, the land is considered a sacred space, and the role of man is the administration and protection of the land for future generations. Allocation, use, and transfer are determined by community leaders according to the community's needs through agreements and symbolic payment. Private tenure developed in developing countries and is concentrated in urban areas. The private tenure system allows for almost unrestricted use and exchange of land to ensure more intensive and efficient use. Public tenure is known as plots of land granted to the State. In capitalist countries, these areas are restricted to strategic and community uses. This concept of public property is a reaction to the limitations existing within private property, as it allows for the development of strategies for community use. Religious land tenure systems are particularly dominant in countries with a Muslim faith. In these areas, there are four categories of land tenure: land held by God, private land, land protected by law or controlled by the state that carries usufruct rights, and communal land plots. The category of informal tenure corresponds to unregulated occupations, unauthorized subdivisions of legally owned land, and various unofficial lease agreements.

Property rights constitute one of the most central elements in the legal structure of a plot of land. Demsetz (1967) and Needham (2006) define property rights as an instrument of society. Needham (2006) argued that there is a variety of property rights indirectly affecting this concept. For example, the right to build is determined by different urban parameters that vary according to each area of the city and the objectives defined in the legislation on city development. The author argued, for example, that the use of 500m² of built area on an urban plot is only permitted because the law regulating the types of construction authorized it. Property cannot be defined as a finite list of concrete rights, as property represents all possible rights, even those not yet conceived. A person with full property rights may have the right to divide their property rights with other people. These people do not possess all the rights but are

authorized by the owner to exercise them for a specific period. The situation in which all possible rights over a thing belong to one person is described as total dominion over that *thing*. For Kruse (1939), the right of total ownership was identified as a set of powers existing in all normally developed property laws. For the author, the different existing property rights are the power of use; the power to alienate; the power to pledge and concentrate property rights to another for usufruct; and the power of hereditary succession. For Denman and Prodano, ‘The right of ownership is that unique dominion which a man claims and exercises over external things, in total exclusion of the right of any other individual’ (Denman and Prodano, 1973, p. 30) The legal right of ownership corresponds to the right to use a plot of land. Three types of property rights are organized by Needham (2006): i. the right to use a piece of land in a particular way, where this use can coexist with other uses of the same plot; ii. The right to use part of a piece of land, where other uses are excluded from that part horizontally or vertically; and iii. the right to use the entire plot, where other uses are excluded and the duration of use is specified. If the duration of use is limited, it is specified to whom the right will revert at the end of the term; an example of this is a lease.

The legal dimension of urban plots is also redefined in the three-dimensional context, as cities grow upwards and downwards. International experience shows that surface rights above and below ground require sophisticated legal structures to accommodate overlapping uses. For example, Paulsson (2007) analysed the development of 3D property rights in several countries, highlighting the importance of three-dimensional cadastral systems for registering distinct interests in the ground, air, and subsoil. Kitsakis *et al.* (2022) revisited public law constraints in three-dimensional land administrations, emphasizing how laws and regulations should shape rights, restrictions, and responsibilities in vertical spatial units.

The legal dimension of plots can take collective or institutional forms, combining property rights in different ways. To cite a few examples, in the trust system, we observe the so-called dual ownership: the trustee holds the legal title to the asset, while the beneficiaries have the equitable title, a division that offers flexibility in management and asset protection (Zhang, 2023). Borden and Vattamala (2011), examined LLCs as strategies for real estate investors, allowing the segmentation of properties into different series under a single entity, reducing management costs and simplifying the legal structure without compromising the separation of assets. Table 5 presents a list of empirical studies on different types and existing property rights, and how they are associated with plots.

Table 5 - Research about economic legal and urban plots

Source	Theme	Synthesis of study	Synthesis of results
Payne (2001)	The article addresses policy options for urban land tenure in developing countries, questioning whether formalizing tenure through legal titles or recognizing expanded rights without formal titles is more effective in ensuring security of tenure.	This is a critical review of the existing literature on urban land tenure in the Global South, combining case studies, evaluations of titling programs, and analysis of empirical and policy evidence to compare the effects of title issuance versus other forms of tenure recognition.	The issuance of legal titles alone does not always result in significant improvements in investment or housing conditions; in many contexts, the recognition of informal or de facto rights, the provision of urban services, and institutional integration are more critical to security of tenure than simply granting titles.
Gülöksüz (2002)	Evolution of property rights in two agricultural estates transformed into urban neighbourhoods in the city of Istanbul between 1874 and 2000, analysing how property conflicts, informal urbanization, and state shaped urban plot rights.	A historical-sociological study based on a documentary survey of property laws over time, records of land transfers in the two large agricultural estates (which became 'illegal' urban districts in the 1970s), and a qualitative analysis of the conflicts between public and private actors in the informal urbanization process.	The results show that property rights in these urban areas are not static but emerge from negotiations and conflicts between the excluded and the included, between private and public interests, with the actor's adjusting property and urban planning legislation as part of the processes.
Chernina <i>et al.</i> (2014)	Impacts of property rights and the formalization of urban tenure in contexts of rapid urbanization, focusing on how security of tenure influences occupant behaviour and the urban land market.	Quantitative empirical analysis to assess the effect of formalization or legal recognition of ownership on variables of investment in housing, densification, or security of tenure.	Legal recognition of property rights or their improvement is associated with greater investment in the property, a lower probability of involuntary displacement, and better housing conditions in urban areas.
Havel (2014)	This research investigates how the delimitation of property rights constitutes the institutional basis for urban land markets in countries in transition, analysing the processes that structure arrangements of ownership, use, and exchange of urban plots.	A critical reflection on the regulatory frameworks of urban land and the institutional structure of land markets in contexts of transition, using legislative review and comparison between national cases to understand how property rights are formalized and modified in the urban context.	The study concludes that in countries in transition, clarity regarding property rights, who holds the right, for how long, and under what conditions, is fundamental to the efficient functioning of urban land markets.

Cai <i>et al.</i> (2018)	This study examines the interplay between urbanization and land rights, exploring how the security of property rights impacts patterns of urbanization and economic development.	Empirical data from various countries are used to estimate models that relate land rights indicators to urbanization variables. Panel regressions, with institutional and socioeconomic controls, are employed to identify associations between property rights and urbanization.	The results indicate that more secure property rights are associated with faster rates of urbanization and more organized urban expansion.
Tomic <i>et al.</i> (2022)	This article examines how 3D property rights registration can improve urban management, evaluating the usefulness of three-dimensional cadastral models for representing rights, restrictions, and responsibilities in complex urban environments.	The methodology involves detailed 3D modelling of spatial units, comparison with existing 2D property records, and evaluation of their functionality for urban governance purposes.	The 3D cadastral system provides a more accurate and complete representation of vertically overlapping property rights, correcting limitations of the 2D system. The results indicate significant improvements in the integration of legal and physical data, transparency in the real estate market, infrastructure management, and support for smart urban governance policies.
Ma <i>et al.</i> (2025)	It comprehensively investigates the impact of land ownership rights on land use efficiency.	The study analyses 165 countries between 1990 and 2020, combining global data on urban built-up expansion and population growth to measure land-use efficiency. To estimate the effect of property rights, the authors apply panel models with fixed effects and use the legal origin of the countries.	The results indicate that greater security of property rights is strongly associated with more efficient land use, reducing urban sprawl that exceeds population growth. The effects are statistically significant and robust across multiple specifications.
Hangen and Brien (2025)	The study investigates how obscurity in rental property ownership, caused by corporate entities such as LLCs, hinders the identification of owners and hides property consolidations, contributing to inequalities in the housing market.	The authors compare different text matching methods in Boston property tax assessment records (2004-2019) to link properties to owners and also use corporate records to detect when property is masked by entities such as LLCs.	They found that the main barrier to tracking landlords has shifted from poor quality administrative data to a deliberate strategy of obscurity via LLCs. This obscurity not only hides increasing property consolidation by large landlords but is also associated with concentrations of poor-condition properties, evictions, and inequalities in rental housing.

3.6 Planning/institutional dimension

‘The common definition of plot ratio is the relationship between a building's gross floor area and the area of its plot boundaries; this primarily describes its volumetric and intensity features. In planning implementations, plot ratio control is a very common regulatory and instrumental parameter defined by land-use planning to ensure planning goals for a given zoning area are met. This control indirectly restricts building volume, infrastructure weight, and development intensity.’ (Lin *et al.*, 2022, p. 119).

The planning dimension is based on the capacity of the plot to organize and receive different urban development strategies. To think and plan a plot is therefore a fundamental act in the construction of place, since it is within the plot boundaries that activities and individuals are organized (Merlin, 1988). In most cities, once the street pattern is established, a second foundational action is the definition of the plot pattern. Plot patterns are determined by decisions, both premeditated and spontaneous, made by individuals over time, whose private interests transform street blocks and plots. The dialectical relationship between the street, the street block and the plots create the urban fabric and the dynamics of cities. It is through the continuation of this relationship, which can be modified, extended, and replaced, that the city's capacity to adapt to the physical, socioeconomic, and cultural changes that mark urban evolution resides (Merlin *et al.*, 1988; Tarbatt, 2012; Karaman *et al.*, 2020).

With the decline in the importance of urban form in planning practice, plots began to be structured primarily for the allocation of buildings, without considering their relationship to the street and the neighbourhood. There is a historical tendency for larger plots to be subdivided into smaller plots as land supply decreases and demand for it increases (Oliveira, 2016). After the Second World War, new ideas for the construction of planned and rational cities based on the separation of their four main functions – life, work, leisure, and transportation – were widely adopted in reconstruction plans worldwide (Tarbatt, 2012). The concern with zoning land for single use, accompanied by the merging of plots with more sustainable patterns as a means of achieving their potential for diversity of uses, functions, and development agents, both in existing urban centres and suburbs, became neglected. This rational planning process brought to cities a monoculture of land uses, standardized constructions, and segregated communities (Taylor, 1998; Allmendinger, 2017).

However, land plots can directly influence and indirectly guide urban processes through planning policies established through the development of urban plans (Qadeer, 1981; Oliveira, 2016; Bobkova, 2019). Urban plans are accompanied by zoning, with specific development guidelines and urban parameters for land subdivision and building construction. In the first case, land subdivision parameters are general rules for maximum and minimum size for each plot (Burke *et al.*, 2016). In the second case, construction parameters are specific rules for building construction within each plot, such as: land use coefficient, occupancy rate, permeability rate, maximum height, types of use, etc.

Urban plans, therefore, enable the generation of different types of forms and are highly related to the political and governmental interests of the current administration of a given city (Altshuler, 1965; Crecine *et al.*, 1967; Ratcliffe *et al.*, 2021). The set of strategies, implemented punctually, through zoning and urban parameters promote different urban dynamics that result in characteristics, both positive and negative, for the city and society. Recent examples affirm, in different ways, the role of land plots as influencing agents in these processes.

Lin *et al.* (2022) showed how planning biased by private interests, for example, through manipulation of plot rates to optimize invested capital, recreating urban areas to capture the greatest development potential, the benefits of plot concessions, and the transfer of construction rates to other locations.

Urban zoning, the most common form of planning for urban areas, is a city development practice aimed at mapping areas for development, establishing criteria for land use and urban indices for intended growth. Zoning involves the physical separation of land use. The economic implication of this separation occurs through non-conforming uses that impose external diseconomies on the permitted uses of the zone. Some authors have conducted studies to identify the role of zoning in the economic quality of a given area. Crecine *et al.* (1967) conducted a study using market values in Philadelphia and found no significant statistical evidence of external diseconomies to justify zoning. On the other hand, Needham (2006) argues that land use planning directly influences property rights, since the State can limit the use of property in the name of public interest. According to him, territorial planning can enrich or impoverish property owners, for example, through indirect investments in infrastructure. From his perspective, urban development would be more efficient if individuals themselves could freely decide how to use their plots of land, allocating scarce resources more rationally than under rigid restrictions imposed by urban planning codes.

Recent literature also highlights the centrality of the plot in contemporary urban transformations. Vicuña and Rivas (2022) developed a study on plot transformations and their effects on public space. The study was conducted in eight verticalized neighbourhoods in the Santiago metropolitan area, Chile, and developed quantitative and qualitative analyses identifying four categories of plot transformations: (1) homogeneous verticalization with regular plot transformation; (2) incomplete verticalization through various plot configurations; (3) dispersed and intense verticalization, with partial plot reconfiguration; and (4) dispersed verticalization with a change in the plot pattern. The analysis was developed in two periods, in the initial phase of verticalization of the areas and currently (2022). The plot area measurements and the depth-to-façade relationship were mapped. The area of the plot sought to identify its potential for conducting various strategies by residents and owners, and the relationship between the depth and façade of the plot reveals the potential for contact between the plot and the immediate public space. In addition, the variables of net population density, percentage variation in plot density between the initial and current temporal states, and the percentage of verticalized area were analysed. As a result, the authors identified that verticalization functions as a process of spatial dispersion and develops under flexible land-use zoning regulations, with urban parameters such as increasing the maximum height for buildings, allowing for areas with greater density, and reducing built-up areas. The main transformation of the plot identified in the work of Vicuña and Rivas was the joining of smaller plot units to form larger plots. The

author argues that urban regulations allow for verticalization. Urban plans establish rules for plots with minimum and maximum sizes with the possibility of high densities, promoting the merging of plots into tall buildings.

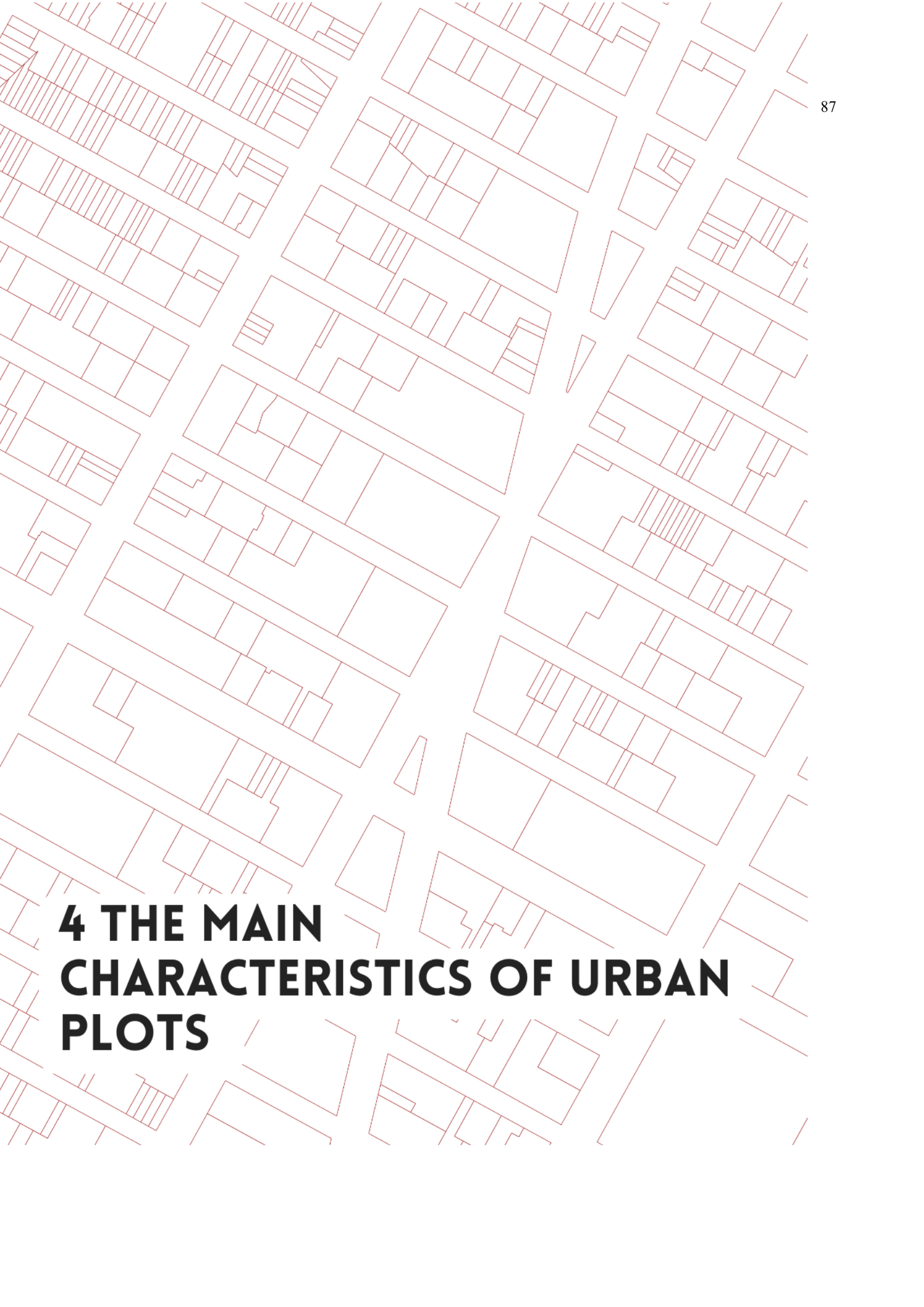
AlSadaty (2022) developed a study on a plot-based approach to morphological transformation in urban heritage contexts. The author argued that uncontrolled plot alteration promoted changes in building configurations and typologies, distorting heritage contexts; and advocated a plot-based strategy to maintain urban character in heritage contexts in Egypt. The case study was developed in the New Gourni area, Luxor, Egypt. The author argued that the plot-based approach could inform development plans and regeneration attempts in heritage value areas, to create responsive urban interventions. The author defended plots as a planning control tool, arguing that land plot control mechanisms represent an important planning tool and can contribute to the success or failure of urban areas. The case study identified, in terms of urban configuration: the merging of two or more plots; the subdivision of a main plot into derived plots; and the addition of street sections to original plots or the creation of plots that did not exist in the area's original design. The quantitative analysis included a study of the plot area, the boundary index, and the usable area rate. The author identified a considerable number of transformations of historical heritage buildings due to alterations in the physical boundaries of the plots. She concluded that mechanisms to control land subdivision should be included as planning management tools considering heritage contexts.

Table 6 presents a list of empirical studies that address the planning and institutional conditions of urban plots.

Table 6 - Research about planning/institutional dimension and urban plots

Source	Theme	Synthesis of study	Synthesis of results
Alterman (2013)	How do urban planning laws and development controls, especially in developing countries, affect social equity in cities.	It proposes a conceptual framework for understanding the regulatory layers of urban planning (land subdivision laws, zoning, density control) and reviews the existing literature on the effects of these regulations on the social composition of neighbourhoods, housing prices, and urban accessibility.	The impact of planning laws on social equity is mixed: while they can potentially promote urban justice, in practice they often favour dominant interests and reinforce inequalities, especially in contexts where regulatory enforcement is weak or value compensation mechanisms are not well defined.
Zeković <i>et al.</i> (2015)	How do urban planning instruments and institutional land regulation mechanisms influence the land market and urban expansion in a post-socialist society.	Institutional and spatial analysis of the Belgrade metropolitan area, combining a historical review of urban policies with empirical data on urban expansion, land consumption, and market mechanisms, to assess the relationship between existing planning instruments and the land market.	Extremely inefficient urbanization and uncontrolled urban sprawl. Belgrade's urban area has tripled in a few decades, with very high per capita land consumption. They conclude that institutional planning instruments have not yet been adequately transformed and that current urban land policy strongly contributes to urban sprawl.
Moroni <i>et al.</i> (2020)	It proposes that simple (and not overly complex) legal rules can offer greater spatial flexibility and legal certainty in urban planning, addressing the prevailing regulatory complexity.	Conceptual and normative analysis, reviewing the historical evolution of regulatory systems and comparing complex versus simple regulatory models, identifying principles for the development of more direct and effective rules.	They conclude that <i>simple</i> rules can reduce legal uncertainties, facilitate innovation and experimentation in cities, and promote more flexible planning without sacrificing predictability; they argue that such rules allow for accommodating real urban complexity, rather than burdening it with overly detailed regulations.
Domingo <i>et al.</i> (2021)	The study investigates how zoning plans affect the dynamics of urban land use, especially in terms of density and preservation of natural areas.	They used a model that combines cellular automata with multivariate logistic regression to simulate urban growth.	Zoning plans can effectively direct urban growth to areas already designated for urbanization, significantly reducing pressure on agricultural land and natural areas.

Zhao (2022)	Examine how legal restrictions on minimum plot sizes affect the urban redevelopment process.	A discrete-time dynamic programming model incorporating endogenous residential maintenance decisions was built to simulate developer behaviour under different minimum lot size constraints.	Zoning with minimum plot sizes delays the conversion of vacant land and slows demolitions; encourages developers to keep buildings longer; stabilizes the pace of urban regeneration and reduces housing turnover.
Jalali <i>et al.</i> (2022)	Analyse how different urban planning regulations dynamically affect housing and land markets.	It uses systems dynamics modelling to build a causal model, integrating housing, land, and construction markets, based on theoretical microeconomic and regulatory relationships.	Simulations show that strict urban growth limits increase land and housing prices by restricting supply. Minimum plot size requirements only have short-term effects and do not significantly alter prices over the long term.
Mottelson (2023)	How does urban planning influence urban form in contexts where urban laws and regulations exist, but their enforcement is limited, by comparatively analysing planned and unplanned settlements.	Geospatial surveys in three adjacent regions in the city of Maputo, Mozambique, comparing planned and unplanned settlements established more than 40 years ago under weak enforcement of urban planning regulations.	Planned areas had higher built densities, a greater proportion of public space, and wider streets on average than unplanned areas; the data suggest that road network planning and plot layout have a positive impact on urban form and the viability of infrastructure investments.
Wang <i>et al.</i> (2024)	The government-led urban renewal model in the city of Guangzhou, China, and how this renewal model affects older and less profitable residential areas.	An urban renewal project analysis was used, identifying and comparing different old residential blocks that underwent government intervention, conducting land use surveys, <i>stakeholder</i> interviews, and cost-benefit assessments of the intervention.	The government-led renewal model has proven effective in enabling projects in areas that the private market tended to avoid, aiding the physical and social restructuring of these residential areas; however, the study also highlights challenges related to resident displacement, the adequacy of existing infrastructure, and the need for appropriate institutional mechanisms to mitigate negative impacts.



4 THE MAIN CHARACTERISTICS OF URBAN PLOTS

4 The main characteristics of urban plots

Understanding the comprehensive meaning of plots requires a perspective that recognizes in them a set of attributes that shape the evolution of cities over time. As discussed in the previous chapter, plots articulate multiple dimensions of urban life. In this chapter, the focus is on the intrinsic characteristics of plots, the ways in which they transform, persist, structure, and influence the territory.

This chapter delves deeper into these essential characteristics, identifying their meanings, the ways in which they are analysed in the literature, and the methods and indicators used to empirically recognize them. Drawing from different fields of knowledge, examples are presented that demonstrate the strategic role of plot characteristics in urban development processes and territorial organization.

The chapter is structured into five subsections, each dedicated to a main characteristic identified in the literature review. The first subsection addresses the characteristics of *transformation*, discussing how plots constitute incremental units of change and how processes of subdivision, amalgamation, alteration of functions, or changes in real estate value reveal the continuous dynamics of the city. The second subsection develops the characteristic of plot *location*, understood as the relative position of the plot in the urban fabric and how its accessibility, connectivity, and proximity influence its value, uses, and city structuring strategies.

The third subsection examines *occupation*, which expresses the intensity of land use through the occupancy rate and the age of buildings - elements that highlight the relationship between built form, urban density, and development cycles. The fourth subsection explains the *control* characteristic, which concerns the forms of physical and institutional regulation of plots, conditioning both the urban experience and territorial governance. Finally, the fifth subsection deals with the *function*, analysing the functional diversity of plots and describing how the presence and combination of uses contribute to urban vitality and socioeconomic patterns.

Together, these five characteristics broaden the understanding of what plots represent for the urban system. They contribute to explaining how plots are organized and develop over time, reinforcing their structural and multifaceted nature.

4.1 Transformation

The transformative characteristic of plots refers to the capacity of these elements to change over time, reflecting economic, environmental, social, regulatory, and other pressures. Several authors in urban morphology highlight that the plot is the smallest territorial unit where urban transformations materialize, becoming a fundamental indicator of the evolution of cities (Conzen, 1960; Moudon, 1986; Kropf, 2017).

The transformative characteristic highlights the importance of continuously monitoring changes over time - changes such as the reconfiguration of plot boundaries, variations in land value, building density, and the dynamics of property rights. This transformative capacity is fundamental to ensuring that land remains functional and productive in the face of the most critical needs in economic, environmental, and social terms. Within this set of transformations, changes in permeability and vegetation cover also stand out, revealing the capacity of the plots to respond to environmental challenges, such as stormwater management and mitigation of the urban heat island effect, complementing the structural, legal, and economic changes observed in building density and property transfers. Thus, the transformation processes within and on the plot become determining factors and directly influence the different dimensions and characteristics related to the plots.

In this context, the reconfiguration of physical boundaries, through the division or amalgamation of one or more plots, expresses how different agents shape the territory according to their interests and the demand for construction. In situations involving large-scale developments, where investors are interested in verticalization or the construction of large condominiums, commercial galleries, shopping centres, among others, plots may undergo amalgamation processes. On the other hand, when the interest is in developing individual and small-scale developments, the process of plot division occurs. The possibilities for transforming plots have an impact on the dynamics of the immediate neighbourhood. In situations involving large-scale developments, congestion problems may occur in the neighbourhood, for example (Rojas Symmes, 2023); while a considerable number of plot divisions in a given area can promote urban vitality, if this plot division is combined with a considerable number of different uses and functions (Marcus, 2019).

Literature also documents how these processes manifest themselves in different urban contexts. In her classic analysis, Moudon (1986) identified significant transformations in the plot patterns of San Francisco (United States) as a result of strategies by large corporations that acquired several smaller plots and joined their physical boundaries for the construction of large buildings. The author reported that in the 1960s, plot sizes began to vary considerably. A single plot could accommodate several buildings, the number and size of plots became arbitrary, and their 'anonymous identity' became a good representation of public and private corporate ties.

In Figure 5, the two images are examples of representations of this transformation process identified by the author. While in San Francisco, between 1850 and 1890, large plots were divided into smaller plots for individual owners, from the 1890s to 1970, this process reversed, and the plots became 'invisible' properties and began to be amalgamated. In a more rigorous analysis, Moudon counts plots per block in different periods, namely 1899, 1931, and 1976,

identifying an almost equal number of plots in the 1890s and the late 1970s. ‘It is surprising to find in the study area the same number of plots as when the area was developing and in its full maturity as a built urban environment’ (Moudon, 1986, p. 98). New forms of construction were designed before the area was completely transformed. This means that the trend of amalgamating plots initiated the major structural changes that occurred in the 1960s, including the introduction of modern buildings (Figure 6).

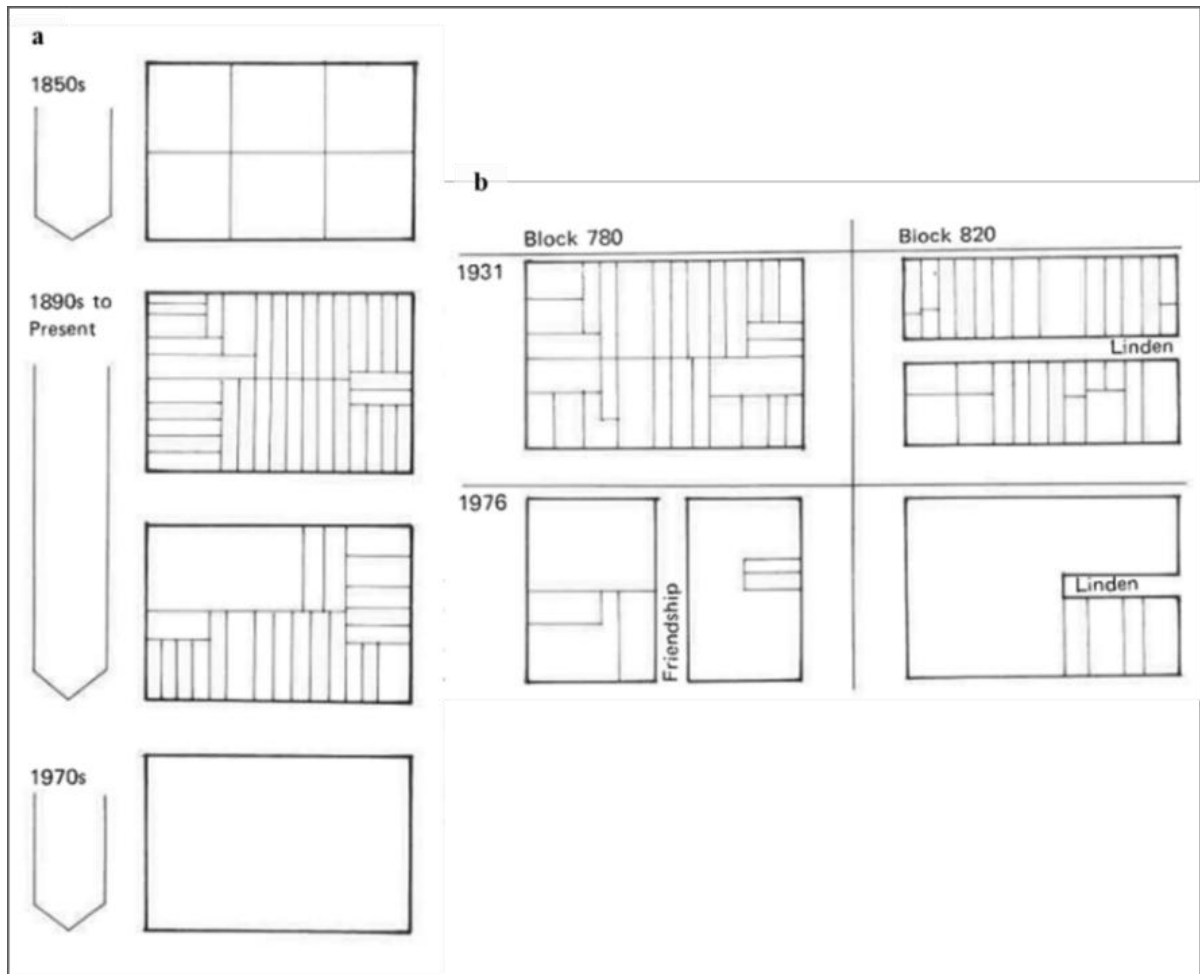


Figure 5 – Land division patterns between 1890 and 1970 (a); modifications to the division of plots between the years 1931 and 1976 (b). Source: Moudon (1986).

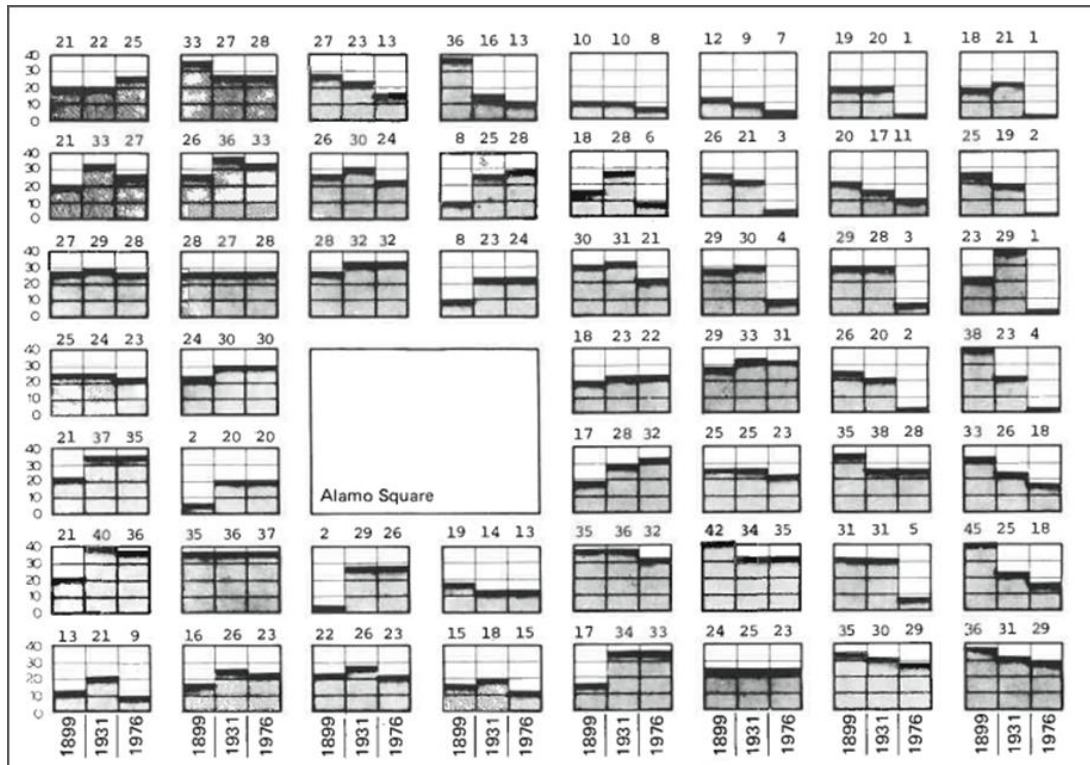


Figure 6 – Number of plots per block in Alamo Square in the years 1899, 1931, and 1976. Source: Moudon (1986).

Moudon (1986) argued that the size of the plot could determine the shape of residences, conditioning the design and placement of a given building (Figure 7 a and b). The size of the plot affects the occupation of the built environment, the building's placement, and its position in relation to the street. Furthermore, it also affects the variety of the built environment, because different owners construct different buildings, and these are transformed into different ways. In addition, the author emphasized that the plot functioned as a normative management element, regulating the location of residential buildings in the urban space. According to Moudon (1986), the analysis of changes in the urban form of San Francisco in the 20th century occurred especially in land subdivision, bringing changes in the form and organization of buildings. While in the 19th century, the subdivisions of plots corresponded to small limits of land intended for small-scale construction and building management, in the 20th century small-scale properties began to be unified into large plots with large buildings (Figure 7 c). The author also argued that the plot is an incremental element of change. City change occurs plot by plot. Thus, Moudon argues that the original plots have a determining effect on urban development. Plots are considered 'the basic module of urban space in which change occurs' (Moudon, 1986, p. 133). The reconstruction of the urban environment is part of a relatively slow and small-scale process that occurs within plots and incrementally, reinforcing the importance of the initial parcel design and pattern for implementation. A neighbourhood of small plots constitutes the property of many agents, who can influence how the urban environment is designed, maintained, and monitored (Moudon, 1985).

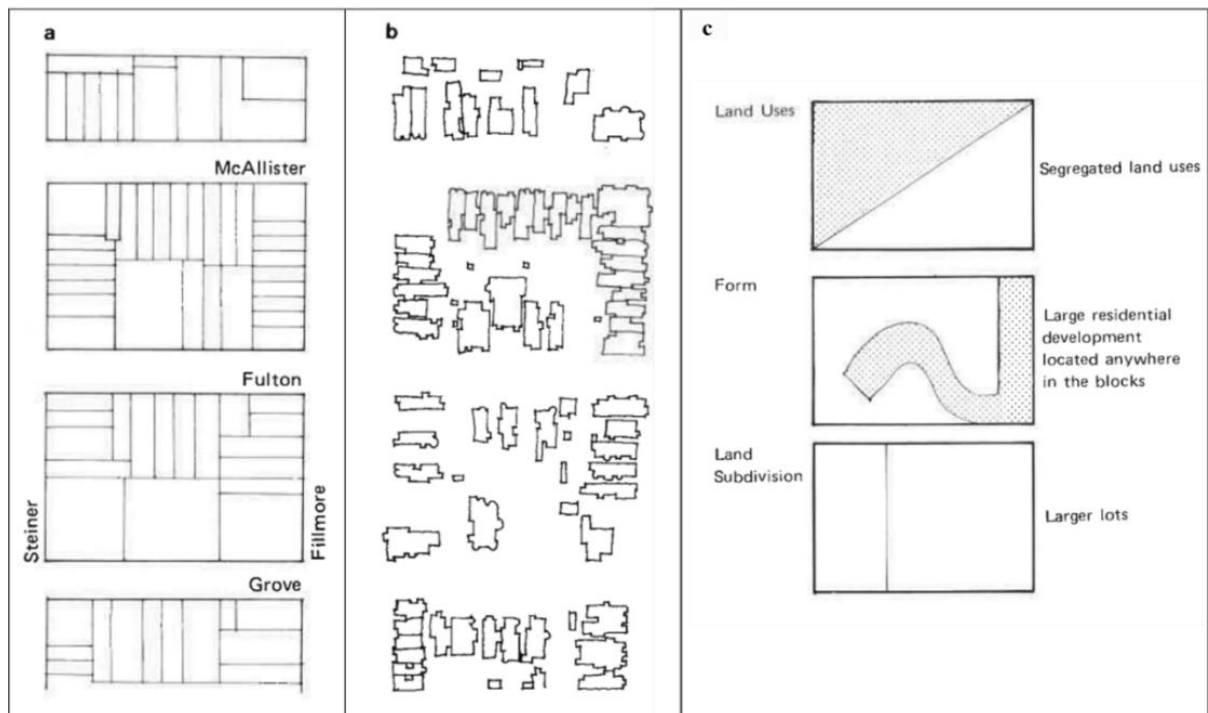


Figure 7 – Physical structure of the plots (a) and buildings (b) of Alamo Square in 1890; rules governing plot boundaries, form and use of Alamo Square in 1960. Source: Moudon (1986).

Conzen (1960) conceptualized the process of plot transformation as *metamorphic* or *hypermetamorphic*. Metamorphic plots undergo a process of amalgamation or plot division. *Hypometamorphic* plots undergo only minor changes in their boundaries. Whitehand *et al.* (2016) developed a comparative analysis, with a historical-geographical focus, of Como (Italy) and Pingyao (China), mapping the changes in the elements of the city plan. Regarding plots, the authors highlighted the lack of cadastral data and maps on Chinese plots, a characteristic related to the political system. One of the highlighted analyses of this work was the comparison for the recognition of three plot classifications (Figure 8). The first was the variation between plots that are more persistent in their boundaries (or original plots), called *orthomorphic*, and those that are slightly altered (*hypometamorphic*). The second was the radical transformation of the plots through the process of amalgamation or division, called *metamorphism*. The Pingyao plots were characterized by a certain regularity in their boundaries, while the Como plots were almost entirely irregular (Whitehand *et al.*, 2016).

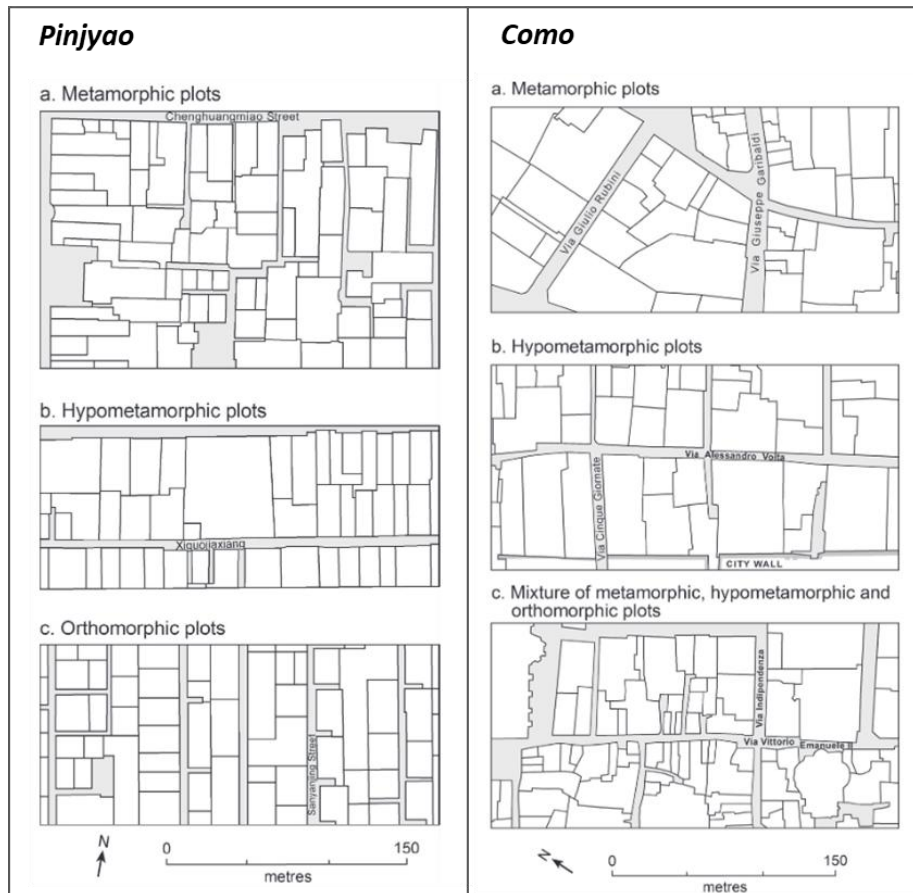


Figure 8 – Plot patterns in the cities of Pingyao, China (left) and Como, Italy (right).
Source: Whitehand *et al.* (2016).

Cantarino and Netto (2017) conducted research on the process of urban transformation, diversity, and microeconomic growth. The case study was the Brazilian Popular Housing Program ‘*Minha Casa Minha Vida*’ in Rio de Janeiro, Brazil. This work was developed in three parts: an analysis of the degree of microeconomic support that the built environment can offer to residents; the morphological and functional interfaces of the new housing complexes and their surroundings; and the impacts of these processes on the economic diversity of the immediate environment. One of the most relevant results was the importance of land plots in this process. The authors argued for the significant influence of land subdivision on land use change in urban expansion areas. The infrastructures of architectural morphology, namely, property plots, seem to participate in the very process of urban transformation, allowing changes to occur or not. This leads to the thought that the structures of the plots, especially their size, may facilitate or not the change in land use and the densification of the urban form (Cantarino and Netto, 2017). The authors argued for the identification of microeconomic activities and diversity concentrated on streets where the subdivisions are small and directly facing the street front.

The transformation of urban plots is a continuous process, which occurs incrementally and often over considerable time intervals, and articulates historical, economic, environmental and regulatory forces. Table 7 presents a list of research that studies the processes of urban transformation of plots and within plots, showing the existence of different transformation processes.

Table 7 - Research about transformation and urban plots

Source	Theme	Synthesis of study	Synthesis of results
Brooks and Lutz (2016)	This study investigates whether there is sufficient consolidation of various land plots to allow the land to be used to its maximum potential, focusing on the urban land market from the perspective of competition, barriers, and institutional frictions that can impede the most efficient use of land.	Data from land transactions in Los Angeles, identifying parcels that were sold for amalgamation and comparing their prices with land sold for other purposes. Controlling variables such as location, zoning, and parcel characteristics, to estimate the value paid for land intended for amalgamation.	The authors found that combining several plots to form a larger plot of land is a difficult and costly process. The plots that end up being used for this type of aggregation are sold for a price 15% to 40% higher than regular plots. This happens because it is complicated to convince multiple owners to sell at the same time.
Ünlü and Baş (2017)	The study investigates the morphological processes that occur in the residential areas of Turkish cities, with an emphasis on the transformations of plots and blocks over time.	Historical data and land use maps of residential areas in Turkish cities were analysed, comparing changes in the size, shape, and subdivision of plots over different periods. Morphological analysis was based on historical plotting data and interviews or documentary sources to understand the mechanisms of transformation.	Plots have undergone significant subdivision and morphological reconfiguration over time, often driven by real estate pressures and urban densification. It has been observed that the original pattern of the plots has been altered by planning policies, residential expansion, or infrastructure changes.
Karaman <i>et al.</i> (2020)	It proposes the concept of plotting urbanism, a form of urbanization that occurs plot by plot, characterized by incremental urban expansion, conflicts over territorial regulation, and local negotiations, particularly in emerging or peripheral cities.	They conducted a comparison between three cities, using a combination of empirical data, field observation, and institutional analysis to identify <i>plot by plot</i> urbanization patterns. They mapped land tenure regulation processes, property rights, and territorial conflicts.	They discovered that plot urbanism manifests itself as a gradual and fragmented process, lacking comprehensive planning, but marked by local negotiations between agents with different land rights. There are constant conflicts between normative modes (legal status, informal law, traditional practices), which generate specific territorial compromises.
Tümtürk <i>et al.</i> (2024)	This study analyses how different types of land plots relate to the physical changes in urban form in three cities (New York, Melbourne, and Barcelona) over a period of time.	The types of plots in each city according to criteria of shape, size, and use, and mapped the physical evolution of these plots over several decades, using historical and modern cartographic databases. They applied statistical analysis to relate plot type to the degree of physical change.	More fragmented (small, irregular) plots tend to undergo more intense physical changes than larger, homogenized plots. Plot type is an important determinant of urban transformability, suggesting that land subdivision and densification policies need to take into account the <i>granularity</i> and morphology of existing plots.

Chen <i>et al.</i> (2024)	This study examines the spatial variation in the conversion of industrial land in China and analyses the factors influencing these transformations, highlighting the impact on urban planning and regional development.	The study uses a combination of spatial analysis and statistical modelling to examine industrial land conversion.	Distinct spatial patterns emerge in the conversion of industrial land, with some areas more prone to change than others. Factors such as proximity to infrastructure, urban density, and planning policies have a significant effect on the probability of conversion. The analysis highlights clusters of industrial transformation.
Herrera-Benavides <i>et al.</i> (2024)	It addresses the spatial patterns and determinants of the subdivision of rural land into zones of high biodiversity value.	The study used spatial and land-use data to map where land subdivisions occur in a key biodiversity region. It then applied statistical models to identify the main factors (such as urban expansion, infrastructure, and regulation) driving these subdivisions.	The results indicate that most land subdivisions are strongly linked to urban expansion processes and access infrastructure, regardless of existing legislation. Subdivisions tend to occur in areas with less regulatory control, suggesting that legislation is being circumvented.
Bertolino and Oliveira (2025)	This study examines how urban plots adapt over time, considering three fundamental dimensions (morphology, functionality, and property rights), and proposes a quantitative method (the Plot Adaptation Index) to measure this adaptive capacity.	The study develops a quantitative method based on three criteria: morphology, functionality, and land ownership rights. For each criterion, sub-indices are created that measure variations in the physical form of the plots, the evolution of their uses, and the number of property transfers over time.	The results show that 60% of New York City plots underwent some type of adaptation between 2002 and 2024. Manhattan stands out as the borough with the highest relative proportion of highly adaptive plots, while Staten Island has the lowest values. The study concludes that plot adaptation is uneven and influenced by historical, economic, and legal factors.
Tümtürk (2025)	This research investigates how the configuration of urban plots, not only their individual forms but also the relationships between neighbouring lots, influences the dynamics of change and persistence in the city's form, testing the <i>neighbour effect</i> hypothesis.	This is a longitudinal morphological database for Midtown Manhattan, covering the period from 1890 to 2021, recording building replacements. It measures both individual geometric variables of plots (size, shape) and configurational variables (such as connectivity and relational configuration between plots).	The likelihood of a plot changing (or remaining the same) depends more on its relationships with neighbouring plots than solely on its individual characteristics. Plots with high levels of mutual support (or connectivity) with neighbours are more prone to persistence or transformation according to specific patterns.

4.2 Location

Some urban plots take on much greater importance than others, not only due to trivial choices, such as the memory of a landmark restaurant, but also because they house symbolic facilities, such as a theatre or a central cultural point of the city. This prominence largely stems from a fundamental characteristic of plots: *location*. Defined as the relative position of a plot in relation to other plots and elements that make up the urban fabric (transport networks, commercial areas, services, employment zones, etc). This spatial characteristic confers on the plot not only economic value, derived from its attractiveness for investments and commercial uses, for example, but also cultural value, by integrating symbolic meanings and collective functions in the urban space (Qadeer 1981, Webster and Lai 2003). These characteristics are associated with the accessibility of the plot, represented by the best location of a plot in terms of cost-benefit (O'Sullivan, 1996; Sevtsuk *et al.*, 2016).

From an economic point of view, location is one of the main determinants of a plot's value. Location is one of the criteria that contributes to determining the economic value of a plot. Qadeer (1981) highlights that location constitutes the most distinctive attribute of urban land, defining the position of a plot in relation to others and influencing the arrangement of adjacent uses. For example, the presence of a commercial use on a given plot can attract or displace nearby commercial, residential, or institutional uses. This accessibility is rooted in economic, social, and technological interdependencies, and underlies the so-called 'urban land paradox': a plot on a main street may prosper commercially, while another, with seemingly equivalent characteristics, remains undervalued due to lower demand. Qadeer (1981, p. 178) observes that 'little is known about these micro-variations of plots', highlighting the complexity of understanding the heterogeneity of urban land.

Accordingly, O'Sullivan (1996) reported that the price of urban land is determined by the accessibility of the plot location to other activities. The price of land decreases as urban plots are further away from the city centre. The author identified that the median location of a plot between points of interest has the minimum travel cost and the maximum rental cost and argues that plots with lower transportation costs due to high accessibility nevertheless have high rental costs.

Furthermore, the importance of plot location has been reiterated by an increasingly robust set of urban facilities and infrastructure that reinforce its centrality in the production of land value. Among these factors, accessibility to essential services such as education, health, commerce, leisure areas, and administrative centres stands out, reducing travel time and increasing convenience for residents and businesses. Empirical studies show that proximity to services and the density of urban infrastructure - road networks, sanitation, telecommunications, and public facilities - have a direct impact on plot pricing, generating significant locational values in more integrated areas (Debrezion *et al.*, 2007; Zhang, 2023).

Location also promotes cultural value. It is from the construction of space, and the decision of how this space will be developed, together with the people who are occupying and developing it over time, that culture is created and continued. Cultural value is attributed based on the importance of the historical, emotional, social, and symbolic factors of a locality (Golany, 1995;

Sepe and Pitt, 2014). This characteristic creates local identity. The way a community or region perceives itself and is perceived by others, based on its distinctive characteristics and shared experiences (Erickson and Roberts, 1997; Chen and Romice, 2009). This entire process largely occurs through the organization of plots. The way plots are designed in space, organized and experienced, and how they relate to each other, plays an essential role in local identity, influencing the formation and cultural expression of a given place. The plot is the recipient of the manifestation and materialization of idealizations developed by a group of residents in a community, through its existing physical and social environment (Porta and Romice, 2010; Slomska-Przech and Slomski, 2022).

The theory of spatial syntax contributes to reinforcing the understanding of plot location by demonstrating that urban value depends not only on the physical distance from services, transportation, or employment centres, but also on the configurational position of the plot within the city's spatial network. Hillier and Hanson (1984) argue that urban configuration structures patterns of movement and social interaction, which can directly influence the economic and cultural potential of plots. The concept of natural movement (Hillier *et al.*, 1993) shows that more integrated streets attract a greater flow of people, favouring the establishment of economic activities and symbolic functions, thus increasing locational value. Subsequent research (Sevtsuk, 2014) confirms that highly accessible areas from a configurational point of view are more likely to concentrate commerce, services, cultural activities, and socially significant uses. Marcus (2010) used configurational measures of spatial integration and accessibility to urban plots, which allowed him to assess the overall accessibility between spaces and the accessibility to specific content associated with each plot. The author found that the position of a plot in the urban network explains significant differences in density, diversity, and socioeconomic performance (Figure 9). Table 8 presents a selection of studies on location and urban plots.



Figure 9 - The variations of urbanity according to the definition of spatial capital as accessible diversity, where spatial diversity is measured as the amount of accessible plots within a radius of three axial lines (top), and spatial integration and capacity overlaid in one map, showing the continuous variations of spatial capital (bottom).

Source: Marcus (2010).

Table 8 - Research about location and urban plots

Source	Theme	Synthesis of study	Synthesis of results
Sevtsuk <i>et al.</i> (2016)	This research investigates how the morphology of city blocks, plots, and streets influences pedestrian accessibility, essentially determining how many plots pedestrians can reach and how movement opportunities vary depending on morphological dimensions.	The pedestrian accessibility index measures the number of accessible plots within a given radius. It models different regular grid configurations by systematically varying the dimensions of the block, plot, and street width. It uses quantitative analysis to relate these morphological variations to the accessibility index.	Plots with smaller frontages and shallow depths significantly increase pedestrian accessibility. Smaller blocks also improve accessibility, as they reduce the distance between intersections. Street width has less influence than lot and block size, although narrower streets contribute moderately to higher density of accessible plots.
Gao <i>et al.</i> (2017)	This article investigates how to define and extract functional urban regions using Points of Interest (POIs) data and human activity on location-based social networks, in order to better capture the true function of urban spaces.	Collecting data from Points of Interest (POIs) and user check-ins to build a thematic set of locations and activities. They applied the <i>Latent Dirichlet Allocation</i> (LDA) model to infer latent topics representing urban functions based on the co-occurrence of POI types and user behaviour.	They found several distinct <i>functional topics</i> that combine types of POIs and check-in patterns, suggesting latent urban functions such as commerce, leisure, housing, work, etc. They showed that the same region can have multiple functions, with different probabilities. They also identified that similar types of functional regions can be located in non-contiguous areas of the city, indicating that urban function does not strictly follow administrative or geometric boundaries.
Berghauser Pont <i>et al.</i> (2019)	Quantitative typologies for streets, plots, and buildings in five European cities, focusing on the spatial distribution and frequency of these types to understand urban morphological patterns and test classical theories of urban morphology.	The authors collected geometric and relational data for streets, plots, and buildings in five European cities. They used multivariate analysis to cluster typologies of streets, plots, and buildings based on these variables. They constructed intercalary typologies that relate streets, plots, and buildings, that is, they combined geometric descriptions with relational descriptions.	Several distinct typologies exist for plots in each city, differentiated by variables such as built density, size, and type of land division. Certain plot types tend to be associated with specific street and building typologies, indicating coherent morphological patterns. The spatial distribution of these typologies reveals that some plot types are more common in central areas while others predominate in peripheries or intermediate neighbourhoods.

Bobkova <i>et al.</i> (2019)	To develop data-driven classification methods that translate the morphological properties of batches into measurements that reveal their systemic and structural characteristics.	Transition from geometric to configurational plot descriptions, using data-driven clustering techniques to classify plot typologies. The methodology translates fundamental plot properties into three main configurational measures that quantify the role of location in the system: accessible number of plots, accessible plot frontage, and accessible plot compactness.	Successful demonstration that analytical typologies, based on configurational measures, are robust in quantifying the systemic role of plot location within the urban fabric.
Amen (2022)	This article investigates how the physical characteristics of buildings influence the centrality of the urban network, proposing that not only the street network, but also the associated buildings and plots, alter measures of spatial centrality.	Defining a weight for buildings based on their physical characteristics using GIS data to quantify these qualities. Then, modelling a weighted urban network where nodes take these weights into account, and calculating the betweenness centrality using statistical packages in R.	The results show that the architectural characteristics of buildings, and the associated plots, have a significant effect on the centrality of the urban network. Specifically, when the building is considered, a negative effect on centrality is observed, suggesting that more <i>heavy</i> buildings are less central in the sense of the network. This implies that such locations are less accessible or less likely to play a central node role in the urban network.
Wu <i>et al.</i> (2025)	This work proposes a new way of measuring urban centrality based on the propensity for dynamic interaction, reflecting not only the physical structure of the urban network but also short-term social and mobility flows.	Mobility data are used to estimate the frequency and intensity of interactions between urban locations at different time scales. They define a metric of <i>dynamic interaction propensity</i> that captures how likely two locations are to interact in a short period of time, rather than just connecting structurally. They then apply statistical models to monitor how this propensity varies over time and space, generating measures of urban centrality that reflect the flows.	The study reveals that many urban centres that appear central in static or morphological analyses are not necessarily the most central in terms of dynamic interaction. Some locations have a high propensity for short-term interaction, suggesting that they are ephemeral social meeting points rather than permanent centres. Dynamic centrality also shows temporal variations; certain locations pulsate as <i>centres</i> at certain times, but not at others.

4.3 Occupation

The land use pattern of urban plots is a central element in the production and organization of urban space. It refers to the various ways in which urban land can be used and transformed, as well as the intensity of this transformation, primarily expressed by built density. This land use manifests itself in built forms, constructed volumes, and the dynamics of land use that emerge from these configurations, directly influencing urban vitality, the efficiency of public services, and the quality of the built environment. In practical terms, land use corresponds to how urban agents - residents, investors, owners, and public authorities - materialize the appropriation of land, defining patterns of densification, morphology, and use that shape the structure of each plot and, consequently, the city as a whole. This characteristic refers to the three-dimensional space of the plot, which can be transferred and added to for the purpose of land use. Beyond existing as a part of the land, the plot also exists as a space above that land, allowing for occupation through multi-story buildings. The plot as a space is defined at the planning stage, through decisions regarding the construction potential and maximum height of the development zones.

Although numerous forms of land occupation exist, including informal, irregular, or those resulting from specific socioeconomic dynamics, the predominant occupation in contemporary cities is that regulated by formal urban planning instruments. Norms such as zoning and building regulations establish fundamental parameters, among which the following stand out: the floor area ratio, the occupancy rate, the maximum building height, and permitted uses. These parameters determine not only the buildable volume but also the resulting urban form, ensuring that land occupation develops in a manner consistent with objectives of densification, mobility, environmental preservation, and a balance between infrastructure and urban demand.

The occupation of plots, however, is not limited to the two-dimensional dimension of the land, as it also involves its three-dimensional dimension, which defines the potentially buildable vertical space. Thus, the plot exists simultaneously as a surface and as a volume: it is at the same time the *land* and the *airspace* above it, where successive floors can be built. This three-dimensionality is an essential component of urban planning and is explicitly established in master plans and land use laws, which determine the building potential and maximum heights in each zone of the city. As Qadeer (1981) and several morphological authors observe, the combination of plot area and buildable volume is crucial for defining the density and local socioeconomic structure.

Urban zoning thus produces a wide diversity of occupancy possibilities among different plots. Two plots with identical areas may present completely different capacities for the production of built space: one may allow buildings of only three stories, while another, located in a preferential densification zone, may authorize buildings with twenty stories or more. This difference directly impacts real estate profitability, mobility patterns, the urban landscape, and the capacity to attract economic activities. For this reason, maximum height and construction potential are essential characteristics of the plot, as they represent the total volume it can occupy and condition both its physical density and its function in the urban structure.

Built density, expressed as the ratio between built area and plot area, allows for the assessment of land use and its relationship with housing density, employment density, and the intensity of urban flows. A plot of land may not be established on the surface of the ground; a layer of the surface of space is all it can represent. For example, an apartment on the third floor of a condominium tower is a plot of urban land that exists as a layer of space. This means that the plot is not just a piece of land, but also all the space existing above that land (Djankov *et al.* 2022). In most countries, there are building potential rules for the development of plots. In addition to rules such as utilization coefficient, occupancy rate, and maximum height, the plot is capable of transferring the right to build (Dovey and Pafka, 2014; Berghauser Pont and Haupt, 2023). Madsen and Paasch (2023) investigated how real estate law recognizes these verticalized properties in different jurisdictions, such as Canada, Denmark, and Sweden. The authors analysed specific legislation and showed that it is possible to have common management and individual rights over overlapping parts of the building and the land, highlighting the evolution of the concept of *layered property*.

Transfer of Development Rights (TDRs) have become established as a strategic instrument in several countries, aimed at balancing preservation and urban development. In areas with building restrictions, such as historical or environmental zones, the originating landowner can transfer their surplus building potential to a receiving landowner capable of absorbing greater density. Recent studies have shown that well-structured TDR programs promote urban integration, preserve sensitive areas, and reduce pressures for urban expansion, although they depend on transparent markets and solid regulatory frameworks to prevent speculative valuation or distorted use of the instrument (Serra, 2021; Wang *et al.*; 2023).

In the Brazilian and Latin American context, the onerous granting of the right to build (OODC) plays a role similar to the sale of additional building capacity, allowing owners to acquire, through financial compensation, the right to build beyond the basic potential foreseen for the plot. Research shows that OODC can be a powerful tool for urban financing and territorial equity, but its results vary widely among municipalities, depending on factors such as governance, calculation criteria, transparency in the application of resources, and the adequacy of infrastructure in areas suitable for additional densification. When poorly applied, it can deepen inequalities; when well-structured, it contributes to redistributive investments and improvements in urban infrastructure (Bacellar and Furtado, 2016; Furtado and Maleronka, 2023).

Table 9 presents a list of research studies that examine the different processes of occupation of urban plots.

Table 9 - Research about occupation and urban plots

Source	Theme	Synthesis of study	Synthesis of results
Asami <i>et al.</i> (2006)	This study examines how restrictions on floor area ratio (FAR) in residential plots, defined by zoning and building form controls, influence urban land prices, particularly in Tokyo.	Regression with a sample of residential plots to estimate the effect of the effective FAR (the lower of the zoning FAR and the FAR allowed by form controls) on the price per square meter of land. They also evaluate variables such as plot size, street width, plot shape, and environmental characteristics.	Plots with very low or relatively high effective FAR are significantly cheaper than those with intermediate effective FAR. The low price of plots with reduced FAR is linked to severe restrictions on buildable space, while in plots with higher FAR, depreciation may reflect less attractive landscapes. The analysis also shows that, for many plots, the limiting factor is form control, suggesting that regulations could balance density and market value.
Ahmadian <i>et al.</i> (2019)	This study explores how different urban forms relate to density indicators, specifically plot ratio and land cover, to offer a more informed urban planning tool for sustainable cities.	Generic models of four urban forms varying geometric parameters such as number of floors, plan depth, and cut angle. Based on these models, they constructed a method that graphically maps the relationship between these geometric variables and density indicators.	The analysis shows that different urban forms result in distinct densities. The graphs allow for a comparison of how density changes as geometric parameters vary. In real-world cases, no strong relationship was found between city climate and the studied forms and densities, suggesting that form and density profiles are relatively stable regardless of climate. The authors propose that this method can be used to guide urban policies.
Angel <i>et al.</i> (2021)	Decomposition of average urban density to identify the factors that compose it, in order to explain why different cities, have similar densities through distinct mechanisms.	A methodology for <i>factoring</i> urban density, breaking it down into three or seven factors that, when multiplied, reproduce the total density. In ten cities from different regions of the world, they measured each of these factors using a combination of satellite image analysis and secondary census data.	The results show that cities obtain their density in very different ways: one city may have high density due to tall buildings, another due to high occupancy rates per dwelling, and yet another due to large residential lot coverage. The correlations between urban density and the factors that compose it are weak, indicating that density should not be interpreted as a single measure without considering its subcomponents.

Razak and Yin (2021)	Study the extent to which plot ratio (building index) regulation is being implemented in George Town (Penang) and how this influences land use distribution.	The authors conducted field observations to measure building heights on two distinct streets in the city and used GIS software to map the buildings' compliance with aspect ratio limits. They cross-referenced the height data with land use zones (residential, commercial, etc.) to assess the effectiveness of the control regulations.	In predominantly residential streets, many buildings reach the maximum height limit, while in other areas only a small percentage meet this limit. Compliance characteristics depend heavily on building height, land use typology, and the compatibility of architectural forms with standards. They conclude that current rules are insufficiently detailed and recommend more precise regulations.
Munasinghe <i>et al.</i> (2021)	It proposes a new approach to urban regulation that replaces the exclusive use of the floor area ratio (FAR) with an indicator called Zone Factor, aiming to distribute density more equitably among plots based on lot characteristics to promote sustainable development.	A critical analysis of the current zoning and building regulations in Sri Lanka, identifying their regulatory limitations. They define an alternative model: they calculate the Zone Factor (expected density per zone) based on the total foreseeable floor area and propose a formula to assign each plot its Permissible Floor Area, considering plot size, street width, plot frontage, and the portion of land left undeveloped.	The proposal provides a transparent and fair way to determine building rights for individual property owners, aligning them with the desired overall density for each zone. It encourages the conservation of open spaces, favours larger plots, and recognizes the importance of street frontage. The method can improve density control, make regulation fairer, and be adapted to different urban contexts, although it is acknowledged that it would need to be complemented by other rules to address all challenges.
Pamungkas <i>et al.</i> (2023)	This study investigates the relationship between the floor area coefficient (FAR) and the sustainability of urban life in a central city block of Yogyakarta, exploring whether the observed FAR values are compatible with sustainable densification patterns.	The <i>Urban Modelling Interface</i> (UMI) software was used to simulate the study area, inputting data such as building function, number of floors, dimensions, total floor area, and plot area. Based on this, UMI calculated the FAR for different zones of the block, in addition to allowing automated visualizations and measurements.	The average FAR obtained in the observed areas was approximately 1.125, well below the local standard limit (4.00). Among the four zones, the values varied: the most densely built zone had a FAR of 1.71, while the least dense was around 0.82. These results suggest that the current arrangement of buildings ensures housing sustainability without saturating the land, and that the FAR limit stipulated by the municipality (4.00) may serve more as a long-term guideline to allow vertical growth than as an immediate goal.

Lagarias <i>et al.</i> (2024)	Methodology for estimating urban occupancy using cadastral plot data integrated with building footprints.	They combine geodata from cadastral plots with building footprints to define the minimum unit of analysis and calibrate this model against other pixel-based methodologies; they test the approach on two islands in the South Aegean; and they compare the results of the methodology with those of traditional methods.	The analysis reveals that traditional methods can underestimate urbanized areas by up to 80–90%; using cadastral plots as the unit, a much more significant expansion of urban development since the mid-20th century is identified; the authors argue that more realistic estimates like theirs can underpin more effective planning policies.
El-Husseini <i>et al.</i> (2025)	This review examines the existing literature to investigate the relationship between the floor area index (FAR) and the urban microclimate, particularly in terms of outdoor thermal comfort, in the context of Egyptian cities.	This study uses a deductive approach to analyse academic articles on FAR, building height, roof area ratio, and thermal comfort. Relevant studies were identified, categorized according to two main schemes, variations in FAR and fixed heights, and the factors influencing thermal comfort at ground level were analysed in relation to their interaction with FAR.	The FAR has complex effects on the urban microclimate: it can affect radiance, ventilation, and the relationship between height and plot cover in ways that influence thermal comfort. In certain arrangements, a higher FAR can improve ventilation and reduce direct radiation, but depending on the height and volumetric density, it can also worsen surface heating.

4.4 Control

Control is a central characteristic that determines who has access to the *interior* of a plot and who can influence transformation processes, the physical boundaries of the land, and the built environment (Akbar, 1988; Kropf, 2018). Different forms of control are directly related to property rights. While an owner exercises total control over the use and transformation of the plot, a tenant has restricted rights, defined by agreements with the owner. Furthermore, control of a plot is conditioned by urban policies and plans, which establish strategies, rules, and parameters for development. These regulations determine restrictions such as minimum and maximum plot limits, front, side, and rear setbacks, occupancy rate, and utilization coefficient, among others. From this perspective, the capacity to control a plot can be understood as the ability to determine access for people or objects, the type of land use, internal organization, and other decisions related to space management.

It is important to highlight that control does not necessarily imply ownership, although the owner holds authority over the most relevant decisions regarding the plot, including who uses it, whether themselves or third parties through usufruct. Control is generally established at the interface between the owner (legal dimension) and the plot (morphological dimension) and may also involve a third party authorized by the owner. Moudon (1986) identifies two forms of relationship between ownership and control: possession and dwelling, both limited by defined spatial territory. In this context, the plot and the building constitute ownership, defining the physical limits of possession. Throughout the life cycle of a plot, control manifests itself in different stages, including design, construction, use, transformation, and demolition of buildings (Moudon, 1986).

Akbar (1988) deepened the analysis of different forms of control based on the concept of *claim*, which is based on the ‘plurality of using, possessing, or controlling an object’ (Akbar, 1988, p. 19). In this study, the author organizes control into five main categories. In the unified form, the same party possesses, controls, and uses the property; in the dispersed form, each claim (use, possession, and control) is in the hands of different parties; in the permissive form, the user must relate directly to whoever possesses and controls the plots; in the possessive form, the user and the controller need to deal with the owner; and, finally, in the tutelary form, the party exercising control relates simultaneously to the user and the owner. This typology highlights the complexity of control relations, showing that power over a plot can manifest itself directly or mediated, individually or shared, and that the legal, social, and physical context of the plot profoundly influences these dynamics (Figure 10).

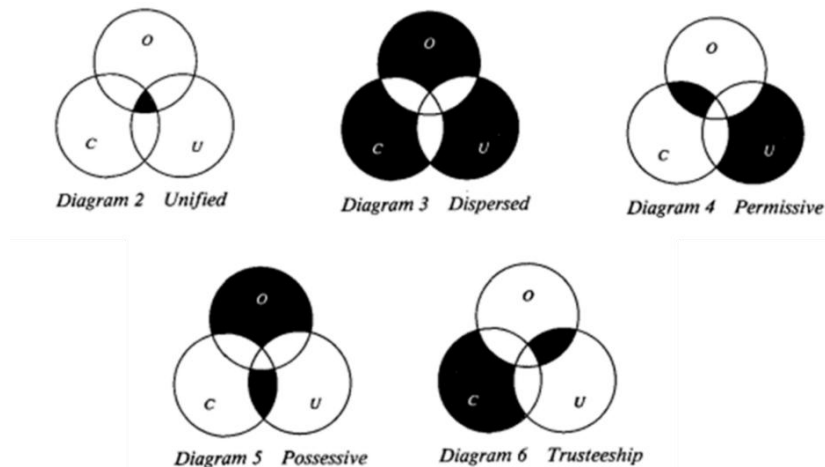


Figure 10 – Different forms of control presented by Akbar⁹. Source: Akbar (1988).

Habraken argues that the plot constitutes one of the main control structures of the city, as it organizes the relationship between property, occupation, and transformation of urban space. For the author, the plot is a land unit that establishes rights, responsibilities, and limits for the actions of different agents, influencing the type of building, the intensity of changes, and the permanence of the urban form over time. The control exercised by the plot system occurs in a decentralized and incremental manner, allowing owners and users to promote adaptations within a relatively stable structure, while elements such as streets and blocks offer more permanent support (Habraken, 1998).

Kropf (2018) argued that the fundamental basis for defining a plot as property is rooted in human behaviour and interactions with the environment. The author presented control as one of the essential attributes of a plot, conceptualizing it as ‘the relationship of the capacity or power to determine who can gain access to and use an area of urban land or built form’ (Kropf, 2018, p. 3). For Kropf, there are two behavioural forms of human beings associated with the plot: the use and the control of space. Use is associated with doing something, the relationship between human activities and the forms created to accommodate these activities. Control is associated with the capacity to have power over the plot and to determine who can obtain the right to use and transform it. In this work, Kropf analyses the variability of plot boundaries in four situations: (1) subdivisions of property without corresponding forms; (2) subdivision of form without corresponding property divisions; (3) overlapping control areas; (4) invasions. Regarding the first situation, the author presents the example of the French system. In France, a given plot can be subdivided for the purpose of assigning title to different people or for tax collection. In this case, there are more property subdivisions than physical boundaries. In the second situation, the author exemplifies the existence of inconsistencies between physical and cadastral boundaries, illustrating it with communist governments. In this case, the land is declared inalienable and the right of private ownership of the land for the purpose of buying and selling is removed. In the third situation, the author presents plots of collective occupation,

⁹ Where “o” is seen it means ownership, where “c” is seen it means control, and where “u” is seen it means use.

such as residential and commercial condominiums. In this case, the movement surfaces offer access to multiple plots, this common space being controlled by all the owners of the condominium. In the last situation, invasion corresponds to the occupation of land use without the owner's permission. The author describes occupation as a primitive form of control, with the idea of property being a later response, offering the notion of a right of occupation recognized and regulated by a social group. Table 10 presents a list of studies that examine different types of control in plots.

Table 10 - Research about control and urban plots

Source	Theme	Synthesis of study	Synthesis of results
Love and Crawford (2011)	This research analyses how parcelling (creative subdivision of plots) can be used as an urban design tool to shape the character of new urban districts, promoting architectural diversity and the participation of different development actors.	Case studies in Sweden, the Netherlands, and Dubai analyse parcelling strategies. Maps show different sizes and shapes of plots within large development blocks, and an assessment of how these divisions influenced financial viability, developer diversity, and the quality of urban space. They also discuss institutional arrangements necessary to make these subdivisions economically viable and urbanistically rich.	They demonstrate that dividing large-scale blocks into smaller plots facilitates the participation of multiple developers, which fosters typological diversity. They show that, to balance market pressures with urban quality, a strong regulatory framework is needed to control how plots are divided.
Liu <i>et al.</i> (2020)	How do planning authorities and developers negotiate with individual owners of small plots when there are densification projects, given the potential resistance of these owners to increased land use.	A comparative case study is conducted in two cities (Thun, Switzerland, and Utrecht, Netherlands) using interviews, institutional analysis, and analysis of densification projects to understand how planning regimes shape the management of property rights at the plots level.	The economic interests of large landowners and developers are often framed as public interest, with justifications such as housing construction or sustainability, which legitimizes the imposition or negotiation favourable to large players. Control is not only physical, but also institutional and political.
Bouwmeester <i>et al.</i> (2025)	This research investigates how urban planners, public authorities, and developers deal with the property rights of individual owners of small plots in densification projects, especially when these owners resist proposals for more intensive land use.	The authors conduct a comparative case study in two cities: Thun (Switzerland) and Utrecht (Netherlands). They analyse project-based development plans, interviews, and institutional strategies to understand how different regulatory regimes and planning norms shape negotiations with small plot owners.	It is observed that many individual property owners are excluded from densification negotiations, their objections being framed more as obstacles to be managed than as rights to be respected.

4.5 Function

The function of a plot represents its capacity to organize activities and uses, meeting individual and collective needs (Conzen, 1960; Kropf, 2018; Peng *et al.*, 2022). This function manifests itself in two ways: as a micro-system, where the plot operates independently, and as a macro-system, considering the set of interconnected and interdependent plots in the city. For the macro-system to function properly, it is necessary that each micro-system, each plot, is fulfilling its function efficiently. In the urban macro-system, the function of plots depends on three fundamental characteristics to guarantee quality: diversity and density of uses and an adequate balance between the public and private interface.

The function is a unique characteristic of a plot, as it allows for daily interaction with other elements of the urban form (buildings, street blocks and streets) through its users. Each function (or use) of the plot presents a different dynamic that enables life and the functioning of the city as a system, and this impacts the immediate surroundings of each plot, depending on the type of function it performs commercial use, residential use, mixed use, industrial use, institutional use, among others. It can be suggested that this is the central objective of a plot: to have a function, a use. Kropf (2018) presented the relationship of *use* between humans and physical form, defining the urban plot as the physical boundary that allows ‘the relationship between human activities and the forms created to accommodate these activities’ (Kropf, 2018, p. 3, our translation). However, function is a dynamic characteristic. Uses change constantly through socioeconomic processes. Conzen (1960) already explained this, ‘the temporary cessation of the use of the plot is the result of socioeconomic transformations, involving an eventual re-evaluation of the land in terms of use’ (Conzen, 1960, p. 97). Furthermore, plots host activities that operate at different times of day, promoting significant impacts on the dynamics of the surrounding area. Three main characteristics of plot functionality are: the type of use and its relationship with the street and the surrounding area. The type of use determines the relationship between the internal space and the space immediately external to the plot, the interface between the street and the plot. Batty *et al.* (2004) developed a study on the multifunctional character of cities through the analysis of density and diversity over time (Figure 11). The authors argued that urban diversity can influence how people engage in different activities associated with different land uses throughout the day. The authors argued that sustainable planning is the foundation for places with greater opportunities for urban life and the direction for cities with different functionalities.

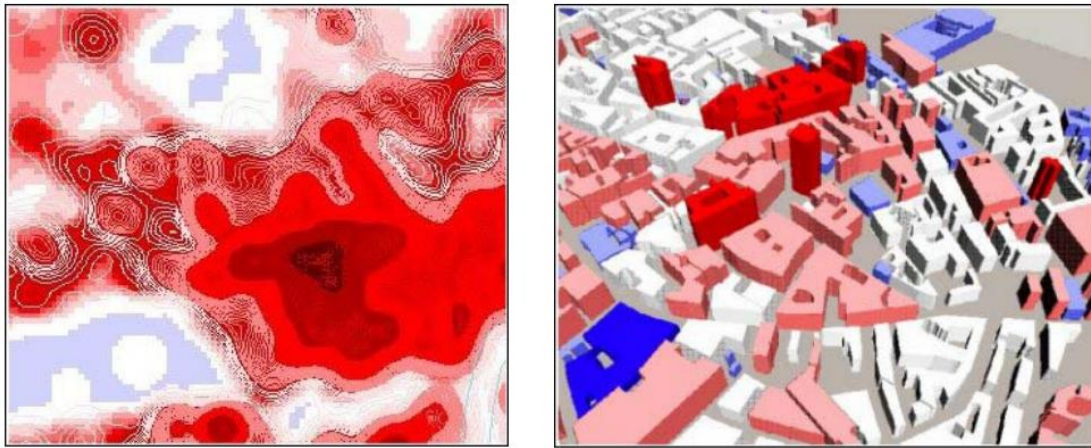


Figure 11 - Different land uses providing different functions – 3D representation.

Source: Batty *et al.* (2004).

The capacity of a plot to accommodate different types of activities allows for the distribution of functions throughout the urban space, influencing the local economy, the flow of people, and the vitality of the city (Marcus, 2010; Bobkova, 2019). The function of the plots determines which activities are concentrated in specific sectors, housing, commerce, industry, services, and community facilities, and how these activities interact in the space. Areas with greater functional diversity attract different groups of people for different reasons, increasing social and economic interaction. Bobkova (2018) highlights that the proximity between plots with varied functions creates potential for a greater diversity of economic activities, while Marcus (2010) argues that this spatial organization increases the city's 'spatial capital', allowing more agents to develop distinct strategies for operating within the urban territory (Figure 12).

This principle aligns with the concepts of urban diversity and specialization advocated by Jacobs (1961) and Webster and Lai (2003), according to which cities with multiple functions distributed across plots, combined with social and economic mixing, promote greater vitality, cooperation, and efficiency in the use of urban space. Thus, the function of the plot not only organizes specific activities but also structures the urban system as a whole, allowing the city to function as an interconnected and dynamic set of spaces, uses, and social interactions.

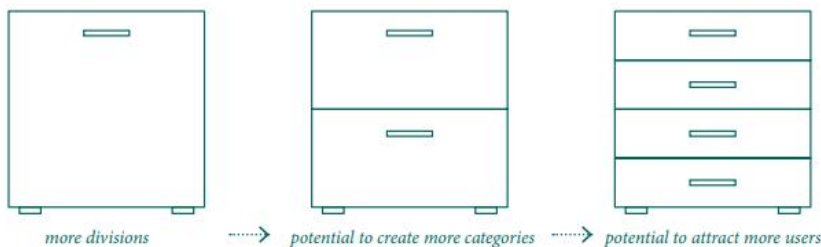


Figure 12 – Representation of the organization and differentiation. Source: Bobkova (2019).

Another characteristic of plot functionality is the relationship of its ‘interface’ between public space and the plot. The public-private ‘interface’ plays an essential role in communicating the use of the plot, privacy, and type of operation. Local dynamics are conditioned by the relationships intended to develop between the uses established on the plot and the visitors. Commercial plots typically invite their customers, for example, through greater visibility and permeability of the façade. Spaces with significant urban diversity, circulation, and the presence of people are directly influenced by the communication of the public-private interface, allowing for the formation of local identities (Dovey and Wood, 2015, p. 3). Dovey and Wood studied the public-private interface and identified six existing categories: permeability, main entrance directly at the legal boundary of the plots, transparency, main access for pedestrians or cars, semi-public spaces for dissemination, and semi-public spaces for permanence (Dovey and Wood, 2015). The combination of these categories results in different urban dynamics in a given area. Figure 13 presents the results of the case study developed by the authors in the city of Melbourne, Australia, identifying the different types of interfaces existing per city block.

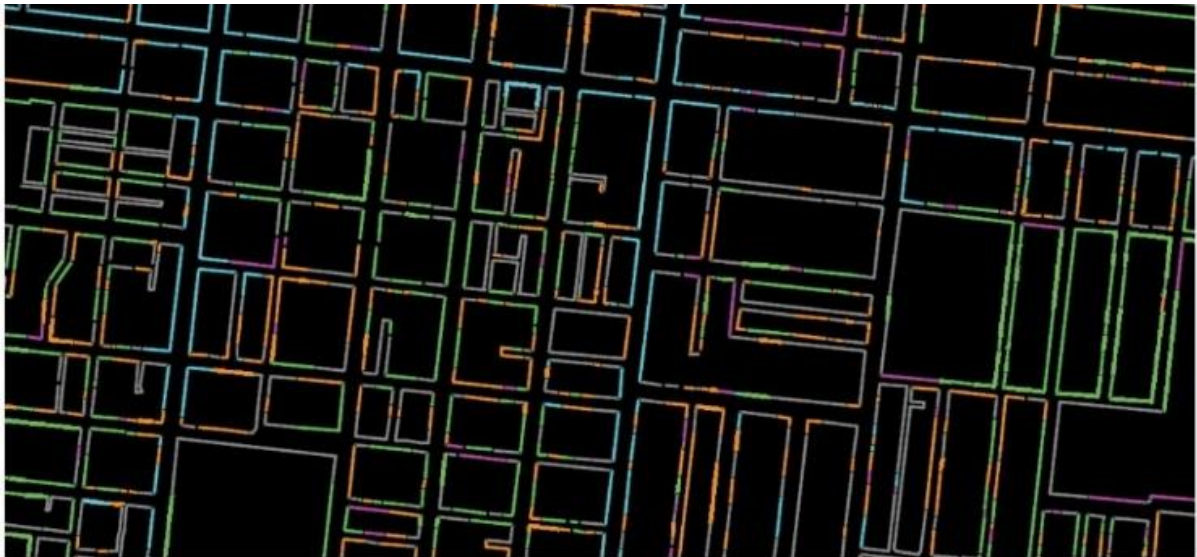


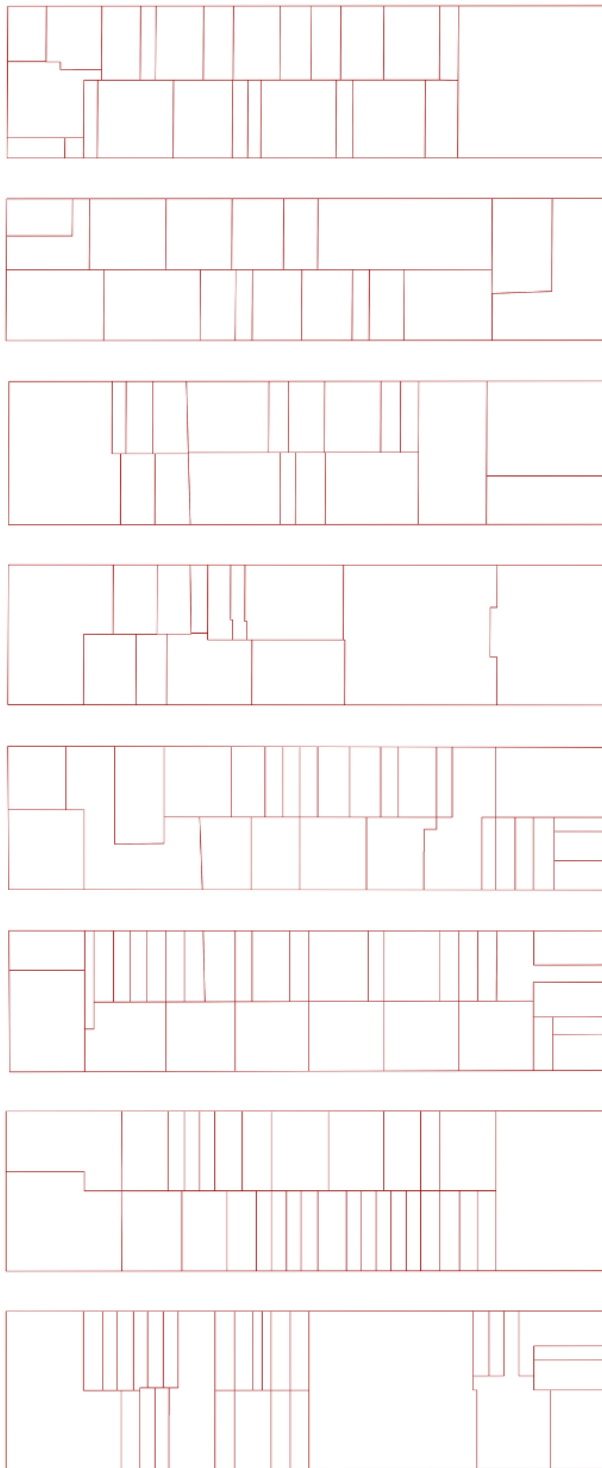
Figure 13 – Analysis of the different types of public-private interfaces in the Melbourne plots. Source: Dovey et al. (2015).

Table 11 presents a list of studies that research the characteristics of urban land use and plots.

Table 11 - Research about function and urban plots

Source	Theme	Synthesis of study	Synthesis of results
Marcus (2005)	This article proposes an analytical theory of urban diversity centered on the syntax of plots; that is, it examines how the spatial configuration of plots, their density, distribution, and accessibility, influence economic and social diversity in the city.	<i>Place Syntax Tool</i> to calculate configurational measures of plot accessibility from each individual plot, using an axial map of the urban network. It defines plot accessibility variables at different scales, measuring how many plots are accessible. It then correlates these measures with socioeconomic diversity indices using statistical analysis.	The results show significant correlations between plot accessibility and measures of diversity: for example, ‘accessible retail density’ correlated strongly with plot accessibility. A very high correlation was also found between plot accessibility and age group diversity. These findings support the hypothesis that the spatial configuration of plots contributes to natural diversity in the city.
Zhang <i>et al</i> (2017)	Land use classification at the plot level in large cities, using multi-source data (LiDAR, high-resolution aerial images, and Google Street View) to identify detailed urban parcel functions and understand the spatial distribution of different land use types.	It uses a Random Forest classifier to classify land use at the plot level, combining aerial LiDAR data, high-resolution orthoradial images, and Google Street View (GSV) imagery. Plot attributes are extracted, including features derived from GSV, to distinguish land use types.	The model achieved overall classification accuracy for plots in a complex megacity. Accuracies for classes such as single-family housing exceeded 92%. The inclusion of features extracted from Street View significantly improved the distinction between mixed-use residential and commercial buildings. It was demonstrated that it is possible to discriminate between diverse classes (residential, commercial, industrial, open space) with good accuracy even in a dense three-dimensional environment.
Zhang <i>et al</i> . (2019)	This article investigates how to recognize the true function of urban plots by combining various sources of geospatial data.	The authors propose the CC FLU (Cross-Correlation Functional Land Use) model, which extracts physical semantics and human semantics (from POIs and mobility data), calculates cross-correlations between these semantic spaces, and then integrates this information to classify the functional use of plots.	The CC FLU model integrated images, POIs, and mobility data to classify urban plot functions with high precision. The cross-correlation between physical and human data captured richer functional patterns than traditional methods.

Wu <i>et al.</i> (2019)	The study proposes a method for grouping urban plots considering both urban morphology and functional connectivity, to improve the representation of the urban structure and assist in planning.	The authors measure the <i>infiltration</i> behaviour between adjacent plots (using POI data to define dominant functions and land use type), define proximity between plots based on segment similarity and compactness, and then group the plots using a compactness-criterion graph algorithm to form coherent functional groups.	The proposed method grouped urban plots in such a way that morphology and functional connectivity were preserved, forming coherent groups. The resulting groups showed a greater mix of uses, while maintaining functional compatibility between adjacent plots.
Shi <i>et al.</i> (2021)	The article addresses mixed land uses (MUU), arguing that the traditional definition focuses heavily on the diversity of uses but neglects the functional compatibility between neighbouring uses, which is crucial for sustainable urban development.	It proposes a new index, the Functional <i>Compatibility Degree Index</i> (FCDI), to quantify how compatible the uses of adjacent plots are, combining expert assessment (who classifies pairs of uses according to compatibility) with geometric variables of the plots (such as common boundary length, area, distance between centroids) to capture spatial interactions.	Most urban plots in Xiangtan exhibit compatible neighbouring uses, indicating a good functioning of mixed-use development. They identify areas with high diversity but low compatibility, especially in industrial zones, where the coexistence of uses generates conflicts. Four combinations of diversity and compatibility were categorized, allowing for spatial mapping of where the mix is positive or problematic.
Liang <i>et al.</i> (2025)	This article re-evaluates how mixed land use (MLU) is measured and proposes new ways of interpreting the mechanisms that drive this mixture, questioning traditional measures that focus only on the diversity of uses.	The authors provide a critical review of MLU measurement approaches (such as entropy indices) and propose new conceptual and metric indicators to capture not only diversity but also spatial structure and "land use patterns" in plots. Furthermore, they discuss the driving mechanisms behind functional mixing, such as location, accessibility, zoning policies, and market forces.	The study shows that traditional mixed-use metrics underestimate the complexity of functional organization within land plots. It proposes a three-dimensional framework (quantity, scale, and texture) to better capture urban functional mix. It highlights that the function of each plots and the interaction between uses are central to evaluating the effectiveness of the mix. It suggests that urban policies should consider the spatial and functional arrangement of land plots to promote sustainable functional mix.



5 THE PLOTS SYSTEM IN DIFFERENT PLANNING PRACTICES

5 The plots system in different planning practices

‘We must recognize that far beyond the moment when plans are formed or processes are initiated and finalized, it is this continuous, silent, and competitive adaptation that constitutes the essence of what a city is and embodies its deepest and most enduring democratic content. It is only through this restless, collective, and uncoordinated adaptation that something like the identity of places is shaped and continually refined.’ (Porta and Romice, 2010, p. 11).

Throughout the history of urban planning, the plot system has played a central, though often underestimated, role in land organization and the development of urban form. From early plans, through post-war reconstruction movements, to contemporary urban planning practices, plots have consolidated themselves simultaneously as physical, legal, economic, and political units structuring how territory is produced, appropriated, and transformed. Although the debate about the role of plots in urban morphology and planning is not recent (Conzen, 1960; Merlin *et al.*, 1988; Moudon, 1997), its multifaceted nature remains largely unexplored in both science (as seen in previous chapters) and in the practice of planning.

The way in which plots are defined, regulated, and transformed varies widely depending on historical moments and different traditions of urban planning and land division. In pre-industrial cities, plots were often a direct expression of land appropriation practices and dominant social and economic relations, without a clear separation between land structure and land use (Conzen, 1960). With industrialization, the accelerated growth of cities led to the need for more explicit regulations, especially regarding public health, land division, and the organization of urban infrastructure.

In the early 20th century, movements such as hygienist urbanism and, later, modernism, brought to the centre of the debate the need for territorial reorganization according to principles of rationality, functionality, and efficiency (Geddes, 1915). However, in many cases, this movement occurred at the cost of devaluing the plot as a structuring unit. Early modernism, by privileging collective landownership, large-scale production, and *tabula rasa* as an intervention strategy, began to see the traditional land structure as an obstacle to be overcome. This significantly influenced the processes of European reconstruction after World War II, introducing urban development models in which the individual plot was frequently relegated to a minor position (Trancik, 1943; Houlston, 1989).

From the second half of the 20th century onwards, there was a resurgence of interest in plots in urban morphology studies. Pioneering research, such as that of Conzen (1960), revealed that the city is constituted by persistent structures, among which plot patterns stands out for its stability and capacity to reveal historical processes of transformation. Samuels (2013) and

Strappa (2018), who emphasized that the plot functions as an *elementary cell* of urbanization, through which both morphological continuities and ruptures manifest themselves.

More recently, proposals such as Parcel-Based Urbanism (PBU), presented by Porta and Romice (2010), have consolidated the idea that the plot is the minimum unit where urban self-organization occurs. This approach emphasizes the importance of recognizing the combined action of its attributes - density, compactness, relationship with the street - to promote more resilient, flexible, and coherent urban forms. Contemporary studies, such as those by Bobkova (2019), reinforce this understanding by stating that, although plots are one of the main structuring elements of urban form, they paradoxically remain the least studied component by planning professionals.

Nowadays, plots are treated in different ways by urban planning. In some contexts, plots are the basis of the entire urban regulation system, being fundamental for allocating building rights, collecting taxes, organizing cadastral records, establishing densities, and guiding public investments. In other cases, they assume a more flexible role, coexisting with informal tenure regimes or other forms of property ownership. Although plots are highly regulated in some of these cities, the regulations and norms are prescriptions based on city development objectives, without in-depth studies on the impacts and influences, positive or negative, that the parcel system may have on urban development.

This chapter seeks to deepen the understanding of how land is recognized, structured, and developed in different cities across various countries, based on their land use and occupation plans, demarcation laws, and other existing regulatory norms. The objective is to understand how urban planning defines, uses, and regulates land – and whether, in fact, it implements any type of regulation considering the boundaries of each plot as the main focus.

This chapter explores these discussions in greater depth through the analysis of five cities located on four continents. In addition to this cultural and geographical diversity, mirrored by a diversity of their property systems, institutional approaches, and planning models, these are cities on which the author has reasonable knowledge, having lived in four of them (with the exception of Maputo): New York, United States (North America); Florianópolis, Brazil (South America); Porto, Portugal (Europe); Maputo, Mozambique (Africa) and Hangzhou, China (Asia).

New York, United States

In the United States, land is primarily privately owned, governed by a legal system based on common law and state and municipal laws. The federal government rarely directly regulates private land use, although it exerts indirect influence through environmental or infrastructure policies. In New York State, there is a state law that authorizes municipalities, towns, and cities to establish their own zoning regulations, provided they align with a comprehensive plan.

New York City (Figure 14), located in the northeastern United States, is the country's most populous city and one of the world's most important financial, cultural, and urban centres. Situated at the mouth of the Hudson River and comprised of five boroughs – Manhattan, Brooklyn, Queens, the Bronx, and Staten Island - the city's geographical configuration is

marked by islands, estuaries, peninsulas, and coastal areas that profoundly influence its urban form. New York combines densely verticalized areas, with medium- and low-density neighbourhoods, presenting a highly diverse urban mosaic. The city has an estimated population of 8,8 million inhabitants (U.S. Census Bureau, 2025), distributed across a territorial area of approximately 789 km². The city of New York has approximately 900,000 legally registered plots.



Figure 14 -New York City location map, United States. Source: Google Earth (2025) and author.

In New York City, these rules are operationalized through the City Charter, which delegates to the Department of City Planning (DCP) and the City Planning Commission (CPC) the responsibility of defining local zoning through the New York City Zoning Resolution, along with municipal strategic plans and complementary regulations (which will be explored further in the following chapters).

The city's main territorial planning instrument is the Zoning Resolution (Figure 15), an extensive set of rules approved in 1961 and subsequently updated, which acts as a master plan and a land use and occupation code simultaneously. This regulation organizes the entire city into use zones (residential – R, commercial – C, industrial – M), each divided into subcategories that define urban planning indices, density, plot shape, building height, setbacks, permeability, façade requirements, permitted uses, and parking rules. The Zoning Resolution also establishes zoning change mechanisms, such as rezonings, special permits, and variances, which allow for adjusting land subdivision and occupation to contemporary urban development needs.

In the land subdivision process, the city uses the concept of subdivision, which allows the division or merging of plots with the approval of the Department of Buildings (DOB) and the Department of City Planning. The creation of new plots must follow the alignment of the blocks, respect the historical orthogonal grid, and guarantee adequate access to public space.

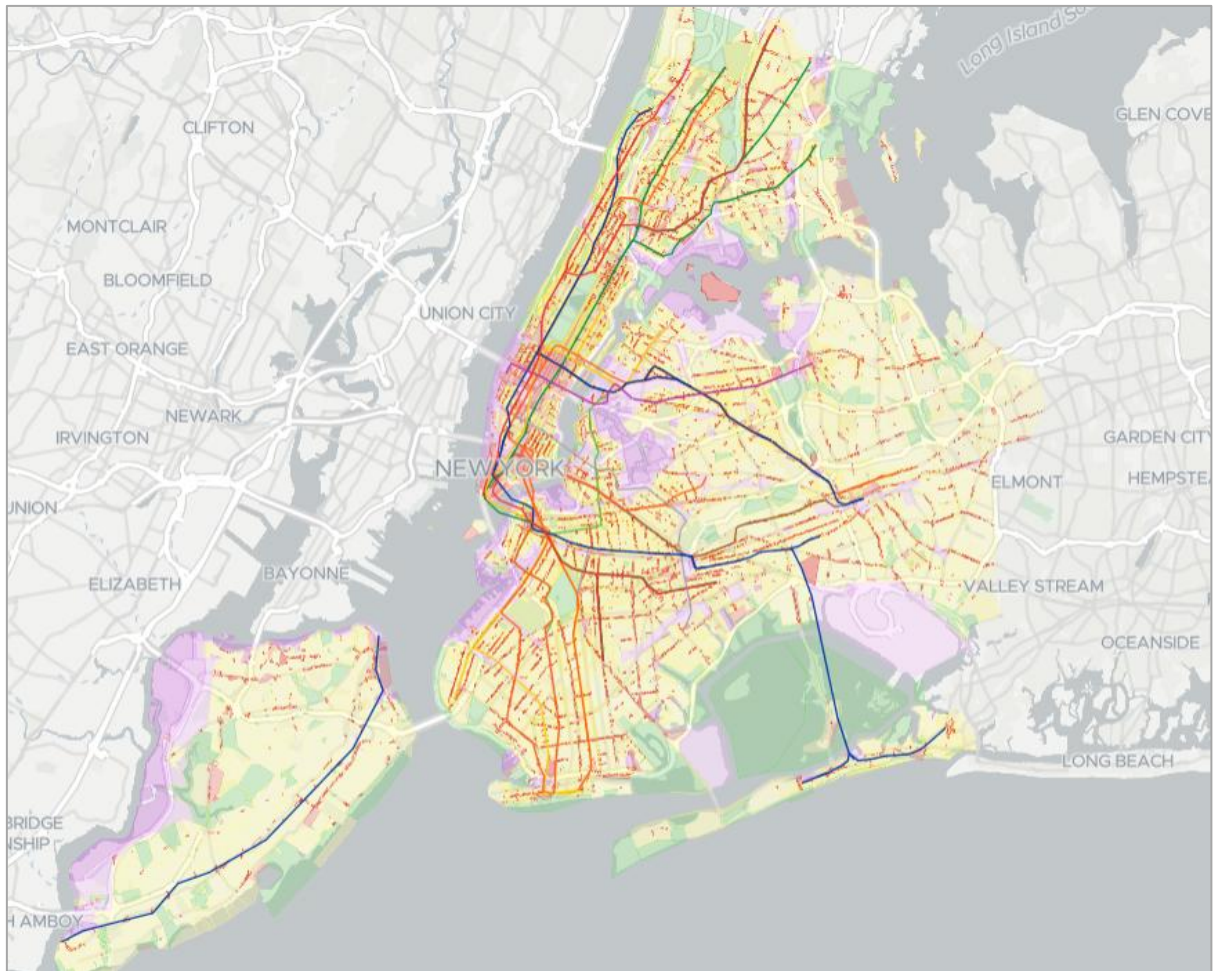


Figure 15 - New York zoning map. Source: NYC, 2025.

Florianópolis, Brazil

In Brazil, the land market is structured based on the constitutional principle of private property, guaranteed by the 1988 Federal Constitution (Article 5, XXII), while also establishing that land must fulfil a social function (Article 5, XXIII; Article 182, §2). Different forms of ownership coexist in the Brazilian real estate market: individual private property; urban public property, which includes parks, institutional areas, streets, coastal areas and properties of the Union; collective and special properties, such as indigenous lands, *quilombola*¹⁰ lands and areas for community use; and derivative forms of ownership, such as condominium ownership, lot condominium ownership, concession of real right of use and surface rights (Law No. 13.465/2017). In the urban context, the most important legal framework is the City Statute (Law No. 10.257/2001), which regulates national urban policy and offers instruments to order land use.

Florianópolis, the capital of the state of Santa Catarina (Figure 16), is an island and mainland city marked by strong landscape and environmental diversity, and by tourism development and

¹⁰ Territories occupied by communities formed by descendants of enslaved people who resisted slavery, keeping their culture and traditions alive, maintaining collective production and a strong connection to the land.

technological innovation. The city has an urban fabric fragmented by bays, hills, environmental preservation areas and beaches, which directly influences its occupation pattern and development model. Its estimated population for 2025 is approximately 587.500 inhabitants (IBGE, 2025), distributed in a territorial area of approximately 674,9 km², which includes Santa Catarina Island, the mainland and several adjacent islands.

Territorial planning and urban regulations are overseen by the Florianópolis Urban Planning Institute (IPUF), the municipal technical department responsible for developing urban studies, analyses, and guidelines, with support from the planning, public works, and environment departments. According to IPUF, Florianópolis comprises about 115.000 legally registered plots, belonging to different property regimes, namely, state, federal, or religious.



Figure 16 - Map location of Florianópolis, Brazil. Source: Google Earth and author.

The organization of urban plots in Florianópolis is based on regulations from federal and municipal legislation. Throughout the urban organization, the treatment of urban land units has been articulated by the federal land subdivision law, Law No. 6.766/1979, and by the guidelines of the City Statute, Law No. 10.257/2001, with the municipal legislation that specifically regulates subdivisions.

The definition of a plot of land for the municipality of Florianópolis is explicitly contemplated in Complementary Law No. 482/2014. A plot of land is considered to be land served by basic infrastructure, whose dimensions meet the urban planning indices defined by the Master Plan for the zone in which it is located. Subdivision corresponds to the division of land that requires the opening of new roads or public spaces, and the execution of urbanization works, while land division refers to the division of a plot into two or more plots using an existing road network, without the need to open new streets. The consolidation, in turn, is permitted for the union of two or more plots in order to comply with urban planning standards, such as minimum area and utilization indices, requiring technical approval and cadastral updating. Current municipal legislation also provides for modalities such as plot condominiums, allowing private

arrangements for infrastructure sharing and management between plots, under specific rules established by the 2014 Master Plan and the law revised in 2023.

The Master Plan is the city's main urban planning instrument, guiding growth, land use, infrastructure, and environmental protection. Its objective is to reconcile urban development with environmental preservation and quality of life, considering the different characteristics of the island and mainland regions. To this end, the plan organizes the city into land use zones, defining specific guidelines for each type of area. Furthermore, the master plan defines urban planning parameters, urban development indices, the height and number of floors within each plot, the occupancy rate, urban instruments applicable to land subdivision, the utilization coefficient, building height limits, setbacks, and permeability, varying according to the macro-zoning or zoning defined for each urban area of the city. Urban planning instruments stemming from the City Statute also provide for applications to urban plots and subdivisions, such as the Onerous Granting of the Right to Build, Neighbourhood Impact Studies, or incentive mechanisms conditioned on a counterpart.

The maps in Figure 17 present the macro-zoning and zoning of the city of Florianópolis, determining the areas for urbanization and the type of land use these areas are intended for. The map in image a) shows the macro-zoning and presents four types of organization. The dark green areas are areas designated not to be urbanized; most are environmental preservation areas. The light green areas are transition areas, intended for controlled urbanization. Areas in orange are areas intended for urbanization. Finally, the blue areas are lakes, lagoons, or the sea.

The map in image b) details the different types of land use intended for urbanization. The green areas are environmental preservation areas. The light blue area is intended for community and institutional use. The light red area is intended for mixed-use development. The brown area is intended for service uses. The orange area is designed for mixed residential use. The yellow area is intended for predominantly residential use. The beige area is intended for rural use. Finally, the purple area is intended for tourism and leisure use.

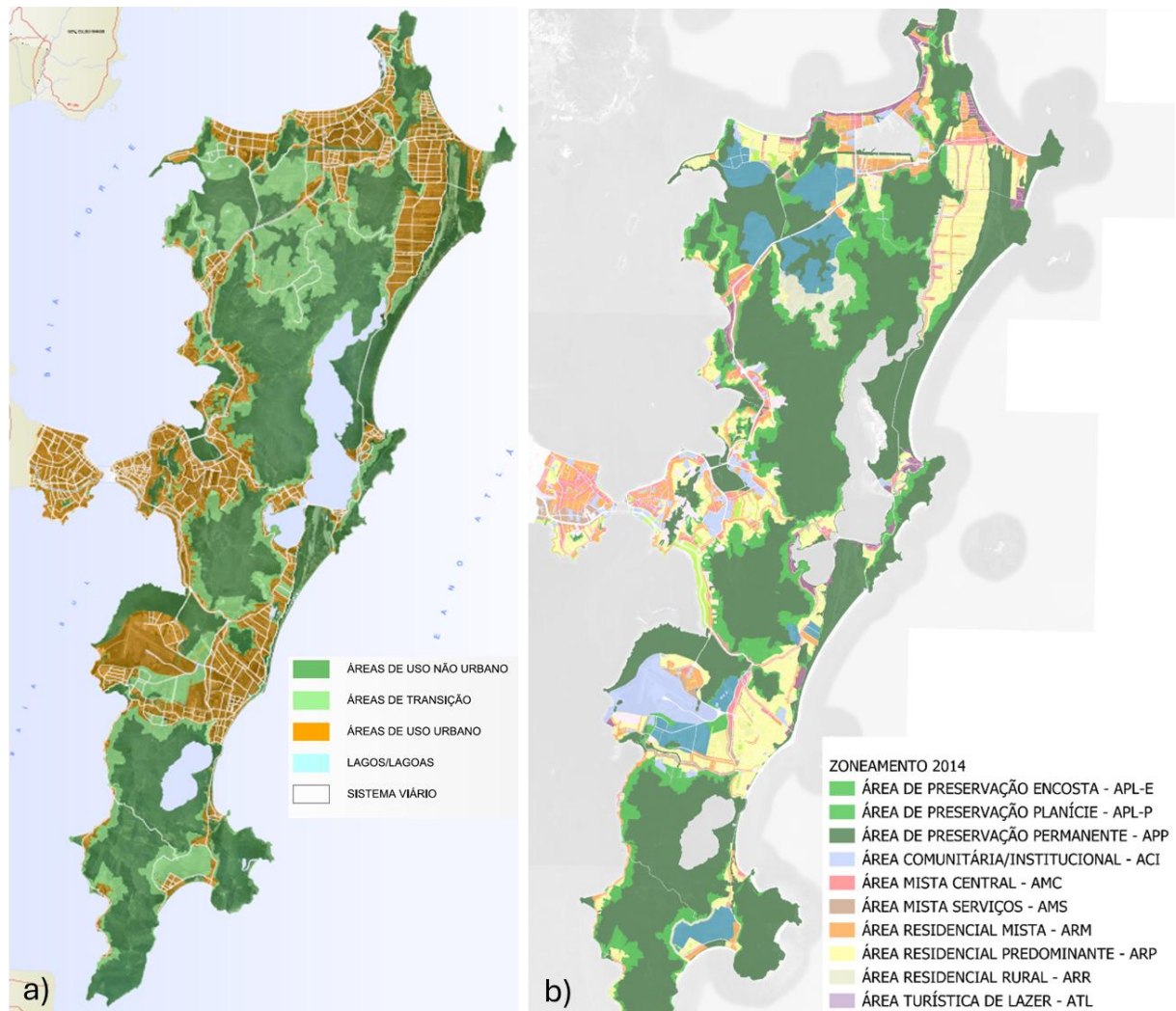


Figure 17 – Macro-zoning map (a) and zoning map (b) – Master Plan of 2014, revised in 2023. Source: IPUF, 2025.

Porto, Portugal

In Portugal, urban land can be fully privately owned. The right to property is protected by the Constitution of the Portuguese Republic (Article 62), which guarantees the economic and social function of property and allows the State to condition its exercise according to the law. This right is also regulated by the Portuguese Civil Code, which establishes the use, enjoyment, sale, leases, and other forms of alienation of real estate, including urban land.

The legislation that regulates land use is the *Lei de bases gerais da política pública de solos, de ordenamento do território e de urbanismo*, Law No. 31/2014. According to this Law, land is classified into two main categories: urban and rural, each with a distinct basic purpose. Within urban land, there is a further classification based on the degree of infrastructure and planning; the law distinguishes between unplanned, planned and urbanized.

Porto (Figure 18), located in northwestern Portugal, is the country's second-largest city and an important historical, cultural, and economic centre of the Northern region. It is situated on the north bank of the Douro River, with a topography marked by steep hills and a sloping relief that shapes its urban fabric. The municipality of Porto covers an area of approximately 41,42 km²,

housing around 238.000 inhabitants. Porto is the centre of the Metropolitan Area, which brings together more than 1,7 million people and extends over approximately 2.040 km² (Câmara do Porto, 2025).

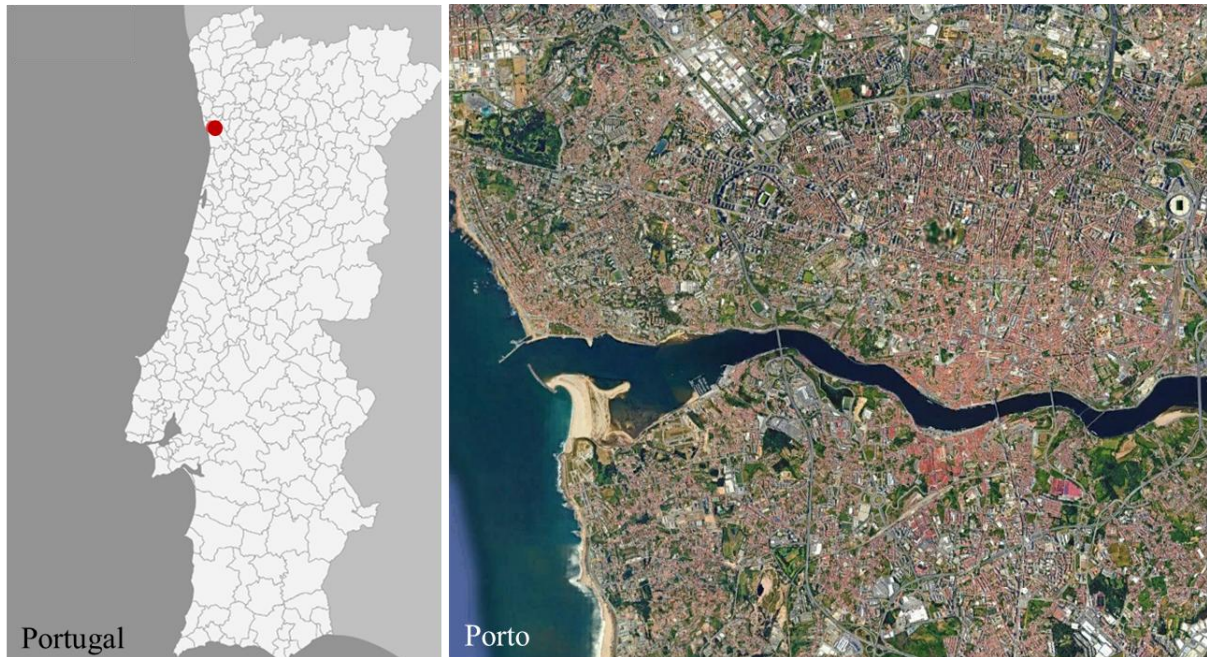


Figure 18 - Map location of Porto, Portugal. Source: Google Earth and author.

The Porto Municipal Master Plan is the basic document for urban planning in the municipality. It defines the land use strategy, the spatial structure of the city, the areas for housing, commerce, green spaces, roads, and public facilities. The Zoning framework classifies the land according to different categories and defines spatial rules, such as density, building volume, façade alignments, dominant alignments, and other urban elements (Figure 19). In addition, the constraints plan identifies important restrictions, such as easements, heritage areas, or risk zones (Figure 20).

There are other plans responsible for determining in more detail how plots are defined and developed in the city. The Master Plan identifies Operational Planning and Management Units (UOPG) for areas that need more detailed planning and specifies that some of these areas should be executed by detailed plans. There is also a specific regulation, No. 214/2021, which complements the Municipal Master Plan and defines how the balance of building capacity and urban planning charges should work in operations that result in an increase in building area. This regulation establishes mechanisms so that, when a new subdivision is created, part of the value generated goes to compensate the municipality, helping to finance urban infrastructure or public facilities.

The resolution of the Council of Ministers, No. 117/2000, establishes a set of minimum urban planning parameters that must be met in land subdivision operations carried out in the municipality of Porto, functioning as a complementary norm to the Municipal Master Plan. This legislation defines requirements related to the creation and dimensioning of basic infrastructure, such as streets, sidewalks, water, sewage and energy networks, and also sets requirements for

the implementation of green spaces, leisure areas and public facilities that must accompany new urban developments.

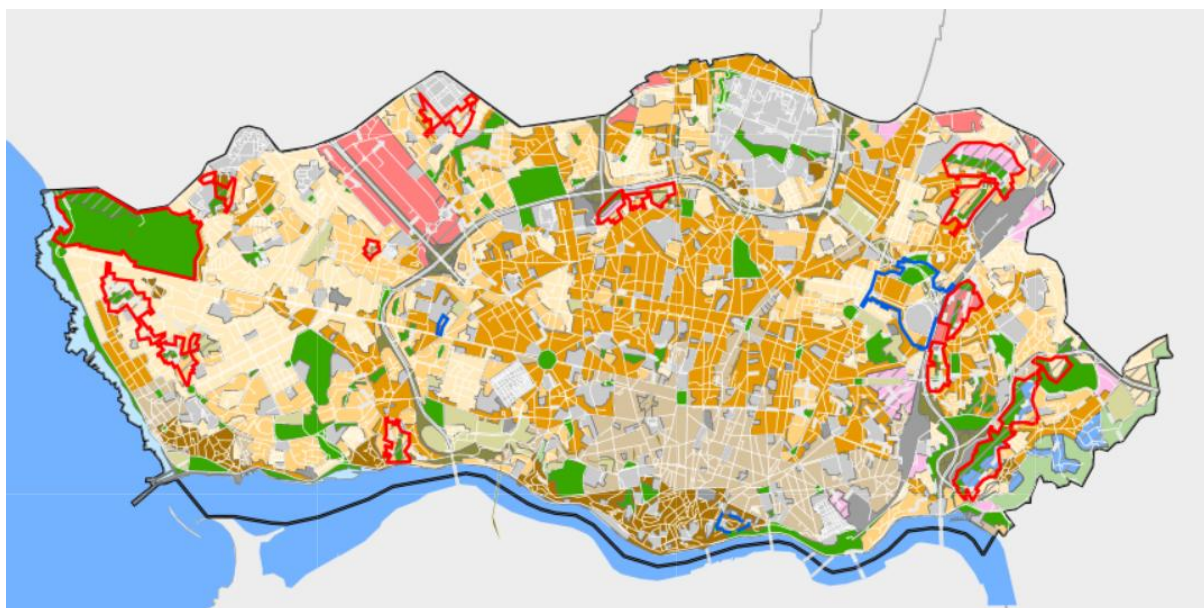


Figure 19 – Urban Land Qualification Charter. Source: Câmara Municipal do Porto, Portugal (2025)¹¹.

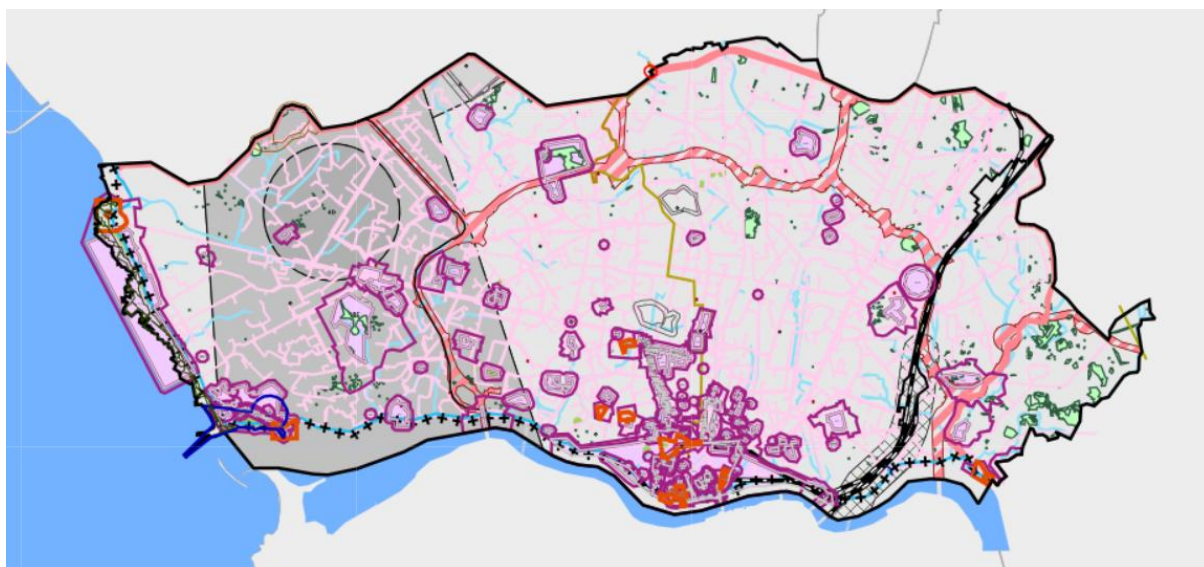


Figure 20 – General Dynamic Conditions Charter. Source: Câmara Municipal do Porto, Portugal (2025)¹².

¹¹ To more detail information: <https://portalgeo.cm-porto.pt/arcgis/apps/sites/#/mapas-do-porto/pages/plano-diretor-municipal-2021>.

¹² To more detail information: <https://portalgeo.cm-porto.pt/arcgis/apps/sites/#/mapas-do-porto/pages/plano-diretor-municipal-2021>.

Maputo, Mozambique

In Mozambique, all land is owned by the State, as established by the Land Law, Law No. 19/1997. This law regulates the Right of Use and Exploitation of Land (DUAT), which is the legal way for individuals, communities, or companies to use land. The DUAT can be obtained in three ways: by tradition or customary occupation, when a community occupies the land according to local customs; by good-faith occupation, when someone occupies unoccupied land continuously and peacefully for at least 10 years; or by authorization from the State, generally for specific urbanization, agricultural, or industrial development projects. The Land Law also establishes rules for the transfer, assignment, and termination of the DUAT, allowing the right of use to be passed on to others or reverted to the State in case of abandonment or violation of the rules. Although the land remains the property of the State, the DUAT guarantees legal security to the occupants and allows improvements made to the land, such as constructions, to legally belong to those who carried them out.

Complementing the Land Law, the Land Subdivision Law (LOT), Law No. 19/2007, defines how urban land should be organized and used, ensuring adequate urban planning. It establishes planning instruments such as Urban Structure Plans, which define the general organization of the city, including residential, commercial, industrial, and green areas; and Partial Urbanization or Detailing Plans, which detail the division of land parcels, road networks, service areas, and infrastructure. The LOT also defines the permitted uses for each type of land, the criteria for granting DUAT (Land Use and Development Rights) in urban areas, and the clauses for plot occupancy, including density, building height, setbacks, and green areas.

According to Mozambique's Urban Land Regulations, Decree No. 60/2006, a plot of land is defined as a delimited portion of land that can be subdivided according to the rules of the urban plan. In addition, there is also the definition of the term *talhão*, which is understood as the last indivisible portion of land, as established in the detailed plans.

Maputo (Figure 21), the capital of Mozambique, is located on the coast of East Africa facing the Indian Ocean, giving the city a territorial configuration marked by coastal cliffs, alluvial zones, and flatter coastal areas. The city occupies an area of approximately 346.7 km², and has a population of about 1.1 million inhabitants, while its metropolitan area exceeds 3 million people (PEUMM, 2008).

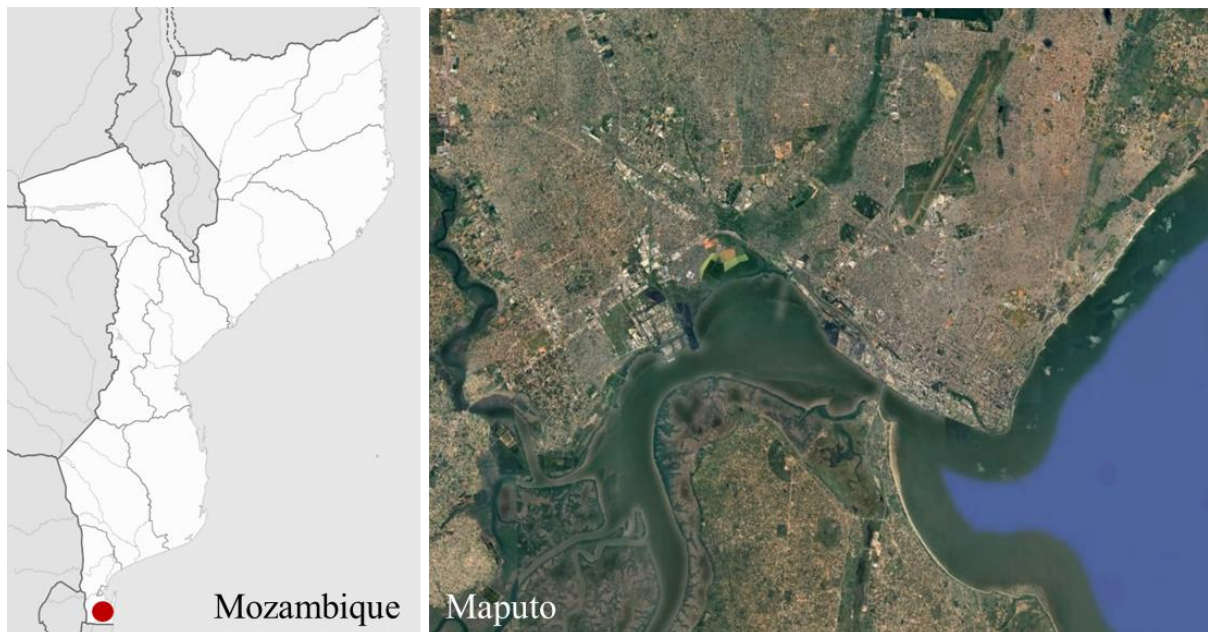


Figure 21 - Map location of Maputo, Moçambique. Source: Google Earth and author.

The *planning of plots* is based on a set of legal and administrative instruments that define how urban land can be occupied, transformed, and used. The main structuring instrument is the Maputo Urban Structure Plan – PEUMM – 2008, which has the legal nature of an administrative regulation and establishes rules, principles, and parameters that guide the physical development of the city.

The PEUMM (Urban Planning and Management Plan) defines that any occupation, use, or transformation of land depends on compliance with regulations, in addition to observing national legislation on territorial planning and land use (Figure 22). The fundamental aspect for planning for land use in Maputo is the classification of the territory. The PEUMM organizes the municipality into large spatial classes, which guide land occupation: urbanized spaces, organizable spaces, industrial and storage spaces, agricultural spaces, spaces related to the ecological structure, spaces for social facilities, and spaces for infrastructure. Each class is subsequently subdivided into spatial categories, which determine specific uses and conditions how plots can be occupied or subdivided.

Based on these definitions, the PEUMM determines how plots are integrated into the territory and what parameters must be followed. In urbanized areas, where the urban fabric is already consolidated, for example, the dominant function is residential. In these locations, regulations allow construction on already established plots but condition the creation of new plots on harmonious integration with the existing urban fabric, avoiding fragmentation. Specific rules define density limits, the obligation to maintain permeable spaces, the prohibition of total plot occupation, parameters for facade height and building depth, etc.

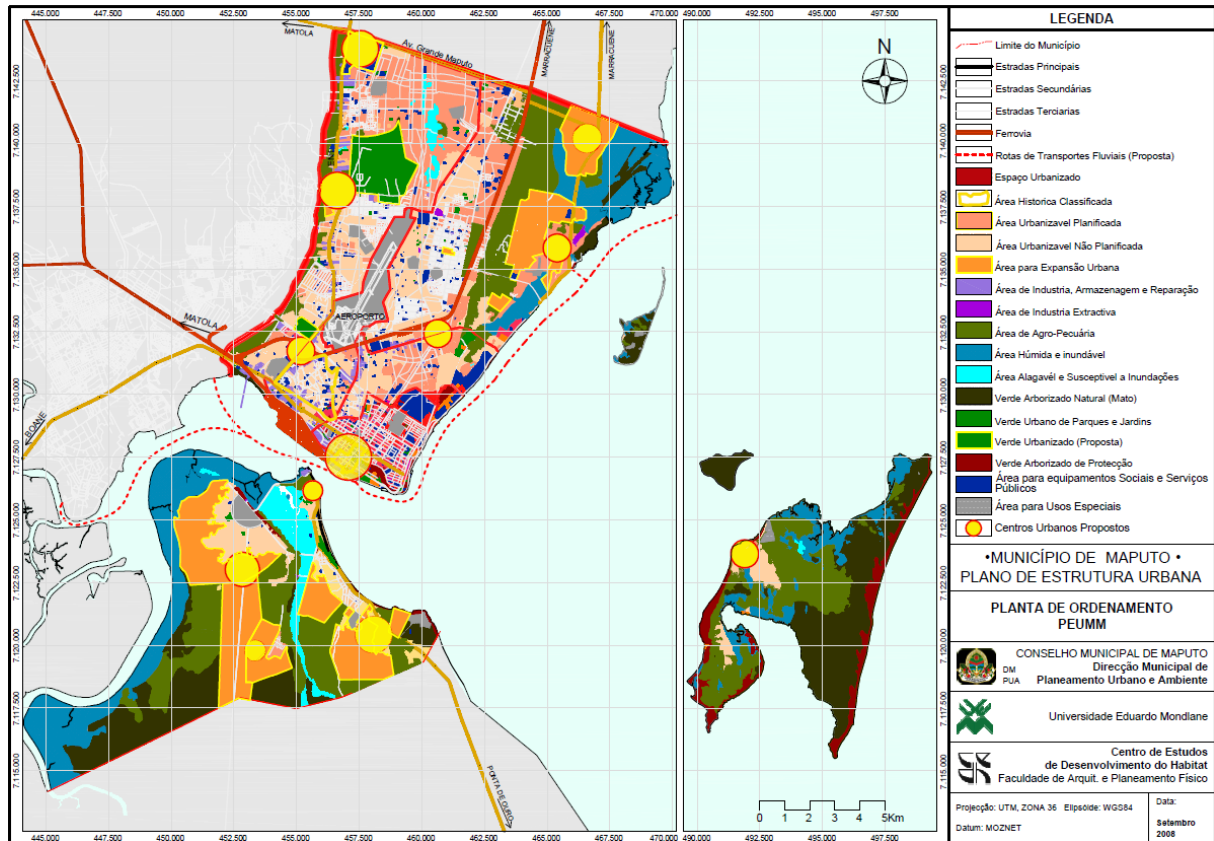


Figure 22 – Maputo Urban Planning Plan, 2008. Source: PEUMM, 2008.

Hangzhou, China

In China, the land system is radically different from most Western countries because land cannot be sold outright to individuals. There is no private property regime, as land ownership largely belongs to the state or rural collectives. The economic reforms initiated in 1978 marked a profound break in the Chinese land regime by introducing a system that separates land ownership from land use rights. While the Constitution maintained urban land as the exclusive property of the state and rural land as the collective property of villages, the government created a mechanism by which land use rights could be temporarily transferred to individuals, companies, or institutions (Ho and Lin, 2003). These land use rights were granted in exchange for payment, for pre-defined periods. For example, 70 years for residential use, 50 years for industrial use, and 40 years for commercial use. As such, the State retains full land ownership but allows users to have almost owner-like rights over a plot during the concession period, being able to build, transfer, mortgage or economically negotiate these rights.

In Hangzhou (Figure 23), the capital of Zhejiang province in eastern China, the urban landscape results from a combination of territory marked by lakes (such as the West Lake), hills, valleys, and the large Qiantang River, which shapes the local geography. The administrative city of Hangzhou covers a vast area, estimated at approximately 16.800 km². The resident population exceeds 12 million inhabitants (Hangzhou Government, 2025).

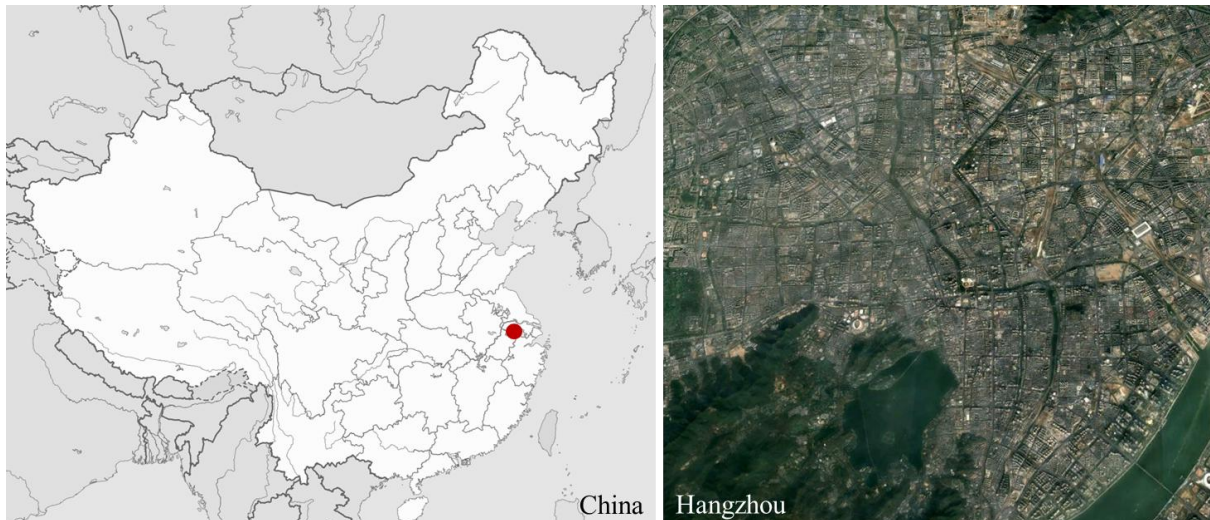


Figure 23 - Map location of Hangzhou, China. Source: Photo – Google Earth and author.

The Territorial Spatial Master Plan establishes the fundamental structure for the management and organization of the municipality's urban territory, integrating environmental protection, historical and cultural preservation, urban form, and land use. The document functions as a comprehensive territorial plan, defining where the city can grow and which areas should remain protected, the guidelines that regulate land occupation, and the development patterns of urban settlements.

Regarding land use (Figure 24), the plan defines a zoning system that directs specific areas towards technological innovation, industries, residential sectors, urban services, tourism, environmental protection, among other strategies. Each zone has guidelines on the intensity of use, including density limits, and general guidelines for the development of each area, which are defined and detailed in the Detailed Regulatory Plans, where the conceptual and spatial bases that guide the development of urban planning indices are established. The areas in yellow are zones intended for residential use. Areas in pink are areas intended for comprehensive services. Areas in red are commercial districts. Areas in brown are industrial development zones. Areas in dark blue are storage and logistics zones. The areas with the first green colour in the legend are intended for green recreational areas. Areas in dark gray are central transport zones. Areas in light gray are areas reserved for strategic purposes. The two green areas are reserved for ecological control.

The organization of plots is deeply conditioned by urban infrastructure. The implementation of mobility corridors, railways, main road systems, driving zones, and technical networks defines restrictions on subdivisions and buildings, ensuring that urban development occurs within the carrying capacity and maintaining structural safety and connectivity. Hangzhou's territorial plan does not treat the plot as a unit of property, but as an integral element of the city's hierarchical spatial system, in which the plot is an element that must contribute to the functionality intended by the city's proposed objectives. In Hangzhou, any plot of land is purchased with a pre-

established plan outlining the activities that will take place on that land, determined by the Master Plan and the municipal government¹³.

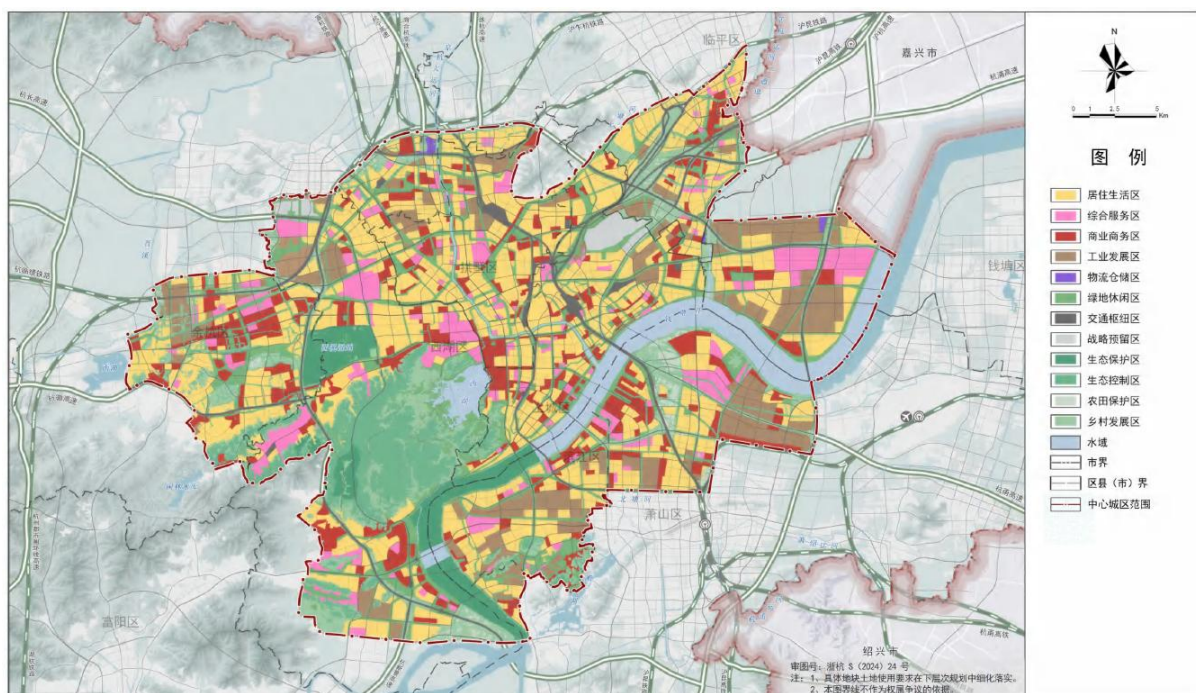
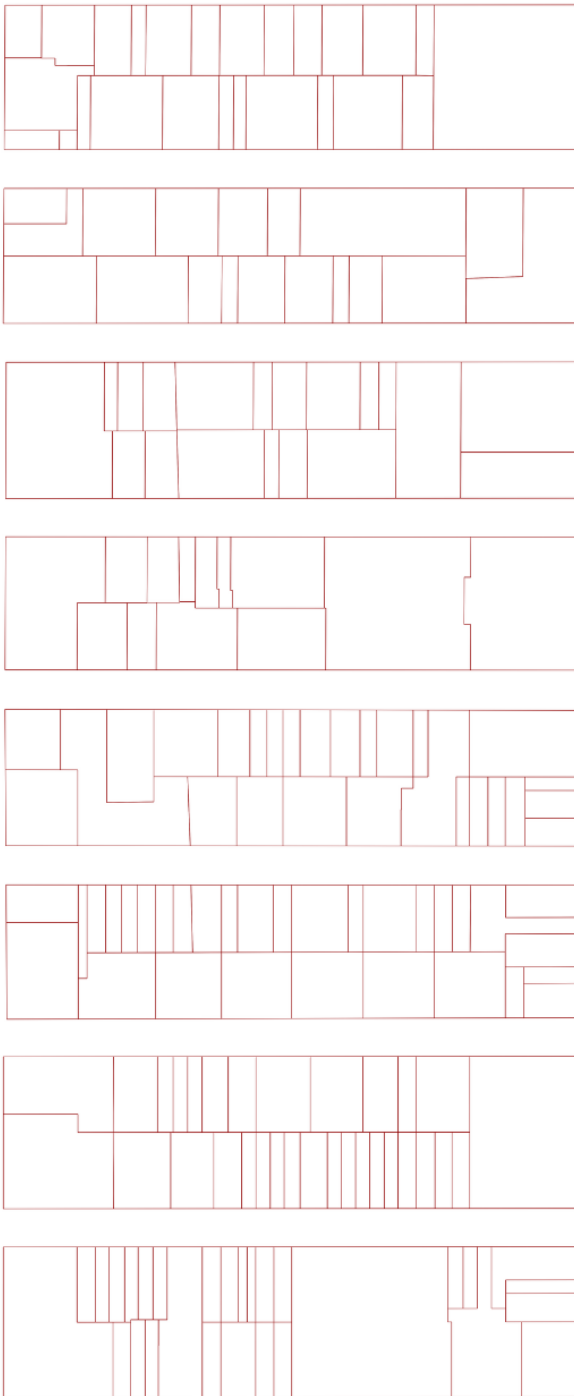


Figure 24 - Territorial Master Plan of Hangzhou (2021-2035) – Zoning map. Source: Hangzhou Government, 2025.

¹³ To more detail: <https://ghzy.hangzhou.gov.cn/>.



6 THE RESEARCH METHOD

6 The research method

6.1 Research method steps

The method developed in this thesis is structured in five complementary and sequential stages, each with a distinct analytical nature. The first two stages are structured based on the concepts of typology and taxonomy developed by Bailey (1994)¹⁴. The first stage consists of building a typology of plot systems to identify and organize their fundamental attributes (based on the literature review). The second stage involves the development of an empirical and classificatory taxonomy of plot systems and the construction of the multifaceted profile of plot systems offered by the *Plotter method*. The third stage is the definition of the case study for the empirical application of the method. The fourth stage corresponds to data management and the development of geospatial databases, which consolidate legal, physical, functional, social, etc. information, and which are fundamental for the operationalization of the model. Finally, stage five proposes a critical view of the method's applicability as a tool for urban planning practice.

The central aim of this thesis is to develop a theoretical-conceptual understanding of the plot systems; and to create a spatial analytical method that categorizes and quantifies these differences. To this end, this research starts from the central problem and seeks to answer the six specific questions that contribute to achieving the aim of the thesis (section 1.2). The method is divided into the five main stages presented above and seeks to answer the questions: stage 1 proposes to answer research question 1; stages 2, 3, and 4 propose to answer questions 2, 3, and 4; and, finally, stage 5 proposes to answer questions 5 and 6. The basic structure of the method is illustrated in Figure 25.

¹⁴ Bailey defines *typology* as a deductive classification, constructed from conceptual or ideal categories, often derived from theory. Typologies are generally used in exploratory and theoretical phases of research and aim to clarify concepts, organize thinking, and propose ideal schemes that may, or may not, occur empirically (Bailey, 1994, p.6). *Taxonomy* is an empirical classification based on similarities observed between real units. This approach uses measurable or observable data, usually applying formal and mathematical methods (such as statistical analysis) to group elements based on similarity (Bailey, 1994, p.7).

Research questions	Stage	Nature	Objective	Main Output
1. What are the different qualities of a plot system?	1. Typology of the plots	Theoretical and conceptual	Identify and structure the fundamental attributes of the plot systems	Conceptual framework with key dimensions and characteristics of urban plots
2. What are the key indicators that can be used to distinguish each dimension and characteristic of urban plots? 3. How can different indicators be combined to construct representative profiles for each characteristic and dimensions of urban plots? 4. How can the integration of profiles generate a multifaceted view of the dimensions and characteristics of the plot system?	2. The Plotter model: A multifaceted profile of the plot (Taxonomy)	Methodological and interpretative nature	Systematically classify plot system based on measure data. Integrate and represent multiple aspects of plots as complex urban units.	Plot classes with shared patterns; systematic organization of empirical types. Plotter model: integrated analysis of the plots.
	3. Case study definition	Empirical nature	Apply the classification and profiles in real urban contexts to validate the Plotter model	Validated plot profiles across different urban contexts; empirical support for the taxonomy method.
	4. Data management and development of geospatial databases	Technical and operational nature	Organize, structure, and process spatial and attribute data to support classification and analysis of urban plots	Structured geospatial database; set of indicators and spatial variables for characterizing urban plots
5. What are the interrelations between the characteristics and dimensions of plots, and how do they influence urban structure and dynamics? 6. How can the findings of this study be incorporated into urban science and planning practice to guide strategic decisions on city development and management?	5. Plots systems as the central structure of urban planning	Practical and strategic nature	Assess the method's potential as a tool for urban planning	Interactive data representation and guidelines for practical use of the method in real urban planning contexts

Figure 25- Base structure of the method

The first stage of the research method (section 6.2), with a conceptual and theoretical nature, consists of drawing up a typology of plot systems, based on a systematic literature review in urban morphology, geography, urban economics, urban law, and spatial planning. This review enabled the identification of multiple attributes associated with urban plots, such as area, shape, use, density, location, and land value, among others. These attributes were analysed in three stages to understand the plot system as a multifaceted entity. This stage configures a typology in the Weberian sense, i.e., an ideal-typical construction that guides the subsequent empirical reading (Weber, 1949).

The second stage of the method (section 6.3) consists of two interrelated phases: constructing a numerical and classificatory taxonomy of plot systems and preparing the conceptual bases for developing the *Plotter method*. Building on the conceptual references established by the

typology created in the first stage, an empirical and classificatory taxonomy of plot systems is generated from data obtained through spatial measurement techniques, morphological analysis, and data analysis. This data is applied to formal classification methods, aiming to identify patterns of similarity based on quantifiable indicators at the plot scale.

The taxonomy, therefore, constitutes a fundamental stage in developing the *Plotter method*. This method is a multifaceted model of an operational and interpretative nature, which organizes the six urban dimensions and five characteristics in a structured way. It synthesizes the results of the typology and taxonomy into two multifaceted profiles that represent the plots behaviour as interdependent physical, legal, social, and functional units. It utilizes measurable, comparable indicators designed to objectively translate the aspects of each dimension and characteristic. The *Plotter method* thus provides an integrated and dynamic view of urban plots, highlighting their various aspects in the different spheres of urban life, with which they are associated, and their significance in the organization of the territory.

The third stage of the research method is the definition of the case study (section 6.4), a fundamental step for the empirical application of the *Plotter method*. The choice of the case study involves technical and conceptual criteria that ensure representativeness to test the multiple attributes of the model.

The fourth stage focuses on data management and the construction of geospatial databases (section 6.5), an essential step for the method's operationalization. In this phase, information of a diverse nature - legal, physical, environmental, social, among others - is gathered and integrated, which makes up the empirical basis of the model. This process requires the use of geoprocessing tools and systematic organization of spatial and alphanumeric data to guarantee its consistency, comparability, and applicability. The quality and robustness of this database are decisive for the proposed interpretative analysis, allowing the construction of indicators and the identification of patterns that support an integrated approach to plot systems in urban planning.

The fifth stage of a practical and strategic nature consists of linking the *Plotter method* to urban planning practice (section 6.6). In this phase, the results obtained through the plots multifaceted profile are discussed as a fundamental part of planning to guide technical and political decisions in urban development processes. To this end, a critical analysis of the current urban plan in force in the case study is proposed to identify the current role of the plot system in planning practice and provide an interactive and easy-to-read data representation.

6.2 Plot system typology

The process of constructing a typology of the urban plot system involves three main stages that aim to transform theoretical knowledge into a systematic classification, useful for urban analysis and planning. The first stage consists of clearly defining the object of study and the scope of the typological process - that is, understanding plots as fundamental urban units and delimiting the aspects to be analysed. In this phase, the aim is to map, through a systematic review of the literature, all relevant attributes mentioned, such as area, density, location, land value, environmental conditions, accessibility, among others. These attributes are collected

comprehensively to capture the complexity and diversity of meanings that influence the behaviour of plots in the urban context.

The second stage involves organizing and understanding these attributes, grouping them into structural axes that represent central analytical dimensions of plot systems. These axes function as structuring categories based on the semantic or functional affinity between the attributes. For example, general attributes of the plot can be grouped under the category of characteristics, while attributes that express specific meanings in different disciplinary areas can be classified as dimensions. In this stage, the attributes are systematically organized according to their nature. The third stage corresponds to the structuring and definition of these attributes in each identified axis. The constituent elements of each axis are detailed, classifying them and assigning a set of specific categories to the plots. Figure 26 describes the steps of the process.

Stage	Main action	Main Output
1	Attribute mapping via systematic review	Broad, non-hierarchical list of attributes
2	Grouping of attributes by conceptual axes	Structuring the axes
3	Interpretation and definition of typological categories	Formal typology of the plot system

Figure 26- Stage of the plot system typological process

6.2.1 Result of the plot system typology

Based on a robust literature review on the plot systems, following each of the methodological stages previously described, this thesis identified the main attributes that make up and characterize this system. These findings are illustrated in Table 12 and Table 13, which express the multifaceted complexity of urban plots by integrating fundamental dimensions and characteristics that go far beyond the division of land. Table 12 presents the typology of the plot system, which classifies plots based on six major urban dimensions – social, economic, environmental, morphological, legal, and planning/institutional – highlighting how each one manifests itself both at the local and city scales, allowing a comprehensive reading of the different functions and meanings of plots in the urban fabric.

Each of these dimensions represents a specific set of attributes linked to district aspects of urban life. The social dimension includes aspects such as belonging, identity, and community ties, influencing how residents relate to space and to each other. The economic dimension deals with the logic of land use associated with production and land value, revealing the role of plots in the city's economic dynamics. The environmental dimension addresses the presence and role of green areas, land permeability, and local microclimatic effects. The morphological dimension is related to the physical configuration of the plot and its relationship with the urban fabric. The legal dimension is related to property rights, occupation, and use. Finally, the institutional dimension is related to the norms and guidelines that guide and shape the use and occupation of urban land.

Table 12 - Typology of the plot system – structural axis: dimensions

Literature review	Atributte	Structural axis	Definition of the city scale	Definition of the local scale
Burgess (1978), Qadeer (1981), Erickson and Roberts (1997), Bordieu (1986), Musterd (2005), Roberts (2007), Joseph <i>et al.</i> (2007), Soja (2009), Chen and Romice, (2009), Kavaratzis and Ashworth (2010), Puddifoot (2010), Fainstein (2014), Arthurson (2012), Lawton (2012), Williams (2013), Blokland and Savage (2016), Danenberg <i>et al.</i> (2018), Vejchodská <i>et al.</i> (2022)	 Social dimension	Dimensions of urban life associated with the plot	Refers to users who own the property in which they reside. This dimension seeks to identify the resident's social bond with the house and the community, considering aspects of identity, belonging and rootedness in the territory.	Refers to the different forms of housing, the presence of owner-occupants and tenants.
Hoyt (1960), Qadeer (1981), Harvey (1985), Leaf (1992), O'Sullivan (1996), Jäger (2003), Webster and Lai (2003), Needham (2006), Lall <i>et al.</i> (2009), Tarbatt (2012), Ratcliffe <i>et al.</i> (2021), Cole and Wilson (2017), Bouwmeester and Hartmann (2021), Mesgar and Ramirez-Lovering (2021), Altreiter and Litschauer (2022), Mondal (2023)	 Economic dimension	Dimensions of urban life associated with the plot	Refers to a physical space of the urban land intended for the development of economic activities. It is also a product of real estate market and capital accumulation, whose occupation and use economically influence the surrounding area and neighbors.	Refers to the presence and diversity of economic activities within the plot, representing its productive use to local dynamic.
Qadeer (1981), Ong (2003), Gerundo e Grimaldi (2011), Ahmed (2012), Langemeyer <i>et al.</i> (2015), Bren D'Amour <i>et al.</i> (2017), Mwaniki (2018), Oijstaeijen <i>et al.</i> (2020), Marquard <i>et al.</i> (2020), Sanches <i>et al.</i> (2021), Oliveira (2021), Zhu <i>et al.</i> (2022), Yu <i>et al.</i> (2022), Valente <i>et al.</i> (2023)	 Environmental dimension	Dimensions of urban life associated with the plot	Refers to a physical space of the urban land that influences the local microclimate. It is a fundamental component for the promotion of permeable and green areas, capable of improving thermal regulation, rainwater drainage and environmental quality.	Refers to the proportion and location of green and permeable areas present on the plot. This can promote social interaction, increase the attractiveness of sidewalks and contribute to local urban vitality.
Conzen (1960), Slater (1990), Cannigia and Maffei (1979), Moudon (1994), Baird (1988), Siksna (1998), Whitehand (2004), Macedo (2008), Porta and Romice (2010), Marcus (2000, 2010), Tarbatt (2012), Kropf (2014), Whitehand (2016), Oliveira (2016), Kropf (2018), Hjelmbom <i>et al.</i> (2019), Bobkova (2019), Dovey <i>et al.</i> (2020), Freischmann (2020), Liu <i>et al.</i> (2020), Bobkova <i>et al.</i> (2021), Song <i>et al.</i> (2022), Küçük e Kubat (2022), Song <i>et al.</i> (2022), Arat (2023)	 Morphological dimension	Dimensions of urban life associated with the plot	Refers to the spatial configuration of the plot on urban land, including its size, façade, and plot density. This dimension influences the organization of buildings, the use of space and integration with the urban fabric. The morphology of the plot impacts the functionality, circulation and quality of the cities.	Refers to the types of façades of the plots, their relationship with the public space and the way they influence the local urban landscape.
Kruse (1939), Demsetz (1967), Denman and Prodan (1972), Alchian and Demsetz (1973), Bromley (1991), Payne (2000), Webster and Lai (2003), Needham (2006), Chau <i>et al.</i> (2018), Kropf (2019), Scheer (2018), Cazzolino and Moroni (2021), Kantarek and Kwiatkowski (2022), Zazyki <i>et al.</i> (2022), Djankov <i>et al.</i> (2022)	 Legal dimension	Dimensions of urban life associated with the plot	This dimension refers to the property rights associated with the urban plot. It encompasses all formal owners linked to the plot, whether they are residents or not, and defines who holds control, usage rights, and legal responsibility over the land. These legal arrangements directly influence land occupation, transferability, and governance.	Refers to the type of ownership of the plot, which can be identified through the physical characteristics of the plot. This impacts the level of integration of the plot with the local society and the level of physical control that exists.
Altshuler (1965), Crecine <i>et al.</i> (1967), Stuart (1969), Castex <i>et al.</i> (1977), Qadeer (1981), Baird (1988), Merlin (1988), Taylor (1998), Gold (2007), Tarbatt (2012), Oliveira (2016), Burke <i>et al.</i> (2016), Allmendinger (2017), Calder (2017), Peurifoy <i>et al.</i> (2018), Bobkova (2019), Karaman <i>et al.</i> (2020), Ratcliffe <i>et al.</i> (2021), Lin <i>et al.</i> (2022), Vicuña and Rivas (2022), AlSadaty (2022)	 Institutional/ Planning dimension	Dimensions of urban life associated with the plot	Refer to strategic and structural decisions related to urban planning and land use. This dimension considers standards, policies, and utilization rates that guide land occupation and use. Institutional choices influence the organization, density and functionality of urban space.	Refers to specific city laws for plots, which strongly impact the physical structure of the plot and everything within it.

Table 13 - Typology of the plot system – structural axis: characteristics

Literature review	Atributte	Structural axis	Definition of the city scale	Definition of the local scale
Conzen (1960), Slater (1981), Qadeer (1981), Moudon (1986), Ersland (2009), Barbour <i>et al.</i> (2016), . Whitehand <i>et al.</i> (2016), Cantarino and Netto (2017), Scheer (2018), Kropf (2018), Marcus (2019), Vicuña and Rivas (2022), Tunturk (2022), Spolaor (2023), Rojas Symmes (2023)		Transformation Characteristic of the plot systems	Refers to the physical, functional and legal changes that the plot undergoes over time. This characteristic assesses processes of renewal, adaptation and expansion that impact its form, use and value. The transformation of the plot reflects urban dynamics and changes in the needs of the city and its residents.	Refer to changes in the use or form of the plot over time, observed through the union of plots, division of plots, extensions, renovations or functional changes within on plot.
Qadeer (1981), Hillier <i>et al.</i> (1993), Golany (1995), O’Sullivan (1996), Erickson and Roberts (1997), Webster and Lai (2003), Chen and Romice (2009), Porta <i>et al.</i> (2011), Sepe and Pitt (2014), Sevtsuk <i>et al.</i> (2016), Hristova <i>et al.</i> (2018), Sim (2019), Slomska-Przech and Slomski (2022)		Location Characteristic of the plot systems	Refers to the position of the plot within the urban system, including its proximity to facilities, infrastructure, transformation networks and economic activities. This characteristics influences the accessibility, value and integration of the plots with the city. Location defines the role, connectivity and economic potential of the plot in the urban context.	Refers to the position of the plot in relation to urban infrastructure, public services and nearby economic activities.
Qadeer (1981), Wang <i>et al.</i> (2017), Kropf (2018), Leite (2019), Bacellar <i>et al.</i> (2019), Bobkova (2019), De Almeida <i>et al.</i> (2020), Djankov <i>et al.</i> (2022), Łaskiewicz <i>et al.</i> (2022), Ventura (2023), Bertolino and Oliveira (2024)		Occupation Characteristic of the plot systems	Refers to how the land is used and built upon, considering the intensity and distribution of use in three-dimensional space. This characteristic involves the use of the plot and its construction density. The occupation characteristic influences urban dynamics and how the space is structured.	Refers to the intensity of construction and use of the plot, considering the occupation in height and the number of functions that are within the plot.
Banfield (1959), Moudon (1986), Akbar (1988), Coorter and Ulen (2012), Scheer (2018), Bonakdar and Audirac (2019), Akbar (1988), Robinson and Diop (2022), Castro (2023), Bwalya Umar <i>et al.</i> (2023)		Control Characteristic of the plot systems	Refers to the average are under legal control of each owner on a plot. This characteristic influences the possibilities for occupation, intervention, and transformation of the plot. Ownership control defines the degree of autonomy in decision-making regarding urban space.	Refers to the extent of the area under the control of a single owner, which defines the degree of control and autonomy over the use of the plot.
Conzen (1960), Jacobs (1961), Batty <i>et al.</i> (2004), Talen (2008), Tarbatt (2012), Dovey and Wood (2014), Long and Shen (2014), Marcus (2010), Bobkova (2017), Berghauser <i>et al.</i> (2019), Raman (2019), Bobkova (2019), Oliveira (2021), Yao <i>et al.</i> (2021), Yang <i>et al.</i> (2022), Peng <i>et al.</i> (2022),		Function Characteristic of the plot systems	Refers to the number of use attributed to the plot, including economic, residential, institutional or service activities. This characteristic defines the functional role of the plot in the urban fabric. The function of the plot influences the local dynamics, the intensity of use and the diversity of occupations in the urban space.	Refers to the types of functions existing on the plot, such as residential, commercial, institutional or mixed.

6.3 The Plotter method

The *Plotter method* is an analytical approach based on a taxonomy that organizes and interprets, in a structured manner, the different attributes of the plots that make up the urban fabric. Developed to be applied throughout the city, the method operates at the plot level and enables analyses at multiple scales. It combines quantitative and qualitative procedures, intending to

understand both the general patterns and the specificities of the plot systems and the urban spaces.

The structure of the method consists of three main stages. The first is the definition of the indicators and variables that represent, in numerical form, each characteristic and dimension of the plots. These indicators are defined based on the typology of plot systems developed in this thesis (section 6.2). This stage enables the construction of an objective database that supports quantitative analysis.

In the second stage, the profile of each characteristic and dimension is calculated for all plots of the city. The result is a detailed and comparable portrait of plots, which reveals their particularities and relative positions in the urban complex.

The third stage integrates individual profiles, generating the multifaceted profile of the plot system. This composition allows to understand how plots are organized among themselves and how they constitute complex structures in the urban space. The result is a systemic reading of the city, capable of identifying patterns, groupings, and singularities that are relevant for urban planning.

In parallel with the large-scale quantitative analysis, the *Plotter method* is also applied qualitatively to local sections of the city. This application aims to identify aspects that numerical data do not capture accurately, such as particular dynamics and cultural relations. By selecting specific areas for in-depth analysis, the method provides a richer and more sensitive understanding of the various urban dimensions and characteristics.

The results of the *Plotter method* can be interpreted on three distinct and complementary scales: the city scale, offering a comprehensive view of the urban territory; the local scale, allowing a detailed reading of strategic areas; and the plot scale, enabling an in-depth understanding of each territorial unit.

In this way, the *Plotter method* constitutes a robust tool for analysis and diagnosis, which can contribute to the formulation of policies and actions, based on evidence and anchored in multiple layers of territorial reading.

Finally, it is important to acknowledge that, in this method, some indicators are related with buildings. Buildings are one of the most important physical manifestations of the development processes that occur on plots. Plots constitute the enduring spatial division structure through which these processes are organized, developed, and transformed over time. Focusing explicitly on plots and not on buildings, allows a full consideration of how land is effectively divided and used in each part of the city, as well the influence of this ground plan on critical aspects of urban life. A focus on buildings instead of plots – an element of urban form already conditioned by previous decision taken on plots – would fail to capture such a detailed view.

6.3.1 Definition of indicators of the dimensions and characteristics of plot systems

As mentioned above, the first stage of the *Plotter method* is the definition of indicators and variables that represent, quantitatively and systematically, each of the dimensions and characteristics of urban plots. This step is essential for building a solid indicator base that allows for a detailed, precise, and well-founded analysis of the city scale.

In terms of the *dimensions*, beginning with the social, the focus is on identifying links between residents and territory. The indicator used is *Users who are owners* (UOP), which counts the number of people who live in properties that they own (within each plot). The presence of owner-residents reflects a greater degree of belonging, influencing the stability of residential areas and the formation of more cohesive communities. On an urban scale, this indicator makes it possible to map patterns of permanence, identify zones with a higher density of social ties and, on the other hand, reveal areas with greater vulnerabilities.

In the economic dimension, three indicators are applied to measure the role of plots as market assets and productive units: the *Plot Value* (LVP), which corresponds to the sum of the value of the land and buildings; the *Number of Property Transfers* (PTP), which expresses the turnover of the asset in the real estate market; and the *Number of Economic Activities* (EAP), which identifies the presence of economic uses. This data helps to map the plot demand dynamics, reveal areas subject to real estate speculation, and acknowledge the spatial distribution of economic activities in the city.

The environmental dimension is represented by the *Permeable Area* (PA) indicator, which measures the amount of non-impermeable land in each plot. This indicator reveals the role of plots in the environmental regulation of the urban territory, contributing to the control of surface runoff, thermal regulation, and the maintenance of urban biodiversity. When analysing the city, this data allows the identification of critical areas of impermeability and deficit in green infrastructure, which are fundamental for climate and environmental planning.

The morphological dimension refers to the physical configuration of plots and their relationship with the urban fabric. Three indicators are used: *Area of the plot* (AP), which measures the size of the plot; the *Size of the façade* (SF), which provides the extension of the plot defining the public space; and the *Plot density* (PD), which expresses the number of accessible plots within a capture area. These indicators allow the identification of urban morphological patterns, such as centralities, areas of densification or fragmentation, and regions with greater or lesser spatial connectivity.

The legal dimension focuses on property rights and the legal regime associated with each plot. The defined indicator is the *Total Number of Owners* (OP) – including resident and non-resident owners – which quantifies formal owners of one or more real estate units within the same plot. High levels of multiple ownership can represent obstacles to urban management and transformation, since the presence of many owners on the same plot tends to hinder processes such as regularization, public works, and negotiations for land use or changes in the occupation pattern. On the other hand, ownership concentrated among a small number of actors can indicate areas with greater control over land use, which, although it can facilitate decision-making and the implementation of urban projects, may also drive processes such as dynamics of exclusion,

gentrification or real estate speculation. In systemic terms, this indicator contributes to the interpretation of urban governance, land accessibility and land tenure structure.

The last dimension is the institutional / planning, expressed by the *Plot utilization rate* (URP) indicator. This indicator measures the degree of use of the construction intensity permitted by urban legislation. It expresses the effectiveness of the application of planning instruments and allows the identification of underutilized or over occupied areas. At the urban level, this indicator is essential for assessing the occupation between real and normative guidelines, supporting decisions on rezoning, densification, or redefinition of land use.

In terms of *plot characteristics*, the transformation characteristic is associated with the dynamics of physical, legal, and economic changes in plots over time. Within it, three indicators are considered. The first, *Variation in plot area* (VA), measures the number of times the size of the plot has changed over time, reflecting processes of subdivision, amalgamation, which indicates the spatial adaptability of the plot in the face of urban pressures. The second, *Variation in property transfers* (VPT), represents the turnover of land ownership, being an indicator of the fluidity of the real estate market and the attractiveness of the location. The third *Variation in land value over time* (VLV) expresses the processes of appreciation or depreciation of urban land, reflecting the influence of investments, urban policies, and infrastructure on the pricing of the different parts of the territory. These three indicators, when combined, reveal the degree of transformation of plots, allowing the identification of more stable areas or those that are more exposed to urban change.

The location characteristic is linked to how the plot is placed in relation to the broader urban structure. Its indicator, the *Distance of attraction* (PDT) in 800 meters, assesses the spatial relationships of the plot (with different urban uses such as shops, services, and equipment) within a radius of 800 meters (the appropriate distance a pedestrian can comfortably walk), using the *Place Syntax Tool*.

Occupation is related to the intensity of the physical use of the plot, translated by the *Building density* (BD) indicator. This indicator measures the proportion of the built area and the total area of the plot, providing a measure of the efficiency of land use. High density indices indicate greater verticalization, generally associated with areas with consolidated infrastructure and greater real estate pressure.

Control is linked to the governability of land use within the plot, reflected by the *Average plot area for each owner* (AO). This indicator assesses the capacity of each owner to exercise control over a given physical volume of the plot. A greater number of owners per unit area may suggest fragmentation and less individual control, while smaller proportions indicate greater autonomy and clear control over space.

Finally, function refers to the quantity of uses on the plot, measured by the *Number of functions it accommodates* (FP), such as housing, commerce, services, or leisure. This indicator expresses the functionality of the plot and its contribution to urban vitality. Plots with a high level of functionality tend to generate greater flows of people and intensify the use of space throughout the day, promoting security, local economy, and a more active urban life.

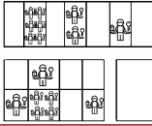
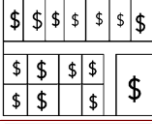
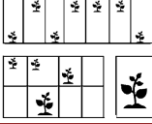
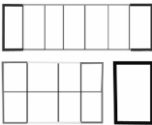
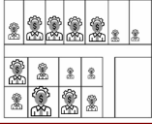
Each of these indicators will be presented together with its respective design equations (in section 6.3.2), enabling uniform application across all plots of the territory. This systematization allows the construction of comparable, evidence-based profiles that provide a comprehensive and well-founded reading of the city.

6.3.2 The profile of each dimension and characteristic of the plot systems

This stage presents the construction of each of the indicators that make up the dimensions and characteristics of urban plots. Table 14 and Table 15 illustrate how these indicators are operationalized through specific equations, enabling their min-max normalization and systematic comparison between different plots of the city. This quantitative structure allows for a precise and well-founded reading of urban reality from multiple perspectives - social, economic, environmental, morphological, legal, institutional - highlighting patterns, inequalities, and intensities that structure the territory.

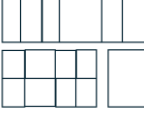
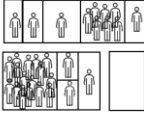
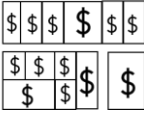
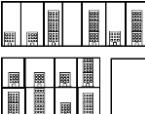
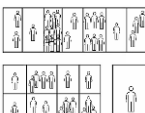
The consolidation of these calculations constitutes the basis for the next stage of the method, dedicated to the construction of multifaceted plot profiles. By organizing and classifying plots based on their performance in different profiles of analysis, this taxonomic construction offers a solid basis at the plot scale to understand the complexity of urban space and support strategic decisions for planning, management, and the transformation of the city.

Table 14 – Indicators and equations of the plot dimensions

Atributte	Definition of the indicator	Equation	Index
 Social dimension (SCD) (belonging and identity)	 Number of users who own their houses within each plot(UOP)	$\text{SCD} = \frac{(\text{UOP} - \min(\text{UOP}))}{(\max(\text{UOP}) - \min(\text{UOP}))}$	0,0-0,3= Low 0,3-0,7= Medium 0,7-1,0=High
 Economic dimension (ECD) (Real estate and productive activities)	 Monetary value of the plot (land value and building value) (LVP)	First step: normalize(n) the indicators $n \text{ LVP} = \frac{(\text{LVP} - \min(\text{LVP}))}{(\max(\text{LVP}) - \min(\text{LVP}))}$	
	 Number of property transfers in the year (PTP)	$n \text{ PTP} = \frac{(\text{PTP} - \min(\text{PTP}))}{(\max(\text{PTP}) - \min(\text{PTP}))}$	0,0-0,3= Low 0,3-0,7= Medium 0,7-1,0= High
	 Number of economic activities within each plot (EAP)	Second step: create the index $\text{ECD} = \frac{(n \text{ LVP} + n \text{ PTP} + n \text{ EAP})}{3}$	
 Environmental dimension (EVD) (Impact on the urban microclimate)	 Amount of permeable area within each plot (PA)	$\text{EVD} = \frac{(\text{PA} - \min(\text{PA}))}{(\max(\text{PA}) - \min(\text{PA}))}$	0,0-0,3= Low 0,3-0,7= Medium 0,7-1,0= High
 Morphological dimension(MPD) (Spatial configuration)	 Area of the plots (AP)	First step: normalize(n) the indicators $n \text{ AP} = \frac{(\text{AP} - \min(\text{AP}))}{(\max(\text{AP}) - \min(\text{AP}))}$	
	 Measures the ratio between the length of the plot's front and its total perimeter(SF)	$n \text{ SF} = \frac{(\text{SF} - \min(\text{SF}))}{(\max(\text{SF}) - \min(\text{SF}))}$	0,0-0,3= Low 0,3-0,7= Medium 0,7-1,0= High
	 Quantifies the number of most accessible plots within the catchment area (PD)	Second step: create the index $\text{MPD} = \frac{(n \text{ AP} + n \text{ SF} + n \text{ PD})}{3}$	
 Legal dimension (LGD) (Property rights)	 Total number of all existing owners within a plot(OP)	$\text{LGD} = \frac{(\text{OP} - \min(\text{OP}))}{(\max(\text{OP}) - \min(\text{OP}))}$	0,0-0,3= Low 0,3-0,7= Medium 0,7-1,0= High
 Institutional/ Planning dimension (IPD) (Strategic and structural options)	 Measures the construction potential of a plot determined by the city's urban planning department (URP)	$\text{IPD} = \frac{(\text{URP} - \min(\text{URP}))}{(\max(\text{URP}) - \min(\text{URP}))}$	0,0-0,3= Low 0,3-0,7= Medium 0,7-1,0= High

* After calculating the arithmetic mean, the inverse of the index (1 - MPD) was calculated, so that the higher values would represent plots with smaller areas and narrower facades, in accordance with the interpretation adopted by the literature.

Table 15 – Indicators and equations of the plot characteristics

Atributte	Definition of the indicator	Equation	Index
 Transformation (TR)	 Number of plots that transformed the plot area over time (VA)	First step: normalize(n) the indicators $nVA = \frac{(VA - \min(VA))}{(\max(VA) - \min(VA))}$	
	 Number of ownership transfers that have changed over time (VPT)	$nVPT = \frac{(VPT - \min(VPT))}{(\max(VPT) - \min(VPT))}$	
	 Variation in land value over time (VLV)	$nVLV = \frac{(VLV - \min(VLV))}{(\max(VLV) - \min(VLV))}$	
		Second step: create the index $TR = \frac{(nVA + nVPT + nVLV)}{3}$	0,0-0,3= Low 0,3-0,7= Medium 0,7-1,0= High
 Location (LO)	 Position of the plot in space, considering its relationship to the entire urban system (AT)	Attraction distance analysis of different land uses in 800 meters. Analysis calculated with Place Syntax Tool-PST and normalized with equation: $LO = \frac{(AT - \min(AT))}{(\max(AT) - \min(AT))}$	0,0-0,3= Low 0,3-0,7= Medium 0,7-1,0= High
 Occupation (OC)	 Ability of the plot to be used based on its ground and aerial area. Analysis of building density (BD)	$BD = \frac{\text{Total area of the building}}{\text{Total area of the plot}}$ Normalize the result with the equation: $OC = \frac{(BD - \min(BD))}{(\max(BD) - \min(BD))}$	0,0-0,3= Low 0,3-0,7= Medium 0,7-1,0= High
 Control (CO)	 Ability of the plot to control access and land use, with average plot area for each owner (AO)	$AO = \frac{\text{Number of plot owners}}{\text{Plot area}}$ Normalize the result with the equation: $CO = \frac{(AO - \min(AO))}{(\max(AO) - \min(AO))}$	0,0-0,3= Low 0,3-0,7= Medium 0,7-1,0= High
 Function (FU)	 Ability of the plot to receive specific uses and activities. Number of functions on the plots (FP)	$FU = \frac{(FP - \min(FP))}{(\max(FP) - \min(FP))}$	0,0-0,3= Low 0,3-0,7= Medium 0,7-1,0= High

6.3.3 The multifaceted profile of the plot system

The construction of multifaceted profiles of urban plots represents an advanced and strategic stage of the *Plotter method*, in which the data obtained and normalized (with this equation: $x_{\text{norm}} = (x - x_{\text{min}}) / (x_{\text{max}} - x_{\text{min}})$) in each dimension and characteristic are integrated into composite calculations. These calculations aim to synthesize, in a structured way, the complexity of the multiple pieces of information obtained in previous analyses. From this, two major profiles are generated: the *multidimensional profile* and the *multicharacteristic profile* (Table 16). The first profile results from the integration of the indices of all the dimensions (social, economic, environmental, morphological, legal, and institutional), while the second is derived from the

combination of the indices of each characteristic of the plot (transformation, location, occupation, control and function).

Table 16 – Multifaceted profile of the plot system – Equations

Multifaceted profile	Definition of the profile	Equation	Index
Multidimensional Profile of the Plot Systems (PDP)	Represents the synthesis of the plot's performance in the social, economic, environmental, morphological, legal and institutional/planning dimensions. It integrates multiple perspectives into a single index, offering a comprehensive reading of the urban reality. It allows for the identification of inequalities, territorial patterns and structural potential.	$PDP = ((SCD) + (ECD) + (EVD) + (MPD) + (LGD) + (IPD)) / 6$	0,0-0,3= Low 0,3-0,7= Medium 0,7-1,0= High
Multi-characteristic Profile of the Plot Systems (PCP)	Represents the aggregation of indicators of the plot's operational characteristics: transformation, location, occupation, control, and function. It assesses the plot's behavior, use and adaptability in the urban fabric. It reveals levels of dynamism and functional diversity.	$PCP = ((TR) + (LO) + (OC) + (CO) + (FU)) / 5$	0,0-0,3= Low multi- 0,3-0,7= Medium 0,7-1,0= High

The *multidimensional profile* offers a broad and integrated reading of the urban conditions of each plot, allowing the identification of levels of development, deficiencies, or specific intensity in terms of social structure, economic dynamics, environmental performance, and morphological organization, among others. By bringing together these variables into a single composite indicator, it becomes possible to map and compare, objectively, the levels of urban complexity in different parts of the city. This integrated view facilitates the recognition of strategic territories for public policies, urban interventions, or investments, aligning territorial evidence with sustainable urban development goals.

The *multicharacteristic profile* complements this analysis by offering a structured approach to understanding how plots operate and relate to their surroundings, based on internal dynamics and spatial interactions. By incorporating attributes such as transformation, location, occupation, control, and function, the profile supports a comprehensive reading of the urban fabric. It allows the identification of patterns related to land use, levels of regulation, spatial organization, and functional diversity. This perspective contributes to an empirical interpretation of urban dynamics, allowing the observation of territorial behaviour.

6.3.4 Plot scale analysis

Plot scale analysis represents the most detailed stage of the *Plotter method*, as it is this minimum unit of territorial organization that concentrates the interactions of the dimensions and characteristics analysed in the previous stages. Plot-scale analysis addresses the space where the studied indicator materializes most clearly.

This analysis is the result of the systematic application of previously defined indicators (sections 6.3.1 to 6.3.3), which allows for the quantification and qualification of the dimensions and characteristics of the plot system. Reading the plot scale allows for verifying the actual numbers and the plot's intensity within the indicators of dimensions and characteristics for

city's urban system. The analysis is performed using a table that combines all the results found for each plot (model presented in Table 17), revealing all the meanings that the plot carries within the different urban aspects.

Table 17 - Plot Scale Analysis Table Template

General information:						
Location's map	Plot's map	Plot's photo	City			
			Name of city		ID	
			Borough		ID	
			Name of neighborhood		Plot's ID	
Area		Date				
Plot's area		Date of analysis				

Multidimensional profile: number of multidimensional profile							Level of intensity				
Dimension Indicator Graph 1 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1 0											
	Social	Economic	Environmental	Morphological	Legal	Planning					
	City scale										
	XXX	XXX	XXX	XXX	XXX	XXX					
	Local scale										
						XXXX	XXXX	XXXX	XXXX	XXXX	

Multi-characteristic profile: number of multi-characteristic profile							Level of intensity			
Characteristics Indicator Graph 1 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1 0										
	Transformation	Location	Occupation	Control	Function					
	City scale									
	XXX	XXX	XXX	XXX	XXX	XXX				
	Local scale									
					XXXX	XXXX	XXXX	XXXX	XXXX	

The importance of this procedure lies in its ability to articulate the micro-scale of the plot with the macro-scale of the urban system. By consolidating empirical evidence and integrating it into comparable profiles, the method allows for the identification of problems and intensity, offering a solid basis strategic urban planning decisions to plot systems.

6.3.5 Local analysis of the plot systems

The qualitative analysis of urban plots at the local scale is carried out based on an on-site survey and specific analysis of official data that captures the essential dimensions and characteristics of these spatial units. This process involves direct and systematic observation, with the aim of recording different attributes, according to the criteria detailed in Table 18 and Table 19.

This approach allows to understand the role of the plots in the context of the neighbourhood, revealing specific dynamics that would not be perceptible on larger scales, as well as identifying how specific laws influence local dynamics.

Table 18 – Local scale indicators – plot dimensions

Atributte	Indicador	Definition of the indicator	Criterion
 Social dimension (belonging and identity)	Relationship between type of tenure and use of space	Refers to the distribution and proportion of people residing on the plot according to tenure status (owner-occupants vs. renters). This indicator highlights how the composition of residents can influence the social dynamics, permanence, and use of space at the interface between private plots and public space. Database are derived from census blocks New York and disaggregated to the plot level.	. Plots where residents are mostly renters, indicating higher turnover and less permanence; . Plots with a balanced mix of renters and owner-occupants, suggesting intermediate levels of permanence and social stability; . Plots where residents are predominantly owner-occupants, indicating higher permanence and the space.
 Economic dimension (Real estate and productive activities)	Local economic activities	Indicates the diversity and presence of productive uses within the plot, revealing their role in the economic dynamics of the surrounding area.	. One activity; . Two activities; . Three activities; . Four activities; . Five or more activities.
 Environmental dimension (Impact on the urban microclimate)	Permeable and green areas	Refers to the proportion and positioning of green areas on the plot, which contribute to environmental comfort, urban vitality and local social interaction.	. No green/permeable area; . Restricted permeable area (not visible or accessible); . Semi-accessible area (visible but not accessible); . Accessible green/permeable area.
 Morphological dimension (Spatial configuration)	Frontage shape	Refers to the configuration of the plot's frontage and its interaction with public space, shaping the landscape and street environment.	. Inactive façade; . Opaque façade; . Semi-active façade; . Active façade.
 Legal dimension (Property rights)	Types of properties	Refers to the legal typologies of property ownership. This indicator highlights how different ownership structures shape investment strategies, stability of use, and the degree of community or market orientation of each plot.	. Limited Liability Companies (LLCs): Companies with limited liability that operate with a business logic oriented to financial return, often associated with higher turnover and capacity for transformation; . TRUSTs: Fiduciary structures managing assets on behalf of beneficiaries. Linked to stability of use, low turnover, and strategies of patrimonial protection or succession planning; . Associations: Community-based, cooperative, religious, or non-profit organizations. Represent a smaller share of plots, normally, reinforcing collective uses and social purposes; . Corporations (INC.): Large companies, including national or multinational holdings. Characterized by significant investment capacity, they tend to drive urban renewal and encourage more homogeneous land uses; . Individual owners: Properties registered to private persons. Associated with permanence, strong local ties, and gradual adaptation to socioeconomic changes; . Public properties: plots owned by public authorities. Although less numerous, they play a strategic role by hosting collective facilities, social housing, or leases of social interest.
 Institutional/ Planning dimension (Strategic and structural options)	Specific urban regulation	This refers to the local land use regulations applicable to the lot, which shape its physical form and permitted occupancy. This analysis is conducted through the Zoning Resolution law, which is in effect throughout New York City and defines different zones with specific use and development restrictions for urban plots.	. Type of zoning in which the plot is located and its main restrictions on use and construction development.

Table 19 – Local scale indicators – plot characteristics

Atributte	Indicador	Definition of the indicator	Criterion
	Transformation	Types of local transformation	It refers to the intensity and nature of the changes that the lot has undergone in its original configuration, considering physical changes (such as mergers or subdivisions), economic changes (land value and ownership transfers) and functional changes (change of use). . Size transformation: subdivision, amalgamation or no change in the analyzed period; . Land value transformation: number of times the value of the plot increased in relation to the value of the initial year of analysis. . Property transformation: number of times the property associated with the plot has changed; . Transformation of existing functions in the plots in the period: decreases, equals or increased the number of functions in the analyzed period.
	Location	Local connectivity	Refers to the position of the land in the urban fabric, considering its proximity and accessibility to public transport systems. . Proximity to bus stops; . Proximity to subway stations.
	Occupation	Occupance rate and age of buildings on the plot	Refers to two complementary dimensions: the occupancy rate, which expresses the proportion of the lot covered by built structures in relation to its total area, indicating the intensity of land use; and the building age, which reflects the temporal dimension of urban built development on the plot. . percentage of land occupation by buildings; . decade since the building inside the plot was constructed.
	Control	Types of physical control of the plot	Refers to the level of physical control of the plot in relation to the public space by means of elements such as walls, fences, gates or the absence thereof. . Fully controlled plot; . Semi-controlled plot; . Public plot.
	Fuctionion	Types of functions	Refers to the different functions present on the plot (residential, commercial, institutional, leisure, etc.), indicating its functional complexity. . One or two family buildings; . Multi-family walk up buildings; . Multi-family elevator buildings; . Mixed-residential and commercial buildings; . Commercial and office buildings; . Industrial and manufacturing; . Transportation and utility; . Public facilities and institutions; . Open space and outdoor recreation; . Vacant land.

During the field survey in New York, digital tools are used, allowing the collection of georeferenced data related to the legal boundaries of the plots, facilitating the linking of the observed data to the plots. Information recorded includes: the presence and interaction of users, diversity of economic activities, types of land permeability, configuration of façades, forms of physical control, in addition to the effects of current local regulations (and others). Photographs and notes complemented the collection, ensuring the qualitative contextualization necessary for the analysis. The on-site analysis was complemented by the analysis of specific legislation affecting each analysed plot, such as land zoning and the type of ownership of each plot.

This multidisciplinary qualitative analysis acts as a complementary tool to the quantitative method of the multifaceted profile of the plot systems, enriching the local understanding and providing valuable support for decision-making.

6.4 Case study selection

New York City was selected as a case study for this thesis because it represents one of the densest, most complex, and best-documented urban contexts in the world (Figure 27). Located in the northeastern United States, the city is the core of a metropolitan region that encompasses 31 counties in the states of New York, New Jersey, and Connecticut – known as the tri-state region – encompassing approximately 900 villages, cities, and towns. With a population of approximately 9 million inhabitants distributed among five boroughs (Brooklyn, Manhattan, Queens, The Bronx and Staten Island), the city presents high demographic, morphological, and socioeconomic diversity (etc.). Its territory is marked by a unique physical interface between land and water, in the New York – New Jersey estuary, and its urban system is composed of more than 10.000 kilometres of streets, 35.000 street blocks, almost 900.000 plots, and more than 1 million buildings.

In addition to this structural and functional complexity, New York is home to a highly developed economy, responsible for approximately half of the metropolitan region's Gross Domestic Product, especially Manhattan, which alone accounts for more than a third of regional economic activity. The city also stands out for the quality and breadth of data available at multiple scales, especially at the plot scale, with public, detailed, and continually updated information. New York was chosen, also, because part of its plot structure has remained over time. This characteristic makes New York a particularly suitable territory for the development and application of analytical methodologies aimed at accurately interpreting the urban structure in the plot scale.

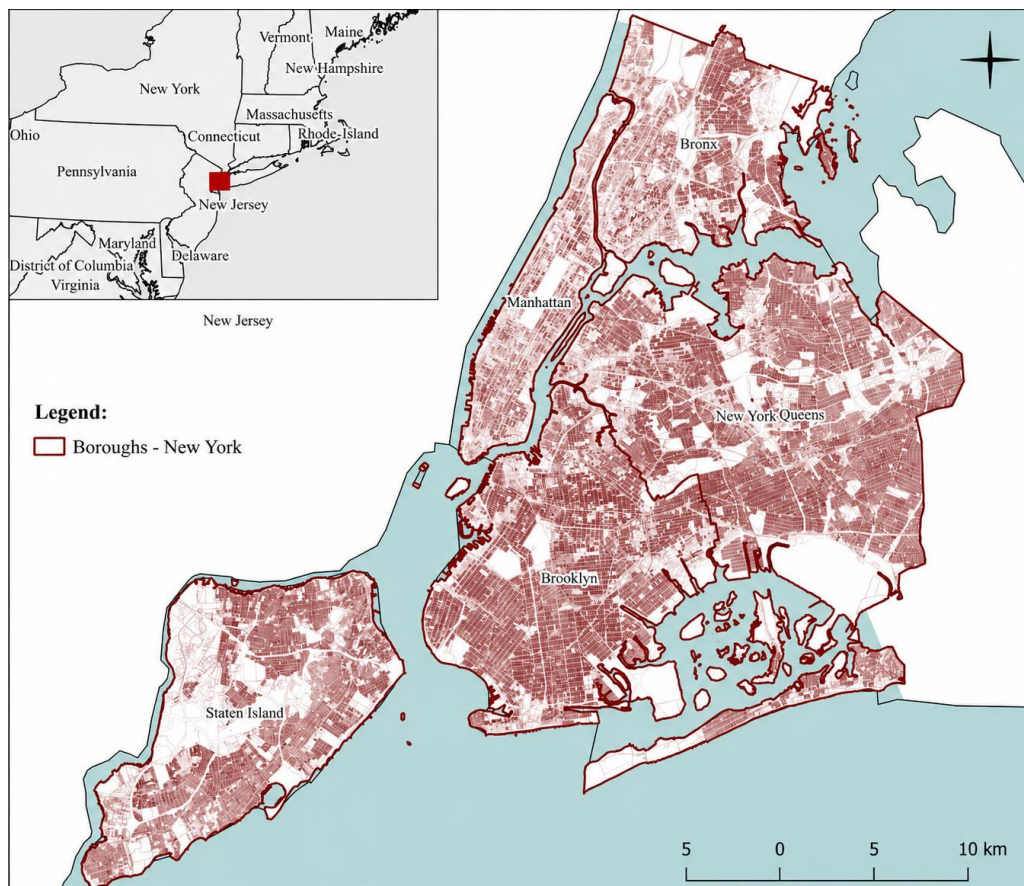


Figure 27 - Case Study Location Map – New York City

The adoption of one only case study as a methodological approach for this research is justified by the need to understand, in depth and rigor, the complexity of the multifaceted nature of plot systems. The case study allows for an analytical immersion in a real empirical context, enabling the integration of spatial, social, economic, institutional, cultural (and others) variables that, together, shape the city. Before applying this urban analysis method to different realities, it is essential to understand in a systematic and detailed way how the multifaceted nature of the plot systems is organized in a specific territory. This initial stage is essential for refining the methodological approach, in addition to enabling the identification of the structural and functional layers that make up the city.

In this sense, the choice of New York is supported by the fact that it offers ideal technical and empirical conditions for conducting methodologically robust research. The availability of precise geospatial and cadastral data at the plot scale allows for a high degree of internal validity, in addition to providing valuable inputs for qualitative and quantitative analyses.

The multiscale analysis of New York City (Figure 28), therefore, constitutes one of the pillars of the investigation. All analytical stages are based on the physical boundaries of each plot, with observations conducted at three interdependent scales: city, local, and plot scale.

At the city scale, the method allows for the identification of structural patterns of the urban system, with an emphasis on the differences between the five boroughs. At the local scale (at the administrative boundary of the *census tract*), specific urban areas are cut out within the boroughs to deepen the analysis of the forms of occupation and spatial organization in more restricted contexts. This scale is essential for capturing local specificities that are not fully expressed in quantitative analyses. Finally, the plot scale provides a detailed reading of the minimum unit that structures the urban space. It is at this scale that it becomes possible to accurately understand the multifaceted profile of each plot.

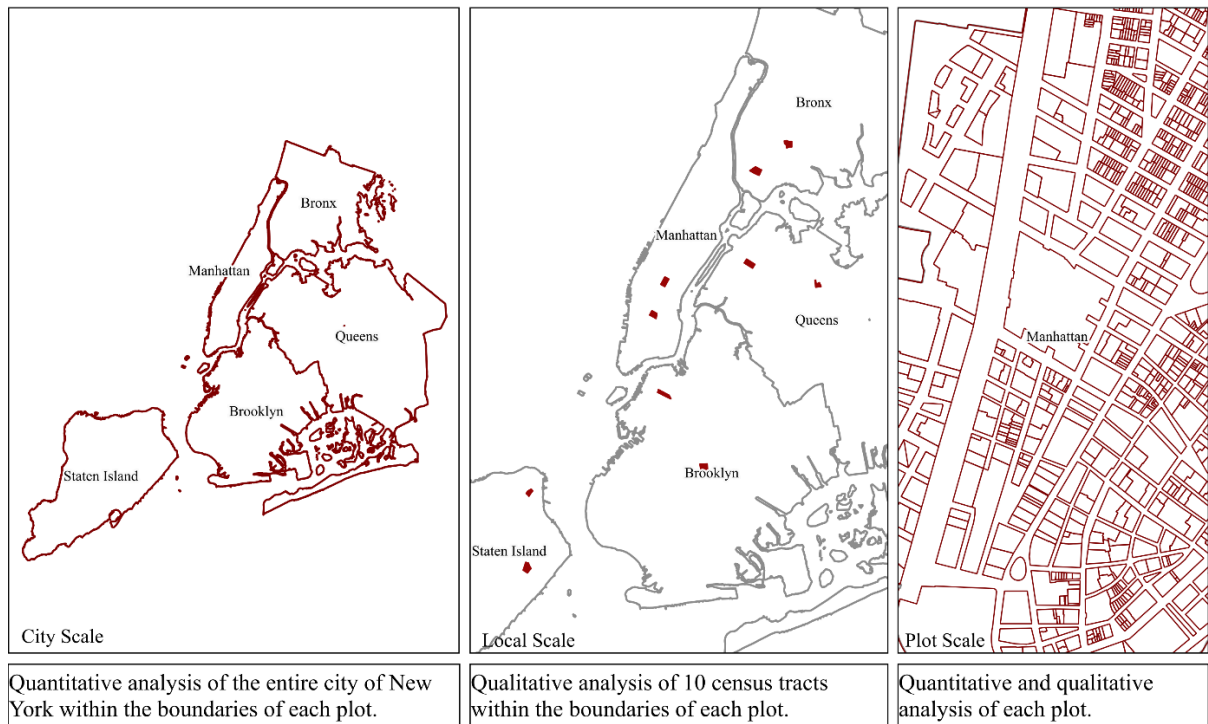


Figure 28 - Multiscale analysis - diagram of each scale of analysis

6.5 Data management and development of geospatial databases

One of the main stages in the research process is the identification of available data, followed by its systematic collection and organization. In the specific context of plot studies, it is essential to gather spatial and statistical information, allowing the analysis of configuration and evolution, thus broadening the interpretative intensity of data.

This data must be selected according to the research objectives and the scale of analysis, as this defines the methodological and epistemological limitations of the study (Scheer, 2016). Information that makes it possible to identify patterns in the subdivision of land, its physical and typological characteristics, as well as its relationship with the multiple dimensions of urban life – social, economic, environmental, legal, and planning – is essential for understanding the process of formation and transformation of urban space at the plot scale. As Kropf (2017) emphasizes, the urban structure should not be understood only as the result of planned actions, regulations, or established physical structures. On the contrary, it emerges from a dynamic combination of factors, which include daily practices of land use and appropriation, historical occupation processes, incremental decisions by different agents (formal and informal), in addition to the physical and functional characteristics of the plots themselves.

In this sense, data collection was based on the proposed method (section 6.3). The aim was to identify which indicators best represent the different meanings of the plot at the city scale and at the local scale. Firstly, a database was built on a city scale with the different indicators that represent the plot and that influence urban dynamics on this scale. This database was drawn up from secondary data obtained from official sources such as planning bodies and municipal cartography. Next, a local database was built, focusing on the local scale, based on field surveys and direct data collection through photographic records, observation sheets and systematic

notes. Both sets of data were organized into structured spreadsheets, categorized thematically and prepared for comparative analyses. These procedures are described in detail in the following subsections.

6.5.1 City scale data source and data types

The main city-scale data used in this thesis is sourced from five main New York City and US Government databases: the New York City Department of City Planning (NYC Planning); the New York City Department of Finance (DOF); the Department of Environmental Protection (DEP); the Office of Technology and Innovation (OTI) and the United States Census Bureau. Other data is built using OpenStreetMap (OSM) and Geographic Information Systems (GIS) tools.

In NYC Planning, the main database used is Primary Land Use Tax (PLUTO). This geodatabase presents geographic and land use data covering the boundary of the tax lot. PLUTO contains more than seventy fields derived from data held by municipal bodies: the Department of City Planning (DCP); the Department of Finance (DOF); the Department of Municipal Administrative Services (LPC). The data provided covers three broad categories: characteristics of the tax lot, characteristics of the buildings on it, and information on geographical, political and administrative districts. The official cartography of the plots presented in this database is adopted as the main cartographic reference for the thesis, including its variations over time. This base serves as the central structure for analysis, to which the other data sources are integrated.

At the DOF, the main source of information used is the ACRIS – Real Property Parties database and the Annualized sales update, that are annual information on the sales of all the properties that are associated with a plot within New York City. The first database is fundamental to understanding the property rights attached to each plot, as well as the profile of the respective owners, including the distinction between residents and non-residents. This dataset lists all the parties – individuals and companies – associated with the plots registered in ACRIS. The second database is essential for counting property transfers that take place during the year, and the period analysed. This database contains information on the exact dates of the property purchase, the address, the type of construction linked to the property, the square footage, among others.

The DEP's contribution is essential to understanding the environmental dimension of each plot. This department developed a geographic information system (GIS) study on land cover types at the plot scale for the entire city. The study, entitled Citywide Plot-Based Impervious Area GIS Study, classifies the land cover on each plot as impervious, semi-pervious or pervious. The *United States Census Bureau* is used primarily to collect information on the types of economic activities that exist throughout New York City, contributing to an understanding of the socioeconomic function of plots in different urban regions. The Office of Technology and Innovation (OTI) is essential for the morphological dimension. The information on the area, perimeter and correct placement of the buildings allowed us to construct the measurement of the front setback of each main building on each plot. In addition, some data is developed with the contribution of GIS tools, on the *QGIS* and *ArcGIS* platforms.

The most relevant data from this set, used in this thesis, is presented systematically in Table 20. The *Database* refers to the name of the database used, or the explanation of how the database was constructed. The *Data* describes the name of the data used and its unit of measurement. The *Code* presents the name of the variable within the Geodatabase constructed in this thesis. The *Attribute* refers to the name of the dimension or characteristic to which the presented variable is associated. Finally, the *Indicator* describes the measure that is chosen as a fundamental part in the construction of the multifaceted profile of the plot systems.

Table 20 – Data source description – city scale

Database	Data - variable used	Code - inside the attribute table	Attribute - dimension and characteristic	Indicator - for plot analysis
PLUTO (2002 to 2024)	Plot area (m2)	LotArea	Transformation	Variation of plot area over time
DOF (2002 - 2024) - Data processed by the author to construct the variable - sum of the value of property sales per plot in the period	Number of property sales within the plot in the period	Cust_trans	Transformation	Variation of property transfer over time
PLUTO (2002 to 2024)	Land value (in dollars)	AssessTot	Transformation	Variation land value over time
PLUTO (2002 to 2024)	Land Use (types)	vari_landuse	Transformation	Variation land uses over time
Built by the author based on OSM (2024) data and PLUTO (2024) Tool used: PST	Attraction distance	Loc_r800	Location	Attraction distance of the plot - r800m
PLUTO (2024)	Plot area (m2)	LotArea	Occupation	Density of construction on the plot
PLUTO (2024)	Building area (m2)	BldgArea		
PLUTO (2024)	Building area (m2)	BldgArea		
DOF (2024) - Data processed by the author to construct the variable - sum of all owners associated with the same plot	Number of owners	Owner_all	Control	The average amount of building area for each owner within a plot
PLUTO (2024)	Number of functions	UnitsTotal	Function	Number of functions on the plot
United States Census Bureau	Different land uses	n_act_nres	Function	Number of different land uses on the plot
DataCensus NYC (2022, 2025 update)	New York owners	Owner_occupant	Social dimension	Number of users who are owners
PLUTO (2024)	Land value (in dollars)	AssessTot	Economic dimension	Plot value
DOF (2024)	Number of property sales within the plot	Qnt_vend24	Economic dimension	Ownership transfers
United States Census Bureau	Economic activities	n_act_nres	Economic dimension	Number of economic activities
DEP (2021)	Permeable area within of plot	Plot_perm	Environmental dimension	Permeable area

PLUTO (2024)	Plot area (m2)	LotArea		
Variable constructed in GIS based on the plots mapping of the PLUTO (2024). Tool used: Oriented bounding box	Minimum area of an oriented rectangle of each plot	area_retan	Morphological dimension	Plot compactness
PLUTO (2024)	Plot façade (m2)	LotFront		
Variable constructed in GIS based on the plots mapping of the PLUTO (2024). Tool used: Geometry	Perimeter	Perimeter	Morphological dimension	Plot façade index
Variable constructed in GIS based on the plots mapping of the PLUTO (2024) and building footprints of the OTI (2024). Tool used: QNEAT3	Front setback	R_front	Morphological dimension	Size of front setback
Built by the author based on OSM (2024) data and PLUTO (2024) Tool used: PST	Attraction Reach	ARw800fpe	Morphological dimension	Plot density
DOF (2024)	Number of owners	Owner_all	Legal dimension	Number of all private owners associated with the plot
PLUTO (2024)	Utilization rate	P_farratio	Planning dimension	Utilization rate of the plot

6.5.2 Local scale data source and data types

All data at the local scale are collected directly during field visits. The data are collected using photographic records and systematic and empirical observation (method presented in section 6.3.4), with the aim of understanding which indicators exist in the plots analysed at the scale. The main tool used on site is the *LandGlide* app (GPS Property Line Map App), complemented by a camera and notepad. This app provides a legal basis with essential information about the properties, allowing, in a practical way, the insertion of markers with the data observed on site, already linked to the legal number of the plot. In addition, it allows the creation of a georeferenced database with photographic records.

The second stage of the on-site survey consists of organizing the data in a GIS environment. The information collected in the field is transferred to a .csv file and linked to the plot mapping (PLUTO). This process makes it possible to build a georeferenced database for local-scale analysis. Table 21 presents the variables collected, as well as their association with the indicators used.

Table 21 – Description of data collected on site – local scale

Data - variable used	Code - inside the attribute table	Attribute	Indicator - for plot analysis
Data Census NYC (2022, with 2025 update). Onwes-occupant and renters.	owner_renter	Social	Relationship between type of tenure and use of space
Number of economic activities at the interface of the lot with the street	econ_act	Economic	Economic activities
Types of permeable area within the plot	perm_types	Environmental	Permeable area
Types of façade	facade	Morphological	Façade
PLUTO (2024) and local analysis. Types of properties.	types_properties	Legal	Types of properties
Zoning Resolution NYC (2025)	devel_restrict	Planning	Development restrictions
Physical types and intensity of local transformation	trans_loc	Transformation	Degree of local transformation
Position of the plot in the urban fabric, considering its proximity and accessibility to public transportation, urban facilities and economic activities.	locat_loc	Location	Local connectivity
Number of floors or the height of the building	occup_loc	Occupation	Intensity of local occupation
Types of physical restrictions	control_loc	Control	Degree of physical control
Number of different functions present on the plot	function_loc	Function	Diversity of local functions

6.6 Plot systems as the central structure of urban planning

The fifth stage of the research method has the main objective of integrating the results of the multifaceted analysis of the plots into the urban planning process. This integration seeks to strengthen the technical and political basis of territorial decisions, offering a new approach for the construction of more precise and effective instruments for urban management. To this end, the data generated by the *Plotter method* can be used both to review the city's urban plans and for the construction of an interactive and continuous digital analysis and monitoring platform, capable of communicating the multifaceted aspects of the plot system in a clear and accessible way. This first stage involves a discussion about the importance of incorporating the *Plotter method* into urban planning practices. The focus of this analysis is to verify the extent to which the plot scale is considered in the current plan, identifying gaps. Therefore, the aim is to highlight how the Plotter method can complement and expand the analytical and propositional capacity in decision-making, especially by revealing morphological, functional, and socio-spatial patterns. This is, therefore, a fundamental step towards repositioning the plot as a key unit in the framework of planning practice. The representation of the results of the *Plotter method* is implemented on an interactive platform based on *Qgis* and *Felt*. This representation is developed in stages: first, the georeferenced data of the plots is organized in a vector database (GeoPackage), containing the attributes extracted from the multifaceted analysis (each profile of the dimensions of the plots and each profile of the characteristics of the plots). This data is integrated into the *Felt* online platform, allowing rendering based on the values of the attributes. The height and colour of the data represent different urban variables, facilitating spatial reading and comparison between the plots. Thus, this interactive tool reinforces the connection between technical knowledge and planning practice by transforming complex data into intuitive visualizations.

6.7 Strengths and limitations of the method

The Plotter method represents a significant innovation in urban analysis due to its ability to integrate multiple dimensions (social, economic, environmental, morphological, legal, and institutional) and characteristics (transformation, location, occupation, control, and function) of each plot of the urban fabric. Its main strength lies in its multifaceted approach, which provides a systemic and detailed reading of plots as fundamental units of urban space. This allows mapping, comparing, and understanding of the behaviour of different areas of the city based on rigorous empirical evidence, both quantitative and qualitative analysis. In addition, Plotter stands out for its analytical scalability: it can be applied from the city scale down to the individual plot level, allowing interdependent and multi-scale readings. This flexibility makes it suitable for both comprehensive diagnostics and specific interventions. The method also helps to fill a critical gap in literature and planning practice: the lack of a systematic reading of plot systems as a strategic territorial structure, going beyond physical land analysis to include within the plot system its meanings within the different areas of urban life.

Despite the innovation, the *Plotter method* has limitations. The main one is the dependence on robust, georeferenced, and updated data at the plot scale - something that not all cities are able to offer. Contexts with weak or non-existent cadastral systems can compromise the application, validity and comparability of the results. This imposes a structural limitation on the *general* use of the model. However, this research highlights the fundamental importance of urban data and the necessity of its availability. Municipal planning agencies must recognize that access to accurate, up-to-date, and detailed plot-level data is essential for guiding public policies, enabling effective territorial management, and responding appropriately to urban demands. *They need to know the territory, to be able to plan it.*

In addition, the method was empirically tested in New York, a context where private property is well-documented and central to urban organization. This raises methodological challenges for its application in countries or regions where land is collectively, state-owned, or communally owned, as China, or indigenous communities, or informal settlements. In these cases, the *number of landowners* loses relevance, and other forms of land control and use, based on social recognition, informal tenure, or community governance, would need to be incorporated to adequately reflect the local reality.

Finally, although the model assumes a certain uniformity in the choice of indicators that make up each dimension and characteristic, these indicators *can* and *should* be adapted according to the cultural and institutional specificities of each context. This flexibility, however, does not compromise the conceptual essence of the method, since the meaning attributed to each dimension and characteristic of the plot remains relevant. Thus, the application of the method requires sensitivity to the local context and a careful process of adaptation, when necessary, supported by a prior qualitative reading of the territory.



7 NEW YORK

7 New York

The application of the method developed in this thesis aims to test its viability and effectiveness in understanding urban plots as fundamental and multifaceted components of territorial structure. As argued in the last chapter, New York City was selected as the case study due to its high urban density, morphological and socio-economic diversity, and the availability of detailed, plot-level geospatial data. These factors make the city an ideal empirical context in which first to test the *Plotter method*.

The first section of this chapter begins with a brief description of the historical context of New York planning. The remaining sections develop the case study, applying the multiscale method. The case study is structured across three interdependent scales of analysis - city, local, and plot - to ensure a comprehensive and integrated reading of urban patterns and the specificities of each land unit. This multi-scalar approach makes it possible to investigate not only the physical configuration of plots but also their social, economic, environmental, legal, and institutional functions - in addition to the specific characteristics of the plots, each in varying degrees of detail.

At the city scale, the analysis draws upon data from official public databases as well as datasets developed exclusively for this research (presented in detail in section 6.5). These inputs form the basis for constructing multifaceted profiles of all plots in the city, organized around six urban dimensions and five structural characteristics. This stage focuses on identifying recurrent spatial patterns, intra-urban disparities, and critical zones for planning, offering an integrated, evidence-based perspective of urban structure.

The local scale deepens the investigation within selected urban areas, defined by criteria such as morphological diversity, intensity of use, and strategic relevance to the urban fabric. In these areas, qualitative data collection through direct observation, photographic records, and field notes complements the quantitative analysis, along with official city data. This phase is essential to capturing variables that are not fully represented in numerical datasets, such as symbolic relationships with space, appropriation dynamics and specific attributes of each plot.

At the plot scale, the analysis turns into the smallest territorial unit of urban planning. Based on indicators defined by the *Plotter* method, individualized profiles are constructed to reveal the internal properties of each plot. This refined reading enables a more precise understanding of each plot's role in the city's dynamics and provides valuable input for strategic decision-making, both in public policy and targeted interventions.

Through the integration of these three scales of analysis, the study aims to demonstrate the methodological robustness of the *Plotter method*, its adaptability across diverse urban contexts,

and its relevance as a technical tool for supporting more coherent and evidence-based planning decisions.

7.1 Brief description of the historical evolution of urban planning in New York

New York, initially known as New Amsterdam by the Dutch (who have occupied the territory after the Lenape people), evolved as an important port and trading post under the British rule (Burrows and Wallace, 1999).

The planned development of New York began with the imposition of a rational order on Manhattan (Figure 29 and Figure 30). The Commissioners' Plan of 1811, signed by Simeon De Witt, Gouverneur Morris, and John Rutherfurd, defined a grid of 12 avenues running north to south and 155 streets crossing them from east to west. Ignoring streams, valleys, and hills, the plan created a system of about 2.000 uniform street blocks, with each block intended for efficient buying, selling, and development. The plan did not define the boundaries of individual plots, but the modular size of street blocks encouraged their division into small plots. In practice, typical residential plots were approximately 25 feet wide and 100 feet deep, a dimension that became the standard for row houses and tenements that proliferated in the following decades.

However, this rigidity of the plan resulted in the absence of public parks (Ballon, 2013; Koeppl, 2015). The answer to this shortcoming came with the proposal by William Cullen Bryant and Andrew Jackson Downing to create a large central park. Recognizing the need for green space and recreation for population, Mayor Ambrose Kingsland formalized the idea, and in 1853, New York City acquired the 'plot' for the Central Park (Figure 31). Meanwhile, Brooklyn, Queens, The Bronx, and Staten Island, still separate municipalities, had their own forms of local planning. In these boroughs, land subdivision was often driven by landowners and village councils, responding more to local needs and the extension of streetcar and railroad lines than to a unified master plan (Ballon, 2013).

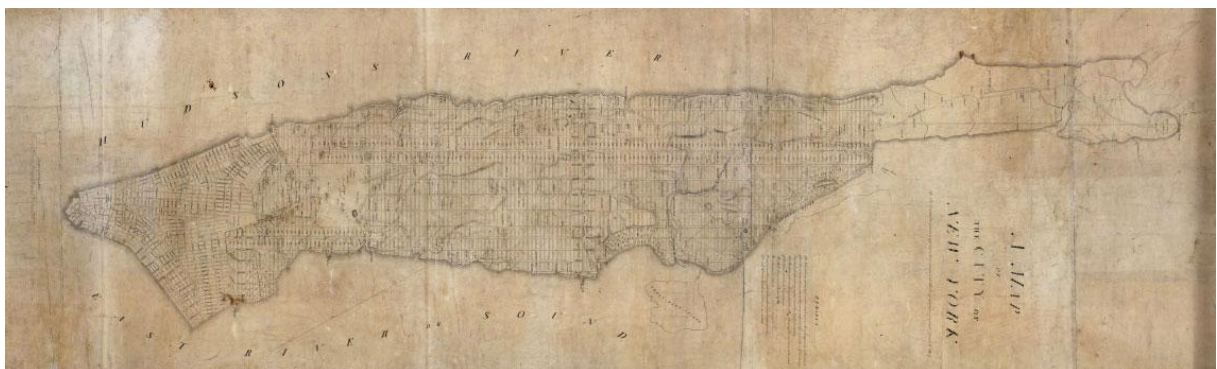


Figure 29 – The Commissioners's Plan of 1811. Source: The New York Public Library – John Randen, Jr (1811).



Figure 30 – Map of New York City and Manhattan in 1811 - *Commissioners' Plan*. Source: Library of Congress Geography and Map Division Washington, D.C. 20540-4650 USA dcu. Created by Pontes, William (1814) and Maverick, Peter (1780-1831).

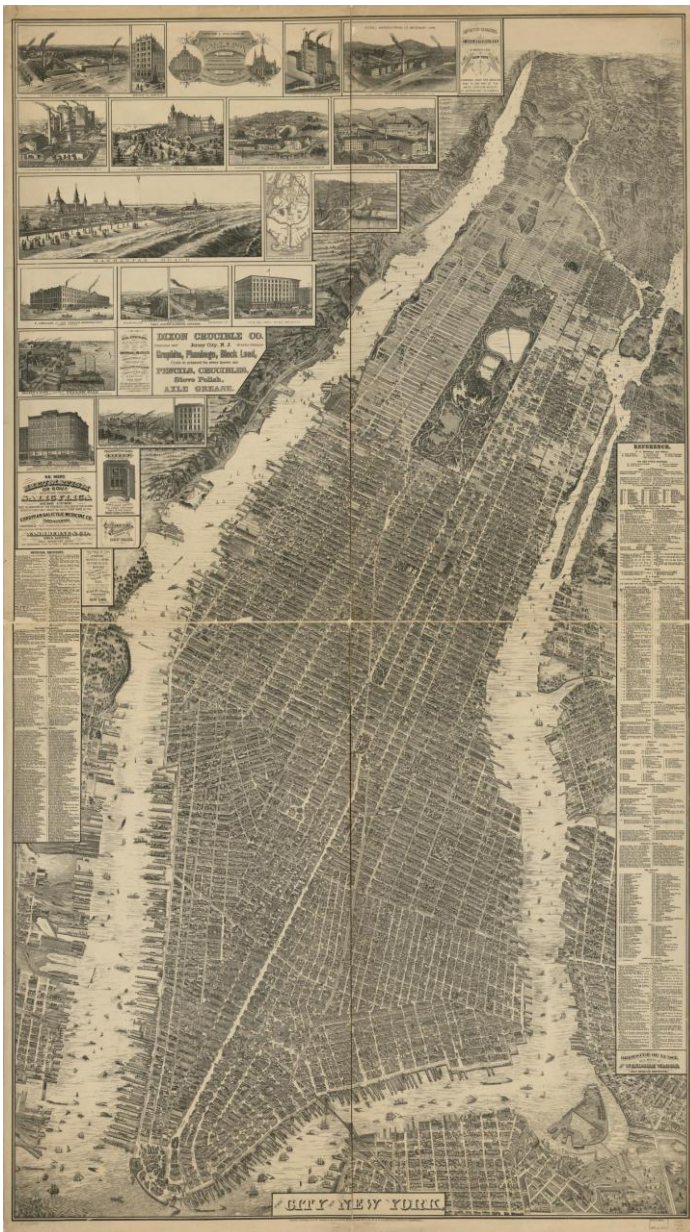


Figure 31 – *The Galt-Hoy Map – with Central Park*. Source: <https://www.loc.gov/resource/g3804n.pm005990/?r=-0.487,0.382,1.738,0.792,0> . Created by William I. Taylor (1879).

Rapid industrialization and population growth in the early 20th century created a new kind of urban challenge, culminating in the passage of the Zoning Ordinance of 1916. This was the first comprehensive zoning law in the United States. Its goal was to combat uncontrolled densification and the mixing of incompatible uses, while protecting access to light and air on the streets. For each plot, the legislation defined three main types of zones: use (residential, commercial, and unrestricted), height (with height limits of 1 to 2,5 times the street width), and bulk (with coverage and setback limits). The catalyst for the ordinance was the construction of the Equitable Building (1915), a skyscraper that cast a permanent shadow over the neighbourhood. The new legislation divided the city into districts (residential, commercial, and unrestricted) and imposed regulations on individual plots. It established height limits, required building setbacks, and determined maximum plot coverage, proposing the preservation of light, air, and public space (Zoning Resolution, 1916).

The first half of the 20th century was marked by the rise of Robert Moses, whose deterministic vision of urban planning shaped the city's infrastructure for four decades. Moses, who wielded power across multiple agencies, believed that progress depended on the construction of major highway projects and urban renewal. His influence extended to all boroughs but was especially felt in The Bronx and Staten Island, where his massive infrastructure projects radically transformed the social and physical fabric. The Cross Bronx Expressway, for example, cut through entire neighbourhoods and displaced thousands of families in The Bronx, mostly low-income and minority communities, creating physical barriers that accelerated urban decline. Similarly, the construction of the Verrazzano-Narrows Bridge in 1964, which connected Staten Island to Brooklyn, transformed the island's previously isolated rural landscape and accelerated suburbanization and real estate growth. Moses' planning prioritized vehicle traffic over community life, resulting in the fragmentation of neighbourhoods and the demolition of housing deemed obsolete (Caro, 1974).

In the 1960s, Moses' approach faced growing opposition, led by activists and intellectuals such as Jane Jacobs. She argued that diversity, density, and social interaction were vital elements of a healthy city. She argued that vibrant neighbourhoods could not be planned top-down and that the human scale was fundamental. Her successful fight to prevent the construction of Moses' proposed Lower Manhattan Expressway was a landmark in the history of urban planning. This paradigm shift led to a new focus on historic preservation and community revitalization, with movements across boroughs, such as Brooklyn Heights and Greenwich Village, fighting to protect architectural and cultural heritage from demolition. Dissatisfaction with Moses' approach and the need for a more flexible legal framework to guide future development, in contrast to the rigidity of the 1916 law, culminated in the passage of the Zoning Resolution of 1961.

The 1961 Zoning Resolution represented a significant evolution from the 1916 legislation. While maintaining the separation of uses (commercial, residential, and industrial), its main objective was to introduce flexibility that would allow for the emergence of modern buildings, such as skyscrapers with open plazas, while also controlling density and building mass in a more sophisticated manner. The main rules that applied to urban plots, and which defined modern New York, were: the Floor Area Ratio (FAR), which established a ratio between the total floor area of a building and the area of the plot on which it stands; height and setback

regulations that, instead of the rigid setback rule of the 1916 law, offered more flexibility and encouraged the creation of public plazas in exchange for permission to build taller buildings; and the plot coverage ratio, which established rules for the maximum percentage of the plot a building could occupy, ranging from 30% to 35% in low-density residential areas to up 100% on corner plots in commercial districts. This zoning system is not uniform, with each borough having a variety of zones that reflected local issues, with Manhattan housing the highest density zones and the highest FARs, while Staten Island and Queens prioritized low density to preserve suburban character. In Brooklyn and The Bronx, the zones were more varied, with high-density areas concentrated in transportation hubs and commercial corridors, while the inner areas maintained a medium-density pattern.

In the 21st century, New York City's urban planning framework is a governance system that combines existing zoning legislation with strategic plans and rezoning initiatives in response to contemporary challenges. The 1961 Zoning Resolution, although it has undergone several amendments over time, remains in force today. However, it is complemented by strategic programs such as *Yes City*, which seeks to modernize zones to support economic growth and housing construction; and *OneNYC*, a long-term strategy for a more sustainable and resilient city, addressing issues such as climate change and social equity. In addition, other sectoral plans for strategic locations.

7.2 City Scale Analysis

This section aims to analyse New York's urban patterns at the city level, with a specific focus on urban plots. The *Plotter method* applies quantitative indicators to the city's plots, considering their multifaceted nature. This method is based on the premise that the plot is more than a physical unit - it is also an expression of different urban dimensions (social, economic, environmental, morphological, legal, and planning) and characteristics (transformation, occupation, control, function and location).

The analysis encompasses the whole New York City in its five boroughs: Brooklyn, Manhattan, Queens, The Bronx and Staten Island (Figure 33). This delimitation allows for a comprehensive approach that captures the city's internal homogeneity and highlights the spatial contrasts between the different boroughs and intra-boroughs. The analysis covers approximately 862.000 plots registered in the city (according to PLUTO/NYC 2024 database), with specific variation in coverage due to specific data gaps for the different analyses.

The city-wide analysis is conducted in two main stages. First, each indicator related to the dimensions and characteristics is examined separately, forming an individualized profile. To this end, during the application, the most representative variables for each dimension and characteristic were selected based on their empirical relevance and data availability. These profiles are described through the spatial distribution of the indicators across New York City, using thematic maps and tables that highlight the patterns identified each borough.

In the second stage, individual data is synthesized into two composite indices: the multidimensional profile, which integrates indicators from the six dimensions, and the

multicharacteristic profile, with combines indicators from the five characteristics. The composite indices are constructed using a standardized method, with variables normalized according to technical criteria and, finally, data aggregated into a single metric per plot (section 6.3.3). The result provides a concise yet analytically robust view of New York's plots system urban structure.

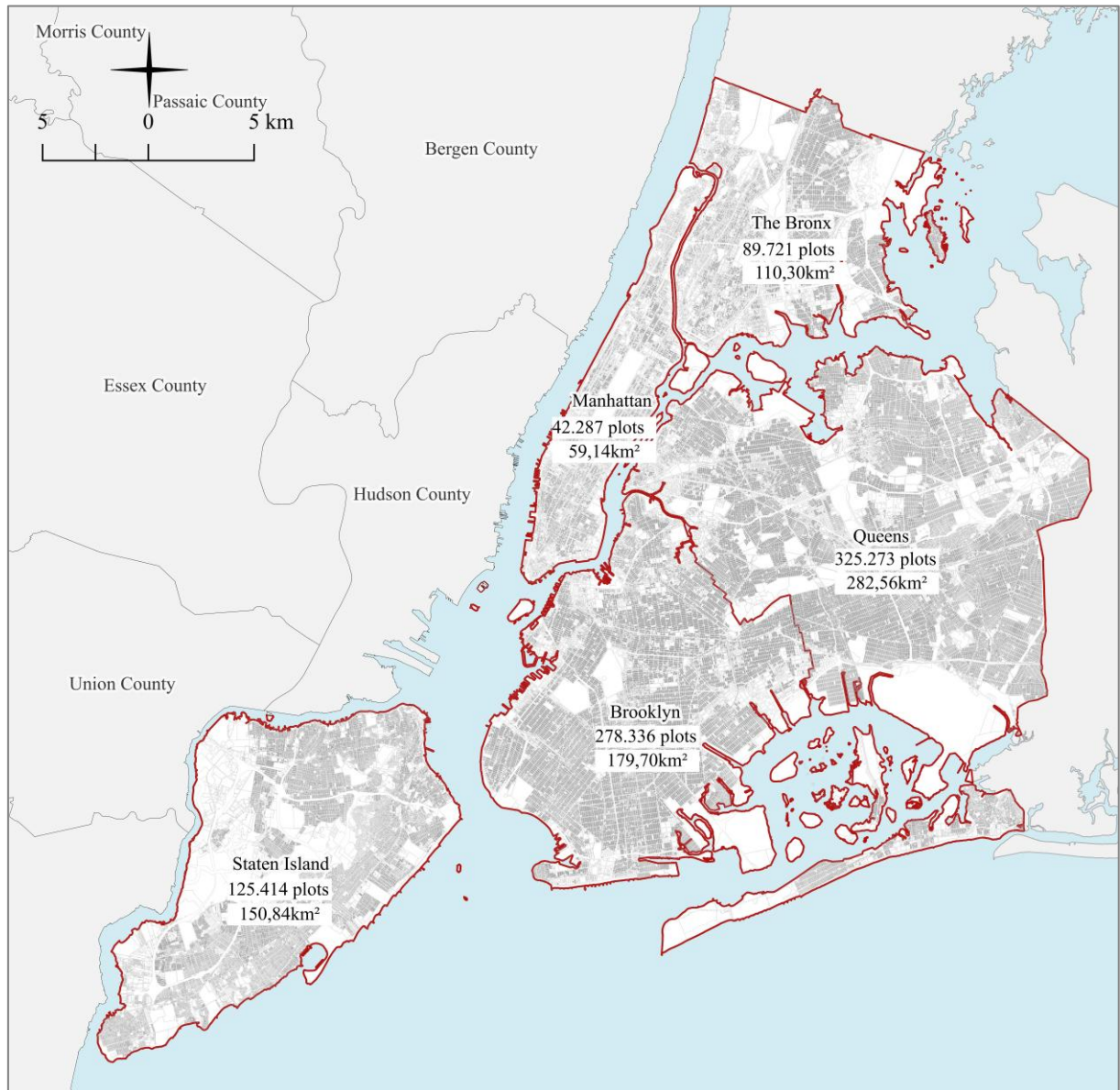


Figure 33 - City-scale study areas - the five boroughs of New York

7.2.1 Dimensions

7.2.1.1 Social

The social profile is defined by the degree of connection between the users of the plot and the ownership of that same plot. This profile is measured through the *Users who are owners*¹⁵ (UOP) indicator, which represents the proportion of residents who are also owners. This indicator is central to the social dimension because it objectively reflects residential stability and the intensity for community cohesion in the urban fabric. Its relevance is anchored in evidence from the literature (Chapter 3 and 4), which associates the prolonged permanence of residents with the formation of strong ties and the symbolic appropriation of space.

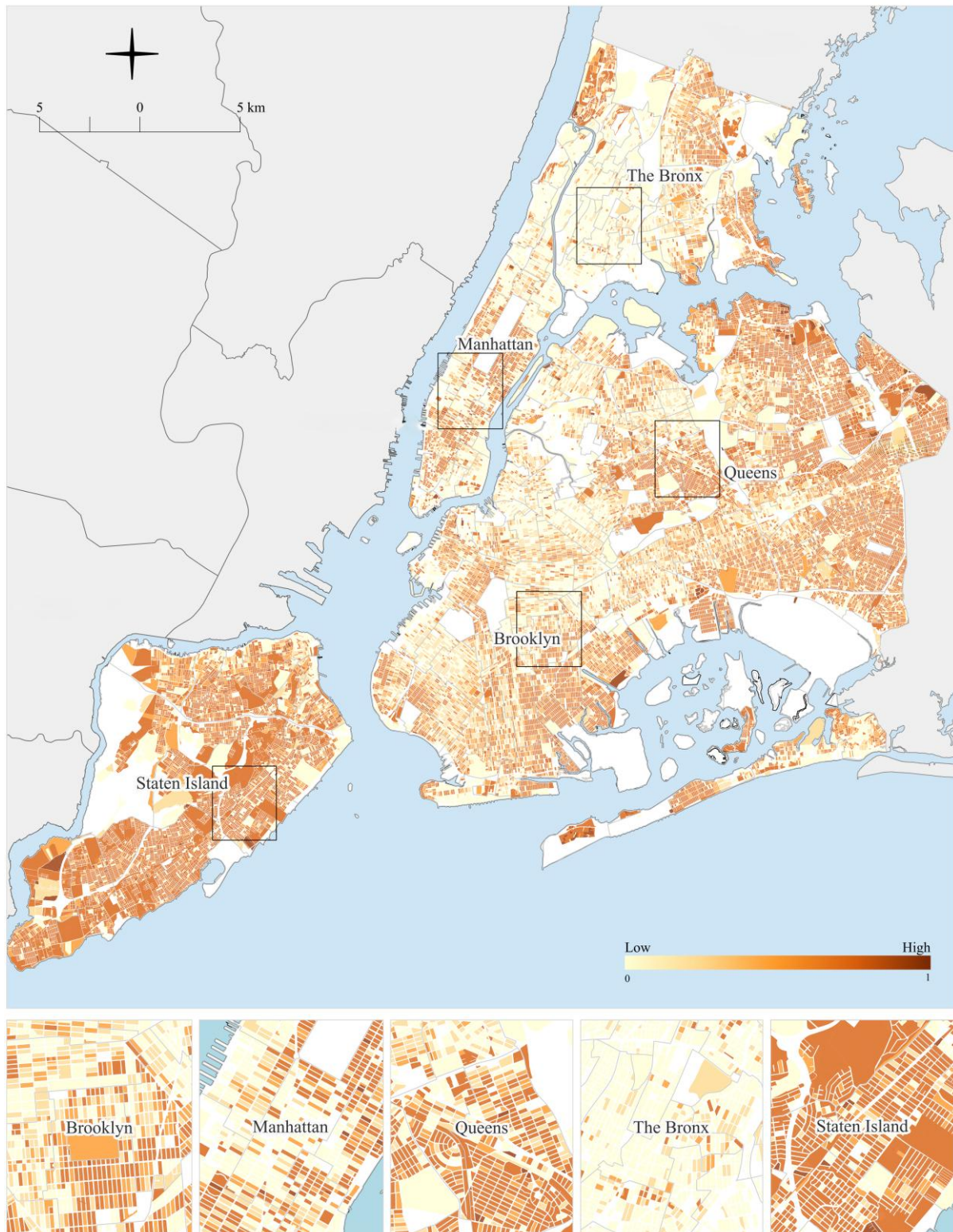
The spatial distribution of social profiles in New York City, presented in Figure 34, reveals a pattern largely dominated by a low presence of owner-occupiers, 85,4 % of the city's plots show low intensity¹⁶, while only 0,06 reach high intensity. High intensity cases are rare and concentrated mainly in Staten Island, with residual occurrences in Queens and Brooklyn. Manhattan and the Bronx do not have high intensity of owner-occupier plots.

Among the boroughs, Staten Island stands out with the largest share of medium intensity (34,7%) and a comparatively lower predominance of low (64,8%), consistent with its lower-density urban fabric and significant presence of single-family housing. Queens, with 15,9% medium intensity, and Brooklyn, with 89,5% medium intensity, display peripheral clusters with higher UOP values, whereas Manhattan (89,5%) and The Bronx (92,3%) reveal particularly weak profiles in terms of owner-occupation, consistent with a land structure shaped by renting and investment logics. Areas with a higher proportion of owner-occupiers tend to exhibit greater social stability and territorial rootedness, fostering more enduring bonds between individuals and place. Conversely, areas with low UOP values sustain more volatile dynamics, often linked to high demographic and economic turnover, which limit the consolidation of a cohesive social fabric over time.

More broadly, the UOP, when observed at the scale of the plot, goes beyond being a simple measure of tenure. It offers crucial analytical lens into the less visible dimensions of urban life, such as the sense of belonging, attachment to place, and intergenerational permanence. In this regard, the plot emerges not merely as a unit of land use but as a social anchor of the city, supporting the everyday practices, relationships, and memories that collectively give meaning to urban life. Recognizing this social dimension highlights that the resilience and vitality of the city depend as much on its physical infrastructure as on the web of human connections rooted in its territorial units.

¹⁵ The UOP analysis was powered by Data Census NYC (2022, 2025 update), with census block scale converted for each associated plot. The analysis was performed by dividing the total census block population by the total number of owner-occupants.

¹⁶ Low intensity is equivalent to 0,0 to 0,3 in quantitative analysis. Medium intensity is equivalent to 0,3 to 0,7; and High intensity is equivalent to 0,7 to 1,0.



	Brooklyn	Manhattan	Queens	The Bronx	Staten Island	Total
Total plots	278.336 32,2%	42.287 5%	325.273 37,7%	89.721 10,5%	125.414 14,6%	861.031 100%
High (0.7 to 1.0)	48 0,10%	0 0,0%	91 0,02%	0 0,0%	438 0,34%	577 0,06%
Medium (0.3 to 0.7)	18.039 6,48%	4.455 10,53%	51.814 15,92%	6.478 7,22%	43.607 34,7%	124.393 14,4%
Low (0.0 to 0.3)	260.249 93,5%	37.832 89,46%	273.368 84,04%	82.821 92,3%	81.369 64,8%	735.639 85,4%

Figure 34 - Social dimension profile. Source: Author with database DtaCensus NYC (2022).

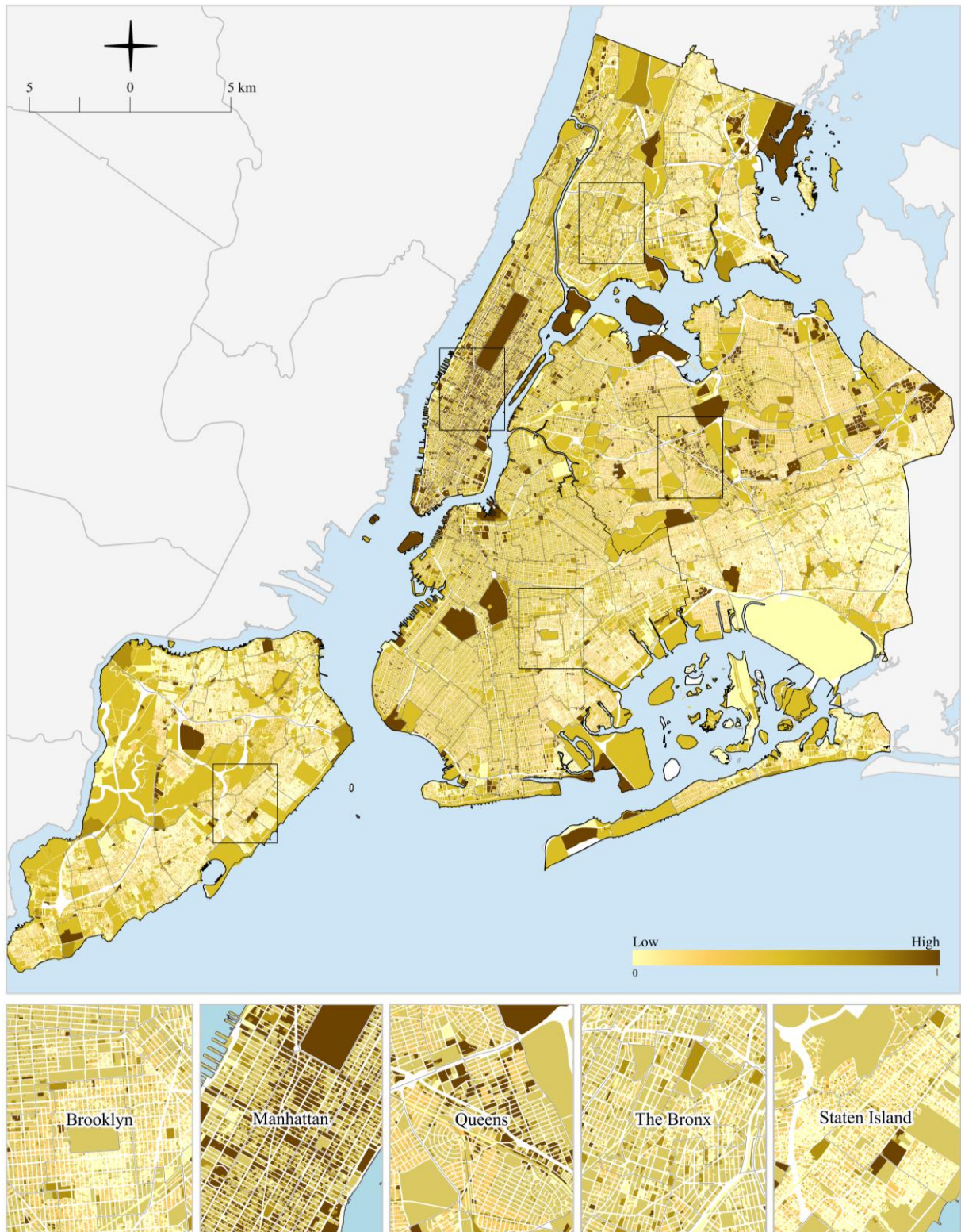
7.2.1.2 Economic

The economic profile of the plot seeks to reveal how urban land, divided into sections, participates in the city's productive dynamics and economic plot. In this dimension, the plot is seen as a space for the development of economic activities and as a product of the real estate market. In this regard, three indicators are analysed: the total value of the plot (LVP - *Land Value and Property*), the number of property transfers (PTP - *Property Transfers per Plot*), and the number of economic activities recorded per plot (EAP - *Economic Activities per Plot*). Each of these indicators fulfils a specific analytical function: the LVP expresses the degree of plot of the land and its buildings; the PTP captures the dynamics of property circulation in the real estate market; and the EAP reveals the intensity of economic activities. Together, these indicators offer a comprehensive understanding of the plot's economic dimension.

Data analysis reveals that the economic performance of plots is heavily concentrated in specific areas of New York (Figure 35), with Manhattan standing out. Of all its plots, 6,2% are classified as having high economic intensity and 74,4% as having medium intensity. This profile reflects Manhattan's central role in New York's urban economy, where intense land appreciation, high land turnover, and the significant presence of economic activities make the plot a structural element in the dynamics of urban capital. In contrast, Brooklyn presents a more fragmented profile. Despite having areas undergoing transformation such as Downtown Brooklyn and Williamsburg, only 0,18% of plots achieve high economic intensity. Most plots in this borough, 82,2%, are classified as having low economic intensity, demonstrating that high economic intensity is concentrated in small areas. In Queens and The Bronx, the results show a lower average, although there are occasionally areas with outstanding performance, generally associated with logistics hubs, industrial centres, or traditional shopping centres. Staten Island, in turn, records the lowest economic profile values, demonstrating a predominantly residential, low-density occupation logic with limited insertion into the real estate market.

This distribution reveals that New York City concentrates capital, infrastructure, and economic opportunities in specific areas, particularly in Manhattan's downtown core. Outside of these areas, much of the city operates at lower intensity of valuation and productivity.

Plots with low index values indicate areas less integrated into the dynamics of economic valuation. This analysis highlights that New York City's economic dynamics are marked by profound spatial asymmetries, in which land use directly reflects inequalities in access to capital, infrastructure, and development opportunities. An integrated analysis of the three indicators allows us to understand where economic dynamism is concentrated and where barriers to economic growth persist. Recognizing this logic is crucial for guiding policies capable of promoting investment in underutilized areas, strengthening local economies, and integrating peripheral areas into the city's economic productivity networks.



	Brooklyn	Manhattan	Queens	The Bronx	Staten Island	Total
Total plots	278.336 32,2%	42.287 5%	325.273 37,7%	89.721 10,5%	125.414 14,6%	861.031 100%
High potential (0.7 to 1.0)	514 0,18%	2.397 6,18%	716 0,22%	103 0,11%	69 0,05%	3.799 0,44%
Medium potential (0.3 to 0.7)	48.664 17,57%	28.883 74,4%	31.430 9,77%	13.899 15,5%	9.233 7,37%	132.109 15,4%
Low potential (0.0 to 0.3)	227.752 82,24%	9.795 25,2%	291.590 90,0%	75.469 84,3%	115.947 92,5%	720.553 84,1%

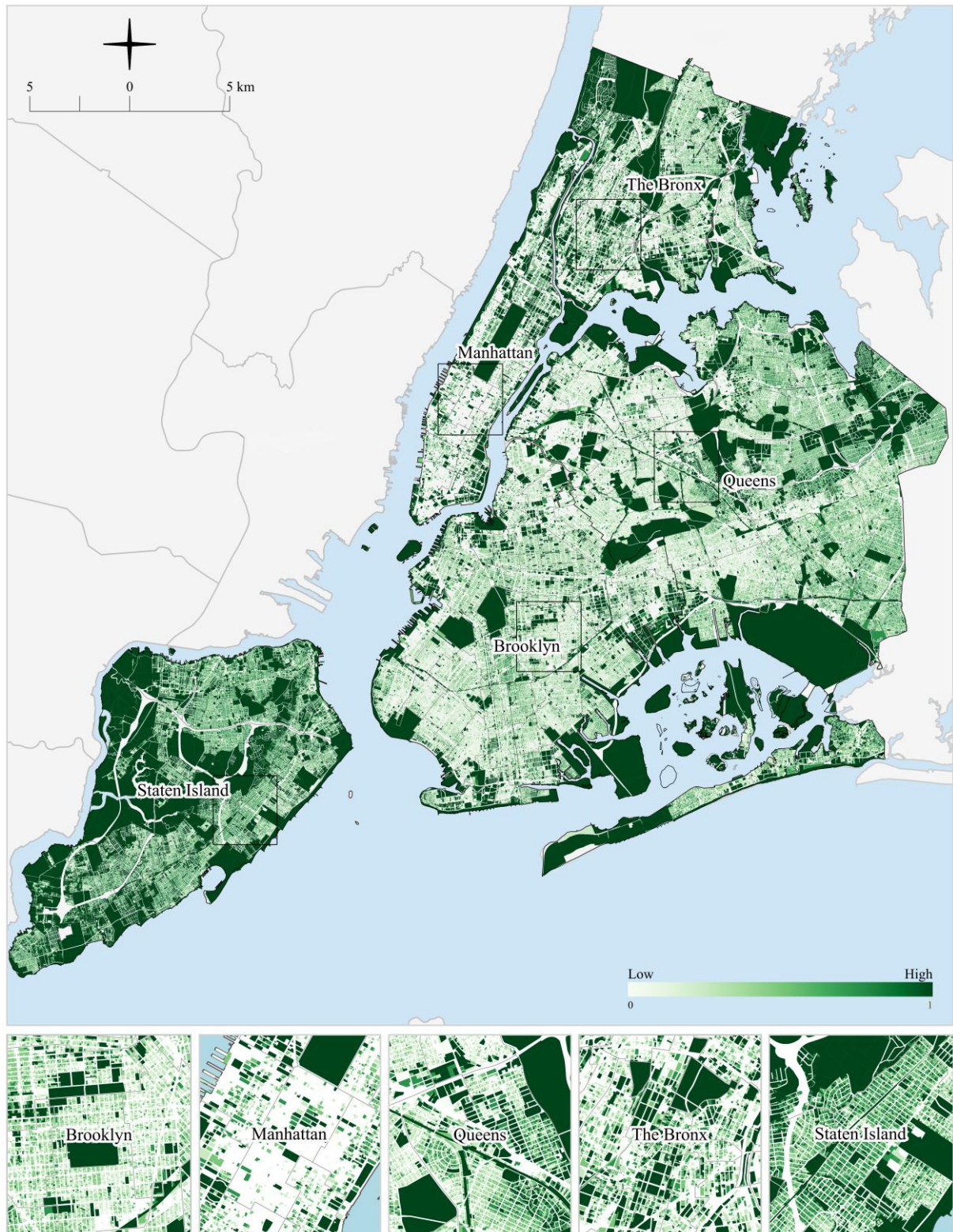
Figure 35 - Economic dimension profile. Source: Author with database PLUTO, DOF, USCB (2024).

7.2.1.3 Environmental

The environmental profile expresses the ecological capacity of plots through their *Permeable Area* (PA). This indicator objectively measures the extent of permeable land in each plot. The importance of permeable area lies in its strategic environmental function: mitigating surface run-off, reducing the formation of heat islands, conserving local biodiversity, and improving the urban microclimate. In highly urbanized areas, where land impermeability is dominant or exclusive, the presence of permeable land fractions within plots becomes a rare and valuable environmental asset. Thus, this profile allows to understand the role of plots in the city's ecological infrastructure, with direct implications for the climate performance and environmental sustainability of urban areas.

Figure 36 reveals that only 10,9% of New York plots are classified as having high environmental intensity, while 16,4% have medium intensity, and most, 72,6%, have low intensity. Staten Island stands out as the borough with the best environmental performance, measured by this indicator, with 31,8% of its plots classified as high intensity and 29,8% as medium. This condition is explained by the predominance of single-family residential areas, low building density, and significant presence of gardens, yards, and permeable side setbacks. The Bronx has 15,2% with high intensity and 13,4% with medium intensity, while 72,2% are in the low intensity group. This scenario reflects a mixed urbanization, with less dense residential areas and a significant presence of open spaces. Queens, the borough with the largest number of plots, has 6,4% with high intensity and 19,3% with medium intensity. Still, 74,2% are low intensity, demonstrating the borough's extensive urbanization and large impervious areas. The same pattern is identified in Brooklyn, with 5,2% having high intensity and 8,3% having medium intensity. The vast majority, 86,6%, are classified as having low environmental intensity. Manhattan, in turn, despite having one of the lowest absolute numbers of plots, has 11,9% with high environmental intensity and 13,2% with medium intensity. This represents a high percentage performance, surpassed only by Staten Island. However, it's important to note that the absolute number of high-intensity plots in Manhattan is significantly lower than in other boroughs, highlighting the difference in proportions and territorial scale. The majority of Manhattan, 74,8%, still exhibits poor environmental performance due to intense verticalization and total land cover by buildings and urban infrastructure, especially in areas such as Midtown and the Financial District.

In this sense, this profile provides a valuable empirical basis for understanding how urban land contributes, or fails to contribute, to ecological processes essential to the environmental balance of cities. By mapping land permeability, ecological inequalities in the urban land structure become visible, enabling the identification of critical zones for climate planning and water management. Recognizing the plot as a functional unit of urban environmental infrastructure also reinforces its role in climate change mitigation and adaptation strategies, reinforcing the positioning of permeable land within each plot as a vital element for the efficiency of urban space.



	Brooklyn	Manhattan	Queens	The Bronx	Staten Island	Staten Island
Total plots	278.336 32,2%	42.287 5%	325.273 37,7%	89.721 10,5%	125.414 14,6%	961.031 100%
High (0.7 to 1.0)	14.383 5,22%	5.006 11,88%	20.781 6,40%	13.664 15,2%	39.958 31,8%	193.792 10,92%
Medium (0.3 to 0.7)	23.062 8,37%	5.582 13,25%	62.820 19,37%	11.999 13,4%	37.428 29,8%	140.981 16,44%
Low (0.0 to 0.3)	238.394 86,58%	31.538 74,8%	240.603 74,2%	63.656 72,2%	47.982 38,2%	622.173 72,6%

Figure 36 - Environmental dimension profile. Source: Author with database DEP (2021).

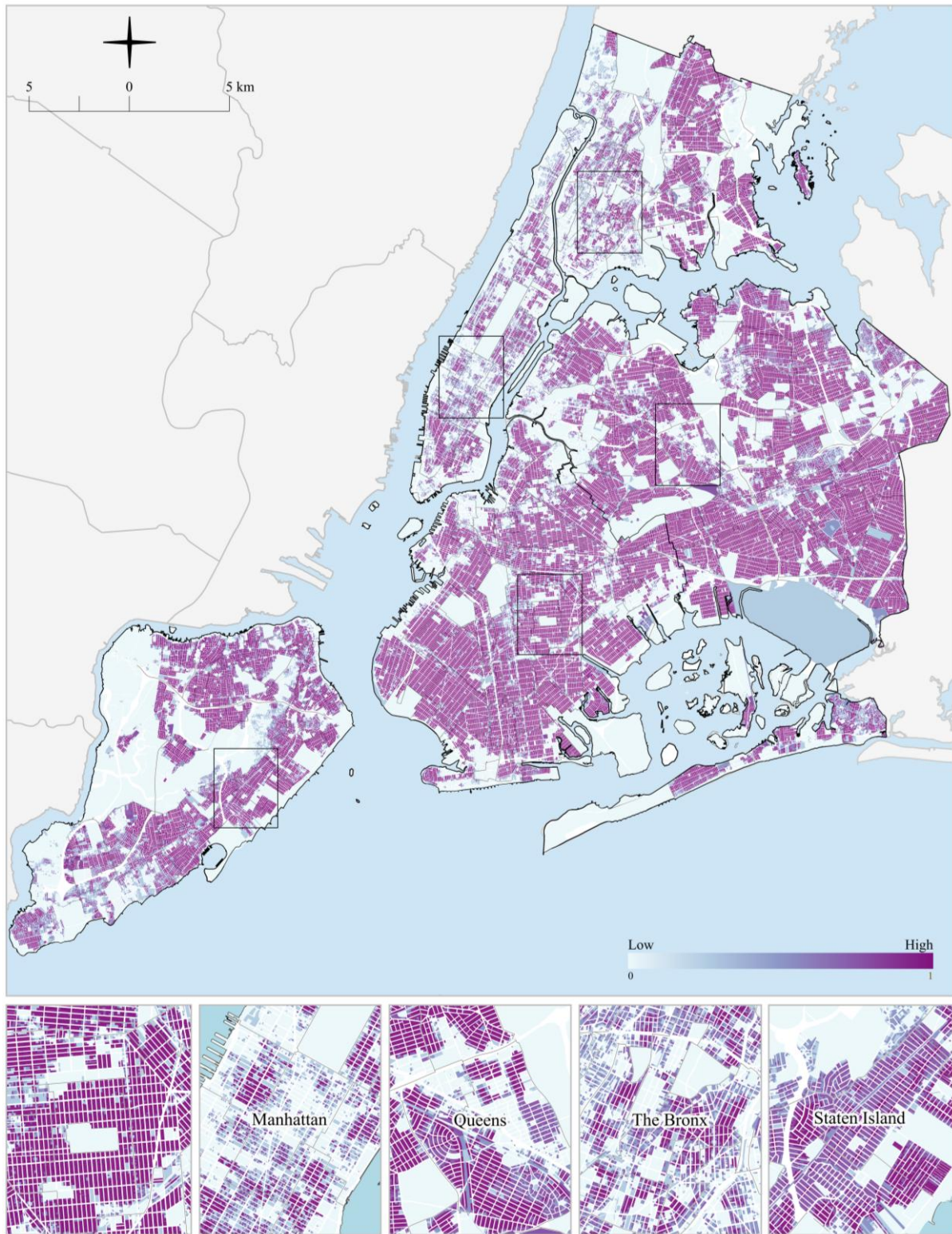
7.2.1.4 Morphological

The morphological dimension of plots plays a fundamental role in city planning and development, as it determines the organization of urban space. The analysis of this profile is based on three morphological indicators: *plot area* (PA), *frontage size* (FS), and *plot density* (PD). These elements not only define the physical characteristics of plots, but also directly influence land use, the flow of people and vehicles, as well as the pace and pattern of residential, commercial, or mixed-use development. By evaluating these variables within a composite index, it becomes possible to identify essential structural patterns of plots morphology, such as areas of centrality, greater densification or fragmentation, and accessibility.

The literature has demonstrated a strong correlation between smaller plots, narrow frontages, and high-density plots contexts, on the one hand, and integration with public spaces, mixed use, and increased walkability, on the other hand. These factors are fundamental to promoting more vibrant, functional, and sustainable cities. In this study, the morphological profile adopted considers this criterion as indicative of high morphological intensity of the plots.

Figure 37 shows New York City with a high-performance morphological profile. Of the city's total plots, 77,6% were classified as having high morphological intensity, while 21,37% had medium intensity, and only 1,03% had low intensity. These figures indicate a predominance of plots with physical characteristics suitable for a continuous and connected urban fabric. Brooklyn accounts for 32,2% of the city's plots and has the highest percentage of high morphological intensity (88,3%), demonstrating a dense and structured spatial pattern. Queens, which accounts for 37,7% of urban plots, also has a high morphological intensity index (78,4%), although areas with lower density and connectivity do coexist. In Manhattan, although it represents only 5% of the city's total plots, 65,2% have high intensity, especially in the central areas (such as Financial District and Midtown Manhattan). The Bronx has 70,2% of high-intensity plots, while Staten Island has 61,0% high intensity, 37,7% medium intensity, and 1,26% low intensity, indicating a more dispersed occupancy pattern.

The data indicates that New York City's morphological profile is largely composed of plots with physical characteristics that favour the formation of a cohesive, compact, and integrated urban fabric. The significant presence of plots with high morphological intensity distributed broadly across the districts demonstrates a balanced structural plots system, capable of supporting decentralized and diversified urbanization, with different agents acting in different ways. The proximity of plots creates ideal conditions for multiple land uses, allowing the establishment of different types of businesses that meet a wide range of local population needs, in addition to favouring the coexistence of residents with distinct socioeconomic profiles in mixed areas. Furthermore, the well-distributed density of plots throughout the city's urban fabric contributes to the optimal use of existing infrastructure, such as transportation, service networks, urban amenities, etc., promoting greater efficiency.



	Brooklyn	Manhattan	Queens	The Bronx	Staten Island	Total
Total plots	278.336 32,2%	42.287 5%	325.273 37,7%	89.721 10,5%	125.414 14,6%	861.031 100%
High potential (0.7 to 1.0)	244.811 88,3%	27.572 65,2%	255.908 78,4%	63.010 70,2%	76.557 61,04%	667.858 77,6%
Medium potential (0.3 to 0.7)	30.661 11,0%	13.636 32,2%	66.863 20,8%	25.140 28,0%	47.383 37,7%	183.683 21,37%
Low potential (0.0 to 0.3)	1.596 0,61%	1.079 2,60%	2.502 0,80%	1.571 1,80%	1.474 1,26%	8.222 1,03%

Figure 37 - Morphological dimension profile. Source: Author with database PLUTO (2024).

7.2.1.5 Legal

The legal dimension of plots varies significantly across geographic and cultural contexts, reflecting the particularities of each society. In most legal systems, land ownership is classified into three main categories: private, state, and communal. Each category grants distinct rights to its owners, such as the right to use, alienate, inherit, seize, or concentrate usufruct rights. These rights are fundamental to defining how a plot is used and its role in the real estate market and urban planning. However, despite the importance of property rights, many urban planning systems fail to fully consider the legal nature of plots. As a result, aspects such as ownership, tenure type, and the rights associated with plots are often disconnected from urban development strategies. This gap can limit the effectiveness of planning, as the legal rights of a plots directly impact its accessibility, functionality, and future urban development possibilities.

Various property rights are associated with each urban plot in New York. Regardless of the property type, understanding the property rights associated with a plot helps us assess the intensity of the agents involved in decision-making. The central indicator of the legal profile is the *total number of owners* (OP), which quantifies the number of property rights, whether held by residents or not, to one or more real estate units within a single plot. This indicator is crucial for understanding the land structure, as the number of owners per plot directly influences the capacity for urban transformation and management.

The data reveals a heterogeneous distribution of the legal profile in New York (Figure 38). Overall, 28,3% of New York's plots have high legal intensity, representing areas with high property fragmentation. Medium-intensity plots account for 26,3%, while low-intensity plots account for 45,3%. The analysis by borough reveals striking contrasts. Manhattan has the highest proportion of plots with high legal intensity, 34,4%. This high density of property rights in each plot is characterized by vertical urbanization, with the presence of multifamily properties, residential condominiums, and overlapping commercial uses, making this area a highly complex legal environment for urban interventions. In Queens, the borough with the highest absolute number of plots, 32,9% have high legal intensity, while 40% of plots have medium intensity and 27% have low intensity. In The Bronx, 28,1% of plots have high intensity, 40,7% have medium intensity, and 30,8% have low intensity. In Brooklyn, 24,7% of plots have high legal intensity. Staten Island, on the other hand, represents the opposite scenario, with 0,01% of plots having high legal intensity, 0,2% having medium intensity, and 99,7% having low intensity. This indicates a territory with a much simpler legal structure, with a predominance of single-family properties and little fragmentation of plots ownership. Despite the land viability for direct actions in this borough, the intensity for transformation also depends on other factors such as demand, connectivity, and investment in local infrastructure.

The legal complexity of urban plots in New York is linked to building density and contemporary forms of property use. This includes the accumulation of rights, the intensification of leasing, and the presence of multiple actors in areas undergoing transformation, for example.

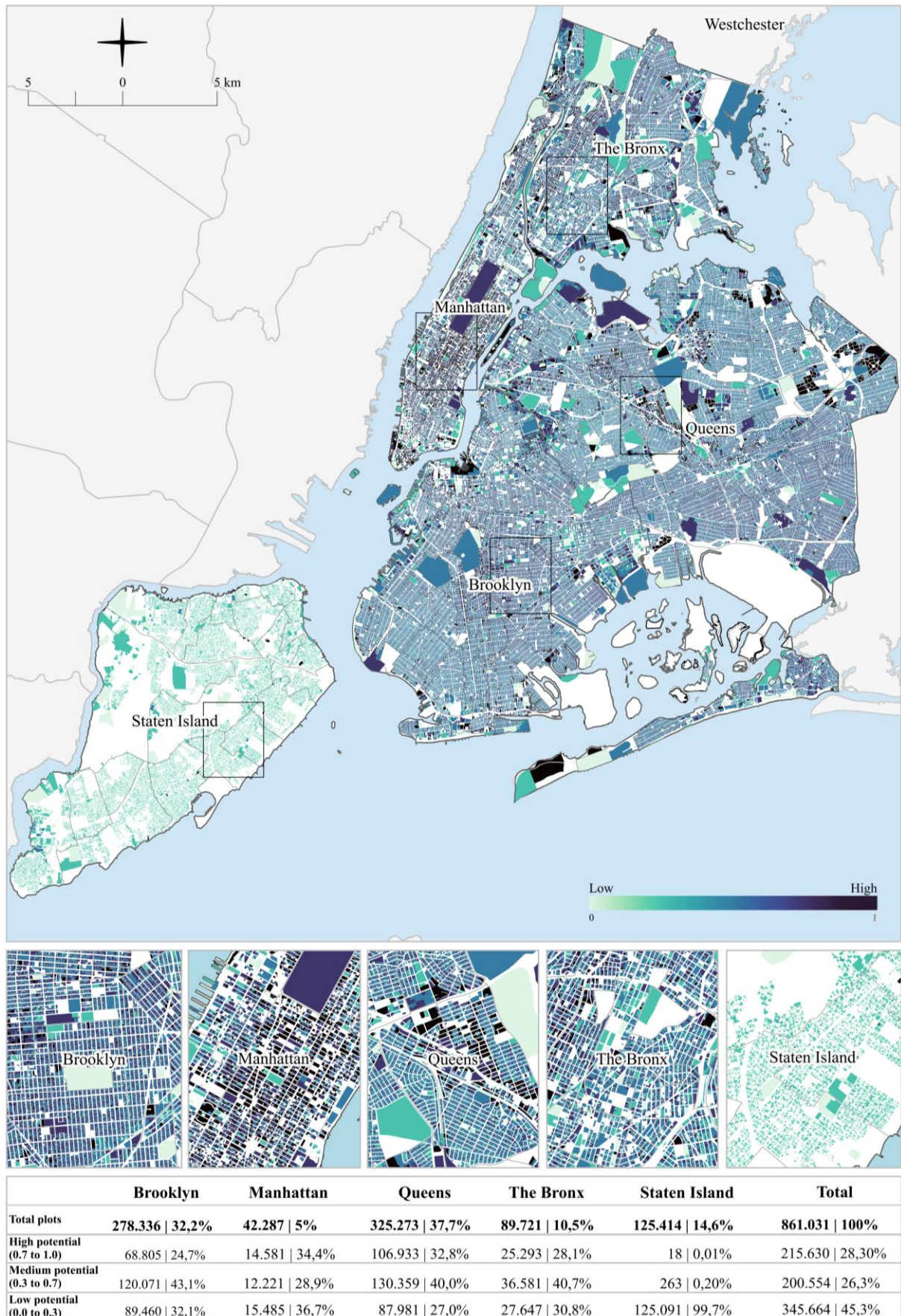


Figure 38 - Legal dimension profile. Source: Author with database DOF (2024).

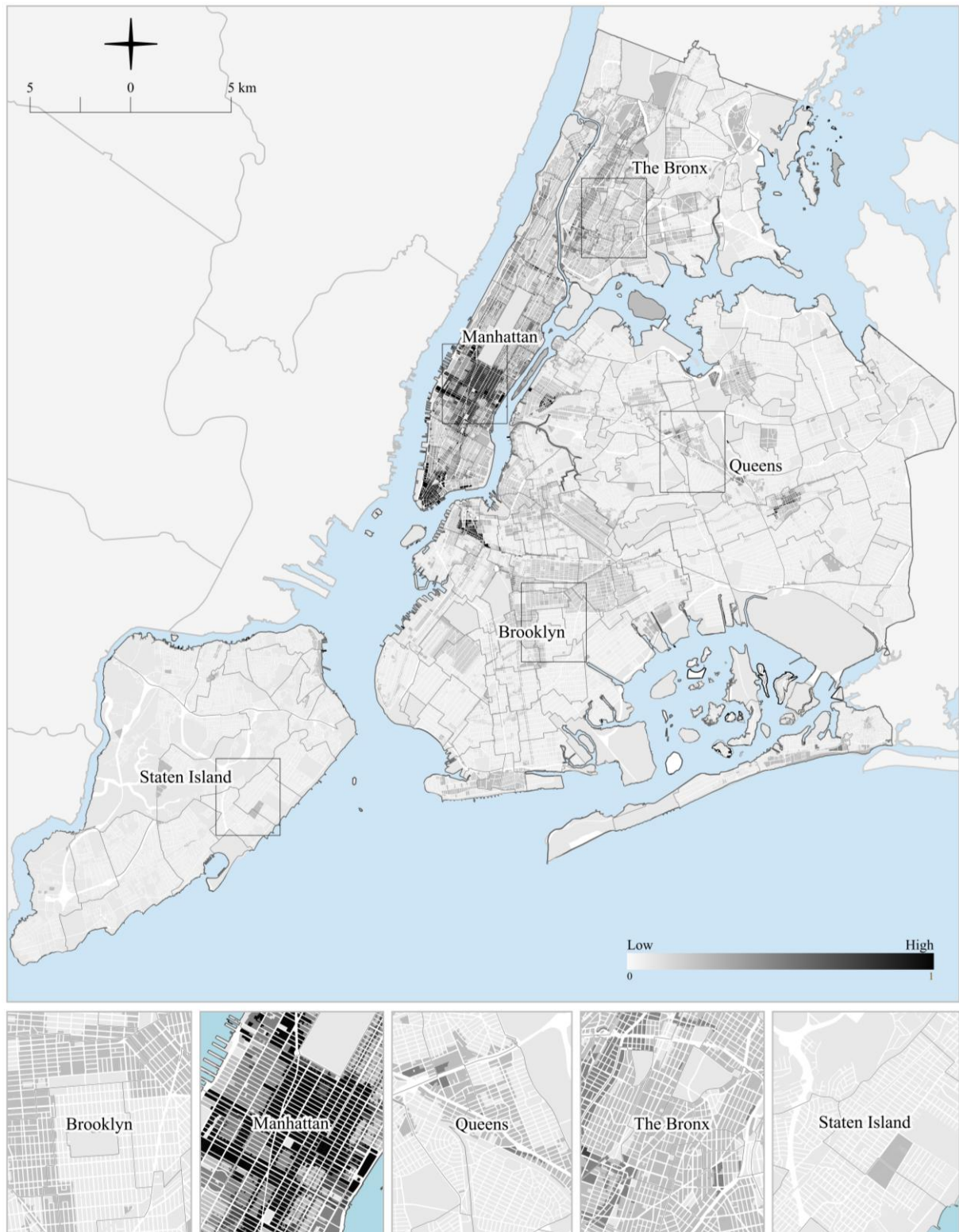
7.2.1.6 Institutional/Planning

Planning and land subdivision processes are essential to the formation of places. It is within the boundaries of plots, on each street block, that activities and the distribution of residents and workers occur. Therefore, plots are fundamental units for implementing urban development strategies, serving as the basis for infrastructure (or part of the infrastructure), services, and buildings. The institutional and planning dimension examines the capacity of plots to organize and integrate diverse urbanization strategies, directly influencing the functionality and dynamics of cities.

To assess the institutional and planning dimension, the plot's construction intensity and its suitability for specific plans were considered, including the maximum permitted construction for residential, commercial, and utility use, as defined by the current New York City Zoning Resolution (<https://zoningresolution.planning.nyc.gov/>). The indicator reflects the plot's compatibility with urban planning guidelines and its capacity to support transformations guided by current urban policies. Thus, the higher the indicator's value, the greater the plot's regulated construction intensity. This data is strategic for identifying areas with greater institutional viability for urban interventions and densification.

Spatial analysis reveals that only 0,4% of all plots in New York City have high planning intensity (Figure 39), meaning they have a higher rate of developmental intensity. Manhattan has the highest proportion of high-intensity plots, 7,8%, demonstrating its strong connection with planning instruments and alignment with development intensity. Brooklyn has 0,1% high intensity, followed by Queens, with 0,02%. The Bronx and Staten Island have virtually no plots with high planning intensity. In the case of the Bronx, 3,9% are in the medium-intensity range, while Staten Island is almost entirely composed of low-planning-intensity plots.

These results highlight an uneven distribution of planning intensity across New York City's boroughs, with a predominance of plots classified as having low intensity in terms of development intensity. This configuration reflects the existence of regulatory limits that guide land use and urban form, directly impacting the plots' capacity for physical transformation. The predominant presence of plots with low utilization rates indicates that, in much of the city, the parameters established by urban planning instruments restrict the possibility of densification or conversion of use, significantly impacting the performance of other urban dimensions at the plot scale. On the other hand, the greater presence of high-intensity plots in Manhattan highlights the structuring role of institutional guidelines in the organization of urban space. The planning profile of the plots, therefore, offers a fundamental understanding of the capacity for territorial adaptation to current regulatory strategies, reinforcing the centrality of institutions and planning mechanisms in the formation and implementation of strategies for the transformation and development of urban areas.



	Brooklyn	Manhattan	Queens	The Bronx	Staten Island	Total
Total plots	278.336 32,2%	42.287 5%	325.273 37,7%	89.721 10,5%	125.414 14,6%	861.031 100%
High potential (0.7 to 1.0)	362 0,13%	3.327 7,86%	74 0,02%	0 0,00%	0 0,00%	03.763 0,43%
Medium potential (0.3 to 0.7)	2.094 0,75%	14.378 34,0%	1.204 0,34%	3.480 3,90%	0 0,00%	21.156 2,46%
Low potential (0.0 to 0.3)	274.361 99,1%	24.582 58,1%	323.151 99,6%	85.974 96,0%	125.091 100%	833.263 96,9%

Figure 39 - Planning/Institutional dimension profile. Source: Author with database PLUTO (2024).

7.2.2 Characteristics

7.2.2.1 Transformation

The transformation profile of plots is fundamental for understanding the fundamental urban dynamics. It refers to the physical, legal, and economic changes that plots undergo over time and can be measured using three main indicators: *variation in plot area over a predetermined period* (VA), *variation in property transfers* (VPT), and *variation in land value* (VLV). These combined indicators reveal the degree of plot transformation, highlighting stable areas and those subjects to intense urban transformation, making their identification essential for urban planning strategies.

Figure 40 represents a detailed mapping of New York City's urban plots in the first decades of the 21st century, between 2002 and 2024. Even within a short period of the city's existence, it is possible to identify plots with greater or lesser intensity for transformation. The map's colour gradation indicates the plots' intensity for transformation, with darker tones representing greater intensity (i.e., greater dynamism in terms of VA, VPT, and VLV), while lighter tones indicate less change.

An analysis by borough reveals important differences. Queens, for example, with the largest number of plots in the city (37,7% of the total number), has a relatively low percentage of plots with high intensity for transformation - 1,5%. This suggests a predominance of more stable areas or those with less pronounced market dynamics and urban development. In contrast, Manhattan, although representing only 5% of the city's total plots, has the highest percentage of plots with high intensity for transformation (7,0%). This data is consistent with the region's high real estate appreciation, intense property turnover, and more flexible land use. Brooklyn also has a considerable number of high-intensity plots (2,8%) reflecting its growing attractiveness and pressure for land-use change.

In total, only 2,4% of the city's plots have high intensity for transformation. Although this number may seem small, it represents spaces with extremely high urban dynamism, as they are priority areas in public or private transformation strategies. Most plots are in the medium intensity category, with the economic transformation factor of the plot value being the indicator of the greatest transformation over time.

This profile is a fundamental strategic tool for both public authorities and urban development agents. By revealing which areas are most prone to change, whether due to physical reconfiguration, high property turnover, or land value fluctuations, this profile allows for more precise identification of investments that can generate the greatest impact, and where preservation, redevelopment, or transformation-stimulating policies are most urgent. Furthermore, this analysis is crucial for guiding cadastral reviews and regulations on land use, occupation, and value.

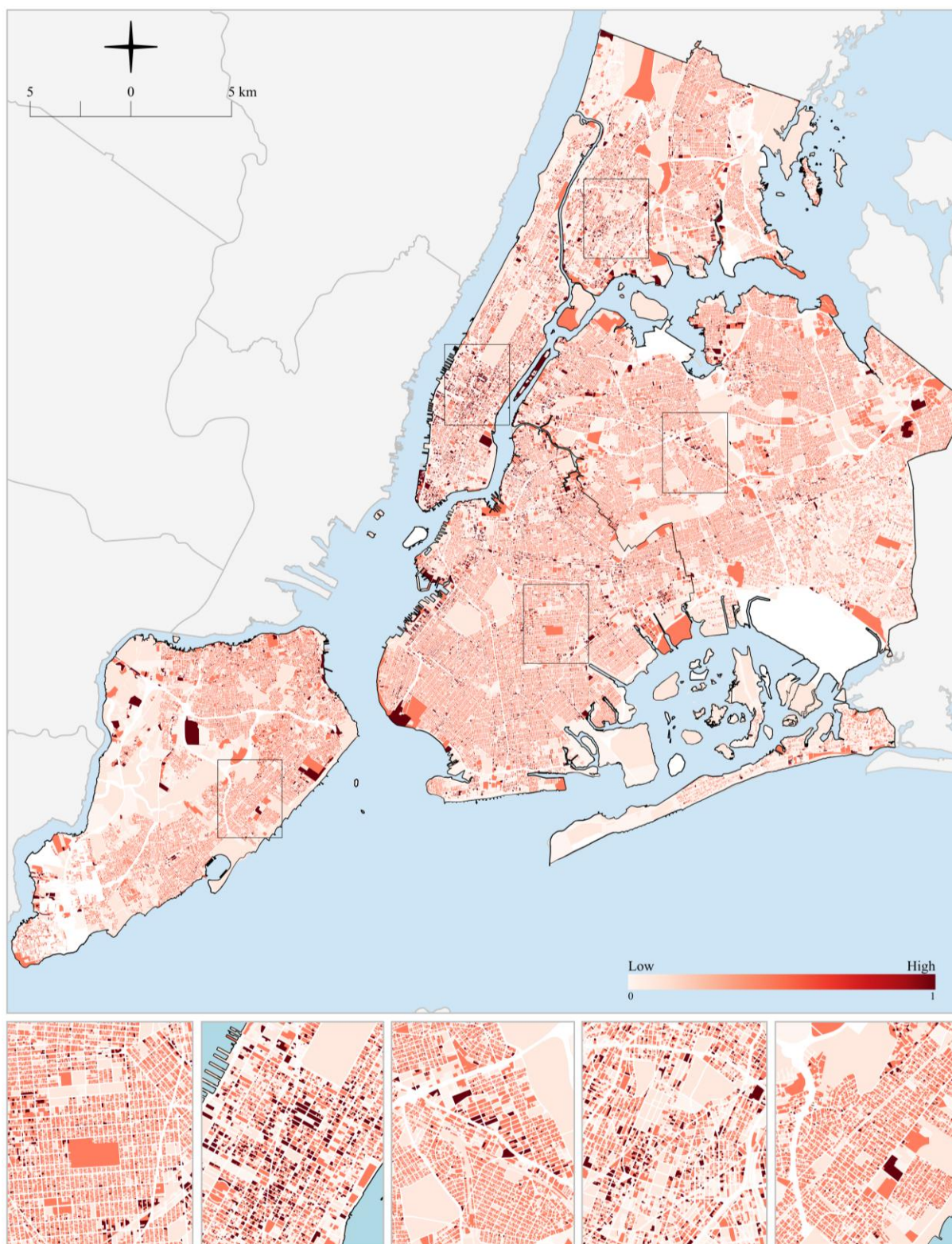


Figure 40 - Characteristics of the transformation of the plot. Source: Author with database DOF (2002-2024), PLUTO (2002-2024).

7.2.2.2 Location

The location profile of urban plots is an essential indicator for understanding how each plot fits into the urban structure. This profile refers to the plot's ability to access, attract, and enhance different types of urban uses, such as commerce, services, leisure, and public facilities, based on its position within the territory. The indicator used to measure this profile is the *attraction distance* (PDT), within an 800-meter radius, calculated using the *Place Syntax Tool*. The higher the PDT value, the better located the plot is in terms of spatial connectivity and intensity for integration with other urban functions. This directly reflects the vitality of the surrounding area, the attractiveness of land uses, and the efficiency of infrastructure.

Figure 41 shows the spatial distribution of plot location profiles in New York City. The analysis indicates that 15,2% of the city's plots have high location intensity, indicating that they are located in areas with a high concentration and proximity of uses. 42,5% of plots are classified as having medium intensity, while 42,1% have low attractiveness.

The largest number of high-intensity plots is in Manhattan, with 46,5% of all plots classified as high intensity and location, confirming the borough's central role as a hub for accessibility and functional diversity. Areas of high connectivity also stand out in Brooklyn, with 13,8%, and in The Bronx, with 19,1%, primarily along commercial corridors and main thoroughfares. In Queens and Staten Island, although there are some specific concentrations, most plots have a medium or low profile, reflecting the more dispersed and less integrated urbanization.

Analysing plot location is strategic for urban planning, as it reveals where plots benefit from spatial integration and where connectivity is lacking. This profile helps understand how the value and use of a plot depend not only on its internal function but also on external spatial qualities, such as its relationship with the urban fabric and the distribution of opportunities around it. Plots well located within the urban structure tend to have greater intensity for transformation and attraction of economic activity, making them key components in urban development and renewal strategies.

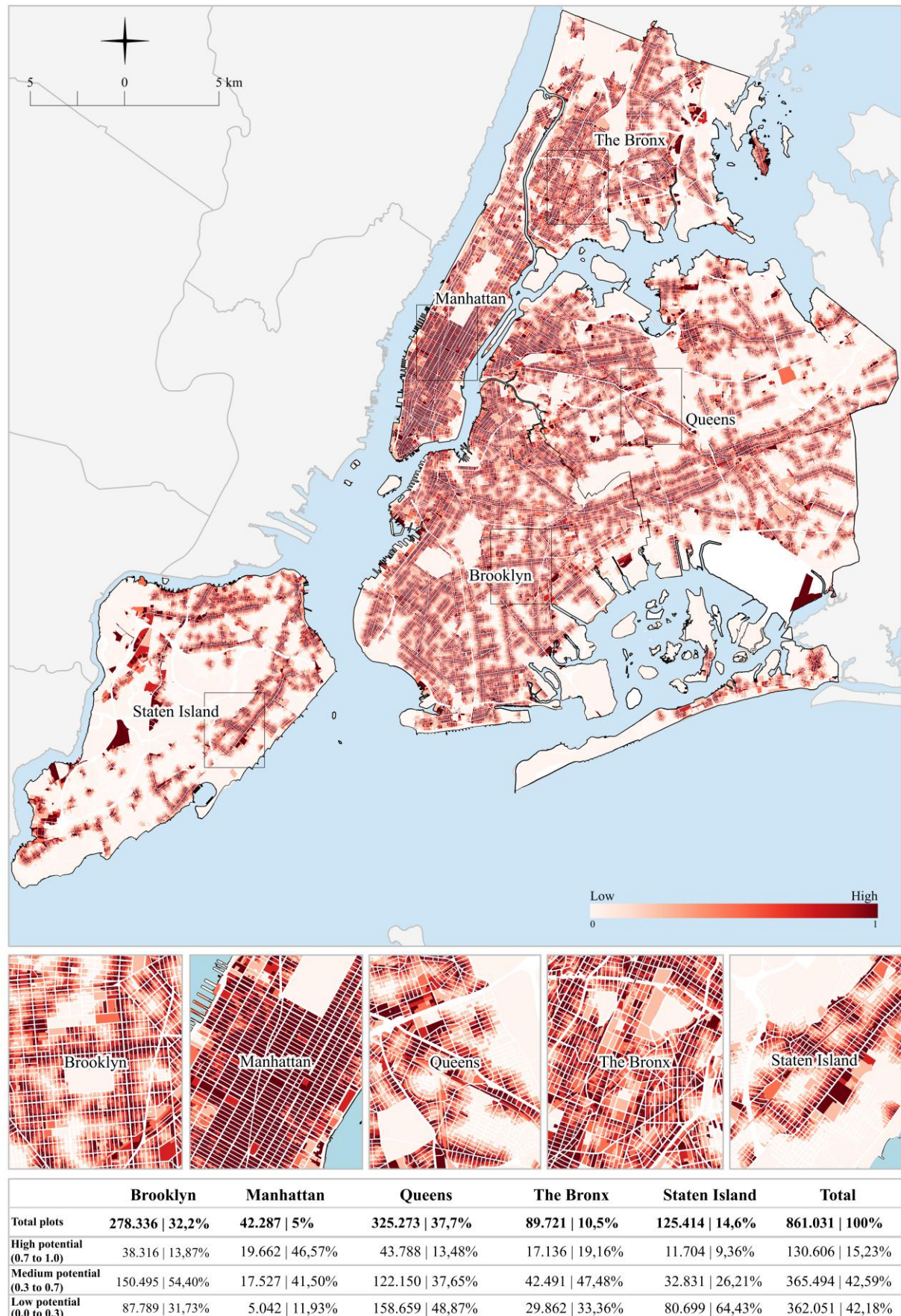


Figure 41 - Characteristic of location of the plot. Source: Author with PLUTO (2024), Place Syntax Tool.

7.2.2.3 Occupation

Plot occupancy is a key aspect for understanding the intensity of urban land use. This dimension directly refers to the relationship between the built-up area and the total area of the plot, expressed by the *building density indicator* (BD). This data measures the proportion of the built-up area relative to the plot size, reflecting the three-dimensional nature of the occupancy. Its analysis allows for the identification of patterns of verticalization and urban space utilization, providing important insights for planning and land management. High building density values are generally associated with more consolidated urban contexts, with greater infrastructure and regulatory permissiveness for intensive uses. Conversely, low values of this indicator indicate areas with low occupancy intensity, often limited by urban planning restrictions. In these areas, the use typologies are less dense, such as single-family housing units.

Spatial analysis of the occupancy profile in New York City reveals an uneven distribution across the different boroughs (Figure 42). Of the total plots analysed, only 4,2% have high building density, demonstrating a concentrated pattern of intensive occupation. Manhattan stands out with 50,7% of its plots classified as having a high occupancy profile, indicating intensive land consumption consistent with its economic centrality and consolidated infrastructure. The Bronx has 6,1% of plots with high occupancy levels, followed by Brooklyn with 1,5% and Queens with only 0,7%. Staten Island has the lowest rate in the city, with only 0,05% of plots in this category.

Medium occupancy, representing 14,5% of the city's plots, is most frequently observed in Manhattan (38,8%), Brooklyn (25,5%), and The Bronx (11,9%), reflecting areas with moderate occupancy relative to their intensity. Conversely, plots with low occupancy profiles predominate throughout the city, totalling 81,2%. Staten Island and Queens account for the majority of these plots, with 97,6% and 91,8%, respectively, demonstrating a more dispersed and less verticalized construction pattern.

Based on these data, it can be seen that New York's dense pattern is highly concentrated in specific areas, while much of the urban territory remains low-density. This profile not only reveals disparities in the intensity of land use but also highlights the role of urban planning and local regulations in mediating land use. The BD indicator allows to identify consolidated areas, where land use is already approaching permitted limits, and areas with greater idle capacity, indicating intensity opportunities for densification policies, urban redevelopment, or revision of urban planning regulations.

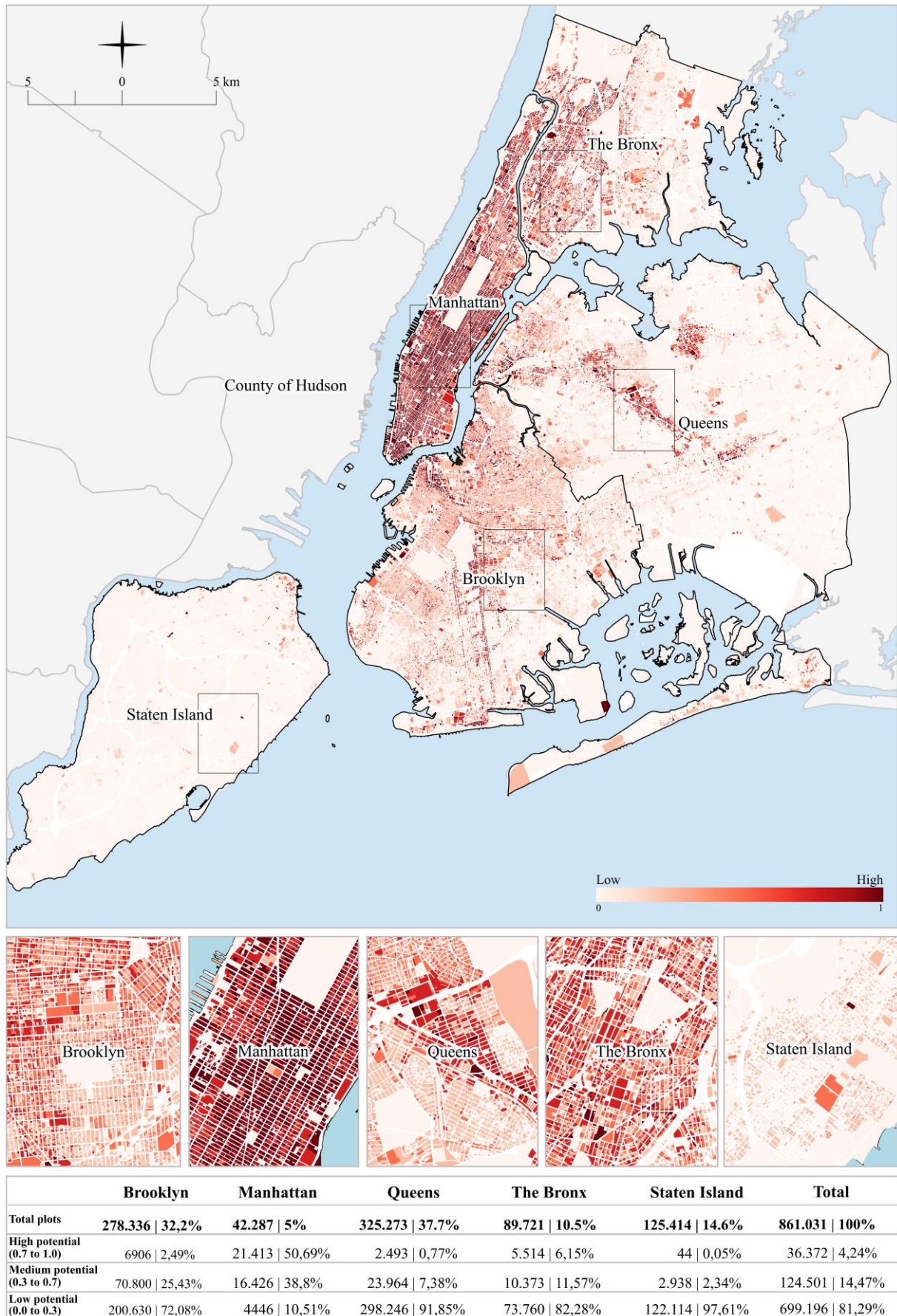


Figure 42 - Occupation characteristic of the plot. Source: Author with database PLUTO (2024).

7.2.2.4 Control

The control profile of urban plots is a crucial indicator for understanding the degree of governance over land use and territory. This control is directly related to the ability of landowners to manage, transform, and preserve their plots. One of the main indicators used to measure this profile is the *Average Plot Area per Owner* (AO), which assesses the amount of physical area under each agent's control. The higher this average, the greater the owner's autonomy to implement changes or consolidate uses; in contrast, greater fragmentation (i.e., many owners with small plots or many owners within a single plot) may indicate less capacity for individual action and, therefore, less effective control over the use of urban space.

Figure 43 represents the spatial distribution of the control profile of urban plots in New York. The analysis reveals that most plots in the city have low intensity for control, 93,5%. Only 2,0% of plots have high intensity (owners who control plots of 600 square meters or more), while 4,4% are classified as having medium control.

When analysing the data by borough, distinct patterns can be identified. Manhattan (although accounting for only 5% of the city's plots) has the highest percentage of plots with high intensity control, at 6,6%. This may reflect the presence of large institutional, commercial, and corporate landowners who concentrate large areas under the same ownership, giving them greater decision-making power over land use. Staten Island also has a high percentage, with 6,4% of plots with high intensity control. In contrast, Brooklyn and Queens, the more populous boroughs, have low percentages of high-control plots, at 1,8% and 0,7%, respectively, indicating greater fragmentation and more diffuse governance.

An analysis of this profile shows that land distribution among multiple owners can play a fundamental role in building a more diverse, inclusive, and economically dynamic city. Territories composed of smaller, individually controlled plots tend to favour a more varied and adaptable land use, allowing for the coexistence of different functions and businesses on a more accessible scale. This more distributed land structure encourages the presence of small businesses and local services, promotes decentralized production networks, and contributes to a more vibrant and socially balanced urban fabric. However, it is important to emphasize that land distribution must be balanced and planned. When there are too many owners on a single plot, difficulties in shared management, conflicts of interest, and obstacles to the implementation of collective improvements can arise. Extreme land division can compromise urban functionality and reduce the capacity for action within the territory. In this regard, evenly distributed control over the plot system, with diverse ownership and clarity regarding responsibilities and ownership over each plot, is essential to ensuring that the city functions as an equitable space.

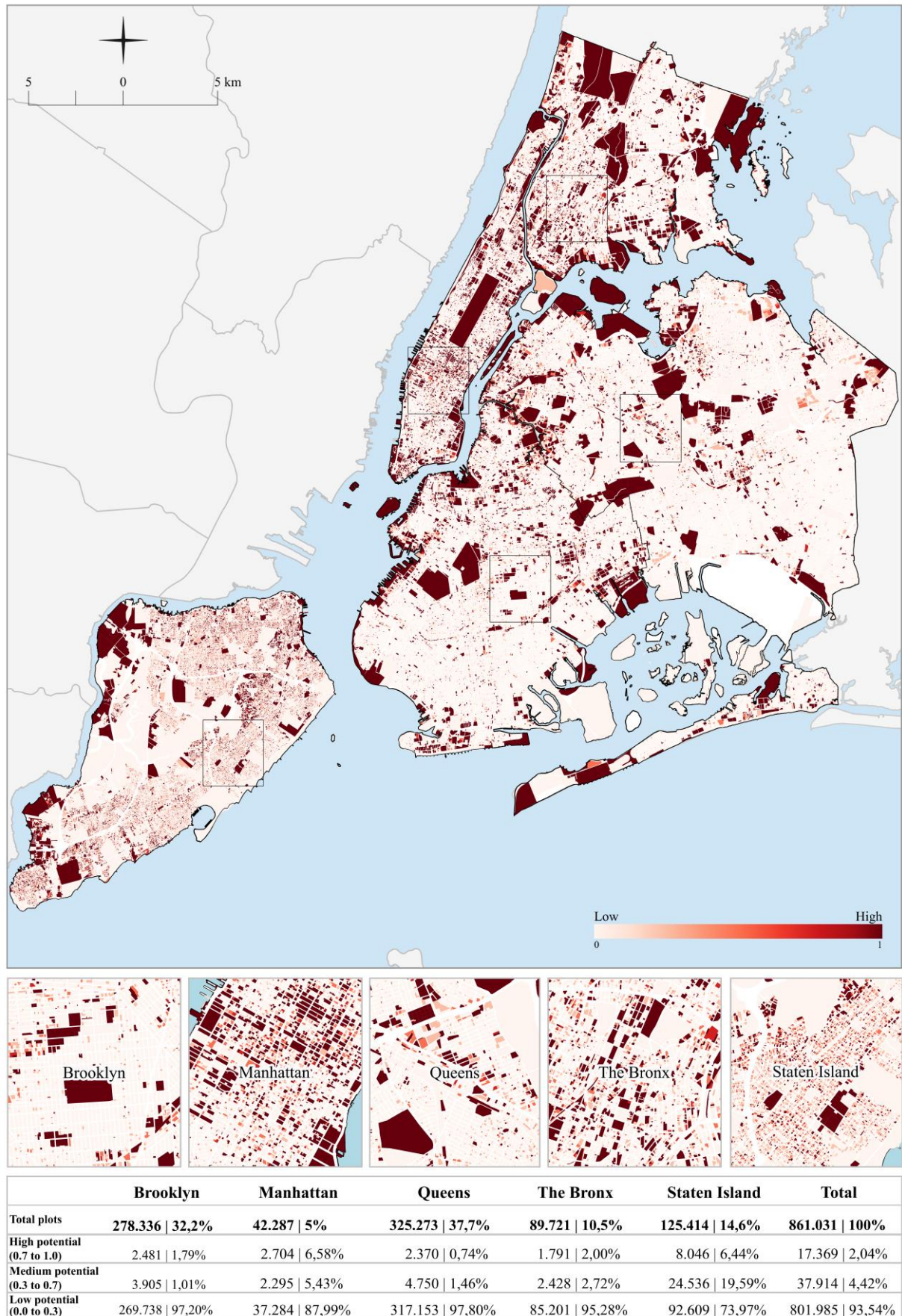


Figure 43 - Control characteristic of the plot. Source: Author with database PLUTO (2024).

7.2.2.5 Function

The functional profile of urban plots is crucial for planning, as it reflects the complexity of land use and its role in promoting urban vitality. It refers to the number of functions a plot accommodates, such as housing, commerce, services, leisure, and others, and is measured by the number of activities existing on a single plot, measured by the *Functional Profile* (FP) indicator. The greater the number of coexisting activities on a plot, the higher its FP value, indicating greater multifunctionality. Multifunctional plots favour the continuous presence of people throughout the day, stimulate local economies, reduce the need for long commutes, and contribute to urban sustainability.

The data reveals a significant predominance of plots with low functional intensity throughout the city (Figure 44). Of all plots in New York, 97,9% were classified as having low functional intensity. Manhattan has the highest proportion of high intensity, representing 6,0% of all its plots. This highlights the intense diversity of land use in this region and the coexistence of residential, commercial, cultural, and institutional functions. This significant presence of multifunctionality directly contributes to Manhattan's urban vitality, promoting continuous use of space at different times of the day.

Brooklyn, despite having a significant number of plots, has only 0,7% with high functional intensity and 1,0% of plots with medium intensity. This is similar in The Bronx, with 0,8% of plots having high intensity. Staten Island, in turn, is the borough with the lowest functional intensity values, at 0,09%.

The geographic distribution of FP indicates clear patterns of functionality; the areas with the highest intensity are concentrated in Manhattan and, to a lesser extent, in parts of Brooklyn and Queens. On the other hand, peripheral, industrial, and largely residential neighbourhoods, such as those found in Staten Island and the outer areas of The Bronx and Queens, have low functional intensity.

Analysing this profile provides essential information for public policies aimed at the sustainable development of cities. Promoting urban multifunctionality at local levels, such as blocks and neighbourhoods, is a strategic factor for reducing dependence on motorized transport, encouraging active mobility, improving public safety through the continuous presence of people, and fostering local economies. Encouraging functional densification and a mix of uses can be an effective tool for building more inclusive, resilient, and dynamic cities.

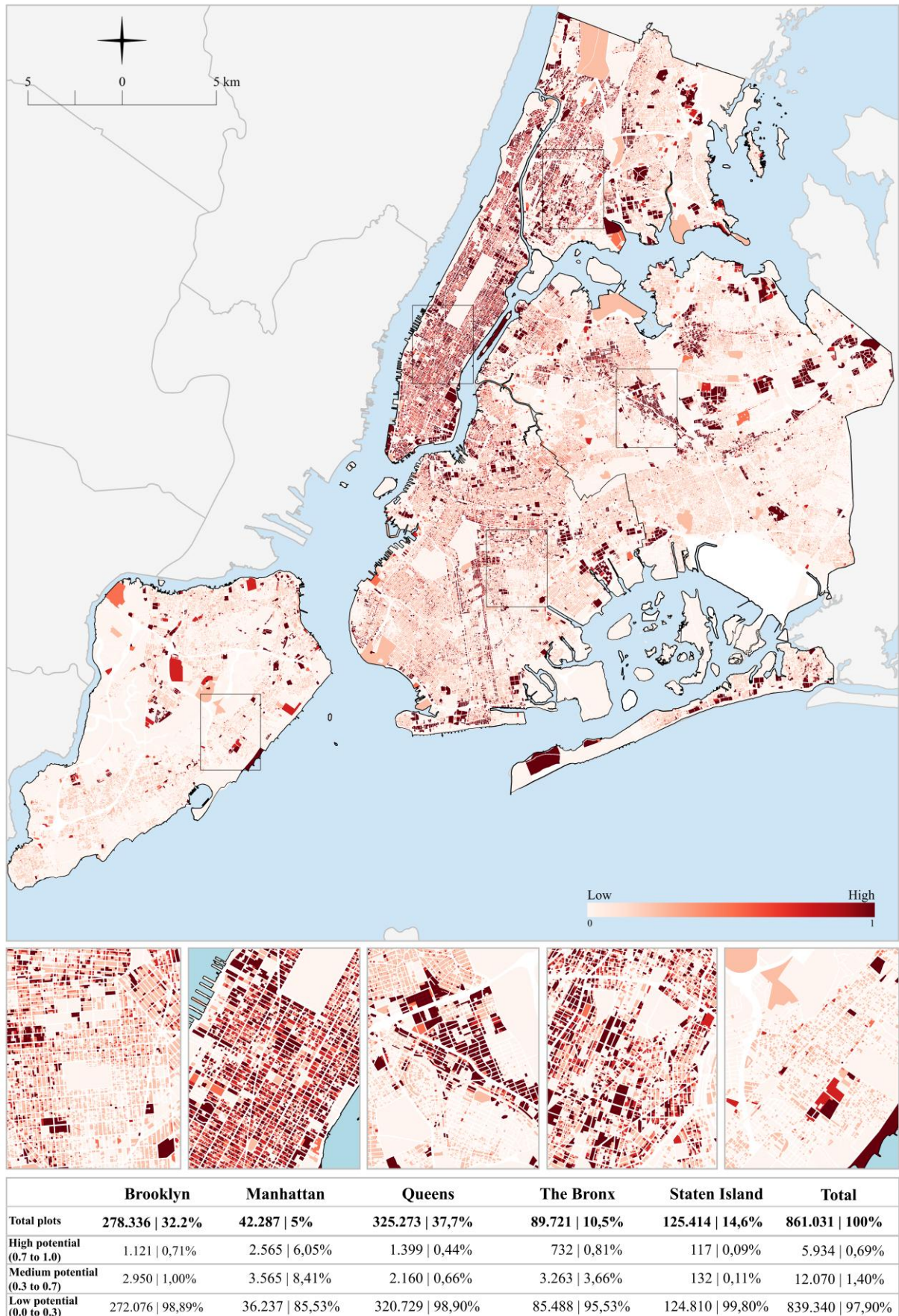


Figure 44 - Characteristic of the function of the plot. Source: Author with database PLUTO (2024).

7.2.3 The plot system's multifaceted profile

Traditionally, plots have been analysed fragmentarily, sometimes as units of use, others as units of property ownership, measure of value, etc. However, this one-dimensional interpretation proves insufficient given the range of roles that plots assume within the urban structure. Sections 7.2.1 and 7.2.2 demonstrate that plots operate as a multifaceted system where different urban dimensions (social, economic, environmental, morphological, legal and planning) and characteristics (transformation, location, occupation, control and function) simultaneously have a role in urban space, shaping the territory and its dynamics from the boundaries of each plot. These two axes - dimensions and characteristics - reveal that the urban plot is not merely a delimited physical entity, but an active interface between the city's material elements and the dynamic processes of urban life, making it a space for life and transformation. Each plot can express varying degrees of economic centrality, social stability, environmental performance, or construction intensity, depending on the specific combination of attributes that coexist within it at the time. For example, a plot with high functional diversity may have low capacity for legal transformation, or an environmentally efficient plot may be underutilized from the perspective of building density.

Understanding the plot as a multifaceted unit, therefore, means recognizing that its configuration and performance derive from the dynamic interaction between physical, institutional, and symbolic aspects of cities. This integrated approach expands the analytical and strategic capacity of urban planning, allowing not only a more accurate diagnosis of territorial inequalities but also the identification of opportunities and weaknesses that would be invisible in sectoral approaches. By revealing the plot as a point of convergence between multiple systems, the method adopted in this research helps consolidate it as an operational cell of the city, essential both for understanding urban reality and for formulating more sensitive and effective interventions.

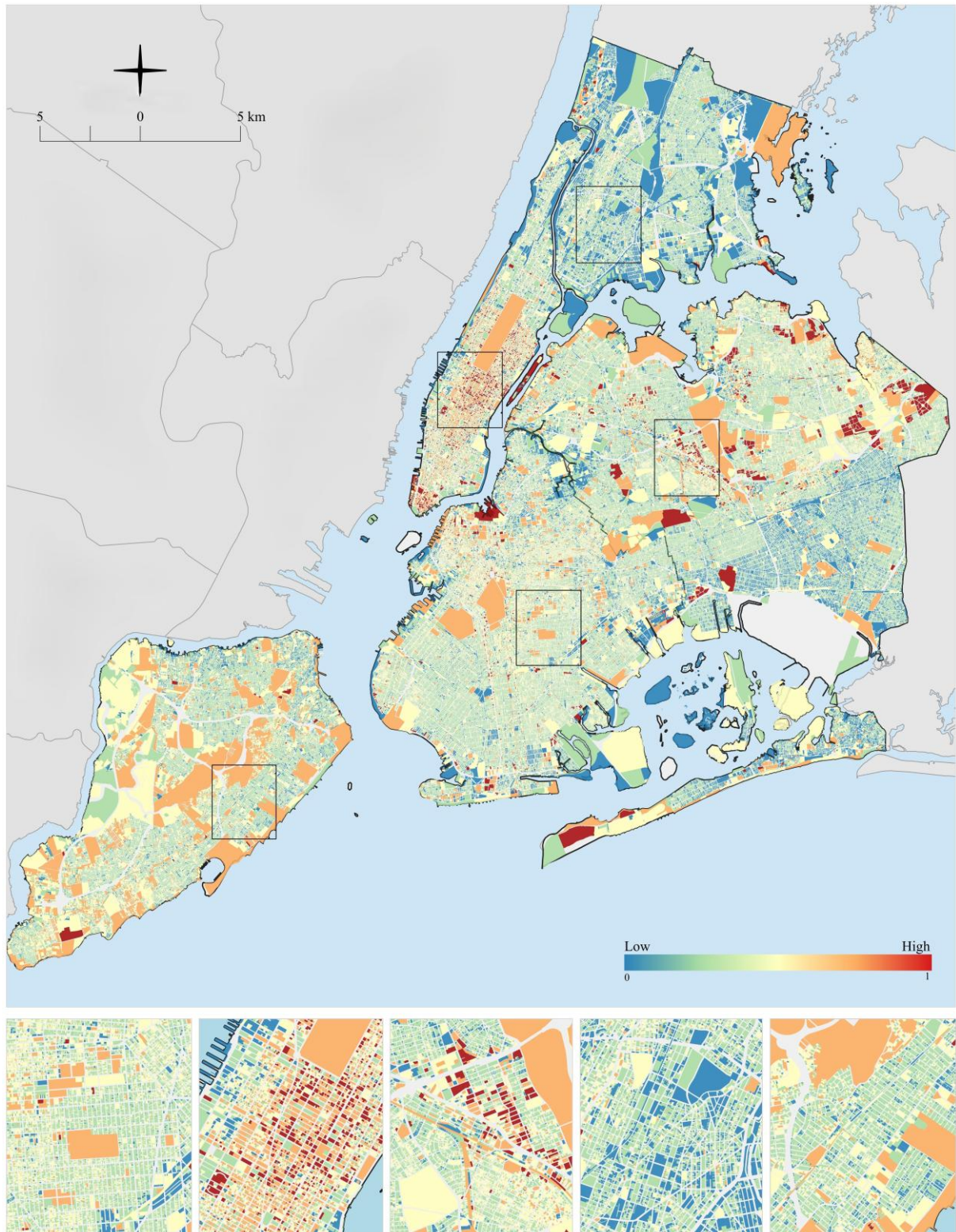
Figure 45 presents the multidimensional profile of New York City. The profile is a composite index resulting from the six normalized indicators studied individually in section 7.2.1 (see also section 6.3.3). The analysis reveals that most plots perform poorly in the multidimensional profile; 73,4% are classified as having low intensity. This group consists of plots that, while exhibiting qualities in some isolated dimensions, do not accumulate significant attributes in a combined manner, reflecting contexts with a lower density of active urban forces. Approximately 25,5% of the plots were classified as having medium multidimensional intensity, revealing contexts in which some dimensions interact better. Only 0,2% of the total plots reach the high multidimensional profile group, in which the convergence between dimensions is more intense and interactive. In these plots, the different urban dimensions operate more homogeneously, reinforcing the centrality and importance of these units in the urban context. The distribution of high intensity is strongly concentrated in Manhattan, which houses 2,8% of its plots. This high intensity indicates that these plots have higher land values, economic activities, property transfers, resident-owners, land permeability, property rights, and utilization rates than other plots in the city. The remaining boroughs have lower proportions of multidimensional profile, reflecting sporadic high-intensity plots.

Additionally, Figure 46 presents the multicharacteristic profile. According to data, only 0,2% of the city has plots with a high characteristic profile. In contrast, 82,8% of plots have low characteristic intensity, revealing a fragmented or reduced presence of these characteristics, while 16,9% are in an intermediate condition. High-intensity plots are heavily concentrated in Manhattan, accounting for 3,7% of its plots. This indicates a significant overlap of urban characteristics that confer high territorial dynamics, such as intense land transformation, high occupancy density, diversified uses, and spatial integration. In the other boroughs, the incidence of high multicharacteristic intensity is quite limited. In Brooklyn, only 0,08% of plots achieve high intensity, in Queens and The Bronx, it is 0,10%, and in Staten Island, only 0,01%. This uneven distribution shows that the combined force of urban characteristics acts selectively on the territory, concentrating in historically more consolidated and structurally favoured areas, while other parts of the city remain with low integration of urban attributes.

An integrated reading of the multifaceted profile (multidimensional and multicharacteristic analysis) reveals direct relationships between the various layers of analysis. Manhattan stands out among the boroughs. Its 2,8% of plots with a high multidimensional profile and 3,7% with a high multicharacteristic profile concentrate the city's most intense urban dynamics. The interplay between privileged location, high real estate appreciation, diversity of uses, high building density, and constant transformation of the urban fabric results in a territory with extremely high complexity and performance. However, such urban intensity also reinforces exclusionary processes, such as gentrification and the displacement of popular uses, requiring urban policies that reconcile territorial efficiency with spatial justice.

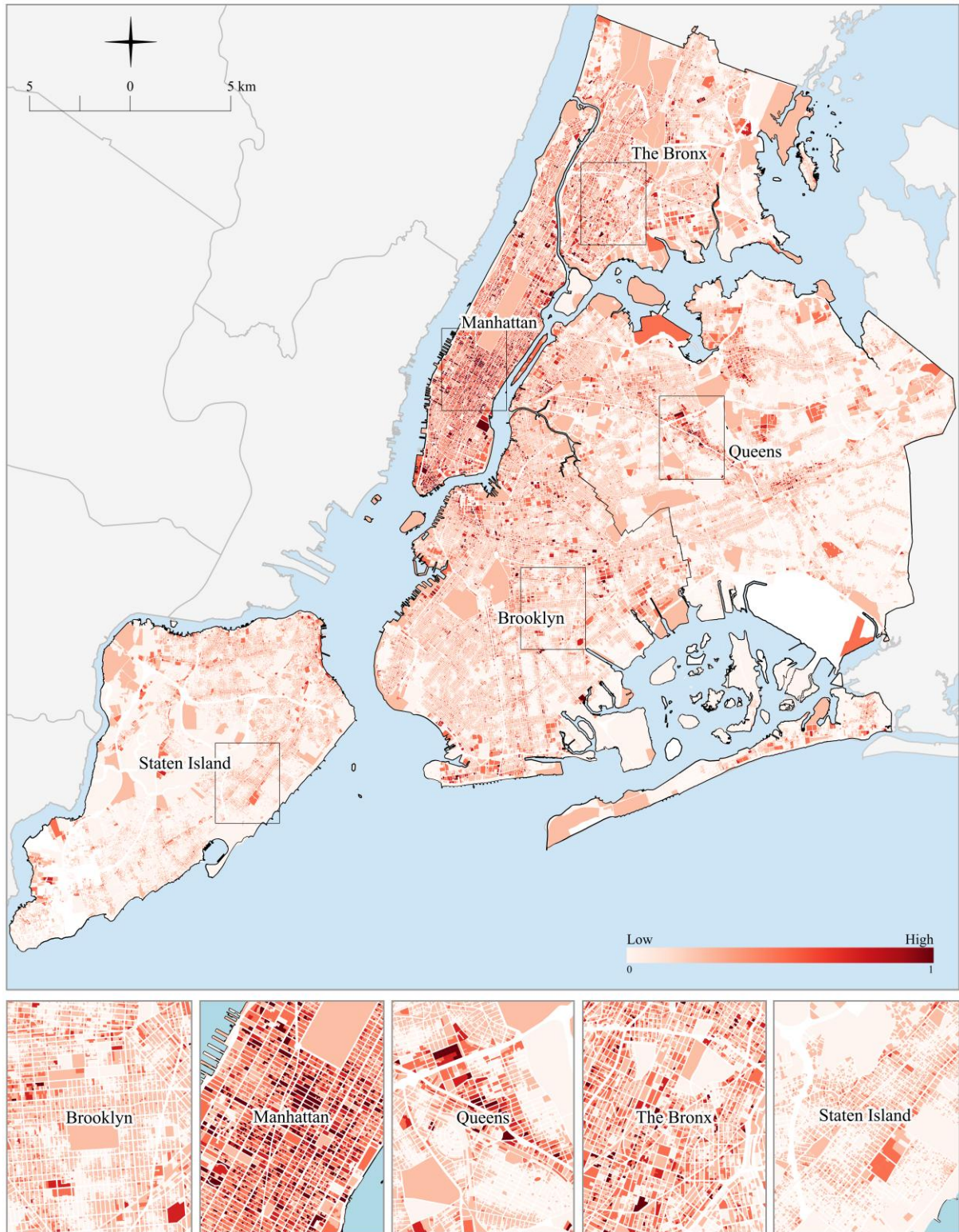
In Brooklyn, the most populous borough, data points to an intermediate profile in terms of multidimensional (34,9%) and multicharacteristic (19,3%). The presence of emerging mixed-use neighbourhoods, such as Williamsburg and Downtown Brooklyn, partially explains this performance. These areas are experiencing an increase in building density and functional diversity, accompanied by accelerated land ownership transformations and economic restructuring. However, most of Brooklyn is characterized by monofunctional residential developments and small commercial centres.

In Queens, the largest borough in terms of land area and number of plots, low-intensity profiles predominate, both multidimensional (81,3%) and multicharacteristic (80,5%). This reflects the predominance of urban fabrics with low density, monofunctional use, a lower incidence of transformations, and less connectivity in the city's arterial structure. In The Bronx, the situation is similar to that of Queens, with a wide predominance of low-performing profiles: 80,5% of plots have low characteristic intensity and 85,8% have low dimensional intensity. Although The Bronx presents reasonable territorial connectivity and moderate urban density, the data points to less functional diversity. Staten Island presents the most homogeneous pattern of low integrated urban performance: 87,9% of plots have a low characteristic profile and 79,8% have a low multidimensional profile. This is a borough with low density, heavy reliance on individual transports, dispersed residential development, and limited functional diversity. The territory presents little land dynamism and low urban centrality, maintaining a suburban configuration.



	Brooklyn	Manhattan	Queens	The Bronx	Staten Island	Total
Total plots	278.336 32.2%	42.287 5%	325.273 37.7%	89.721 10.5%	125.414 14.6%	861.031 100%
High (0.7 to 1.0)	133 0,04%	1.203 2,84%	482 0,14%	25 0,02%	29 0,02%	1.872 0,21%
Medium (0.3 to 0.7)	98.398 34,9%	26.829 63,4%	58.845 18,09%	12.166 13,55%	25.025 19,95%	220.263 25,58%
Low (0.0 to 0.3)	176.913 63,5%	13.965 33,02%	264.615 81,35%	77.011 85,83%	100.084 79,80%	632.588 73,46%

Figure 45 - Multidimension profile of the plot. Source: Author with Database: Full information in section 6.3.



	Brooklyn	Manhattan	Queens	The Bronx	Staten Island	Total
Total plots	278.336 32,2%	42.287 5%	325.273 37,7%	89.721 10,5%	125.414 14,6%	861.031 100%
High potential (0.7 to 1.0)	203 0,08%	1.510 3,70%	142 0,10%	142 0,19%	17 0,10%	2.014 0,23%
Medium potential (0.3 to 0.7)	53.562 19,33%	31.344 74,2%	27.896 8,60%	17.281 19,3%	15.129 12,0%	145.212 16,92%
Low potential (0.0 to 0.3)	223.202 80,5%	9.354 22,1%	296.206 91,3%	71.984 80,51%	110.202 87,9%	710.948 82,84%

Figure 46 - Multicharacteristic profile of the plot. Source: Author with Database: Full information in section 6.3.

The multifaceted analysis of a city's plots allows for an integrated understanding of the territory, starting from the smallest spatial unit: the plot itself. This approach enables the identification of structural, functional, and socioeconomic patterns distributed throughout the urban fabric, revealing how different combinations of indicators are organized and influence urban performance in different parts of the city. By integrating diverse data into a plot matrix, it becomes possible to observe areas of greater or lesser urban complexity, centres of active transformation, areas of stagnation or low integration, as well as spatial relationships between consolidated centralities and peripheral territories.

Beyond the city-wide analysis, it is essential to deepen this analysis at the local scale. A detailed study of how dimensions and characteristics operate within each land unit reveals nuances that are invisible in larger quantitative analyses. This scale of analysis, which is the next step in the *Plotter method*, favours the recognition of the city's internal diversity and provides more precise technical support for context-sensitive urban interventions.

7.3 Local Scale Analysis

The local scale analysis is developed as a fundamental step to deepen the understanding of the role of plots system in their immediate surroundings. To this end, two small areas (NYC Census Tracts) in each borough are selected and delimited (Figure 47). Each selected area (the reasons for their choice are explained in the next paragraphs) is analysed both quantitatively and qualitatively. Integrating these two interpretations allows to construct a specific view of the multifaceted role of the plot as a fundamental unit of urban life.

In Brooklyn, the first area (A), part of Downtown Brooklyn / DUMBO and Boerum Hill, comprises 106 plots and is a high-density area undergoing intense transformation. This area has experienced, particularly in the last two decades, an accelerated process of verticalization and reconversion of the urban fabric. In contrast, the second area of Brooklyn (area B) is part of the Flatbush neighbourhood. With approximately 184 plots, it maintains a more traditional character - it is a low-density residential neighbourhood composed of row houses and multi-family buildings up to six stories high.

In Manhattan, the first area (A) is part of Greenwich Village and has 159 plots. This area is part of one of the city's most iconic neighbourhoods, known for its historic and residential character. It is made of low-rise, mid-rise, and high-rise buildings, many of them protected by heritage preservation regulations. The second area (B), Midtown-Times Square, represents the opposite in terms of scale. With 156 plots in the analysed area, Midtown is the centre of global business and tourism, dominated by office skyscrapers, hotels, and high-rise residential buildings. Times Square, in particular, is an icon of the contemporary metropolis, marked by digital advertising, Broadway, and the constant flow of tourists.

In Queens, the analysed area A is part of the Astoria Central neighbourhood, and the analysed area B is part of the Jackson Heights neighbourhood. Astoria, with 515 analysed plots, has a medium-density, with multi-family buildings up to six stories high, townhouses, and local businesses. Historically, the neighbourhood has welcomed influxes of Greek, Middle Eastern, and Latin American immigrants, reflecting its cultural diversity and local commercial dynamism. In recent years, Astoria has experienced a real estate appreciation process, driven by its proximity to Manhattan and good subway access. Jackson Heights, with 264 plots in the analysed area, is one of the city's best-known neighbourhoods for its ethnic diversity.

In The Bronx, area A is part of the Crotona Park East neighbourhood, with 238 plots in the analysed area, and it is characterized by low-rise residential buildings, occupied largely by low-income families. The Pelham Parkway-Van Nest area, with 259 plots in the study area, features both multi-family and single-family buildings.

Finally, in Staten Island, two areas were identified that reflect the neighbourhood's suburban identity. The first area (A), St. George-New Brighton, with 178 plots in the analysed area, is the main local urban centre and home to the Staten Island Ferry terminal, which connects the borough to Manhattan. It is a mixed-use area with low-density residential buildings. The second area (B), Rosebank, with 243 plots in the analysed area, features low-density development, consisting of single-family homes on large, suburban plots. This area is known for its

predominantly residential uses. The following subsections present the results of the Local Scale Analysis.



Figure 47 – Study areas. Source: Author (2025).

7.3.1 Dimensions

7.3.1.1 Social

Analysing the social dimension allows to understand how the structure of human occupation on plots impacts daily life, starting with the owner-occupants in their homes. The owner-occupant status is closely associated with a sense of belonging and social rootedness; unlike the renter status, which is more subject to mobility, residential instability, and market pressure. Owner-occupant status implies greater permanence, long-term investment in property and, often, an emotional bond with space. Thus, the presence of owner-occupants is understood as the most robust way to capture the social intensity of each plot, revealing the degree of commitment and community identity it can generate within the neighbourhood.

The quantitative analysis map of the study areas shows that, in general, plots are characterized by low social intensity (low presence of owner-occupants). In Queens (areas A and B), The Bronx (areas A and B), and Manhattan (area B), 100% of the analysed plots have low owner-occupant intensity. The same is true for Brooklyn (area B) and Staten Island (area B). The variations occur in three areas. Manhattan in area A, with 159 total plots, has 43 plots with medium owner-occupant intensity and 116 plots with low intensity. Brooklyn, in area A, has 12 medium-intensity plots and 77 low-intensity plots. Staten Island in area A, has 8 medium-intensity plots and 170 medium-intensity plots (Figure 48).

The qualitative analysis map deepens these results by reporting on the relationship between owner-occupants and renters. The data reveal that renters are the majority in virtually all analysis segments. In Brooklyn (area A), home to 4.490 people¹⁷, only 4,6% are owner-occupants and 53% are renters; in area B, the proportion of owners rises to 6,1% and renters represent 30,9%. In Queens, in area A, with 6.291 residents, only 3,59% are owners, compared to 47,5% renters; in area B, there are 4,0% owners and 21,8% renters in a population of 3.647 people. The Bronx also follows the same pattern, with only 4,18% owner-occupants in area A and 9,3% in area B, and 25,8% and 21,4% renters, respectively. In Manhattan, area A, there are 5.419 residents, with owner-occupants representing 20,8%, virtually tied with renters at 23,3%. In area B, homeowners account for 9,9% and renters account for 38,4%. Staten Island, area b, has a total of 5,8% owner-occupiers and 21,0% renters. In area B, there are 13,3% owner-occupiers and 14,5% renters, for a population of just over a thousand people (Figure 49).

¹⁷ Population and housing type data taken from the 2022 NYC Census Data. This information may differ from the actual resident population.

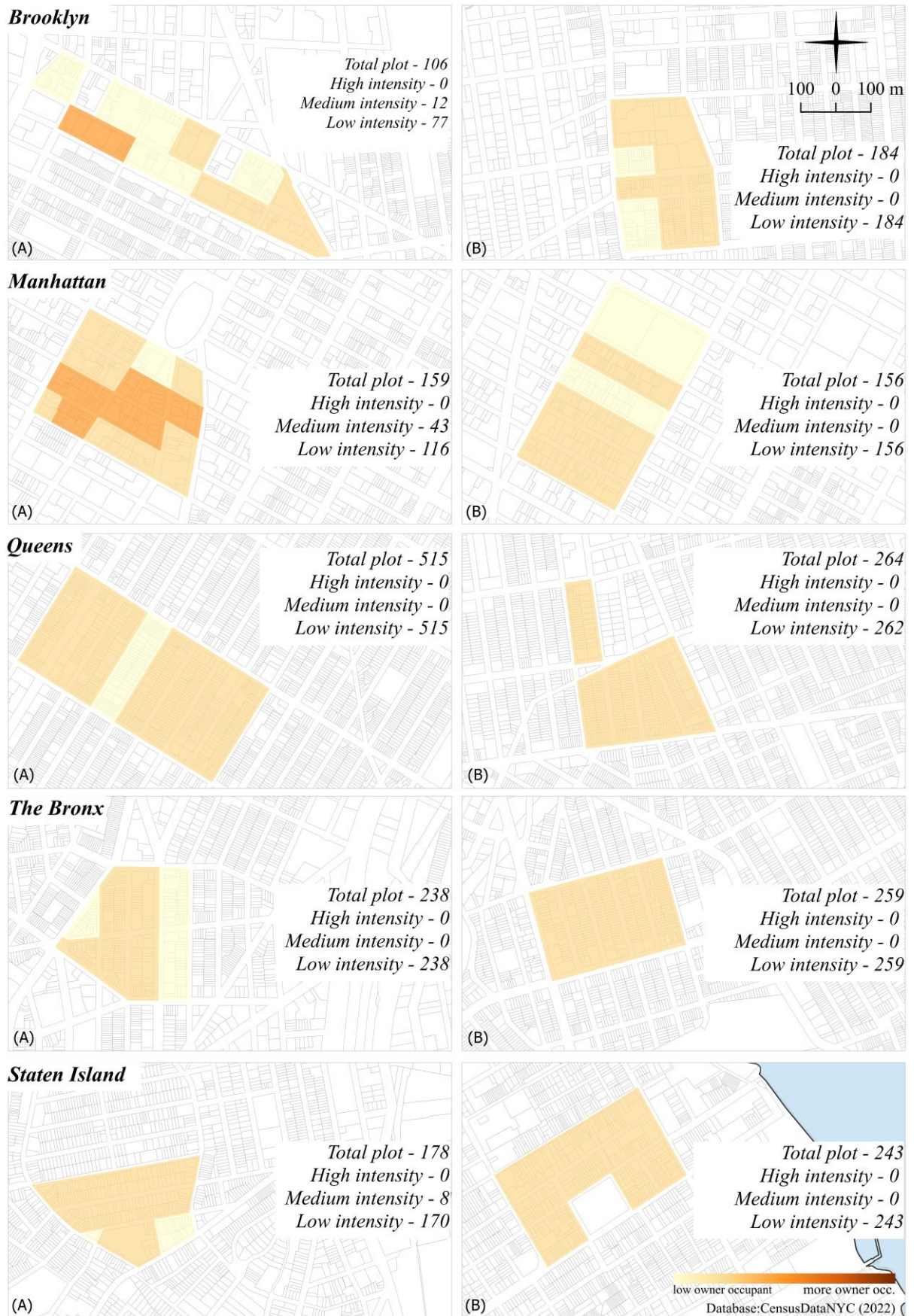


Figure 48 - Quantitative analysis of local scale – social profile.

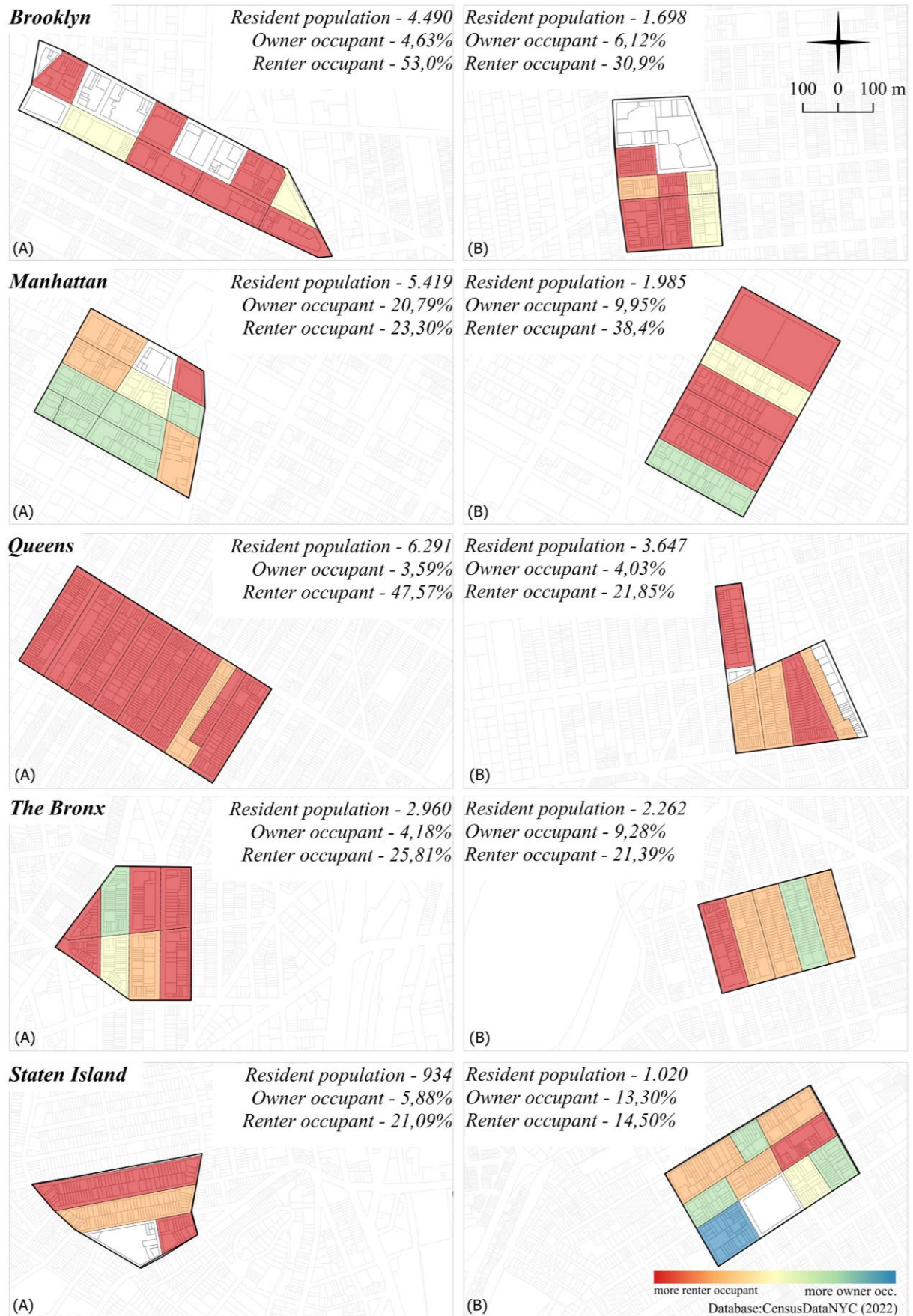


Figure 49 - Qualitative analysis of local scale – social profile

7.3.1.2 *Economic*

The spatial distribution of land value, the number of property transfers, and the concentration of economic activities per plot should not be understood as isolated phenomena, but rather as simultaneous and interdependent processes that structure the urban economy. These indicators, when analysed together, reveal patterns of concentration and economic intensity, and how this potential is expressed in the city's daily life, through the uses attributed to each plot and its interfaces with public space. While quantitative analysis addresses the economic intensity of plots in three important economic indicators at the city level, the local qualitative analysis seeks to understand each of these indicators separately and how economic activities relate to the public-private interface.

The quantitative map (Figure 50) shows the spatial distribution of each plot's consolidated economic intensity. Manhattan, both areas A and B, have the higher intensity, highlighting the commercial and real estate centrality of the city's most valued region. Next, in Brooklyn, there is a large proportion of medium-intensity plots, with a concentration of broader commercial uses in area A and local commercial uses in area B. The area A of Queens also has a significant number of medium-intensity plots. Like other areas tested, low-intensity plots were common in the Bronx and Staten Island, characterized by lower land values, property transfers, and economic function.

The reading of the maps in Figure 51 and Figure 52 reveals that Manhattan not only concentrates the highest land appreciation but also the highest intensity of real estate transactions, especially in area B, where plots are valued well above \$500,000 and there are between 3 and 12 recent transactions. In Brooklyn, especially in area A, land values are intermediate, but there is still a significant presence of high-value plots and intense property turnover. In Queens, values vary widely, with areas of medium appreciation associated with a low number of transactions. In The Bronx and Staten Island, low-value plots and low property turnover predominate.

reveals that Manhattan's area B has greater economic intensity, with 156 plots containing economic activities, corresponding to 97% of the total plots in this area. Of this set, 40 plots house a single activity, while 116 plots concentrate two or more, often subdividing the ground floor into different commercial units or overlapping activities on each floor. In area A of Manhattan, there are a total of 124 plots with commercial activity directly facing the street (75% of the total plots in the subdivision), of which 54 have one activity and 70 have more than one. Brooklyn, in area A, has 98 active plots in commerce (91% of the total), with 35 having a single activity and 63 having two or more, while Brooklyn in area B has 49 plots of economic intensity (23% of the total), of which 33 have only one activity and 16 have more than one. The Queens (A) has 119 plots with economic activity (21%), with 84 single-use plots and 35 with more than one activity.

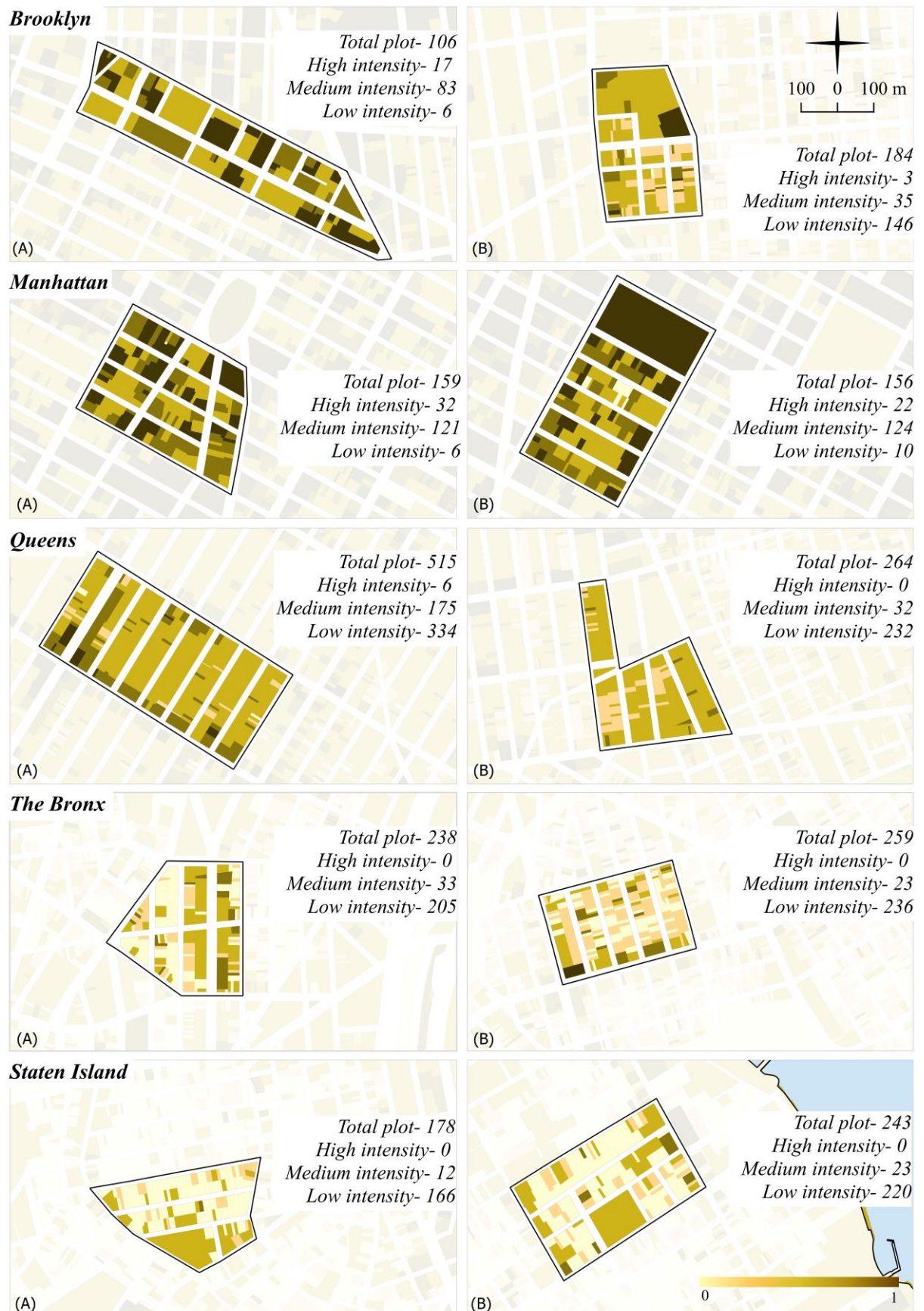


Figure 50 – Quantitative analysis of local scale – economic profile

Queens (area B), has 70 plots (25% of the total), 24 with single-use and 46 with more than one commercial activity. In The Bronx, area A contains 53 plots with commercial activities (20% of the total), of which 38 have single-use and 15 have more than one activity; in area B on The Bronx, 21 plots have commercial activities (6% of the total), 13 with single-use and 8 with more than one activity. Staten Island in area A and area B also have low rates.

The intensity of commercial activity is a crucial indicator for generating urban vitality. In areas with high economic intensity and greater urban centrality, the plot space is typically divided into smaller units at ground level, creating alternative facades that intensity interaction with public space. Furthermore, consideration is given to using space above the ground floor to accommodate vertical commercial activities, optimizing the use of the plot and expanding the range of services and products on a single plot. This combination of horizontal subdivision and vertical use enhances pedestrian flow, increases customer turnover, and contributes to strengthening local economic resilience.

The largest number of plots with vertical development are concentrated in Manhattan, followed by specific areas of Brooklyn. The vertical organization of activities allows the same plot to support different commercial functions, from quick-service establishments on the ground floor to specialized services or extended stays on the upper floors. This arrangement reduces pressure on space in terms of physical expansion, increases land consumption, and intensifies the flow of people, favouring constant circulation throughout the day and increasing the density of interactions in the immediate surroundings. Overlapping uses also contributes to economic resilience, as it diversifies the customer profile and dilutes dependence on a single commercial segment.

Dividing the ground floor space of the plots for different activities generates another type of impact on urban dynamics. The horizontal subdivision of the façade creates a multiplicity of access points facing directly onto the street, increasing the porosity of the public-private boundary and stimulating the spontaneous flow of pedestrians. This configuration is especially complementary between businesses that share the same plot, strengthening local consumption networks and increasing user retention in the public space.

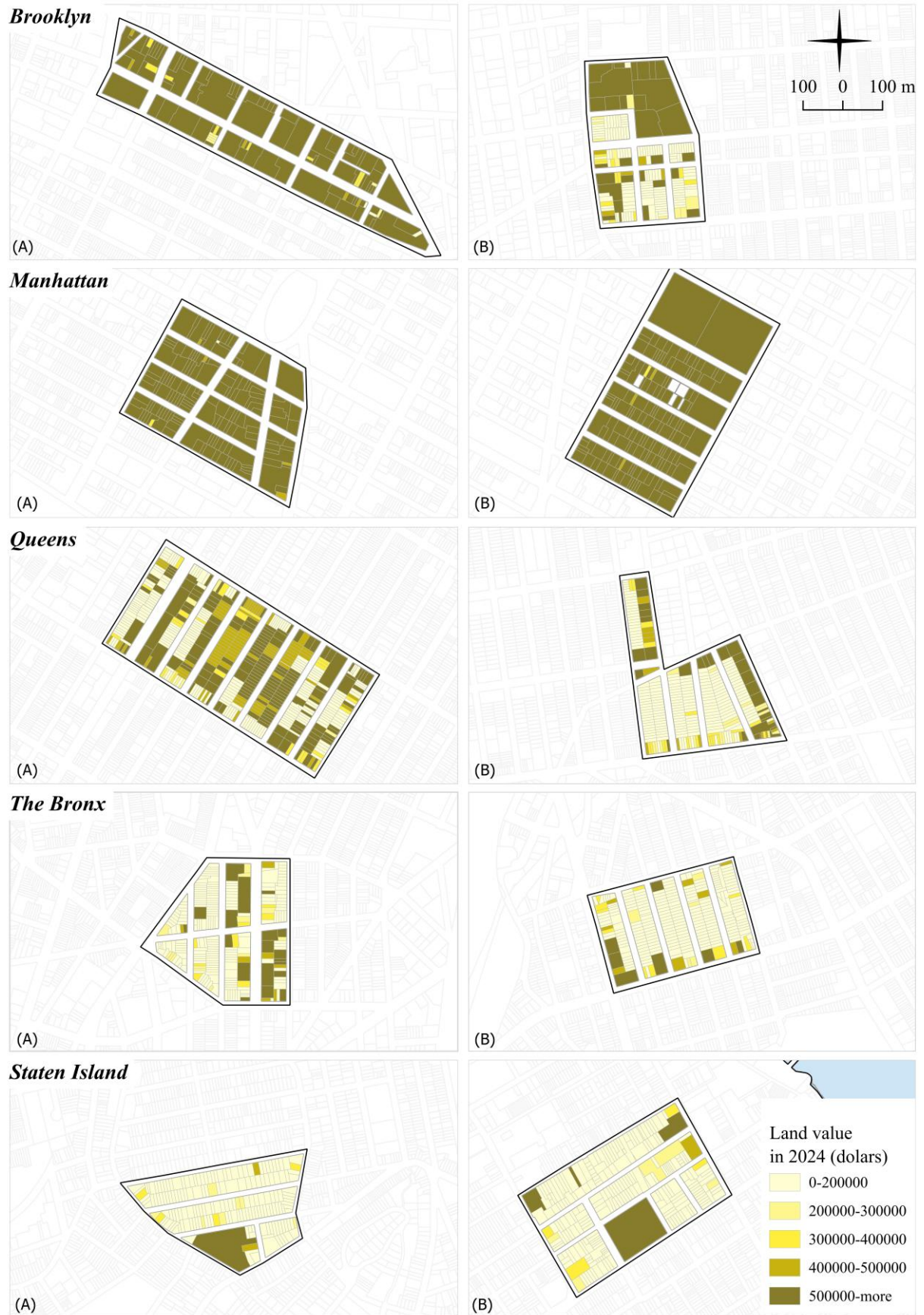


Figure 51 – Qualitative analysis of local scale – land value

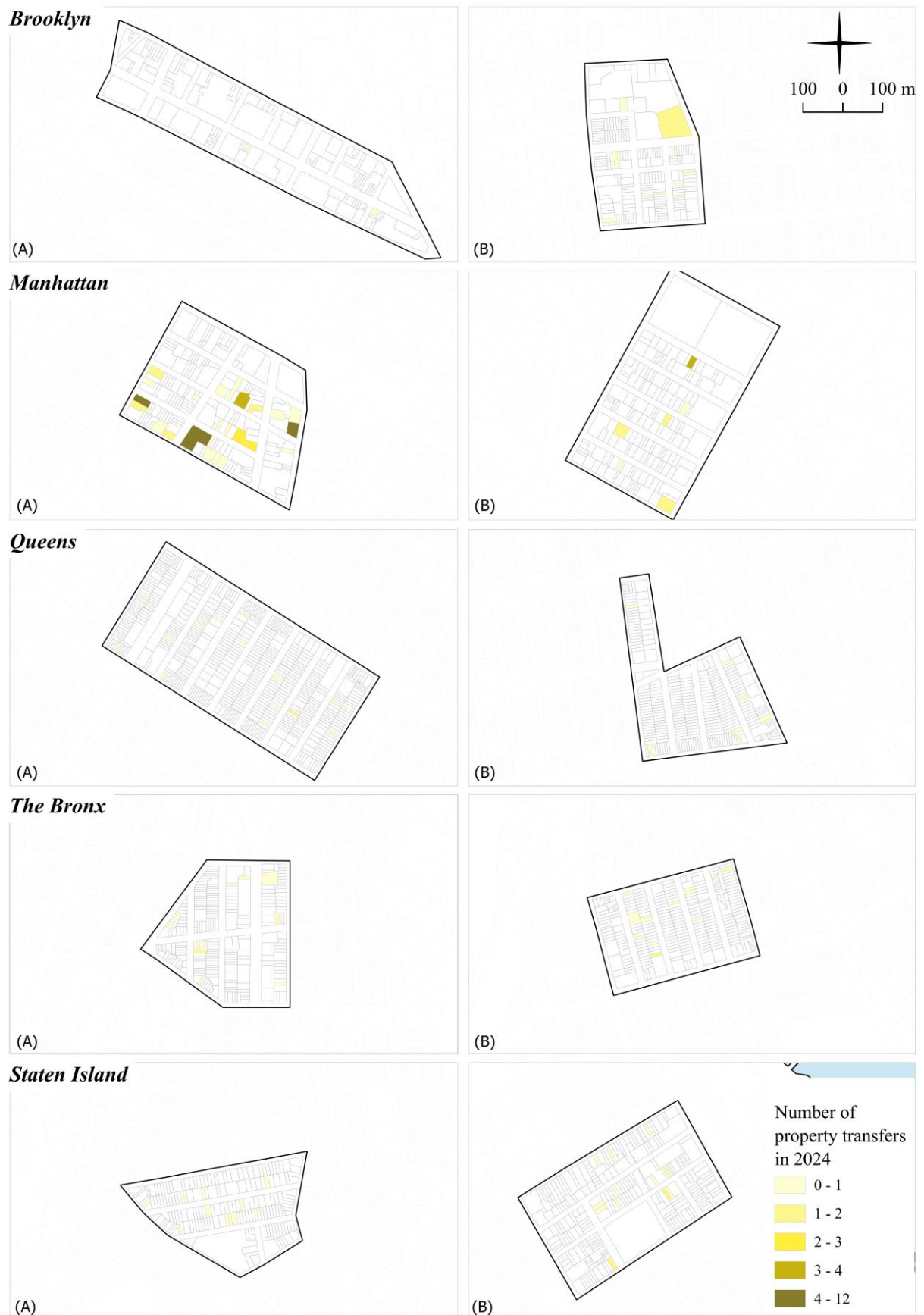


Figure 52 – Qualitative analysis of local scale – number of property transfers

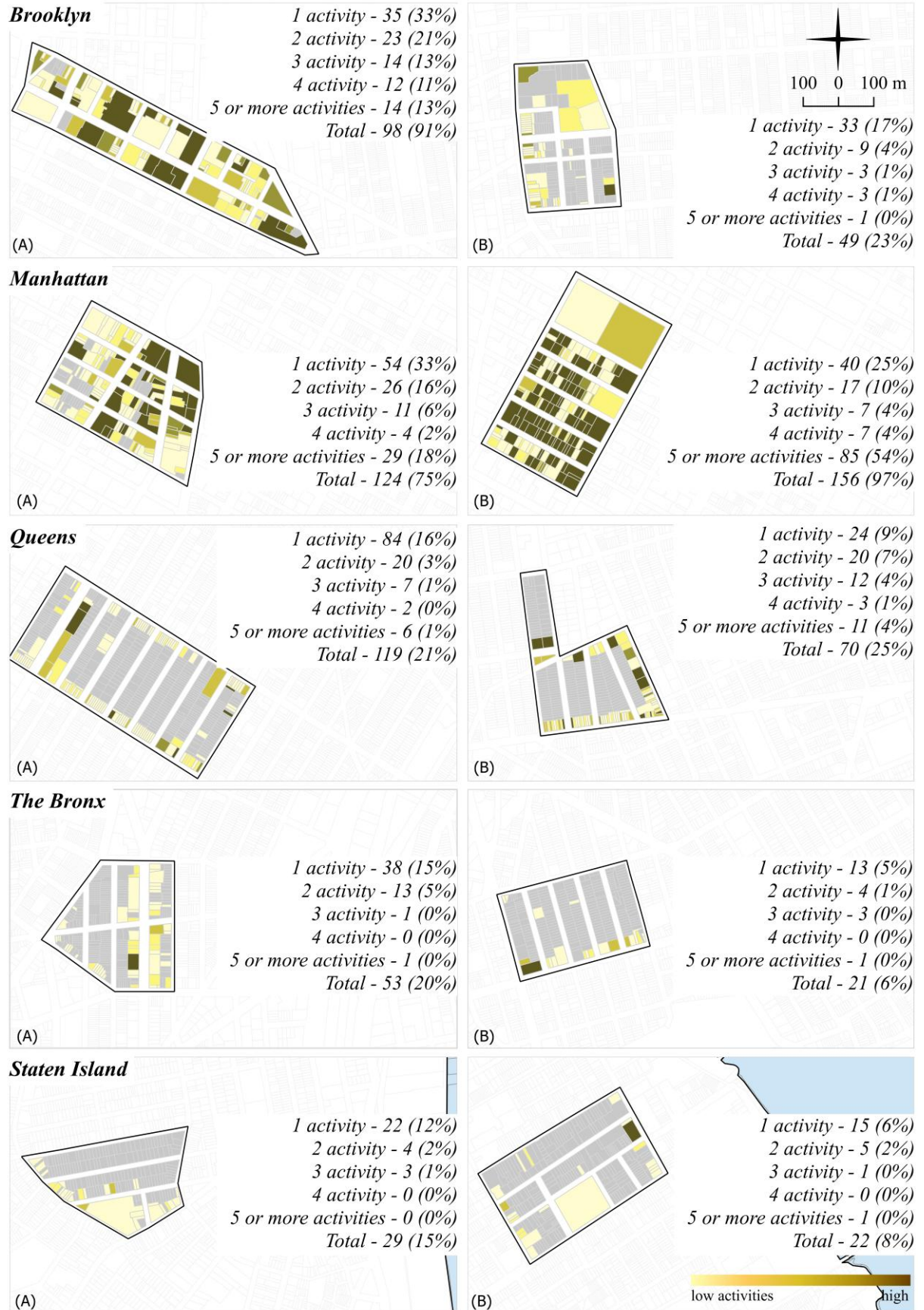


Figure 53 - Qualitative analysis of local scale - economic activities

Figure 54 shows a number of plots with one single economic activity - a lower-density commercial pattern, primarily focused on serving the local population. They are characterized by narrow façades, compact occupancies, and strong integration with the neighbourhood's daily life, serving as supply points for essential services. Although they have low functional diversity, these establishments often establish strong ties with the territory and their clientele, albeit with a more limited capacity to attract significant external clients. Plots with two or more commercial activities (Figure 55) exhibit two main patterns of positioning these activities within the plot: horizontal or vertical division of space within the plot. When the division is horizontal, both façades are visible simultaneously. When divided vertically, the ground floor houses high-turnover activities, such as food and convenience stores, while the upper floors concentrate more specialized services or activities that require appointments, for example.

The plots with three activities (Figure 56) reveal an intermediate degree of functional densification, generally combining two establishments on the ground floor and one on the second floor. This configuration ensures an active commercial base facing the street, while the use of the upper floors adds functional diversity and expands the plot's attractiveness. In the plots with four activities (Figure 57), functional intensification becomes more evident, with arrangements that combine horizontal and vertical subdivisions to optimize available space. The coexistence of complementary uses within the same plot creates micro-centralities, capable of attracting different consumer profiles and extending the time spent in the adjacent public space, potentially strengthening street commerce as a local reference hub.

Plots with five or more commercial activities (Figure 58), represent the peak of functional density and commercial verticalization in the urban fabric. In these configurations, intensive use of the plot area concentrates on a multitude of establishments in an extremely limited amount of land. Typically, these plots house different types of businesses, such as local shops and services, businesses that serve the city, and even businesses that serve a global scale, creating zones of extremely high vitality and overlapping pedestrian and vehicular flows. This pattern is characteristic of the most central and connected areas of the urban system, where high accessibility and strong consumer presence justify the concentration of these activities.



Manhattan



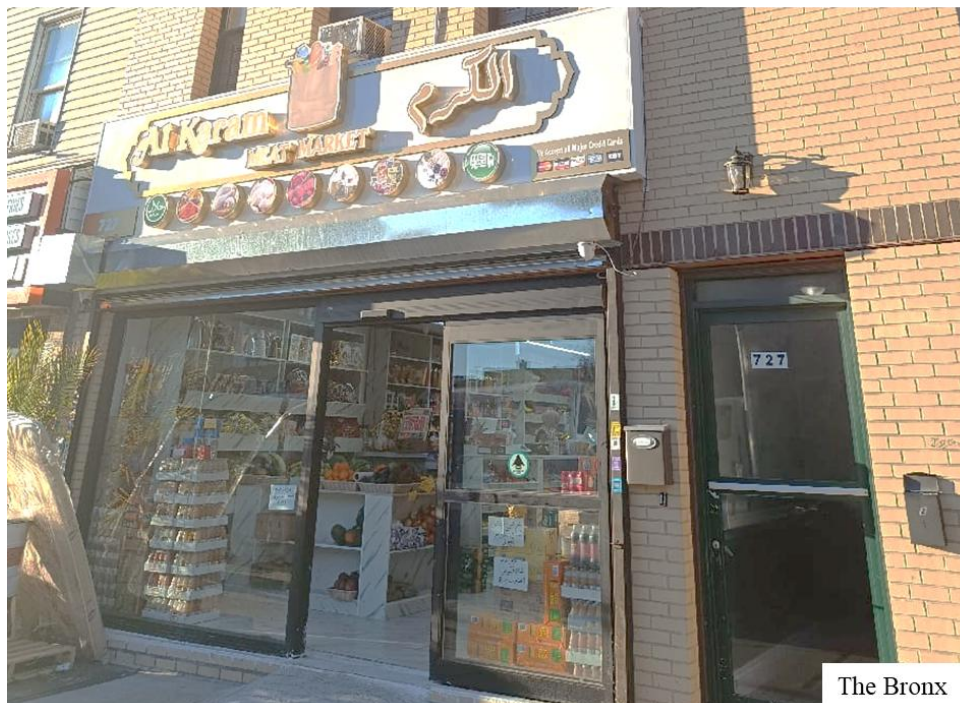
Brooklyn



Queens



Staten Island



The Bronx

Figure 54 – One economic activity per plot



Staten Island



Brooklyn



Manhattan



Figure 55 – Two economic activity per plot



Manhattan



The Bronx



Brooklyn



Figure 56 – Three economic activity per plot





Brooklyn



The Bronx

Figure 57 – Four economic activity per plot



Manhattan



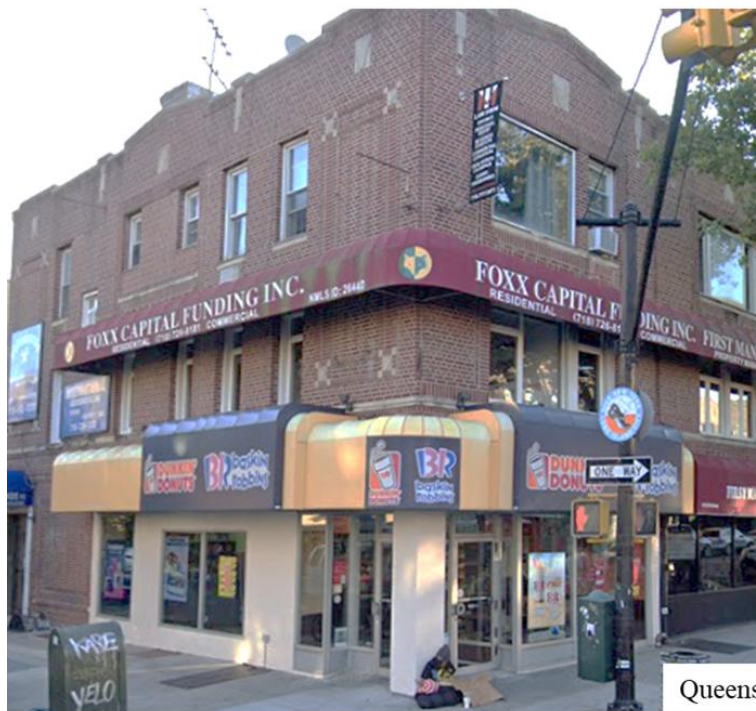
The Bronx



Staten Island



Brooklyn



Queens

Figure 58 – Five or more economic activity per plot

7.3.1.3 Environmental

Local analysis of the environmental dimension contributes to understanding how permeable areas and their position within plot can directly impact the quality of urban life. Permeable areas are essential elements of green infrastructure, responsible for functions such as increasing groundwater runoff, flood mitigation, temperature reduction, filtering impurities, and creating more comfortable microclimates (Benedict and McMahon, 2006; Gill *et al.*, 2007). When positioned in a small front setback or in direct contact with sidewalk, these green spaces add, in addition to ecological benefits, a positive impact on the urban landscape, pedestrian comfort, and the social vitality of the street (Jacobs, 1961; Gehl, 2020). Permeable areas located within the plot or out of pedestrian view continue to play a fundamental environmental role in thermal regulation, stormwater management, and biodiversity support, but with less direct influence on the public space immediately in front of the plot. Furthermore, the lack of green areas between the public-private interface can reduce the intensity of thermal moderation on sidewalks, as treelined front setbacks can significantly contribute to shading and improve environmental comfort for those circulating in public spaces. Therefore, understanding both the extent and location of these areas is crucial to guiding interventions that balance ecological efficiency and the quality of the urban experience.

A quantitative reading of the environmental profile (Figure 59) reveals quite distinct patterns among the boroughs. In Staten Island, the predominance of high-intensity permeable areas is considerable. In area A, 26 of the 179 plots have high permeable surface intensity and only 5 are in the medium category in area B, 52 of 243 plots have high intensity and 29 plots have medium intensity. In The Bronx, although there is still a considerable number of high-intensity plots, the predominance is of low intensity plots. In area A, 31 plots are of high environmental intensity, but 171 of the 238 are of low intensity. In area B, 7 plots are of high environmental intensity and 242 are of low intensity, out of a total of 259 plots. In Queens, area A presents only one high-intensity plot, and 512 low-intensity plots out of a total of 515. In area B, all plots are a low intensity. Brooklyn maintains a similar situation. In area A, 103 plots out of a total of 107 are low intensity. In area B, 181 of 184 plots have the same profile. In Manhattan, in area A, only four plots have high environmental intensity, and in section B, only two. The results show that, in most of the areas analysed, the plots with highest environmental intensity are concentrated in areas far from centres, generally associated with lower building densities and greater availability of open space within the plots. This uneven distribution indicates that, in the densest and most central regions, where the demand for microclimatic comfort and ecosystem services is most critical, the physical space available for high-performance permeable areas within the plots is significantly reduced.

In the qualitative analysis, the results demonstrate the degree of integration of these permeable areas into the everyday street experience, highlighting when the presence of vegetation and permeable land is visible and accessible to the public. Staten Island has the largest presence of accessible permeable areas. In area A, there are 38 accessible plots and 51 semi-accessible plots. In area B, there are 52 accessible and 52 semi-accessible plots. In The Bronx, area B, has 11 plots with accessible permeable areas and 53 semi-accessible plots, while in area A, there are only 34 semi-accessible plots.

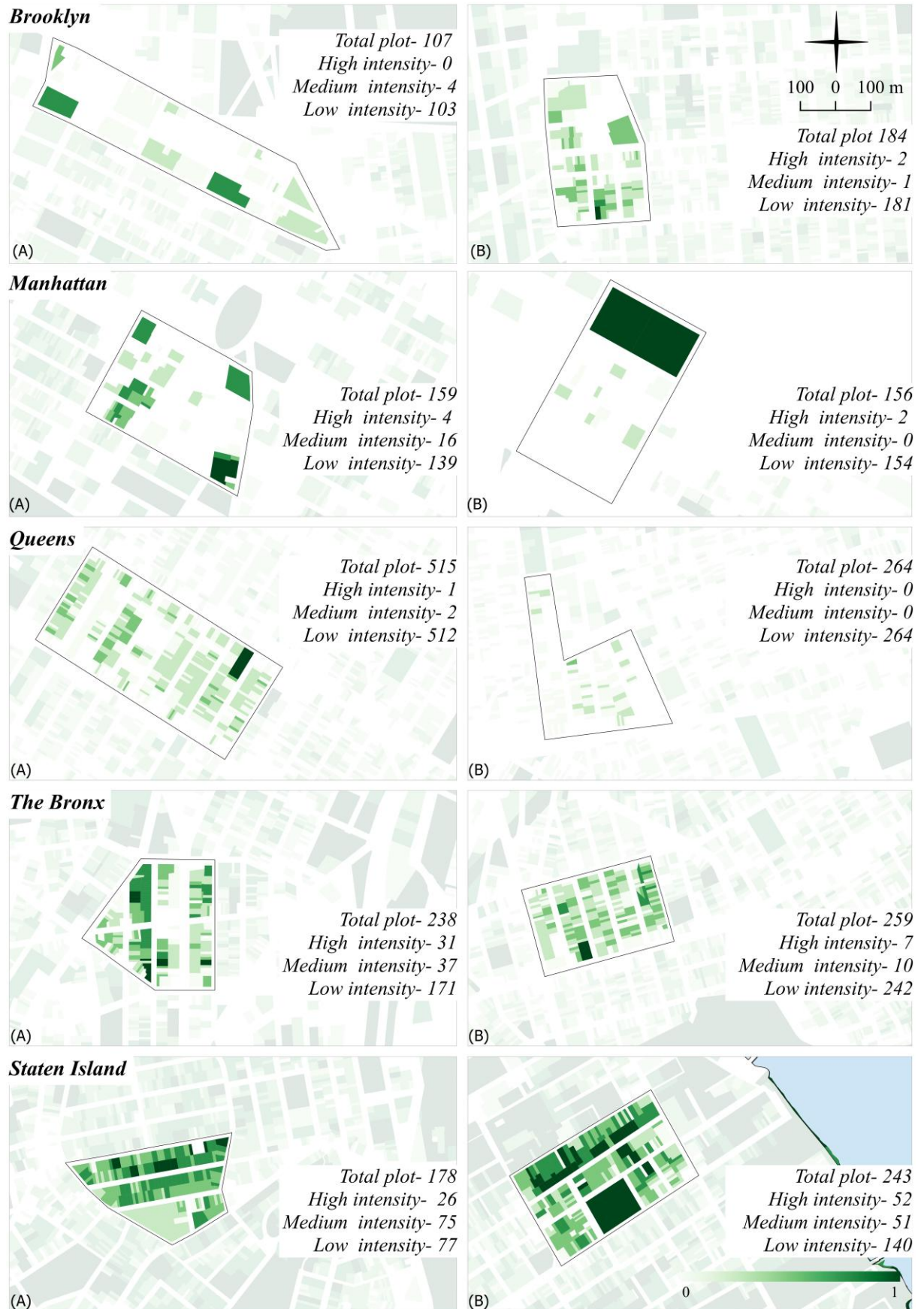


Figure 59 – Quantitative analysis of local scale – environmental profile

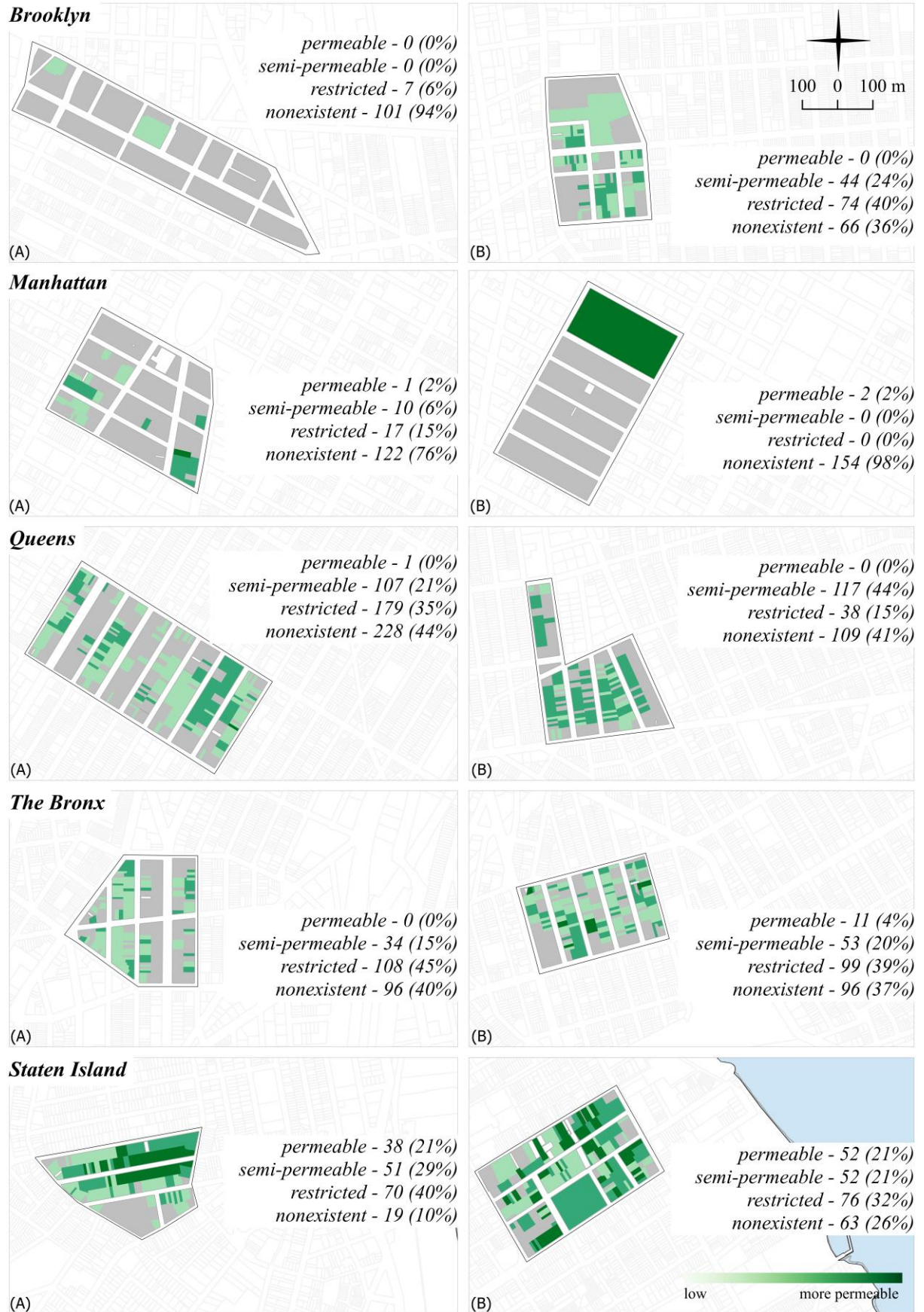


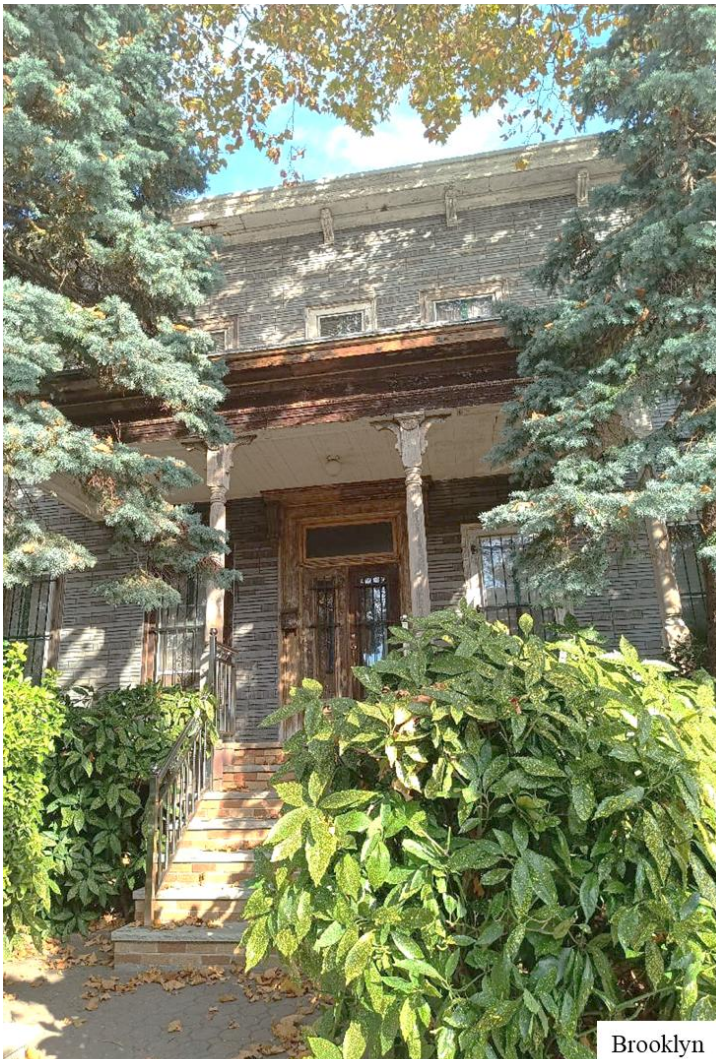
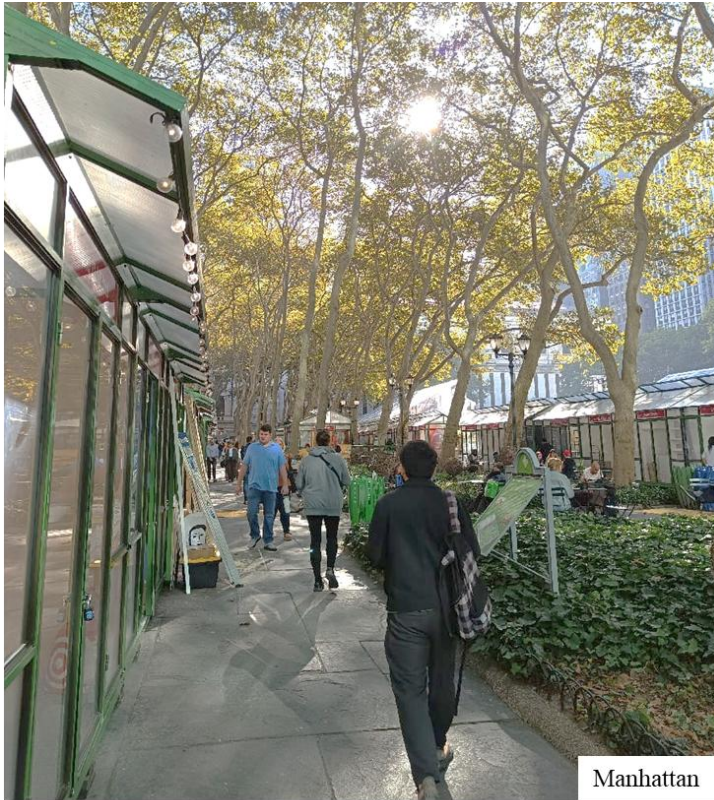
Figure 60 - Qualitative analysis of local scale - environmental profile

In Manhattan, there is one accessible permeable plot in section A, and 10 semi-accessible plots. In area B, there are two accessible permeable plots and five semi-accessible plots. In Queens, area A has one accessible plot and 107 semi-accessible plots, and area B has only 117 semi-accessible plots. In Brooklyn, area A has only plots with restricted permeable areas, and in area B, there are 44 semi-accessible plots.

This combination of analyses highlights that the environmental intensity of a plot becomes more important when the amount of available permeable surface manifests itself at the interface between the plot and the public space. Accessible permeable areas located at the street interface add value to the environmental intensity already identified in the quantitative analysis, as they extend their positive effects beyond the plot, contributing to sidewalk shading, thermal regulation, and aesthetic enhancement of the urban environment. Semi-accessible areas, while not fully fluid, maintain part of the permeable area visible and transparent, providing microclimatic and visual benefits. Restricted areas, located within the plot and out of the view of pedestrians, play a relevant role in the ecological infrastructure of the urban fabric, but with less impact on the plot's interface with public space. Plots with zero permeability miss the opportunity to offer both ecosystem services and benefits for urban coexistence.

The photographic record highlights the patterns identified, through examples found in the boroughs, in the different forms of expression of permeable areas at the interface between the plot and the public space. The accessible permeable area typologies (Figure 61), clearly illustrate how the direct presence of vegetation facing the street can enhance the perception of environmental quality. Well-maintained front yards, laws, and wooded areas visually connect with the sidewalk, providing shade and softening the visual impact of buildings. This configuration reinforces both the ecological and social functions of urban green spaces, fostering microclimatic comfort and urban co-presence. In Manhattan, the photographic record is of Bryant Park. The square demonstrates the importance of permeable, green, and open public plots within high-density areas. In this case, the integration of vegetation, grassy areas and trees with spaces for staying and circulation contributes to thermal regulation, urban drainage and, above all, to offering a meeting and resting point amidst the intense rhythm of the city, reinforcing the social and symbolic function of vegetation in central areas.

In semi-accessible typologies (Figure 62), permeable areas are partially visible from the street, such as gardens protected by low fences or barred gates. These spaces allow some degree of visual and climatic interaction with the public space, offering benefits such as air filtration, while with limitations. In restrictive or non-existent permeable areas (Figure 63), permeable areas are usually located at the back of the plots, isolated by walls or continuous façades without buildings setbacks, often associated with high-density housing. Complete waterproofing of the façade up to the sidewalk eliminates any contribution of the plot to the environmental quality of the public space, concentrating the ecological role of the urban green infrastructure on other scales.



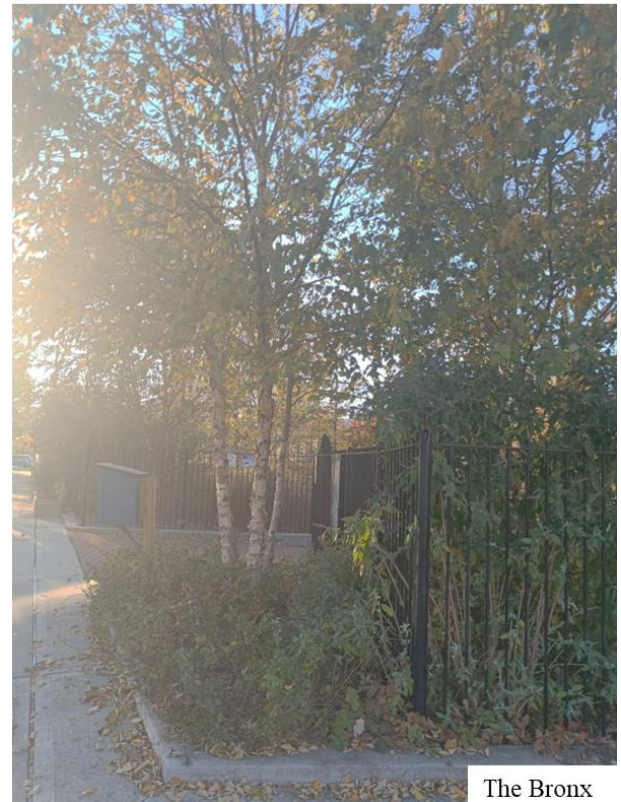
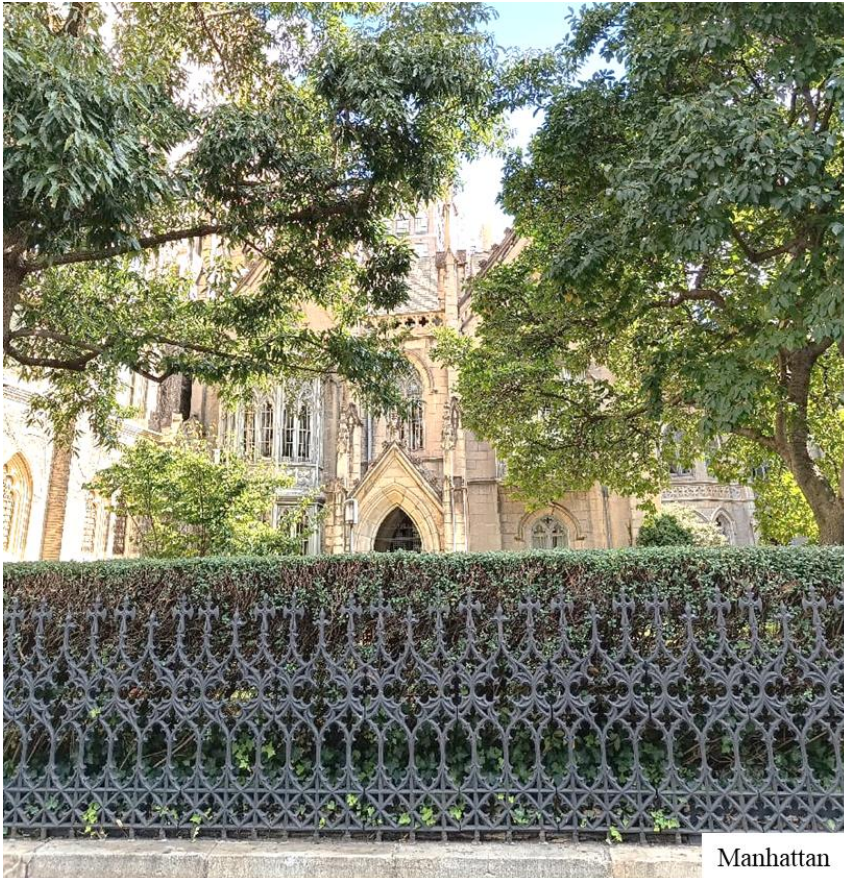


Figure 61 – Permeable area of the plot





Brooklyn



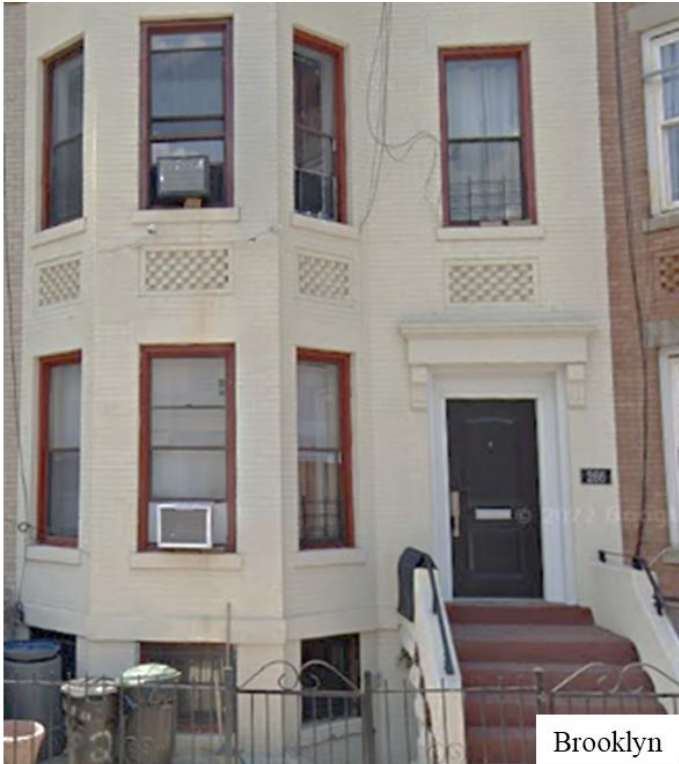
Staten Island



The Bronx

Figure 62 – Semi permeable area of the plot





Brooklyn



The Bronx



Figure 63 –Non-existent permeable area of the plot

7.3.1.4 Morphological

Local analysis of the morphological dimension offers fundamental lens for understanding how the physical configuration of plots influences the dynamics of urban life at a scale sensitive to the neighbourhood and individual experience. While the quantitative morphological profile at the city scale allows to identify general patterns within a complete urban system, it is at the local level that the nuances, contrasts, and specificities of each urban fabric emerge. This integrated approach is crucial to revealing, for example, that two sets of street blocks with plots of similar metrics can, in practice, offer radically different urban experiences. In this sense, façades play a decisive role. They constitute the primary interface between the plot space and the public realm, functioning as mediators of social interactions and determining the degree of visual permeability, accessibility, and attractiveness of the space. It is precisely in observing this interface that the importance of linking quantitative results with qualitative interpretations is consolidated. Morphological analysis on a quantitative scale offers a structuring view of plot morphology, capable of identifying areas with greater physical predominance for sustaining urban activities and social interactions. Qualitative analysis, on the other hand, adds the dimension of experience, revealing how materiality, transparency, and spatial organization influence the use and appropriation of public space. Under these conditions, high morphological intensity in quantitative analysis can reach its full positive intensity when associated with active frontages that are well-connected to the surroundings. Similarly, areas with medium intensity can significantly increase their vitality when offset by façades that favour interaction and visual permeability. Thus, strength lies in the complementarity between scales and types of analysis to highlight the power of plots. A quantitative reading of morphological intensity (Figure 64) reveals distinct patterns among the boroughs. In Queens, high intensity is almost absolute, with 504 of the 515 plots in area A and 249 of the 264 in area B in this category. The Bronx presents a similar pattern, with 219 of 238 plots (area A) and 255 of 259 (area B) classified as high intensity. Staten Island maintains the same patterns, with 173 of 178 plots (area A) and 226 of (area B) in the highest level. Brooklyn, on the other hand, presents greater diversity; in area A, 45 high-intensity plots and 62 medium-intensity plots; in area B, the predominance is again striking, with 166 high-intensity plots and 18 medium-intensity plots. Manhattan, in turn, presents the greatest heterogeneity: in area A, 80 high-density plots and 79 medium-density plots; in area B, 62 high-density plots and 92 medium-density plots. These figures indicate that, although there are areas with high morphological intensity density in all boroughs, Brooklyn and Manhattan have a higher proportion of medium-density areas, signalling a less homogeneous spatial configuration. When moving on to the qualitative analysis of the façades (Figure 65), the interpretation becomes more refined. In Queens, despite the almost total number of plots with high morphological intensity, opaque and inactive¹⁸ façades predominate - 411 in area A and 213 in area B, limiting the degree of interaction between the building and the public space. The Bronx and Staten Island follow a similar pattern, with most façades presenting little permeability in the interaction between the public and private interface.

¹⁸ *Opaque* means the wall is predominantly over the doors/windows - façades with opaque materials, without the possibility of easy access and visibility. *Inactive* means that the façade is abandoned and there is no use for the plot.

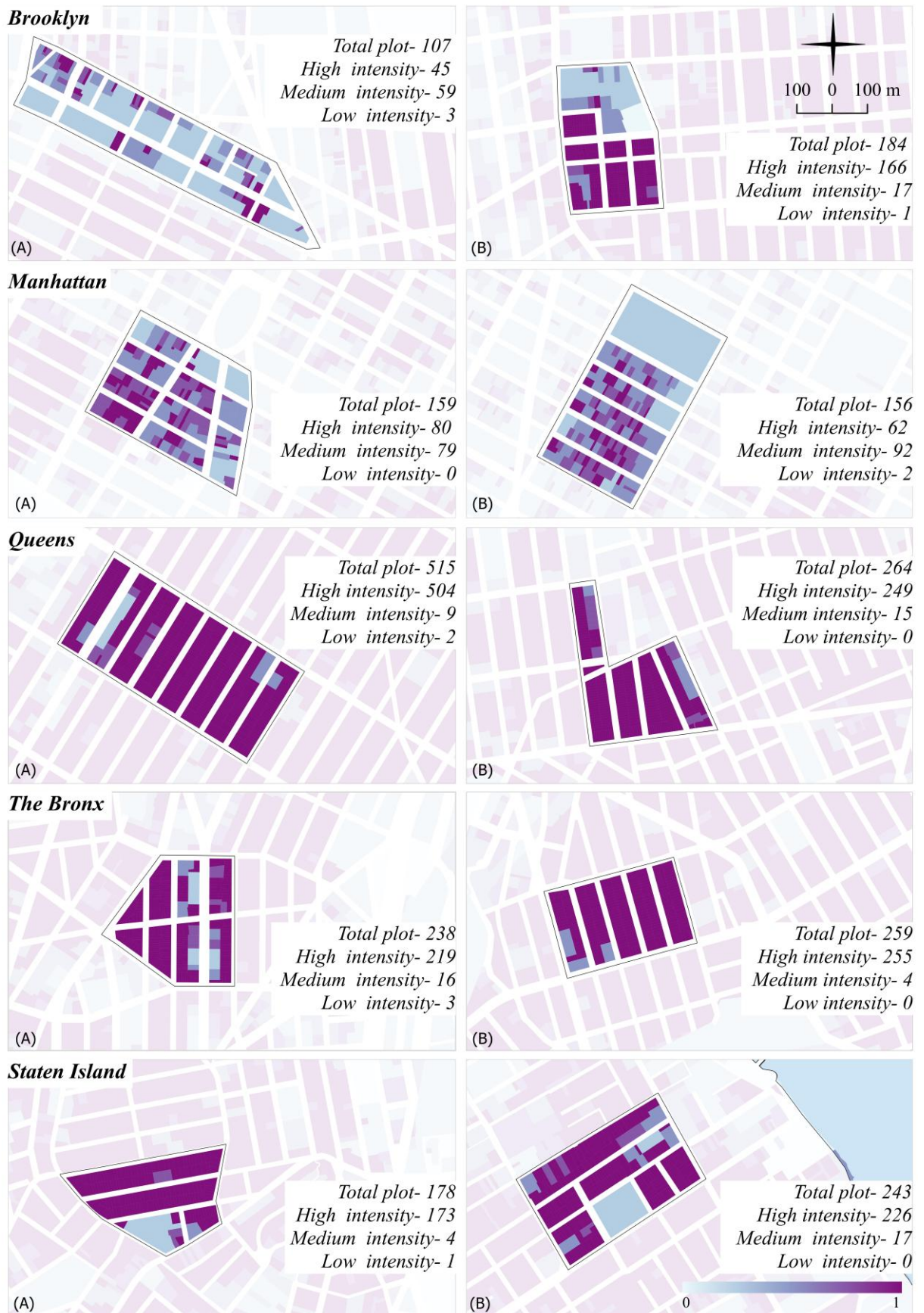


Figure 64 – Quantitative analysis of local scale – morphological profile



Figure 65 - Qualitative analysis of local scale - morphological profile

In Brooklyn and Manhattan, where morphological intensity is more heterogeneous, a higher proportion of active and semi-active façades is observed, especially in mixed-use or street-side retail areas, reinforcing urban vitality even in areas that, according to the quantitative indicators, have medium morphological intensity.

The morphological structure of plots (area, plot density, and façade size) plays a decisive role in urban configuration, as it defines not only the proportions of façades but also establishes limits and possibilities that directly influence the occupancy and development decisions of each plot. This physical dimension determines how the building presents itself to the public space, impacting, for example, the choice of occupancy type, access, construction possibilities, etc.

The photographs presented demonstrate different ways this relationship is expressed. In the active façades (Figure 66), Brooklyn features a neighbourhood grocery store that uses intense visual communication and product displays facing passersby, fostering and immediate understanding of the store's function. In Manhattan, the corner market expands its space onto the sidewalk with displays of flowers and fresh produce, creating an extension of the shopping experience beyond the property's boundary. In Queens, the diner's façade relies on transparency and sidewalk menu signage, inviting entry and strengthening the connection with those passing by. In the Bronx, the pizzeria uses open storefronts and direct signage, maintaining an accessible and family-friendly atmosphere. In Staten Island, the 24-hour corner grocery store highlights its service to the everyday needs of the neighbourhood's community. All facades have open doors, allowing pedestrians to enter without a physical barrier.

In the other types observed, semi-active façades (Figure 67) maintain some level of interaction with the public space, whether through visual openings or access elements. Opaque façades (Figure 68) present more significant visual barriers, reducing internal reading and inviting approach, typically in single- or multi-family residential uses, while inactive facades (Figure 69) virtually eliminate the interface between the public and private spaces of the plot, either through complete enclosure and lack of function, or through continuous walls. Each of these types reflects design and construction decisions, as well as factors such as security, cultural habits, and land use patterns, which shape the form and intensity of the plot's relationship with the public space.



Queens



Staten Island



Brooklyn



Figure 66 - Active façade



Manhattan



The Bronx



Figure 67 – Semi active façade



The Bronx



Staten Island



Brooklyn



Manhattan

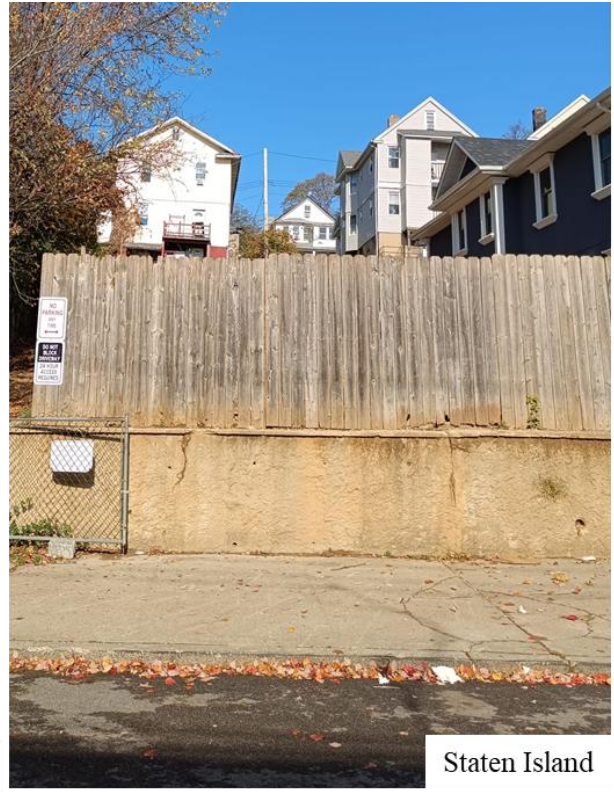


Queens

Figure 68 – Opaque façade



The Bronx



Staten Island



Manhattan



Queens



Brooklyn

Figure 69 – Inactive façade

7.3.1.5 Legal

The plot, as a legal unit, is an element of power that defines land use, possibilities for transformation, and links between land and agents. While city scale analysis allows to understand patterns regarding the intensity of property rights distributed within the urban system, local analysis is important to understand how these rights are distributed and how this directly affects urban vitality and local autonomy.

A quantitative analysis measures the number of property rights existing within a single plot. This participation can occur in both fractions of the plot and in-built units within it, resulting in varying levels of fragmentation or concentration of ownership. Figure 70 presents the results of this analysis at the scale of the local units studied. High-intensity plots have many co-owners or shareholders, resulting in greater administrative complexity. In Manhattan and parts of Brooklyn, this high intensity is strongly associated with multifunctional buildings located on large and small plots, where dozens of owners share the same property. This configuration, while potentially reducing the agility of major interventions, often supports a diversity of uses and businesses that reinforce urban vitality. Medium-intensity areas have a moderate number of co-owners, as in many of Queens and the Bronx. Low-intensity areas, predominantly in Staten Island and peripheral areas of the Bronx and Queens, indicate ownership concentrated in a single owner or a very restricted group. This legal simplicity favours speed in investment decisions and changes of use. Furthermore, when associated with individual owners operating their own businesses, it also contributes to the maintenance of long-term activities and a more deeply rooted commercial identity in the territory.

The qualitative analysis highlighted a diversity of legal typologies of owners (Figure 71), whose type influences the legal function, the intensity of use and transformation of each plot, and the governance of the site. LLCs (*Limited Liability Companies*), which predominate in more dynamic market areas, such as Manhattan, parts of Brooklyn, and Queens, operating with business logic oriented towards financial return. TRUSTS, fiduciary structures administered for the benefit of third parties, emerge occasionally and are associated with stability of use and low turnover, reflecting asset protection or succession planning strategies. Associations, generally linked to community organizations, housing cooperatives, religious organizations, or non-profits, occupy a smaller fraction of the territory. Corporations, large companies, often multinationals or real estate holding companies, are present in central areas, with strong investment capacity, intensifying urban renewal and inducing homogeneous use patterns. Private property owners, who hold properties in their own name, play a significant role in Queens, The Bronx, and even more so on Staten Island. These types of property create lasting bonds between use and space, strengthening local resilience and gradual adaptation to economic changes. Public properties, although a minority, play a strategic role in housing collective facilities, housing programs, or commercial leases of social interest.

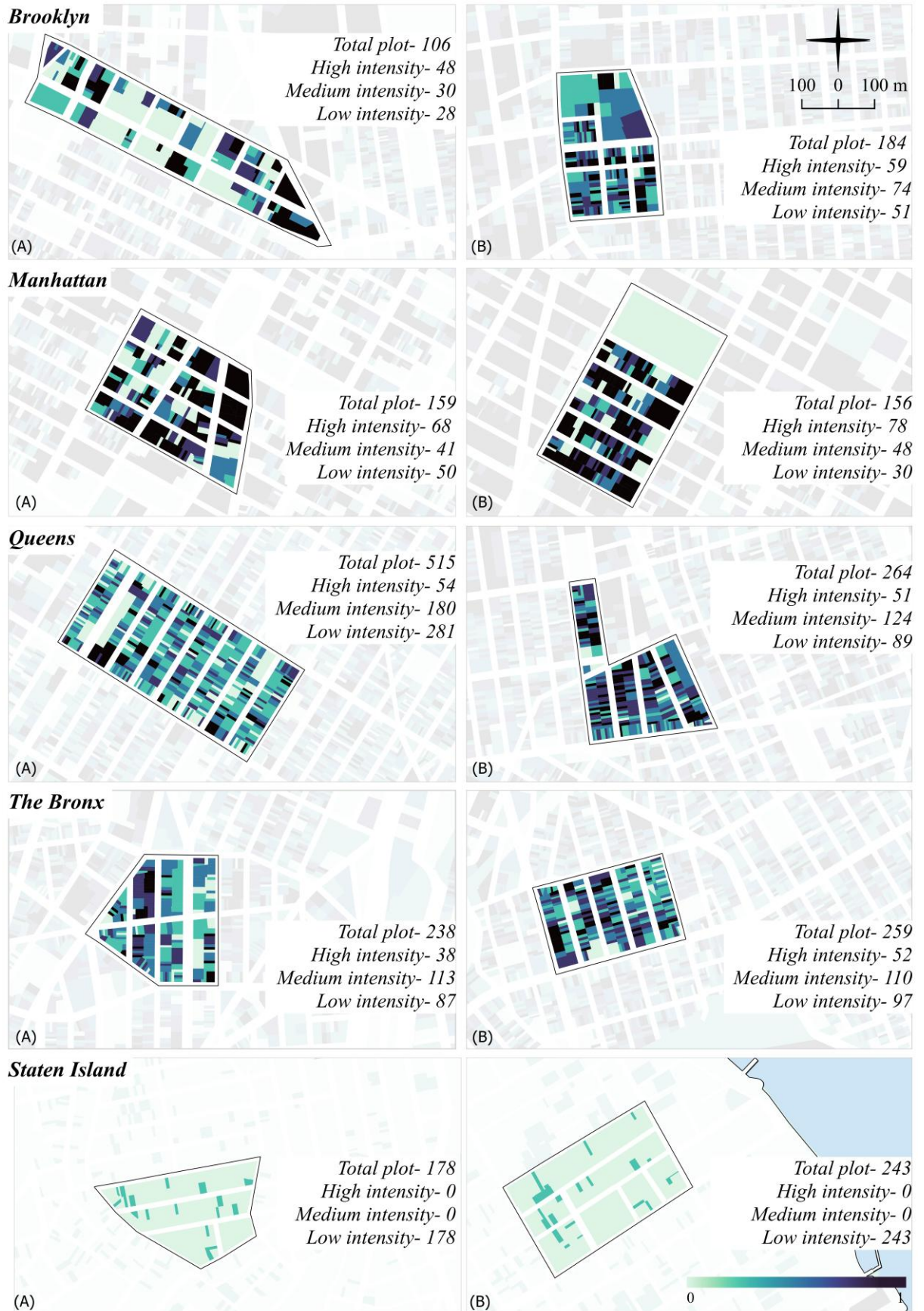


Figure 70 - Quantitative analysis of local scale - legal profile

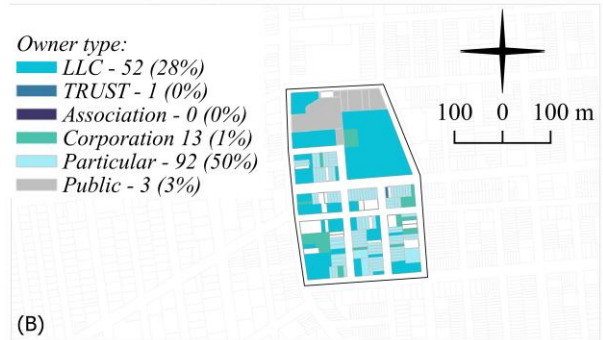
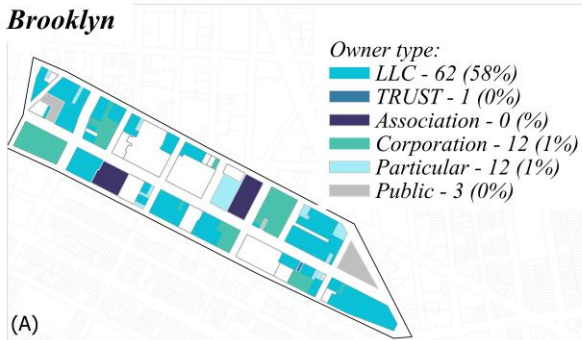
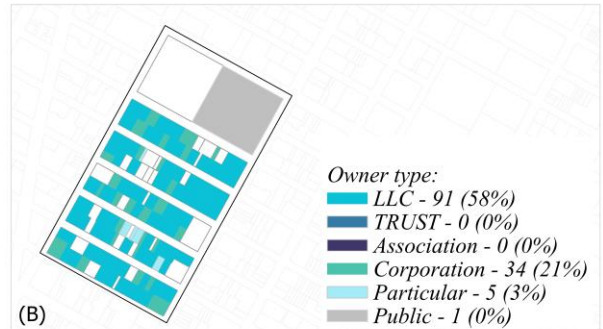
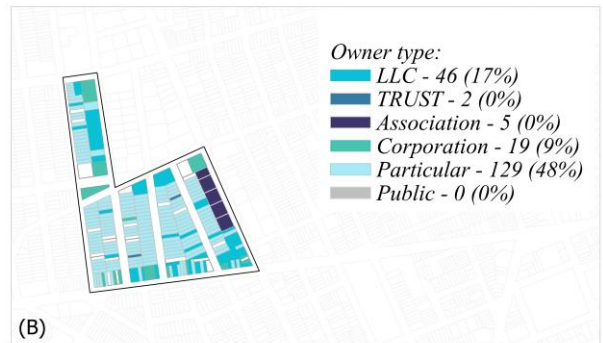
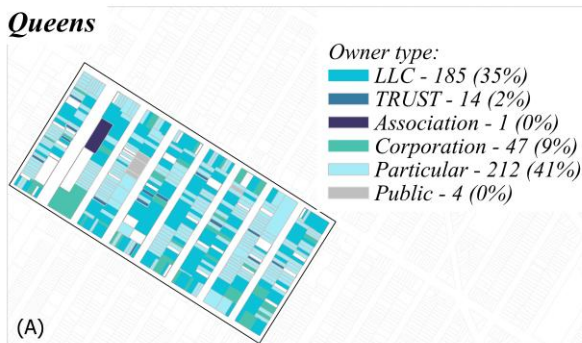
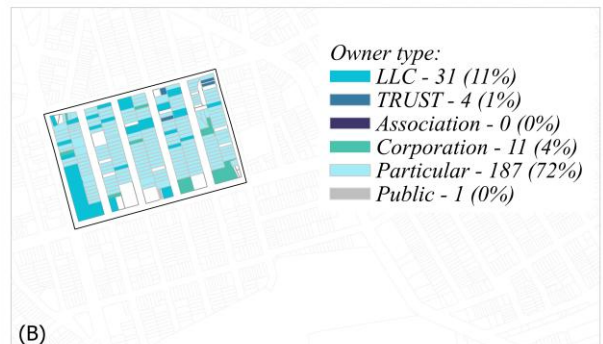
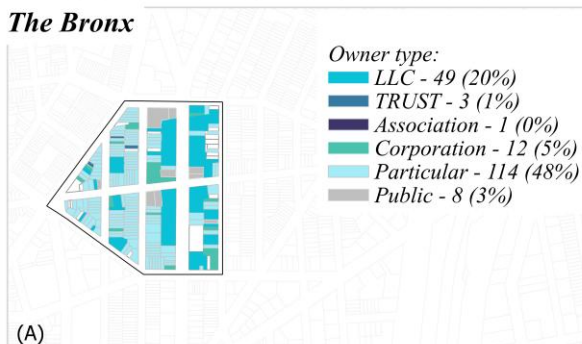
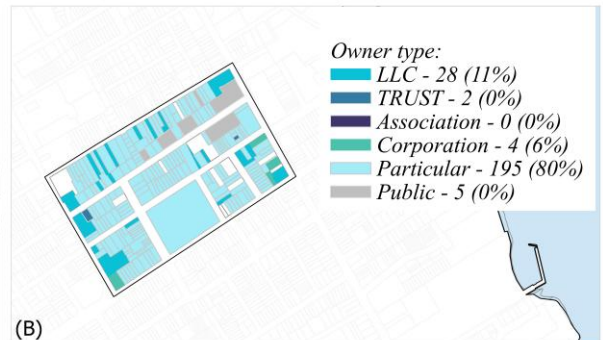
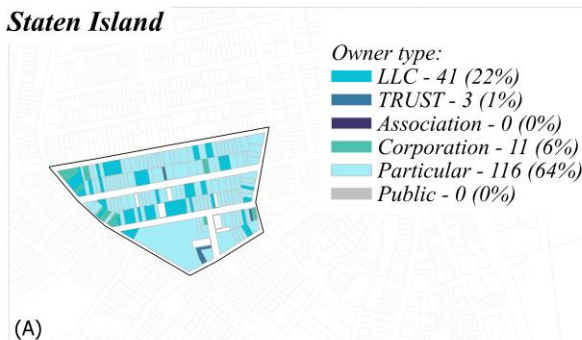
Brooklyn**Manhattan****Queens****The Bronx****Staten Island**

Figure 71 - Qualitative analysis of local scale - legal profile

7.3.1.6 Institutional / planning

New York's planning system is remarkably complex and understanding it is crucial to realize how the city develops and how boroughs and neighbourhoods preserve (or fail to preserve) their characteristics. At the heart of this system is land-use regulation, which is essential for determining how each piece of land can be used. To analyse this process, two aspects are important: the main rule that determines constructive development on each plot of land in New York, the land use rate (FAR), and the laws that define what can be built, land zoning. How these laws apply to plots and shape their development is a central feature of the planning dimension for the plots system.

The quantitative dimension (Figure 72), is measured by the *Plot Utilization Rate* (URP) indicator. This indicator, crucial for analysing the effectiveness of urban planning legislation, quantifies the average level of construction intensity permitted by zoning. In area A of Brooklyn, of the 106 total plots, 105 are high-intensity plots. In area B, of the 184 existing parcels, 168 are low-intensity plots. In Manhattan, area A presents a varied distribution of utilization rates: 14 plots are high-intensity, 117 are medium-intensity, and 28 are low-intensity. In area B of Manhattan, 42 plots are high-intensity and 113 are medium-intensity. In Queens, both area A and area B show a predominance of low-intensity construction (514 of 515 plots and all 264 plots, respectively). This pattern is repeated in The Bronx and Staten Island, where most plots are classified as low building intensity in all areas analysed.

The qualitative analysis is confirmed by the types of land use zones existing in each analysis area. Figure 73 presents the zoning districts. In Area A of Brooklyn, mixed-use and high-density commercial zones predominate. Zone C5-4 is characterized as a large central business district, allowing office and residential buildings with intensive land use, with a base FAR of 10. Zone C6-2A, in turn, is a zone that allows mixed-use construction, regulated by controls that seek to preserve the neighbourhood's scale. In this zone, the residential and commercial FAR is 6, and the maximum height of buildings is limited to approximately 36,5 meters, with mandatory street alignment. Zone C6-4 represents one of the most permissive areas in terms of height and density, with a commercial and residential FAR of 10, which can reach 12 with housing inclusion bonuses. This is a typical zone of Midtown Manhattan extended to Brooklyn, where residential and commercial skyscrapers are viable. There is no absolute limit on land use or setbacks, which allows for slender towers of over 30 stories. The C6-4.5 zone further increases the building intensity, with a FAR of 12 intended for large mixed-use complexes combining housing, retail, and services. This zone was designed to encourage developments with regional urban impact, serving as a metropolitan hub within Brooklyn.

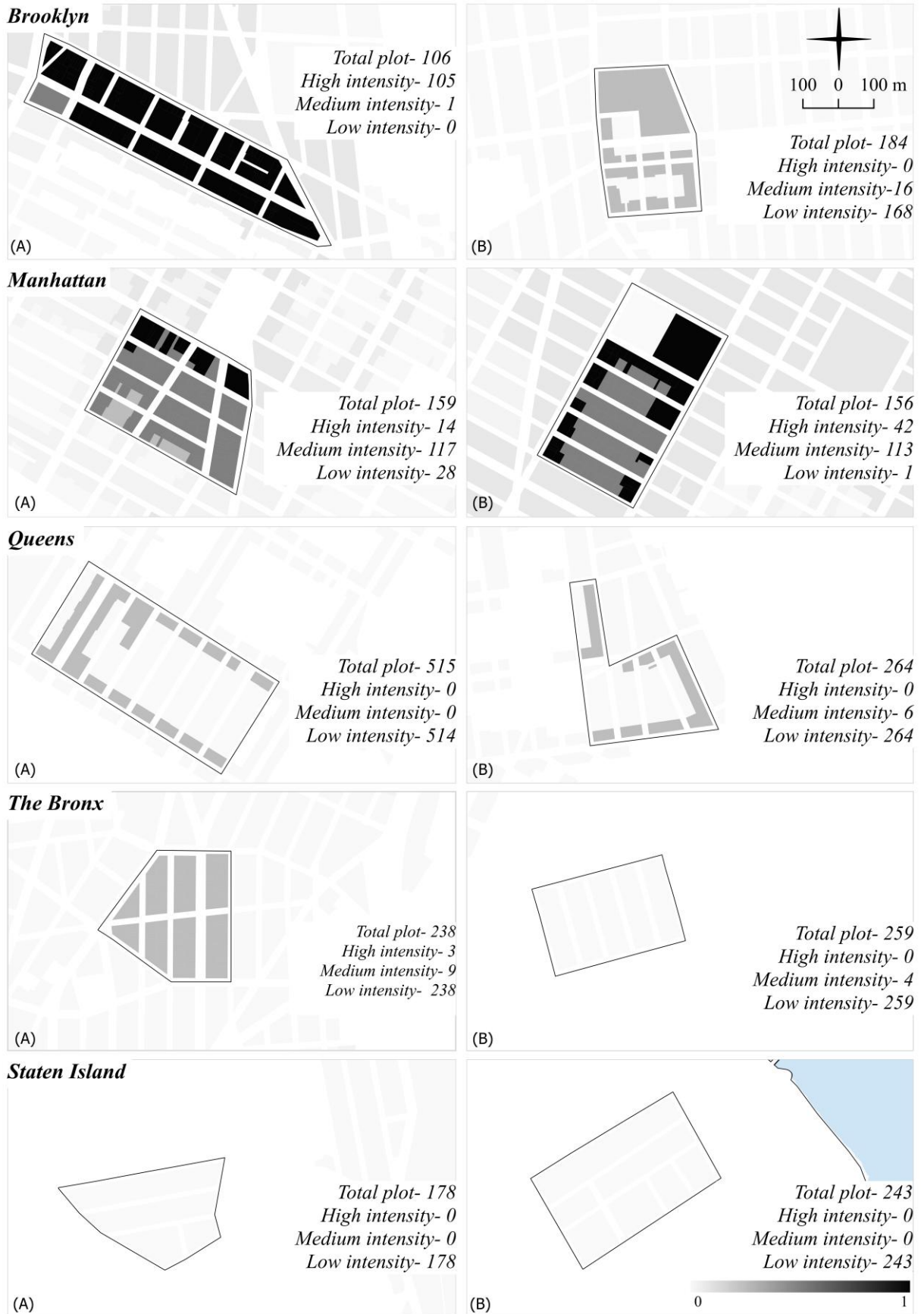


Figure 72 - Quantitative analysis of local scale – planning/institutional profile

Brooklyn's area B features medium-density commercial zones and more controlled residential areas. Zone C4-2 serves as a general commercial district, suitable for neighbourhood centres and shopping malls, allowing both retail and residential development on an interurban scale. The residential FAR ranges from 2,43 to 6,02, depending on the *Quality Housing Program*¹⁹, while the commercial FAR can reach up to 3,4. Zone C4-4A also falls into the commercial district category, but with contextualization criteria, requiring new buildings to harmonize with the existing landscape. In this zone, the commercial FAR reaches up to 3,4. In residential areas, zone R5B is geared toward low-rise, semi-detached, or row houses, promoting more moderate occupancy (FAR of 1,35). R6A (residential FAR up to 3,0) and R6B (FAR 2) permit significant mid-rise apartment buildings. The former maintains street-aligned façades, while the latter reinforces a lower-rise urban fabric. The R7A zone expands possibilities primarily by allowing larger buildings to structure urban corridors. In this zone, the residential FAR is 4,0.

Manhattan is dominated by high-density commercial and high-rise residential zones. The C1-7 zone stands out for its blend of local businesses on the ground floor with residential properties on the upper floors, creating a mixed-use landscape (residential FAR between 3,44 and 4,0; and commercial FAR 2,0). The C6-1 zone represents a central business district that supports medium-density buildings (commercial FAR of 6,0; and commercial FAR between 3,44 and 6,02), while C6-4 and C6-4M are specifically for large-scale commercial and residential uses (a basic FAR of 10,0 for commercial and residential), allowing for skyscrapers and mixed-use complexes in highly urbanized areas. The presence of R10, one of the city's highest-density residential zones, indicates the possibility of residential tower construction, reinforcing Manhattan's characteristic verticalization. The residential FAR in this zone can reach 10,0 under the basic regime and 12,0 with affordable housing incentives. The R7-2 zone allows medium-rise residential buildings with significant density (residential FAR varies between 3,44 and 6,5).

Manhattan's area B contains large-scale commercial land use zones. C5-3 is a high-density commercial zone with a commercial FAR of 15, intended for central business and large-scale financial and corporate buildings. The C6-6 zone, with a commercial FAR of 15, allows for commercial and residential development, serving as a vertical development hub. The C6-4 zone maintains the basic FAR of 10 for commercial and residential uses. The M1-6 zone allows for mixed activities, small industries, offices, services, and retail.

In Queens, area A is dominated by local commercial and medium-density residential zones. Zone C4-2A is a commercial district focused on neighbourhood centres and mixed-use areas. In this zone, the residential FAR ranges from 3,0 to 3,9 when affordable or senior housing is included, while the FAR for commercial and community facilities reaches 3,0. Zone C4-3, in turn, is a mid-sized commercial district, with a commercial FAR of up to 3,4. Residential zones include R6, R6A, and R6B. R6 allows a residential FAR of 2,2 to 3,9, controlled by the *Height*

¹⁹ New York City's *Quality Housing Program* (QHP) is a set of zoning regulations that establish standards for residential construction—such as setbacks, building height, facades, and amenities—with the goal of preserving the architectural character of neighbourhoods (https://zr.planning.nyc.gov/article-ii/chapter-8/28-01?utm_source=chatgpt.com).

*factor*²⁰ and *Sky exposure plane*²¹, allowing for everything from multifamily homes to mid-rise buildings. Zone R6A is contextual residential, with a FAR of 3,0 to 3,9. Zone R6B maintains the smallest scale, with a FAR between 2,0 and 2,4.

Area B of Queens is predominantly residential. The R6A zone supports mid-rise buildings with a base FAR of 3,0, which can reach 3,45 with affordable housing. R6 allows residential FARs of 2,2 to 3,9. The R5 zone allows low-density residential activity. In this zone, the maximum FAR is 1,25.

In The Bronx, an area that allows medium-density commercial, service, and residential activities. The C8-3 zone is designated for medium-sized general services. The commercial FAR is 2,0, and the community FAR can reach 6,5, but residential construction is not permitted. The R7-1 zone allows residential activities with a base FAR of 3,44, with the capacity to reach 4,0 under the *Quality Housing program*. In the R5 zone of the Bronx's Area B, the maximum FAR is 1.25, intended for low-density residential activities.

On Staten Island, low-density residential zones prevail in areas A and B, reinforcing the neighbourhood's suburban character. The R3A zone appears in both analysis areas and is designed for detached single-family homes. The FAR is 0,6. In the R5 zone, in area A, the building density is slightly higher, with a FAR of 1,25. In area B, the R3-2 zone allows for greater variety, including townhouses, low-rise multi-family housing, and detached houses. The FAR is 0,5.

Figure 74, commercial zones are divided into categories that regulate the type of business and its density, allowing for everything from small-scale neighbourhood services to larger establishments. In Brooklyn, area B has a C2-4 zone. This zone allows local retail and service businesses that meet daily needs. In Queens, area A has a C1-3 commercial zone, a low-intensity zone for small businesses, while Area B has two types of zones, C1-4 and C2-4, allowing for more types of services and retail. In the Bronx, area A has C1-4 and C2-4 commercial zones, reflecting a mix of local businesses, while area B has a C1-2 commercial zone, which allows for smaller-scale convenience services. In Staten Island, Area A is zoned C2-2, suitable for local businesses serving medium-density communities, and Area B has a combination of more restrictive C1-1 and C1-2 zones, ensuring that commercial development is compatible with the low-density residential character.

²⁰ The *Height Factor* is a zoning regulation that applies to certain residential districts, such as R6, R7 and R8. It is an optional method for determining a building's density (FAR) that is directly linked to its height. The principle is that the taller the building, the smaller they are of the plot it occupies at the base, which translates into a higher FAR (Article II, Chapter 3 of the *Zoning Resolution*).

²¹ The *Sky exposure plane* is a zoning regulation used to control the shape and mass of buildings in relation to streets and neighbouring plots. The concept is that of an imaginary plane that begins at a certain height above the street line and slopes inward toward the plot. No part of the building can project beyond this plane. The main function of the *Sky Exposure Plane* is to ensure that the street receives sunlight and that the sky remains visible to pedestrians (Article II, Chapter 3, Section 23 of the *Zoning Resolution*).

In addition to the zoning types already presented, New York City has used special districts (Figure 75), to apply additional regulations and achieve unique objectives in some areas of the city. Area A in Brooklyn is part of the Downtown Brooklyn Special District, created to revitalize downtown areas through zoning that allows for higher density, encouraging the development of high-rise residential and commercial buildings. In Manhattan, area A includes part of the *Union Square Special District*, which aims to preserve the area's scale and architectural diversity. In area B of Manhattan, the special zone is the *Midtown Special District*, one of the most complex in the city, designed to manage densification and promote the creation of public spaces and infrastructure improvements in exchange for density bonuses. Finally, in Staten Island, area A is located in the *Hills Preservation Special District*, which imposes strict building restrictions to protect the area's topography and natural landscape from environmental problems.

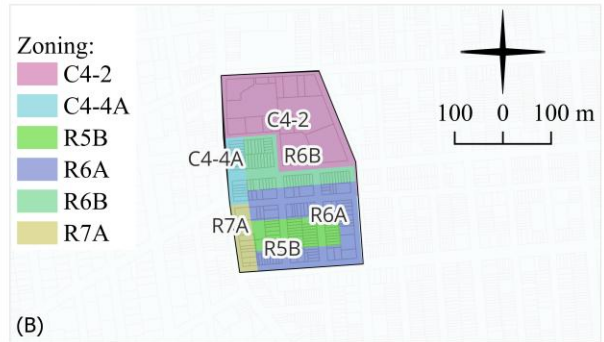
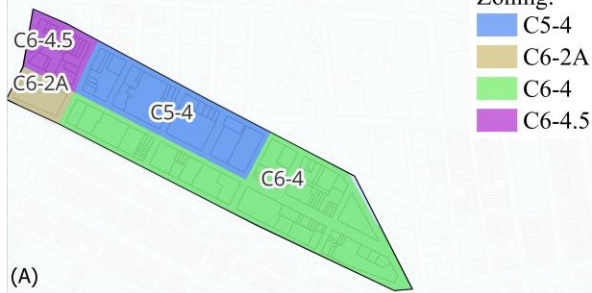
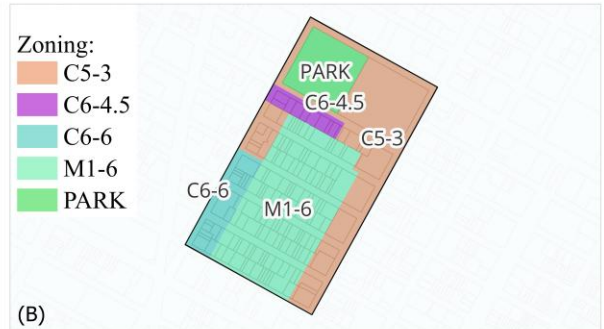
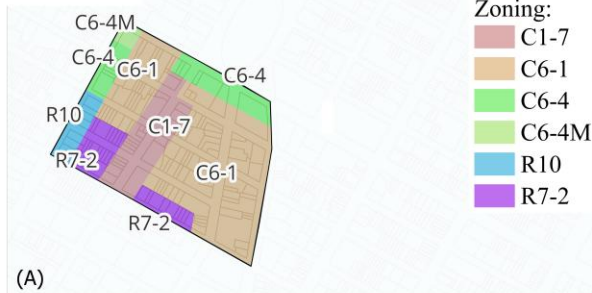
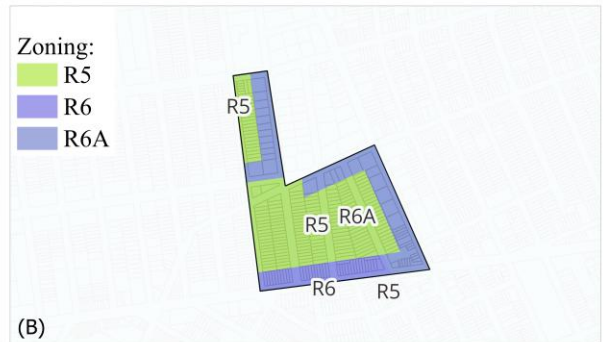
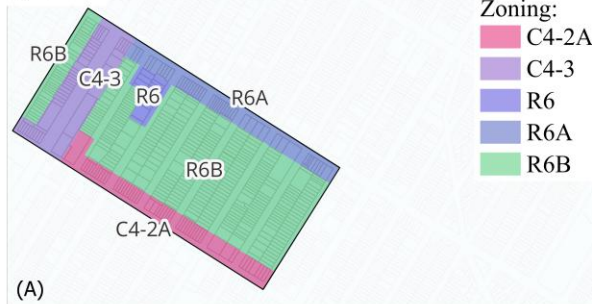
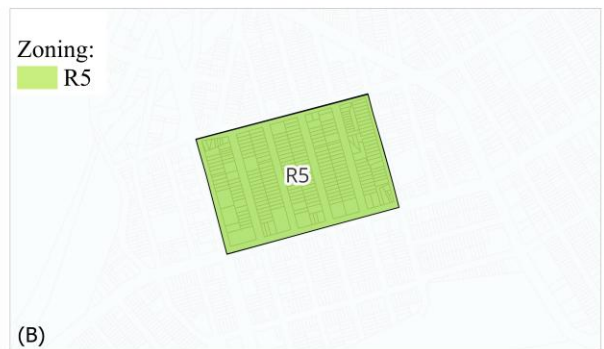
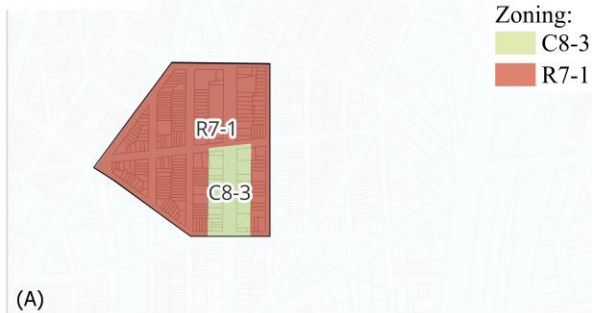
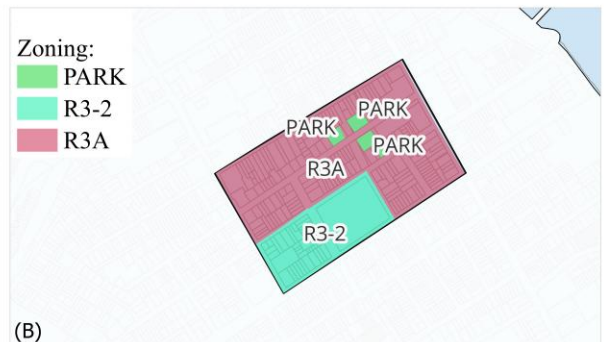
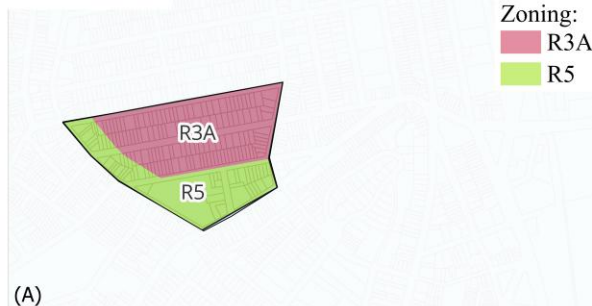
Brooklyn**Manhattan****Queens****The Bronx****Staten Island**

Figure 73 - Qualitative analysis of local scale – planning/institutional profile – Zoning districts

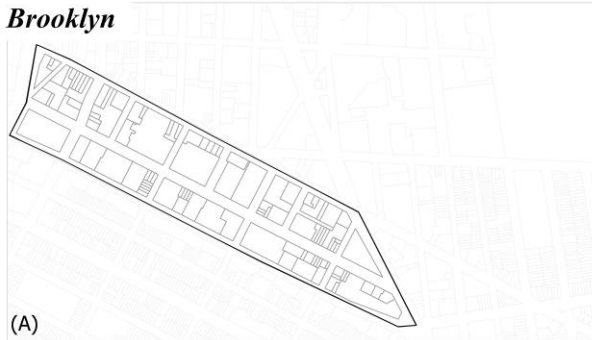
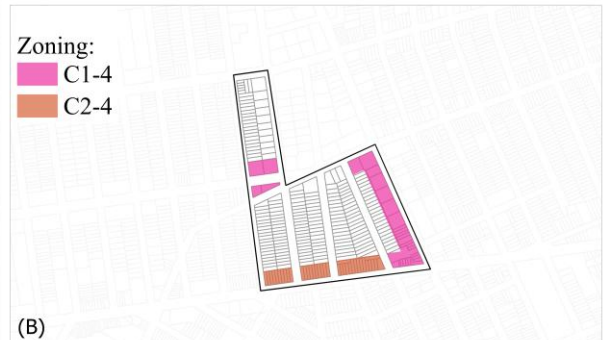
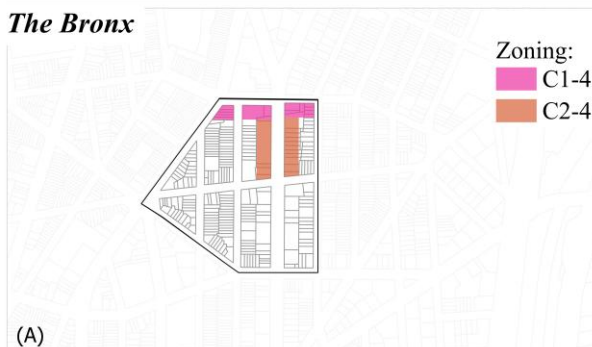
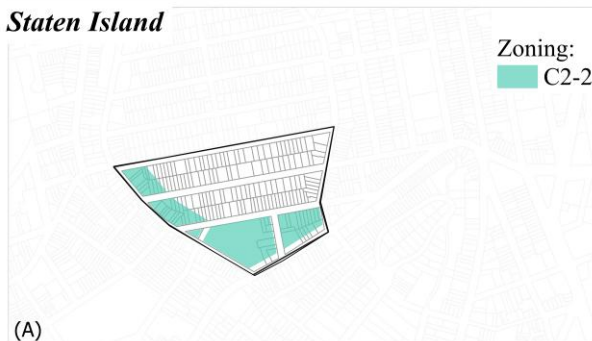
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Figure 74 - Qualitative analysis of local scale – planning/institutional profile – Commercial zoning districts

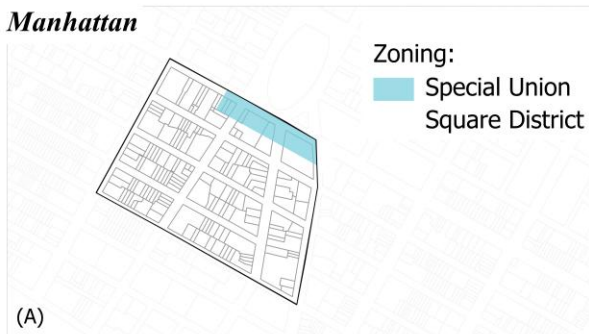
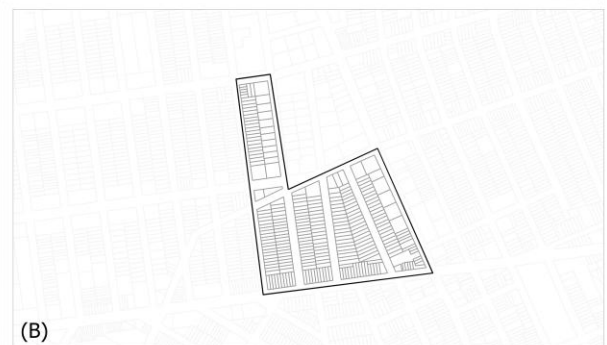
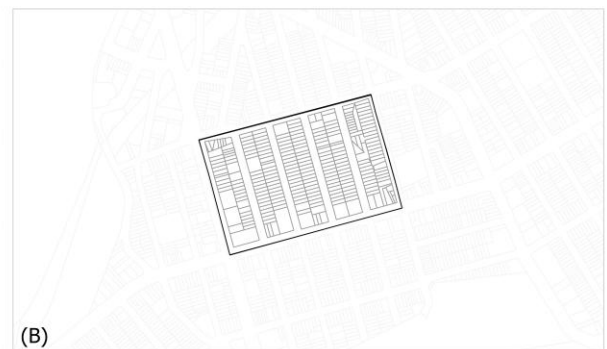
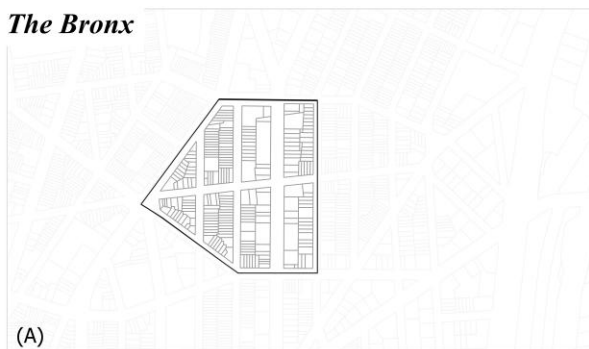
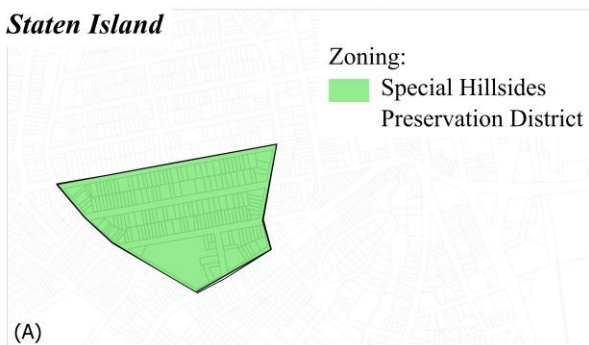
Brooklyn**Manhattan****Queens****The Bronx****Staten Island**

Figure 75 - Qualitative analysis of local scale – planning/institutional profile – Special zoning districts

7.3.2 Characteristics

7.3.2.1 Transformation

Plot transformation refers to the physical, functional, and legal changes that occur over time. This characteristic allows to evaluate the processes of renewal, adaptation, and expansion that directly impact the form, use, ownership, and value of plots. While city-scale analysis integrates the different types of plot transformations and allows for a comprehensive understanding of the number of transformations that have occurred over time, local analysis highlights the specific types of transformations and shows, in detail, how each plot was transformed. Thus, the combined reading of both scales offers a complementary understanding of the characteristics of transformation, linking the aggregate pattern of the transformation process with the concrete mechanisms that produced it.

In the quantitative analysis on a local scale (Figure 76), the areas with the highest intensity of transformation are in Manhattan, area B (Midtown Manhattan), with 34 of 156 plots (21,8%). Next, the Bronx stands out in area A – 20 plots of 238 (8,4% high intensity). However, most plots are classified as having medium-intensity transformation in the analysed period. Queens in area A has 207 plots with medium intensity of 515 (59,6%), in area B there are 168 plots of 264 (63,6%). The Bronx in area B has 183 medium-intensity plots of 259 of the total (70,7%). Staten Island in area A has 115 medium-intensity plots of 178 plots analysed (64,6%). Finally, Brooklyn in area B has 109 medium-intensity plots of 184 (59,2%). The results reveal that, although transformation processes occur more intensely in specific locations, most plots are undergoing some transformation process over time either visibly, with physical transformations, or invisibly.

Regarding the transformation of plot size, the analysis shows that, although stability remains the predominant condition, there are significant occurrences of both subdivisions and mergers, considering that the period studied for the transformation characteristic is the early years of the 21st century, 2002-2024 (Figure 77). The subdivision process is most evident in Brooklyn in areas A and B, and in Staten Island in areas A and B, as well as cases in The Bronx in areas A and B, and in Queens in area A. The merger process is significant in area B of Manhattan and area A of Brooklyn, where the joining of plots suggests consolidation processes aimed at the implementation of larger projects. To a lesser extent, merges are observed in Brooklyn in area B, in Manhattan in area A, and in Queens in area A, in addition to smaller occurrences in Staten Island in areas A and B.

The analysis of land value transformation (Figure 78), reveals that most of the analysed plots experienced significant increases of varying intensity. The greatest growth is observed in Manhattan's area B (Midtown), where a high concentration of plots saw their value increase by 5 to 10 times, and in many cases, more than 10 times. This suggests extremely rapid and intense real estate appreciation. To a lesser extent, but still with notable representation of high growth, areas A and B of Brooklyn, and area A of Staten Island also show a considerable number of plots that saw their value increase by 5 to 10 times or more.

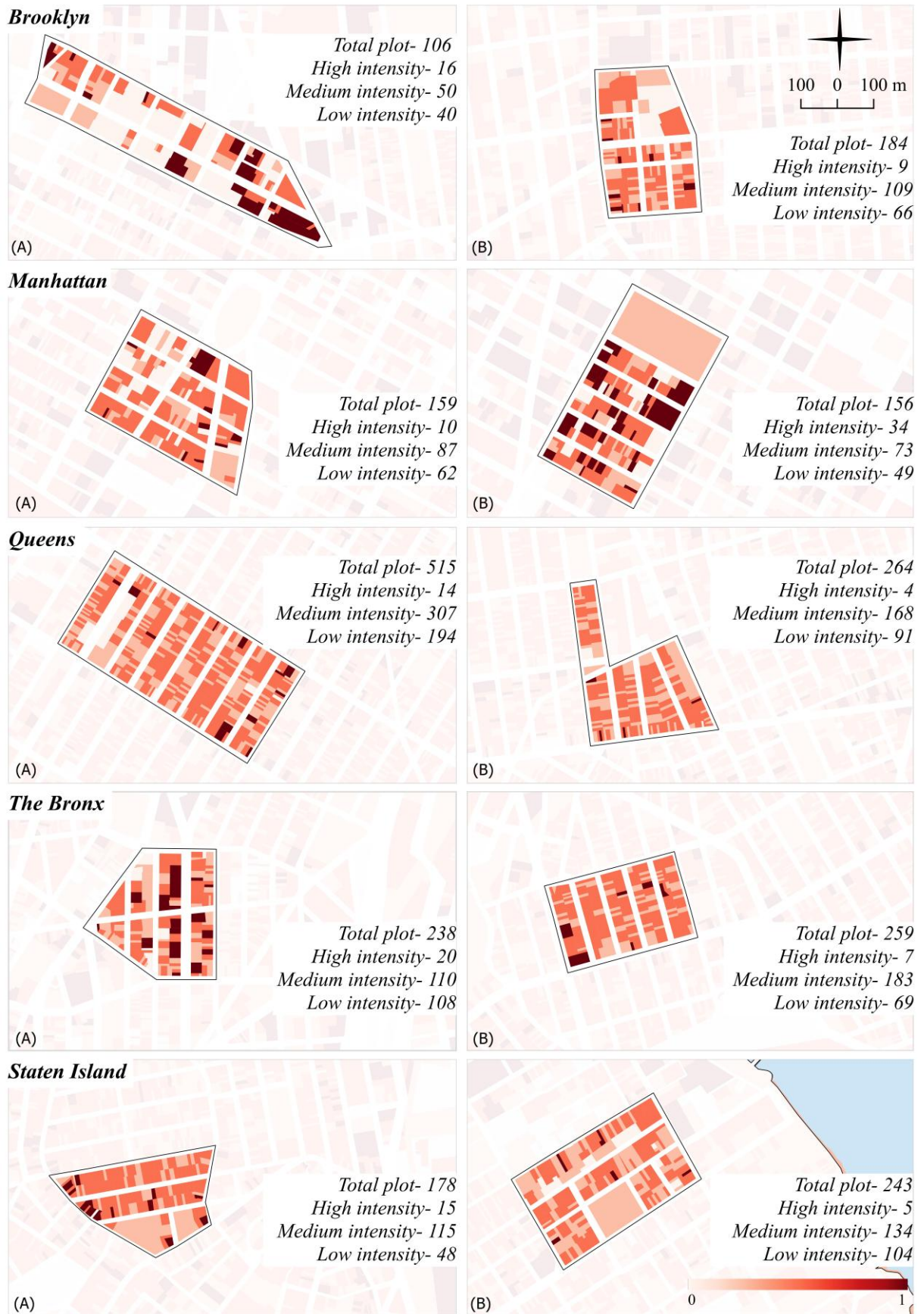


Figure 76 - Quantitative analysis of local scale – plot transformations



Figure 77 - Qualitative analysis of local scale – plot size transformations



Figure 78 - Qualitative analysis of local scale –land value transformations of the plots

An analysis of property transformations in Manhattan, both in area A and area B, reveals a high concentration of plots that registered a high number of transfers, with a specific number of plots having five or more ownership transfers during the period, suggesting an extremely active and highly liquid real estate market. Brooklyn, in areas A and B, and Staten Island, in area B, also demonstrating specific dynamism, with a significant number of plots having two to three transfers during the period. On the other hand, Queens and the Bronx present a more stable pattern, with most plots registering little or no ownership transfers. In general, property transformations are more intense and frequent in higher-value and centrally located areas, such as Manhattan, while stability and ownership retention are more common in other areas (Figure 79).

Analysis of the transformation of functions (Figure 80) reveals a pattern of stability in most areas, but with specific points where plots undergo intense functional transformation. In Manhattan, in both area A and area B, the maps show a strong presence of plots with functions that have increased or decreased, indicating a continuous process of adaptation and reorganization of land use. This characteristic is less evident in other boroughs. However, in most boroughs, the process of functional transformation has increased the number of activities on each plot.

Taken together, the different dimensions of transformation - physical, functional, legal, value, and property - reveal that the city is the result of a continuous process of adaptation and reconfiguration of its landmasses. While stability still prevails across much of the territory, the data show that Manhattan and some areas of Brooklyn are experiencing more intense transformations, both in form and in the appreciation and circulation of properties.



Figure 79 - Qualitative analysis of local scale – property transfers of the plots

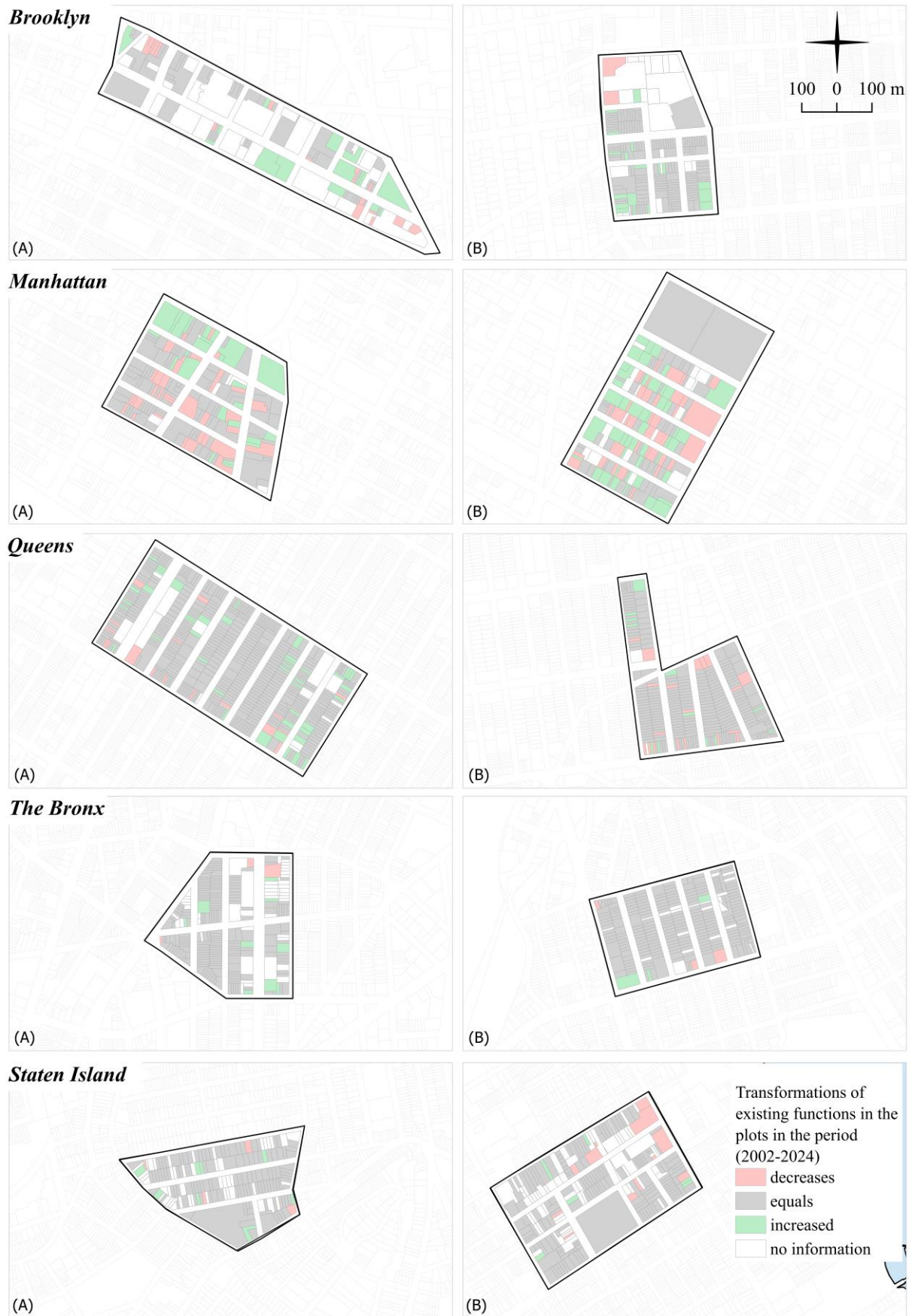


Figure 80 - Qualitative analysis of local scale – transformation of plot functions

7.3.2.2 Location

Location is characterized by the intensity and value a plot possesses in relation to its position within the urban space. At the city level, considering the relative position of plots in relation to all others in the same urban system allows to identify the level of integration each plot presents within the urban fabric. Additionally, analysing the proximity of plots to accessibility points, such as subway stations and bus stops, allows to understand the extent to which a plot is better connected to the urban network, informing its location value.

The quantitative analysis presented in Figure 81 refers to the location indicator calculated using the *Place Syntax Tool*, which measures the attraction distance in 800 meters. This indicator assesses how each plots is spatially related to the different uses existing in other plots within an 800-meter radius. The distribution of results highlights significant differences between neighbourhoods. In Manhattan, there is an almost absolute predominance of high-intensity plots, with high insertion, locational integration resulting from the density of uses and the continuous urban fabric, which Favors connectivity between functions. The other boroughs present more balanced patterns between the high- and medium-intensity categories. Queens, for example, has the largest absolute number of high-intensity plots among the analysed neighbourhoods, both in area A (168 plots) and area B (177 plots), accompanied by a significant number of medium-intensity plots. The Bronx, in turn, presents a predominance of medium-intensity, with 173 plots in area A and 177 in area B, but still maintains a significant presence of high-intensity. In Brooklyn, there is a strong concentration of high-intensity in area A, while in area B the majority of plots are medium-intensity, revealing greater internal heterogeneity. Staten Island stands out for the almost absolute predominance of high intensity in area A (168 of 178 plots), while in area B the distribution between high and medium is more balanced. This interpretation highlights that, with the exception of Manhattan – where high-intensity is virtually exclusive in both areas – the other boroughs share an intermediate pattern, combining high- and medium-intensity plots in a complementary manner.

Figure 82 complements the analysis by incorporating the plots proximity to public transports hubs, such as subway stations and bus stops. This perspective highlights that, in addition to structural integration into urban fabric, a plot's locational value is strongly associated with its degree of accessibility to mobility systems. Areas near subway stations experience greater appreciation, as direct connections to public transportation hubs expand mobility possibilities and reduce time and transportation costs for users. In Manhattan and Brooklyn, the highest-intensity plots coincide with areas with the highest density of public transports coverage, revealing an overlap between spatial integration and mobility accessibility. In the Bronx and Staten Island, on the other hand, more limited transports infrastructure coverage results in patterns of lower locational appreciation, even in areas where the structural indicator points to medium or high intensity.

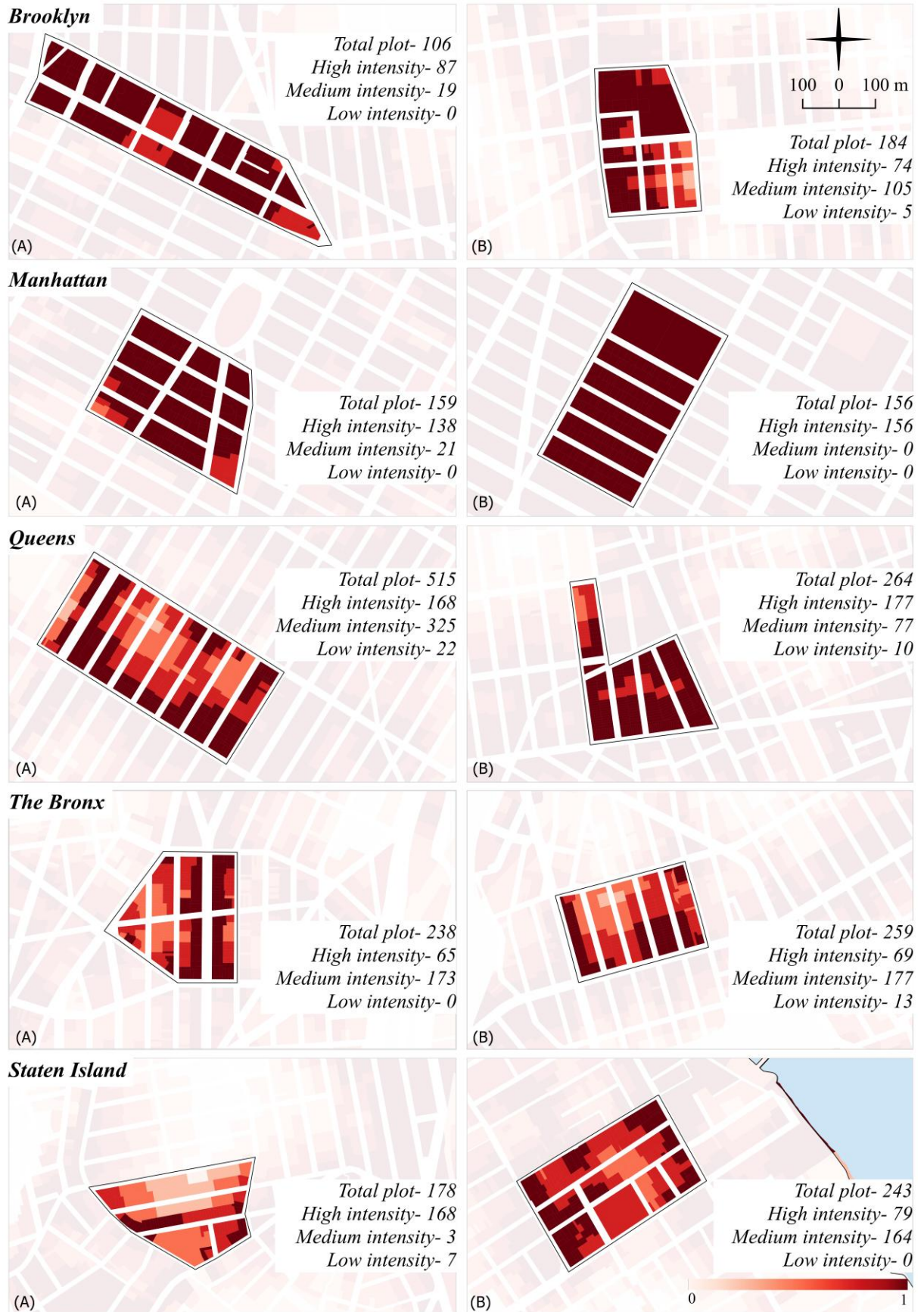


Figure 81 - Quantitative analysis of local scale – location of the plot

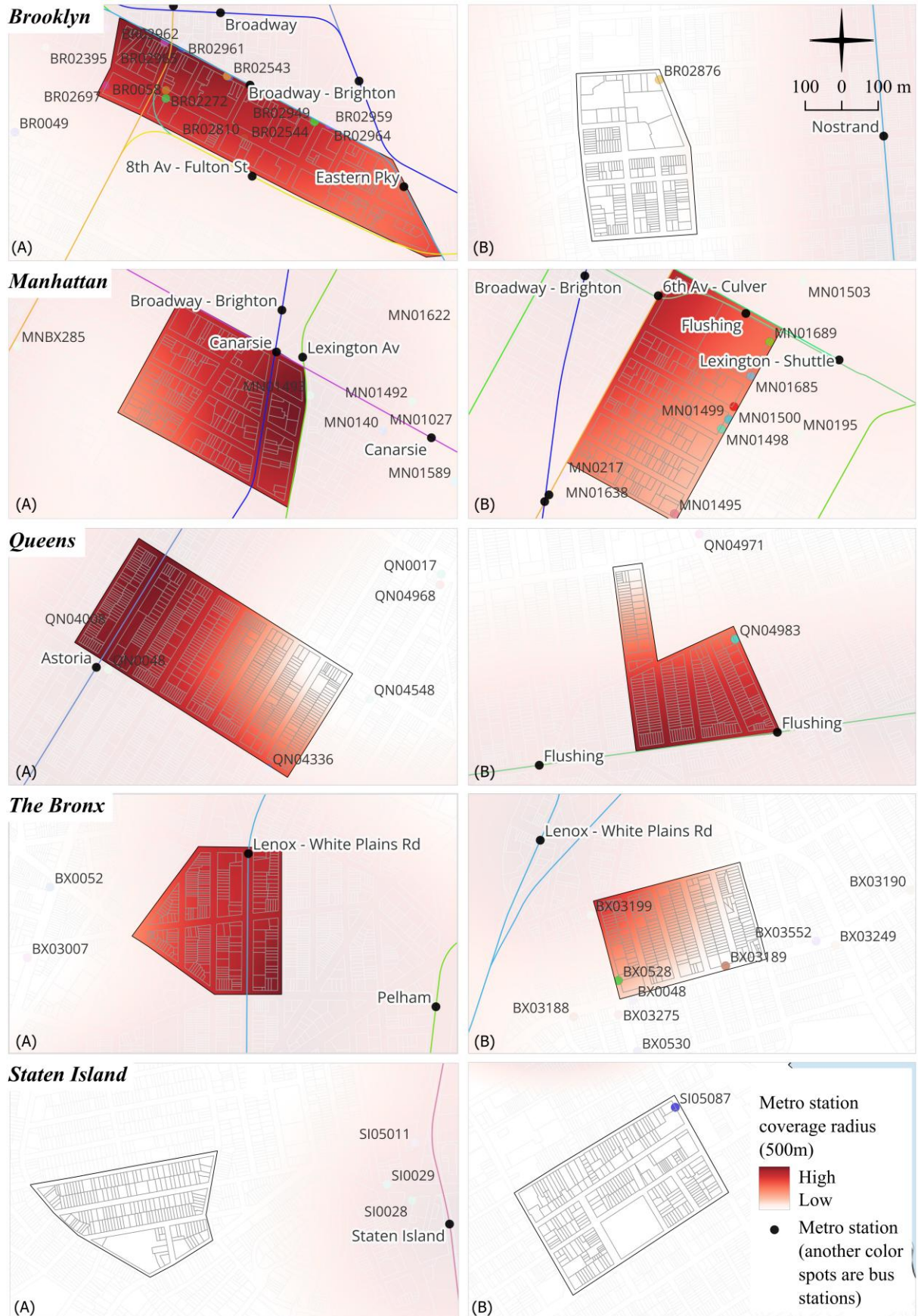


Figure 82 - Qualitative analysis of local scale – accessibility points with public transportation

7.3.2.3 Occupation

Analysing occupancy characteristics at the local scale is essential to understanding the physical form of plots and how they relate to urban space. While city-scale analysis addresses the building density of plots, local-scale analysis complements this with the plot occupancy rate (which identifies the proportion of the plot covered by buildings) and the age of the buildings located on each plot. Building density quantifies the built volume within each plot. The occupancy rate measures the proportion of the plot's area covered by the building's projection. The building's age attests to the plot's history and life cycle.

Figure 83 presents the results of the building density analysis of the study areas. In Manhattan and Brooklyn, high density is predominant. In Manhattan, area A has 103 high-density plots out of a total of 159, while area B has 121 high-density plots out of a total of 156. In Brooklyn, area A has 59 high-density plots out of a total of 106, and area B has 46 high-density plots out of a total of 184. In contrast, Queens and the Bronx represent a mix of building densities, with a predominance of low and medium density. In Queens, area A has 207 low-density plots and 283 medium-density plots out of a total of 515 plots. In the Bronx, area A has 169 low-density plots out of 238, and area B has 220 low-density plots out of 259. In Staten Island, low density is almost absolute. In area A, 172 of the 178 plots are low-density, and in area B, all 248 plots are classified as low-density.

Occupancy rate analysis (Figure 84) complements the density analysis. In Manhattan and Brooklyn, high density is directly related to a high occupancy rate, meaning that buildings cover most of the plots' land area, leaving few permeable areas. In Queens and the Bronx, occupancy rates are more varied, with the presence of medium and low occupancy bands. This diversity reflects the mix of densities, where the presence of permeable areas or setbacks is more common. In Staten Island, low occupancy rates are predominant, aligning with low building density, indicating that buildings occupy a minimal portion of the total plots area.

The age of buildings is an important factor in understanding the dynamism of occupation (Figure 85), contextualizing density and occupancy rate analyses within a plot's life cycle. In Manhattan, Brooklyn, and the Bronx in area A, the predominance of buildings constructed before 1960 suggests an older, consolidated urban fabric. However, it is important to note the occasional presence of newer buildings, especially in areas such as Brooklyn's area A and Manhattan's Area B, where the construction of new buildings points to a process of renewal and densification. This mix of ages reflects areas of stabilization in the urban fabric, but also specific processes of transformation that meet contemporary demands. In Queens and the Bronx in area B, most of their plots feature residential buildings from the 1930s to the 1960s. In Staten Island in area B, most of the buildings are more recent, dating from 1990 to 2024.

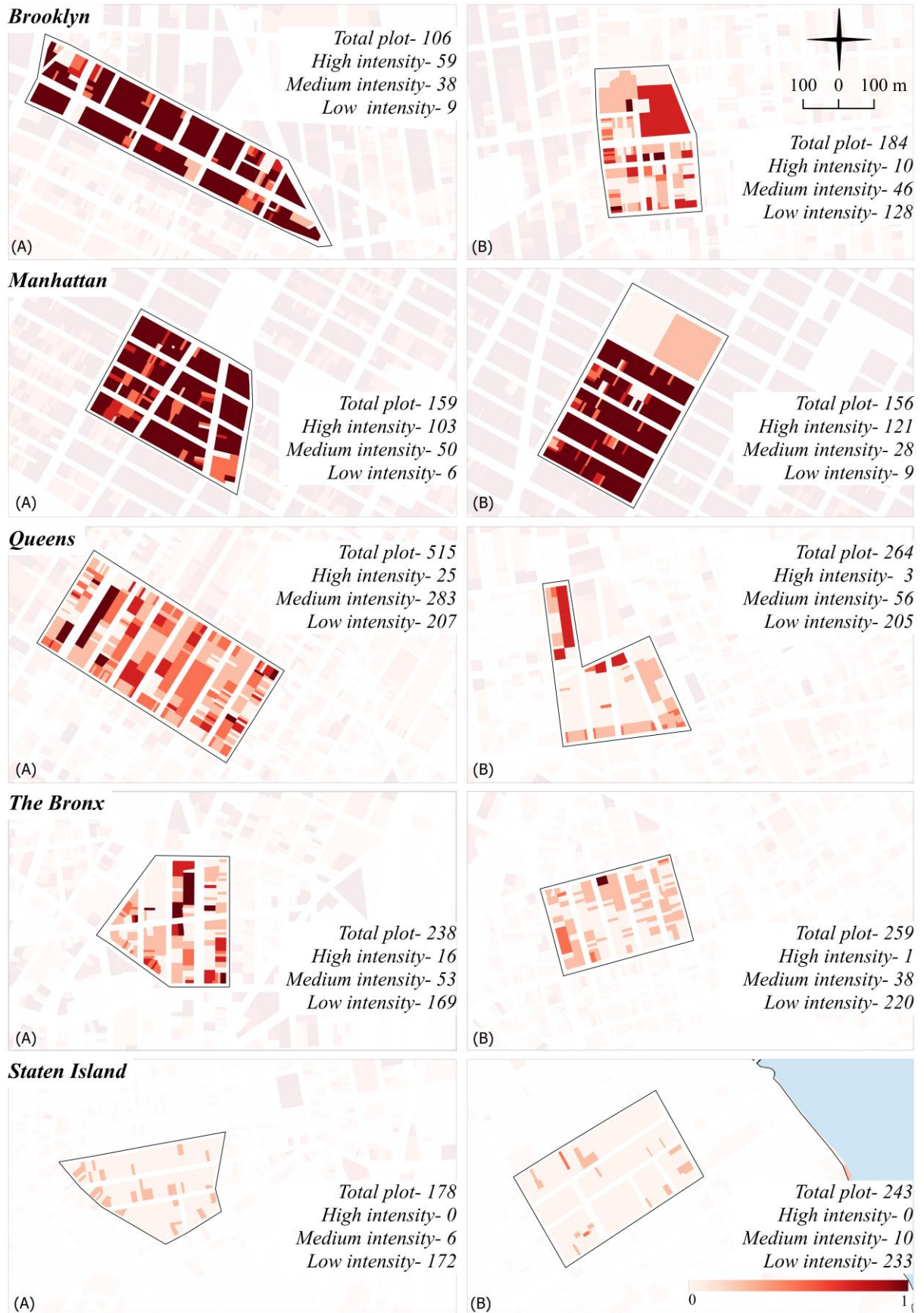


Figure 83 - Quantitative analysis of local scale – occupation of the plot

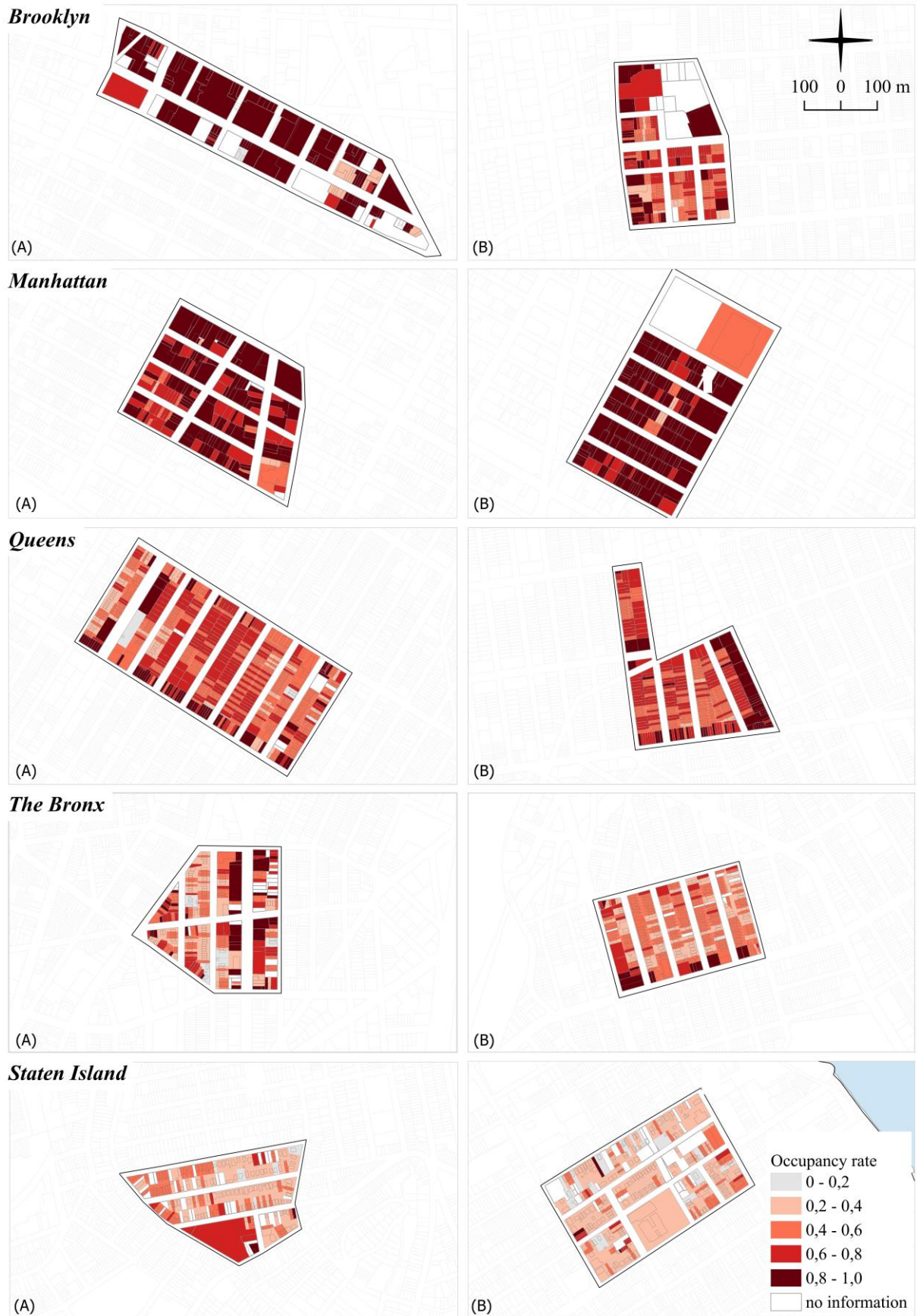


Figure 84 - Qualitative analysis of local scale – occupancy rate of the plot



Figure 85 - Qualitative analysis of local scale – buildings age on the plot

7.3.2.4 Control

The analysis of control in different boroughs and neighbourhoods reveals crucial nuances regarding the governability of space. While quantitative analysis provides a structural view of the power of control each owner has over a given area, qualitative analysis complements and contextualizes this control by showing how the level of physical control is determined through access points, and how this influences the interaction between plots and their surroundings.

In the quantitative analysis, based on the relationship between *the average plot area and the number of owners on that same plot* (AO), plots with fewer owners per area tend to have greater autonomy and control. The maps in Figure 86 illustrate these results. Queens and The Bronx, for example, demonstrate a high predominance of low-control plots, with 496 of 515 plots in area A of Queens and 232 of 238 plots in area A of The Bronx. This pattern of property fragmentation, with a greater number of owners per unit area, can hinder individual autonomy over a plot. In contrast, Manhattan and Brooklyn present greater heterogeneity, with plots with varying levels of control. Staten Island also follows this pattern, showing a varied distribution, with a concentration of low control intensity in area A.

Qualitative reading (Figure 87) adds a crucial dimension to understanding control by observing how plots interact with public space through physical control (doors, gates, walls, etc.). This analysis is based on the observation of activities that allow full access (full control), partial access (semi-controlled), or public access (publicly controlled parcels) on the plots. In Queens and the Bronx, the predominance of fully controlled plots is notable. These areas are characterized by closed interfaces, where access is restricted and the plot's interaction with the street is minimal. This pattern reflects the predominant use of single-family homes and developments that prioritize privacy and exclusive control over space.

In contrast, Brooklyn and Manhattan present a more varied distribution, with a significant presence of semi-controlled plots and, to a lesser extent, public plots. In Manhattan, area A presents a mix of fully controlled and semi-controlled plots, creating a more porous interface. In Brooklyn, area A displays an even more balanced distribution between the three types of control. This diversity reflects the mixed-use urban fabric, where the presence of commerce, services, and residences creates interfaces that allow greater permeability and interaction between the plots and public space at certain times of the day. Staten Island also exhibits a mixed distribution. Area A presents a strong concentration of fully controlled plots, while area B presents a more significant proportion of semi-controlled and public plots.

A qualitative analysis demonstrates that control over plots is exercised in different ways. This analysis presents control exercised through ownership and control exercised through the physical use of the plots.

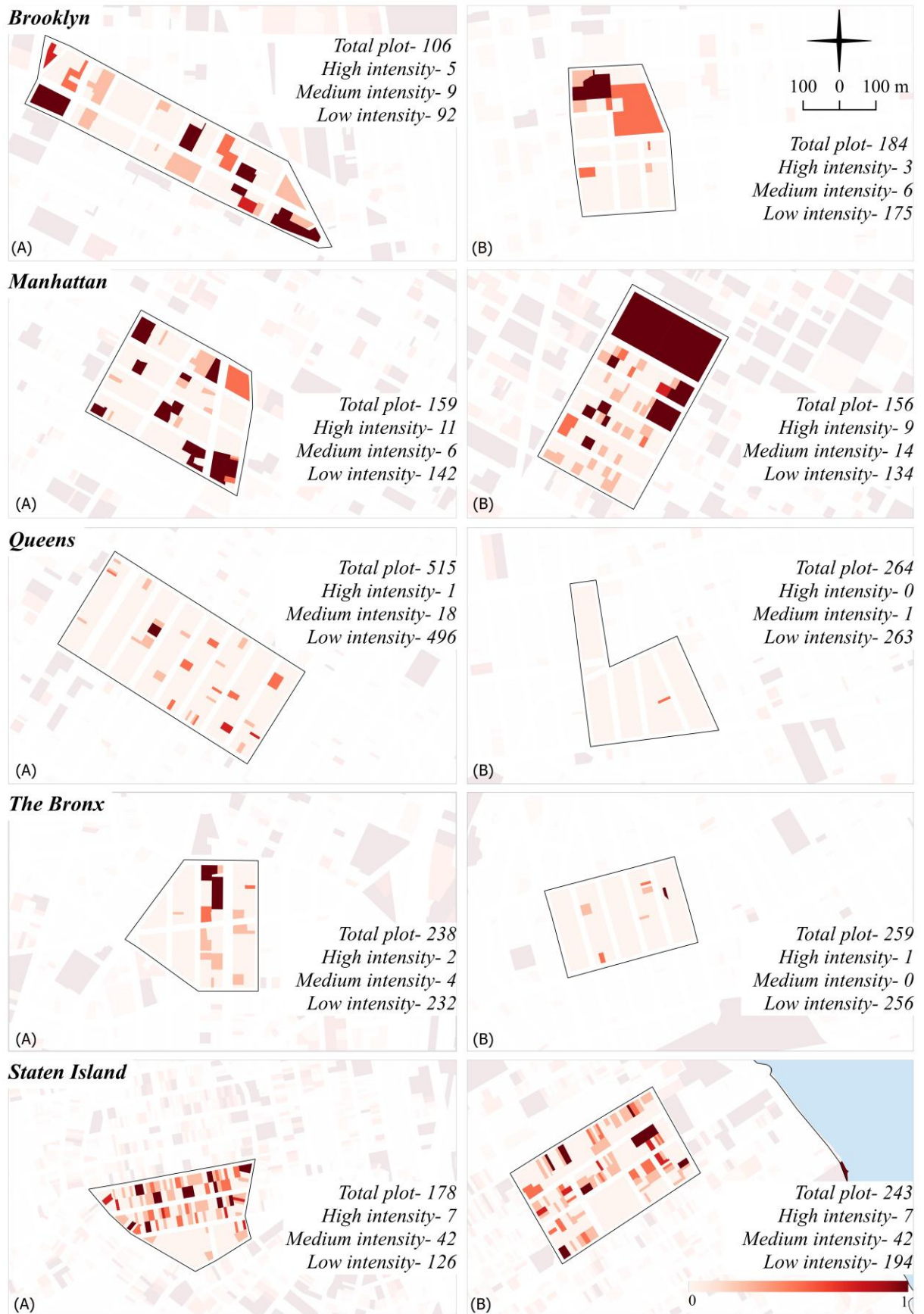


Figure 86 - Quantitative analysis of local scale – control of the plot

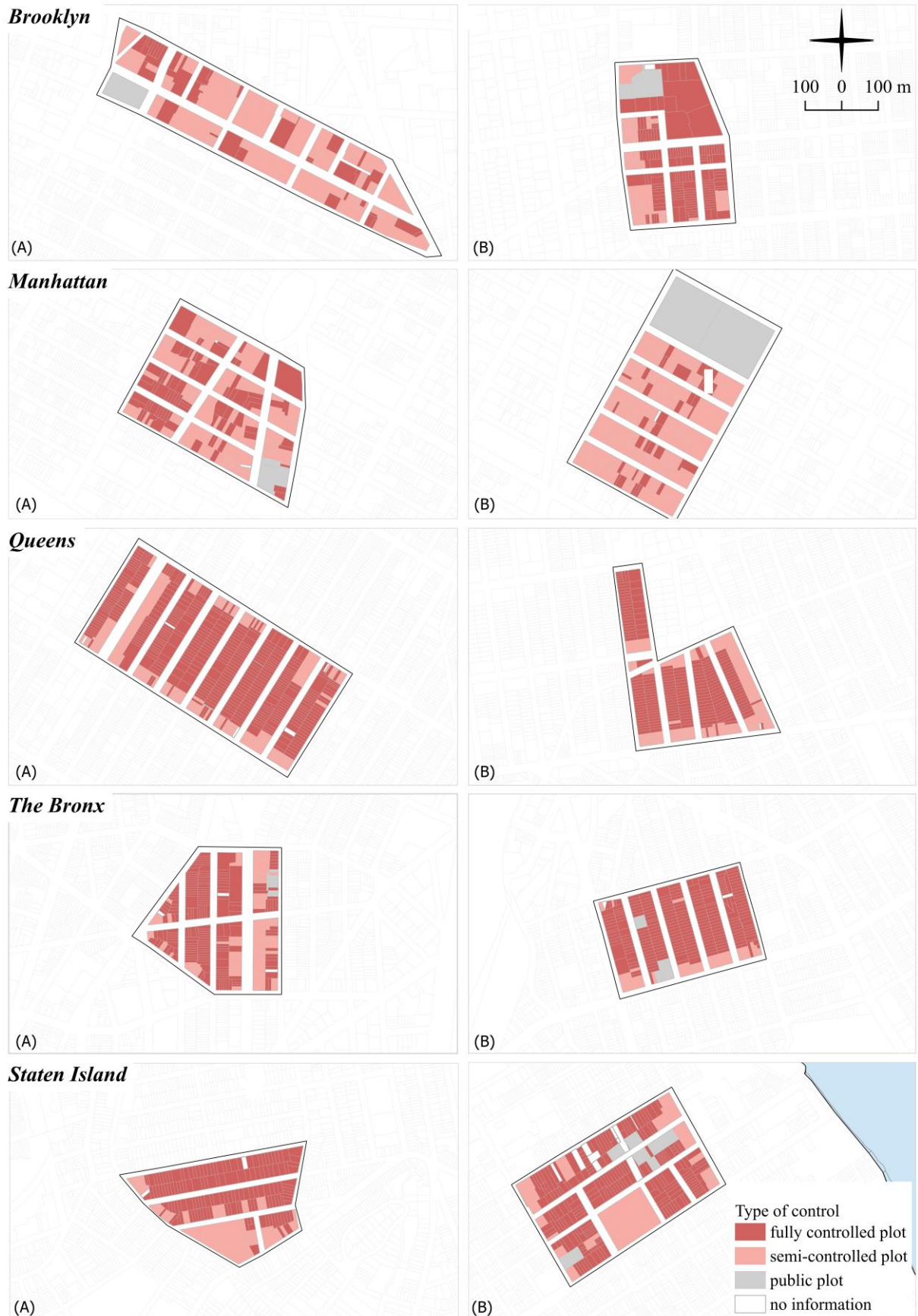


Figure 87 - Qualitative analysis of local scale – control of the plot

7.3.2.5 Function

The plot's functionality is characterized by the diversity of uses within it, reflecting an area's ability to sustain multiple activities and generate urban vitality. Functionality can be analysed from two complementary perspectives: quantitatively, by the number of functions each plot concentrates; and qualitatively, by the types of uses effectively present in each territory. An integrated interpretation of these two perspectives allows to understand how the multiplicity and nature of functions contribute to the city's social and economic dynamism, directly influencing both the space's attractiveness and its urban value.

Quantitative functionality analysis (Figure 88) allows to assess the number of functions in each plot, which reflects its capacity to concentrate diverse activities. For this classification, plots with up to 10 functions were considered low-intensity, those with between 11 and 50 functions were considered medium-intensity, and those with more than 50 functions were considered high-intensity²². The results indicate that most plots in the five boroughs fall into the low-intensity category, revealing a predominance of monofunctional areas or areas with limited diversity of uses. In Brooklyn, area A presents greater heterogeneity, with 15 high-intensity plots and 2 medium-intensity plots, compared to 89 low-intensity plots, while in area B, almost all plots (182 of 184) remain in the low-intensity category. In Manhattan, the diversity is more significant: in area A, 43 plots concentrate more than 10 functions, with 30 selected as high-intensity, and in area B, this number increases to 56, with 21 plots being high-intensity. These results place Manhattan as the borough with the highest concentration of multifunctionality per plot. In contrast, Queens reveals low functional complexity, with only four plots of medium or high intensity in area A and none in area B, where all 264 verified plots are at the low-intensity level. The Bronx presents a similar pattern: in area A, only four plots exceed the 10-function threshold, and in area B, 15 plots reach the medium-intensity level, amid a large majority of low-intensity plots. In Staten Island, in both areas A and B, all plots fall below the 10-function threshold, reinforcing the monofunctional and homogeneous nature of this territory.

A qualitative analysis (Figure 89), on the other hand, reveals the nature of the uses and functions that make up this pattern of monofunctional predominance. In Brooklyn, the areas present a diversity of uses, albeit mostly sectorized: notable is the presence of mixed-use residential-commercial areas, multifamily buildings, and street-level retail, as well as institutional facilities and parking spaces. In Manhattan, greater functional heterogeneity is observed, with a significant presence of multifamily buildings in various typologies (walk-up, elevator), mixed-use residential-commercial, and office buildings, associated with institutional facilities, leisure areas, and open spaces. Queens has a strong concentration of single-family and multifamily residential typologies, with a predominance of low-density housing uses, with occasional insertion of businesses and institutions. In The Bronx, the configuration is similar, with a predominance of uses related to multifamily buildings and a lower presence of commercial or institutional functions. In Staten Island, this is even more homogeneous, with an almost exclusive predominance of single-family residential uses and a low presence of complementary functions, reinforcing the monofunctional character already identified in quantitative analysis.

²² Due to the existence of many plots with high functional intensity in New York.

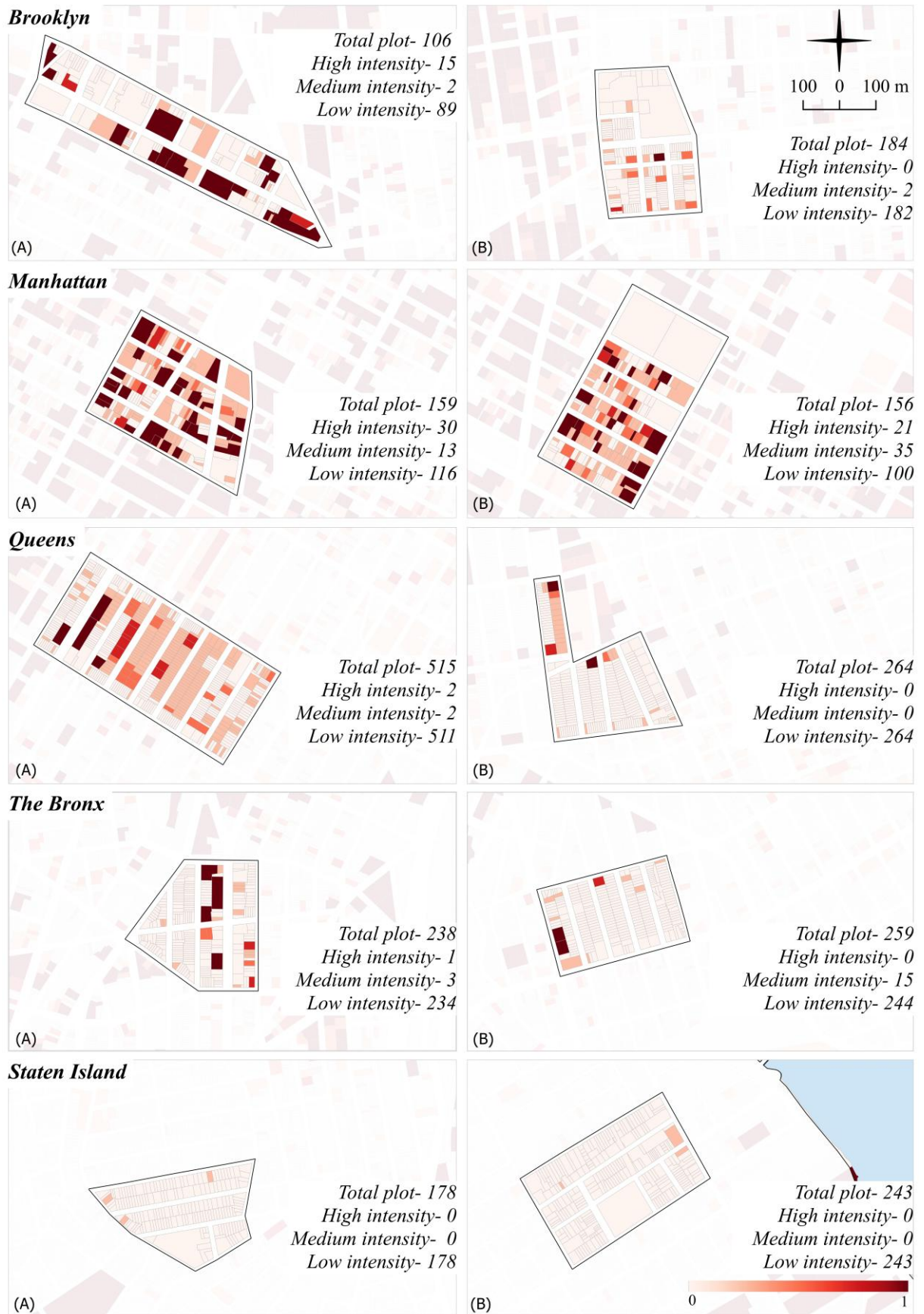


Figure 88 - Quantitative analysis of local scale – function of the plot

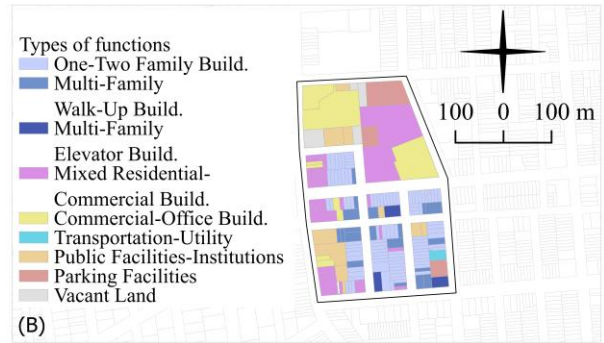
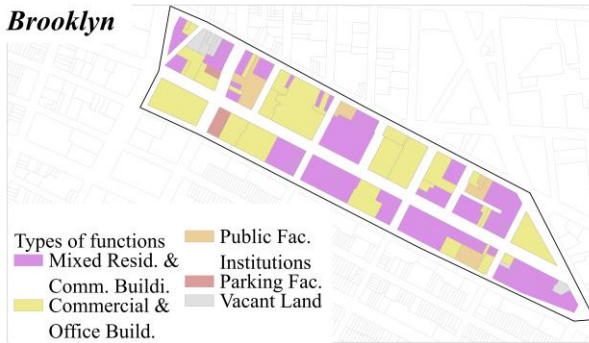
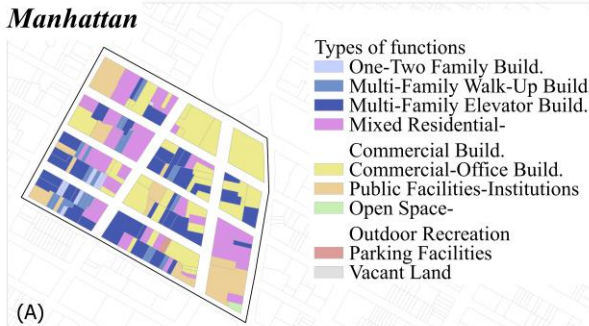
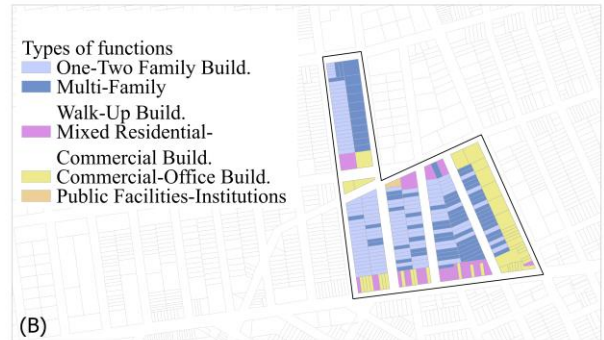
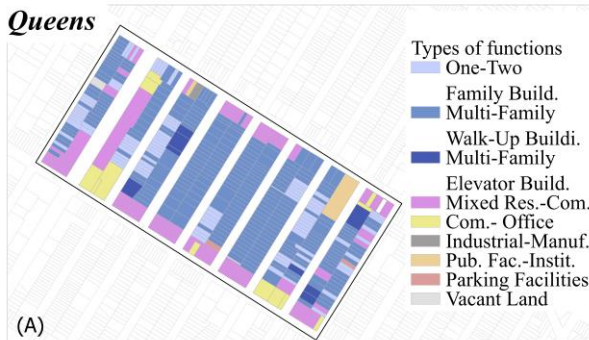
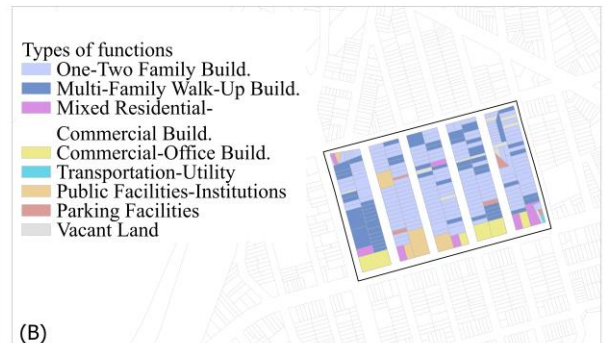
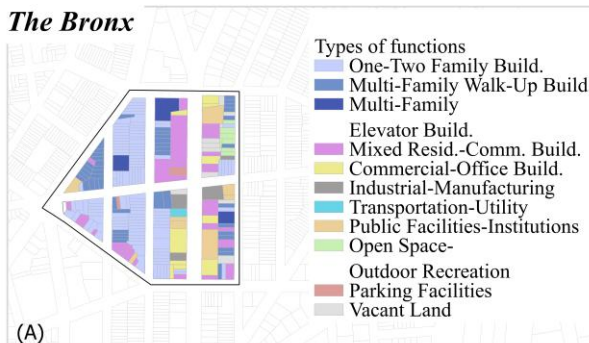
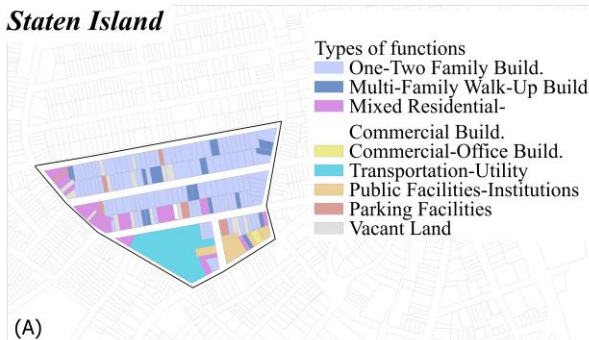
Brooklyn**Manhattan****Queens****The Bronx****Staten Island**

Figure 89 - Qualitative analysis of local scale – Types of functions

7.4 Plot Scale Analysis

As argued throughout the thesis, the plot is the element of urban form with the greatest importance across different fields of knowledge. It is within the plot that uses, values, forms, and social relations (among other aspects described in the previous sections) materialize, and collectively structure the city. A single plot, when isolated, may seem limited in its impact. However, when viewed in relation to its surroundings, it reveals itself to be part of an interdependent network. This system, which begins at the scale of each plot, progressively extends to the neighbourhood and the entire city. Therefore, understanding the role of the plot within its spatial and functional context is fundamental, as its individual attributes directly influence the processes that shape the territory.

Multiscale analysis is not merely an exercise allowing varying detail, but an indispensable resource for deciphering the complexity of the interactions that sustain urban life. Each plot concentrates within its physical boundaries a set of dimensions and characteristics that, when interacting with each other and with neighbouring plots, have significant effects on the urban space. The fact that a plot can change function, be an object of economic interest, or increase its building density can trigger transformations that transcend its physical limits, impacting neighbourhood dynamics, accessibility conditions, the distribution of traffic, and even the identity and local history. It is through the accumulation of decisions made at the scale of each plot that a city is built and transformed.

Therefore, understanding the main dimensions and characteristics of the plot system is important for identifying patterns at the city scale, understanding the effects on local daily life, and considering the significance of each plot unit in this process. The analysis at the plot scale reveals the multifaceted character in detail, with the possibility of considering its strengths and limitations that influence the urban system. This knowledge paves the way for more precise disciplinary inputs, capable of strengthening existing strengths and adjusting weaknesses according to the development and planning objectives planned for each urban context.

The purpose of the plot-scale analysis is, therefore, to systematize the attributes of each plot, identified by both quantitative and qualitative indicators. Integrating these results allows to construct a comprehensive picture of each plot's multifaceted character. To exemplify this type of analysis, which can be extended for each plot in the city, 10 plots were randomly selected, one in each area analysed at the local-scale (section 6.3). The following subsections describe a multifaceted analysis of each of these 10 plots.

7.4.1 Brooklyn

Brooklyn's first plot is located Downtown Brooklyn - Boerum Hill, between Livingston Street and Schermerhorn Street, with ID BK 167 13 (Figure 90). This plot exhibits a high-intensity profile, particularly its multicharacteristic profile (0,91). This high intensity of the multicharacteristic profile is evident in the strong performances for transformation, occupancy, control, and function.

Looking at the multidimensional profile, in the economic dimension, the plots stand out with a score of 0,75, due to the high value of the plot, listed above \$80.000.000 in 2024, and the five recent ownership transfers. The predominance of tenants, instead of owner-occupants, significantly reduces the value of the social dimension (0,04), representing a plot with more flexible and dynamic uses. The plot's size, around 5.000 m² size, combined with the low density of surrounding plots, contributes to a reduced morphological intensity (0,25), despite the local indicator favouring the surrounding urban vitality due to its semi-active frontage. The legal dimension (0,65), with the property linked to an LLC, suggests a plot model that favours greater flexibility for transformation processes. The planning dimension (0,75) places the plot in the C6-4 zone and the *Special Downton Brooklyn District*, which allows for mixed residential-commercial uses and a high occupancy rate, enabling the area to develop as a multifunctional hub. The lack of permeable area in the plot reflects the poor environmental performance.

Brooklyn's second plot is located in Flatbush, between Flatbush Avenue and Clarendon Road, with ID BK 5165 59 (Figure 91). This plot exhibits medium intensity in its multidimensional and multicharacteristic profile. The intensity of this plot is related to the economic and morphological dimensions, as well as the level of occupancy, transformation, and location. In the economic dimension, the plot's value is \$2.000.000 in 2024, and three recent ownership transfers demonstrate that the plot is active in the real estate market. The morphological dimension indicates significant intensity, with a high density of surrounding plots, a size of approximately 375 m², and a small and active frontage. However, the control indicator indicates fragmentation, with many owners controlling part of the plot's area. Furthermore, this plot indicates a low number of functions. In the social sphere, the predominance of renters, rather than owner-occupants, suggests less community stability. The absence of permeable areas (environmental dimension) reflects a choice to maximize the built footprint. Finally, the planning dimension (0.25), with C2-4 and R7A zoning, indicates that the zone allows for low-intensity development.

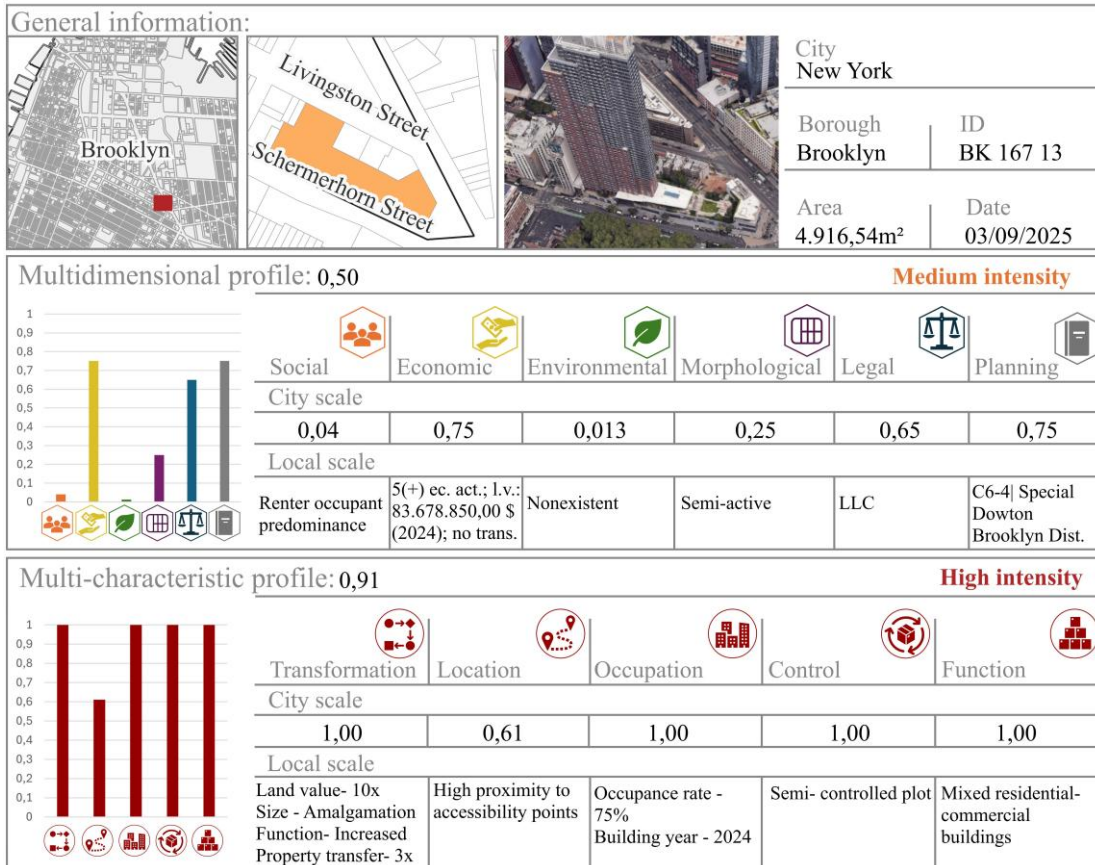


Figure 90 - Plot scale analysis– Brooklyn area A

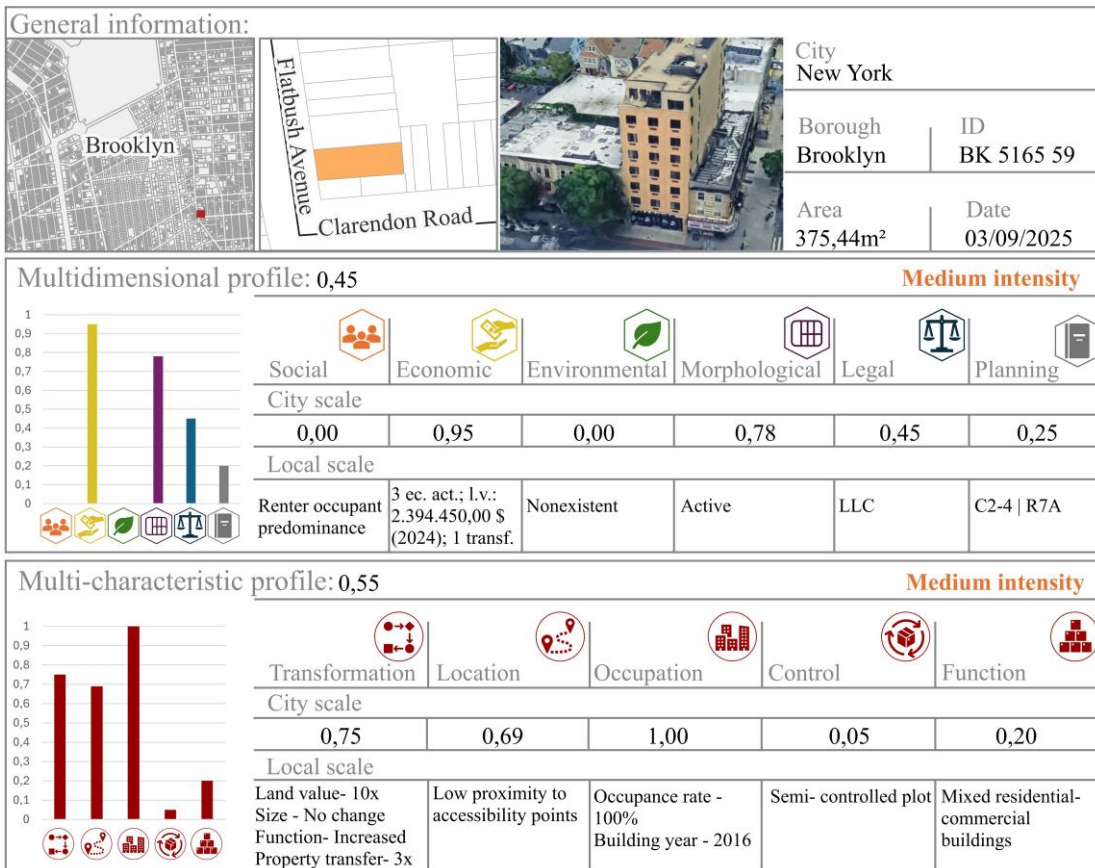


Figure 91 - Plot scale analysis– Brooklyn area B

7.4.2 Manhattan

In Manhattan, two representative plots were defined, one in Greenwich Village and the other in Midtown Manhattan. The first plot, ID MN 568 6 (Figure 92), between 5th Avenue and East 11th Street, has a high multidimensional profile (0.73) marked primarily by strong economic, legal, and planning aspects. The land value of approximately \$10,6 million in 2024, combined with six property transfers in the same year and the presence of economic activities, reflects the plot's economic attractiveness and the dynamism of the real estate market. The high locational power, identified in the plot's characteristics, contributes significantly to strengthening the economic dimension of this plot. In the social dimension, a significant number of owner-occupants are observed, establishing a certain community stability and permanent ties to the territory. From a morphological perspective, the semi-active condition of the façade, combined with the multi-family building type with an elevator, built in 1923, expresses the long-term permanence of the building's form and the plot's physical boundaries. From an environmental perspective, the lack of permeable areas limits the contribution of this dimension. From a planning perspective, the R10 zone in which the plot is located allows for high construction intensity and residential occupancy, reinforcing the intensive and highly regulated housing character. From a legal perspective, the plot is presented as a corporation. The combination of these factors results in a multifaceted high-intensity framework for this plot.

The second plot, located in Midtown Manhattan, with ID MN 838 1 (Figure 93), between Americas Avenue and West 37th Street, presents slightly different results, categorized as having high multidimensional intensity (0.70) and multicharacteristic intensity (0.79). In this plot, the economic dimension also stands out, with a land value exceeding \$57 million in 2024 and the presence of multiple economic activities, demonstrating a strategic strength for the real estate market. The plot's location favours these results, situated in one of the most integrated points of the urban system. In the social dimension, the predominant percentage is the number of surveys, indicating greater turnover and flexibility in land use. The morphological dimension presents an index of 0.91, representing a high density of plots, size, and façades that favour integration with the surroundings. The plot has an area of 2.048 m² and houses a 1986 building with a 100% occupancy rate and a semi-active façade, highlighting this plot's contribution to the area's urban vitality. From a planning perspective, the property is registered as an LLC, and the zoning classification is C6-6/Special Midtown District, which provides regulatory permissiveness for a variety of uses and functions, including residential and commercial properties. The environmental dimension is also lacking in this plot. This plot is located in a high-density area, in one of New York City's most dynamic neighbourhoods, where proximity to accessibility hubs, transportation, offices, hotels, and services significantly increases its economic importance. In this sense, in addition to contributing to local vitality, the plot plays a metropolitan role, intensifying mobility flows, commerce, and services, reinforcing the area's centrality and identity as a multifunctional hub with global reach.

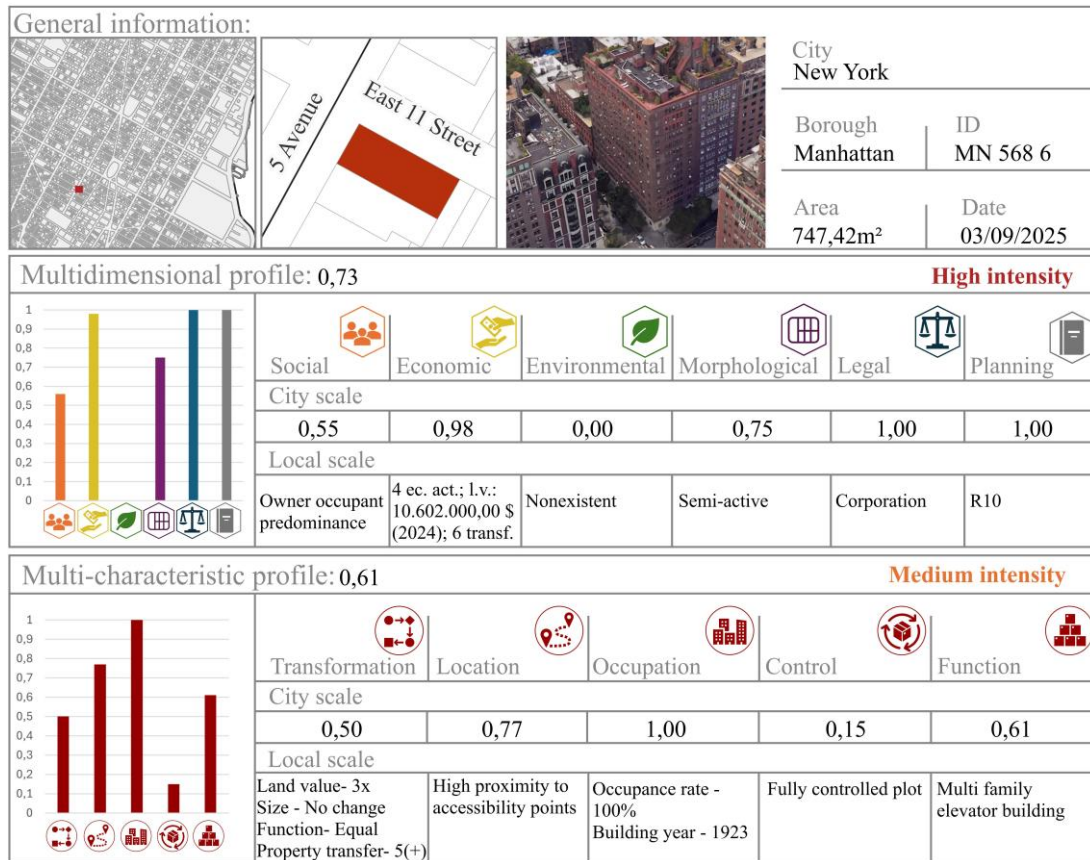


Figure 92 - Plot scale analysis– Manhattan area A

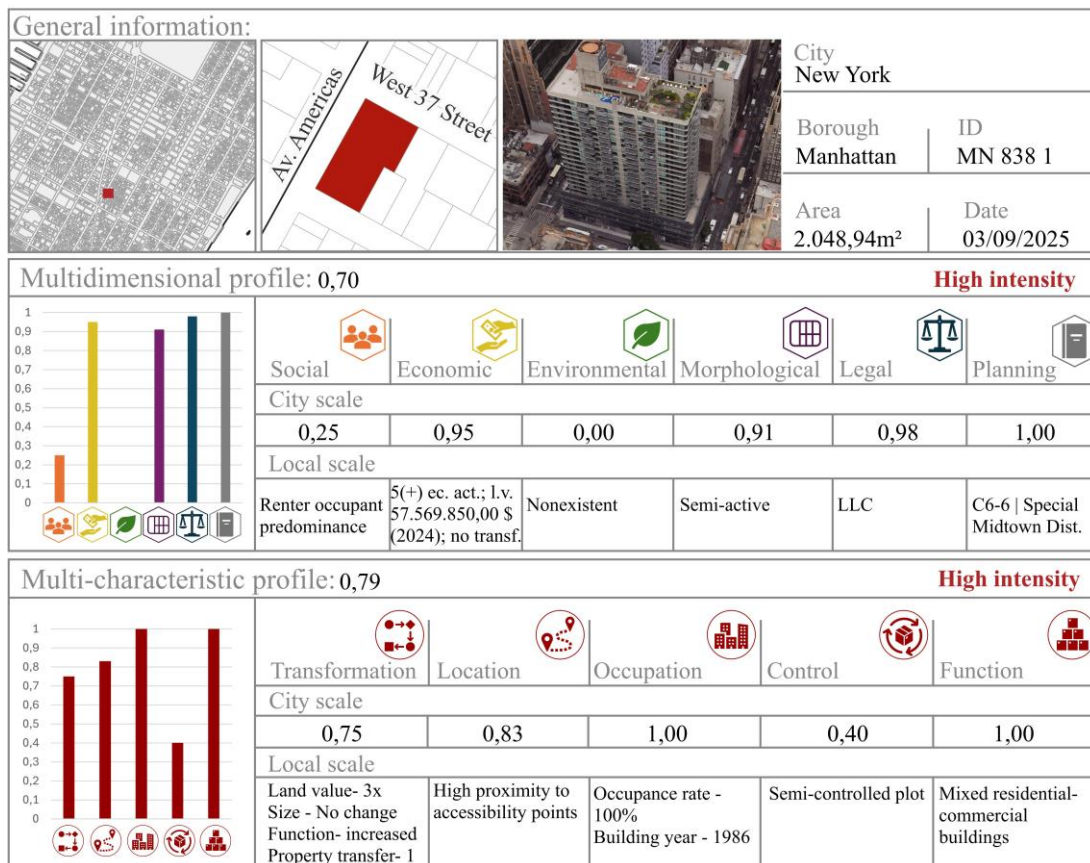


Figure 93 - Plot scale analysis– Manhattan area B

7.4.3 Queens

In Queens, the first plot, ID QN 648 7, is located in the Central Astoria area, between 35th Street and Broadway. The plot exhibits a medium intensity profile, with a multidimensional score of 0.40 and a multicharacteristic score of 0.36. The intensity of the profiles is primarily driven by the economic (0.78) and morphological (0.78) dimensions.

In the economic dimension, the high land value (above \$145,000 in 2024) and the presence of economic activity indicate its economic relevance. The morphological dimension highlights the high density of plots in the area, and the small size of frontage and plot. Furthermore, the active frontage contributes significantly to the urban vitality of the area. However, the low intensity of the social profile and the predominance of tenants point to less community stability. The environmental dimension also exhibits a low intensity (0.13), reflecting the small percentage of permeable area. The planning dimension indicates that the plot is located in a low-intensity development and mixed-use zone, with a C2-4A zone (Figure 94).

The second plot, with ID QN 1482 51, is located at 94th Street and Roosevelt Avenue in Jackson Heights. This plot also presents a medium-intensity profile, with a multidimensional score of 0.34 and a multicharacteristic score of 0.41. The plot's intensity is primarily driven by the legal (0.65), morphological (0.55), and location characteristics (0.93), which indicate high integration within the urban system and close proximity to accessibility points.

From an economic perspective, the plot has a 2024 value of above \$415,000 and four economic activities, ensuring its relevance to the economy. The morphological dimension (0.55) indicates that the plot is located in a context of significant plot density, with a small frontage and small size (184.47 m²). The social dimension (0.15), with the predominance of tenants, suggests less community stability. Finally, the absence of permeable areas in the environmental dimension (0.00) and the classification in the C2-4, R6 zone reinforce the building density of land use and a medium development intensity established by the current zoning law (Figure 95).

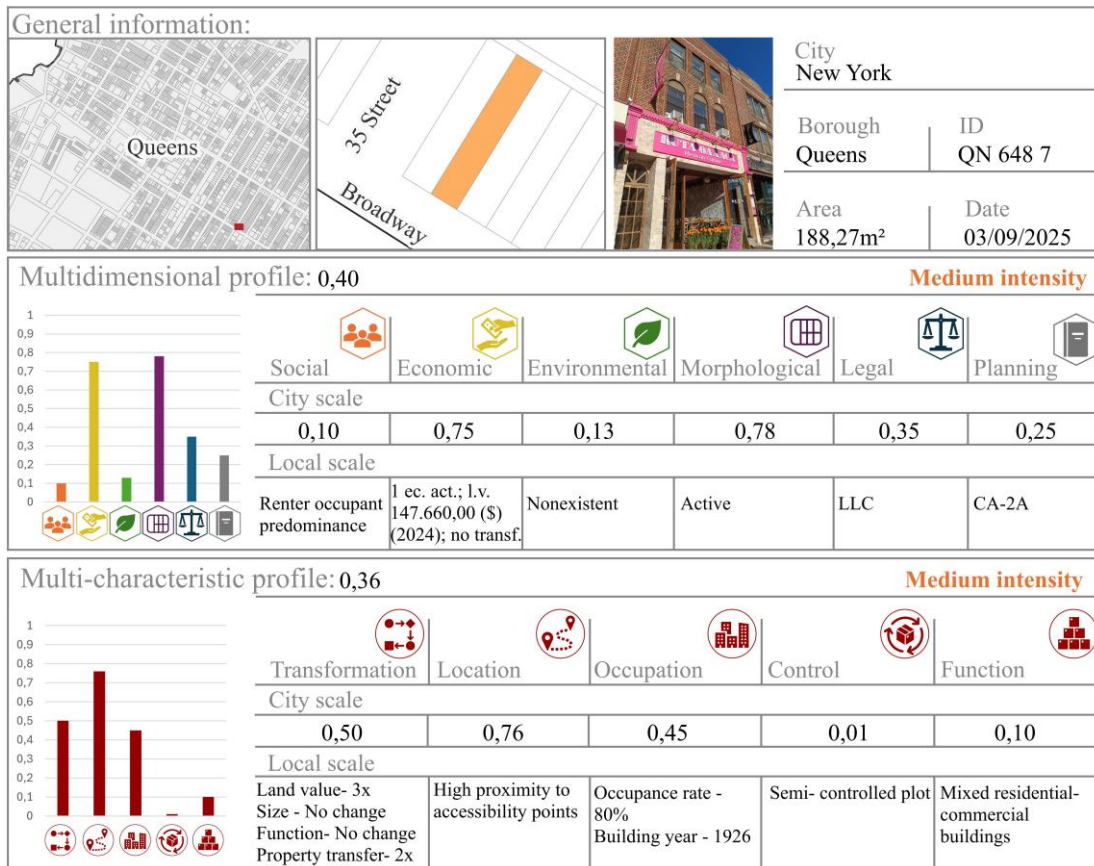


Figure 94 - Plot scale analysis– Queens area A

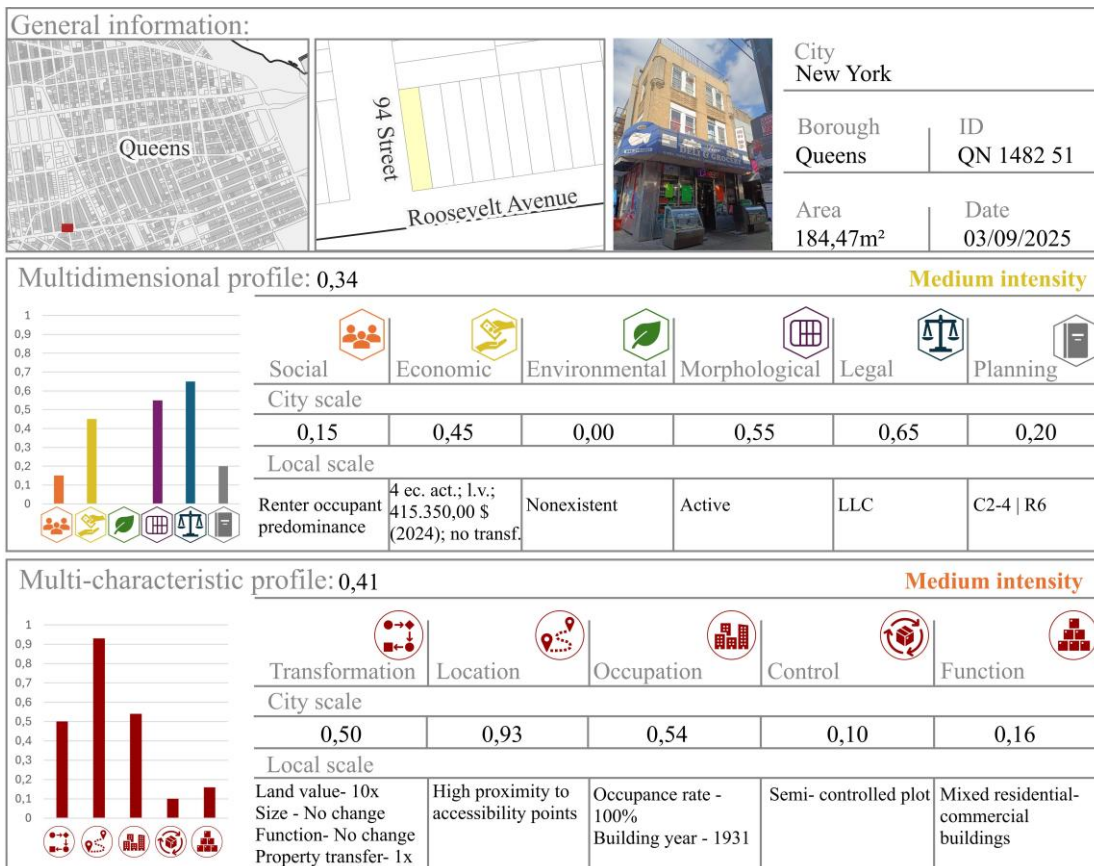


Figure 95 - Plot scale analysis– Queens area B

7.4.4 The Bronx

In The Bronx, two representative plots were selected in Crotona Part East and Parkway-Van West. The first, located between Fox Street and Home Street (ID BX 2719 46), has a multidimensional profile of 0.40, representing a medium-intensity decline, and a multicharacteristic profile of 0.25, classified as low intensity. The economic profile is moderate (0.53), with a land value of approximately \$49.800 in 2024 and two recent property transfers, although no economic activities have been established. The social dimension shows low intensity (0.28), with a predominance of tenants. From a morphological perspective, the plot stands out with a relatively high intensity (0.72), due to its area (252 m²) and small frontage, as well as a high density of surrounding plots. The plot also has an opaque façade, and is a multifamily development built in 1901 with a 60% occupancy rate. The low intensity of the environmental dimension limits the plot's contribution to ecological quality and the urban landscape. The legal profile, with a medium intensity (0.45), indicates a moderate number of property rights associated with the plot, with the property type being tied to an LLC. The planning dimension (0.20) indicates a low level of land use imposed by zoning law. The plot is in the R7-1 zone, which has facilities for multifamily housing. The multicharacteristic profile highlights a moderate intensity of transformations on the plot and a good location due to its proximity to accessibility points (Figure 96).

The second plot, located between Rhinelander Avenue and Hunt Avenue (ID BX 4051 36), has a multidimensional profile of 0.30, also of medium intensity, and a multicharacteristic profile of 0.26, of low intensity. The economic profile of 0.51 represents a medium intensity of the plot's contribution to the economy, considering all other plots in the same urban system. The plot has a land value of \$42.000 in 2024, with a property transfer that same year, but no economic activity. The social dimension has a low score (0.10), reinforcing the predominance of tenants and the fragility of community permanence. The morphological dimension has a relatively high score, with a value of 0.63, due to the plot's area (227 m²) and small façade, with a high density of surrounding plots. The façade is opaque, and the building located on the plot dates back to 1910, with a 60% occupancy rate. The environmental dimension also has a low intensity (0.15), limiting its contribution to environmental issues within the urban territory. In the environmental dimension (0.40), the low index indicates that the number of owners' rights within this plot is low. Furthermore, the property type is private. In the environmental dimension (0.10), it presents a low level of land use imposed by zoning law. The R5 zone in which this plot is located provides limited permissiveness, with a suitable approach for one- or two-family buildings. The multicharacteristic profile highlights a moderate intensity of transformations on the plot and a good location due to its proximity to accessibility points (Figure 97).



Figure 96 - Plot scale analysis– The Bronx area A



Figure 97 - Plot scale analysis– The Bronx area B

7.4.5 Staten Island

In Staten Island, two plots were selected in St. George-New Brighton and Rosebank. The first, located on Corson Avenue (ID SI 35 62), has a multidimensional profile of 0.24 and a multicharacteristic profile of 0.24, both classified as low intensity. The economic profile has a low intensity (0.18), a land value of approximately \$35.940 in 2024, and no records of recent transactions and no economic activity. The social dimension shows low intensity (0.25), with a predominance of tenants in the area, reflecting a certain instability in community tenure. The morphological dimension highlights a relatively high intensity (0.65) due to its area (289 m²), small façade, and high density of surrounding plots. The façade is opaque, and the building located on the plot dates back to 1947, with a 60% occupancy rate. The environmental dimension, with an intensity of 0.28, presents a significant contribution from land permeability, with part exposed to the interface between public and private lands. The legal dimension presents a low intensity (0.05), with private property and few associated rights. The planning dimension is also low (0.05), with the R3A zoning within the Special Slope Preservation District. The multicharacteristic profile shows moderate intensity of transformation due to land appreciation and limited proximity to accessibility points (Figure 98).

The second plot, located in Rosebank with ID SI 2853 52, has a multidimensional profile of 0.25 and a multicharacteristic profile of 0.27, also classified as low density. The economic profile is low (0.18), with a value of only \$57.420 in 2024, with no recorded economic activity and no recent transfers. The social dimension, however, presents a higher intensity (0.35), marked by the predominance of owner-occupants, a condition that favours greater community stability and long-term ties. The morphological dimension, with an average intensity of 0.56, is due to the plot's area (508 m²), medium-sized façade, and medium density of surrounding parcels. The façade is opaque and is characterized by the presence of a single-family building constructed in 1950 and a 40% occupancy rate. The environmental dimension (0.38) reinforces its contribution with a significant area of permeable land. In the legal dimension, the intensity of the profile is low (0.05), with few property rights associated with the plot and with private ownership. The planning dimension also maintains a low intensity (0.05), with R3-2 zoning intended for low-density residential uses. The multicharacteristic profile highlights the moderate intensity of transformations due to land appreciation, in addition to a good location due to greater proximity to accessibility points (Figure 99).

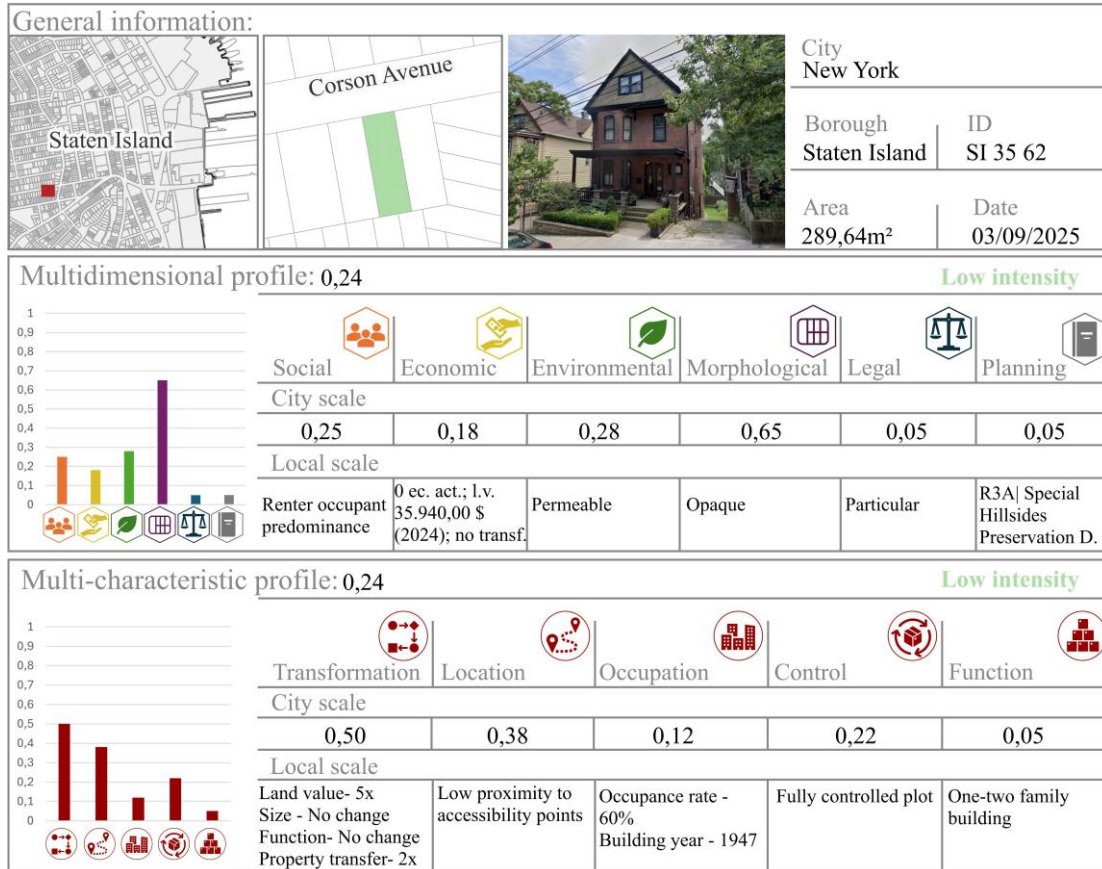


Figure 98 - Plot scale analysis– Staten Island area A



Figure 99 - Plot scale analysis– Staten Island area B



8 PLOT SYSTEMS AS THE CENTRAL STRUCTURE OF URBAN PLANNING

8 Plot systems as the central structure in urban planning

A city is created and developed through a complex network of physical structures. One of the central pillars of this construction is the plot system, upon which most cities are planned, zoned, and built. A detailed analysis and understanding of this system are essential to planning practice, as the meanings of the plot system transcend the limits of land and reflect power relations, social values, financial and economic aspirations, among the various aspects highlighted in the previous chapter. It is in this context, from a multifaceted perspective, that this chapter explores the importance of the *Plotter method* for planning practice and how it can improve this process, despite the acknowledged gap between research and practice in planning (Oliveira, 2021).

This chapter is structured in three subsections. The first presents a description of the *NYC zoning Resolution*, the main regulation governing plots in New York City. This normative document establishes land use rules and construction parameters, serving as a mandatory reference for any project in the city. The *NYC Zoning Resolution* allows to understand how the plot system adapts the cities, defining densities and use limitations, highlighting its crucial importance in city management. Furthermore, the role of the Department of City Planning (DCP), which regulates and monitors urban processes in New York, is described.

The second subsection explains the role of the *Plotter method* as a fundamental tool for urban planning. By graphically representing and detailing the multifaceted profile of plots in an integrated framework, the method allows planners to analyse spatial relationships, identify patterns, and explore different land use scenarios. The method facilitates the integration of normative data with the city's reality, making the planning process more dynamic for decision-making at multiple levels and continuously, from the development of urban plans to specific instructions.

The third subsection explains how the *Plotter method* can be transformed into an *interactive*, intuitive, and long-term tool for analysing and monitoring urban plot systems. This method not only allows for quick and additional queries about plot configuration but also enables continuous monitoring of changes in the urban fabric.

8.1 The NYC Zoning Resolution and the Department of City Planning

New York City planning is widely recognized for the sophistication of its instruments and its ability to shape one of the world's most complex and dynamic metropolises. The *NYC Zoning Resolution* occupies a central position in city planning, serving as the primary legislation regulating land use and occupation. Created in 1916 and extensively revised in 1961 (a brief history is presented in section 6.1), the zoning code prescribes strict and detailed rules regarding how plots may be occupied, what intensity of use is permitted, which uses are compatible, and which parameters must be followed in terms of density, height, setbacks, permeable areas, and parking. It is a prescriptive instrument that determines limits and development possibilities for each portion of urban territory.

The legislation is structured into chapters and articles covering general definitions and principles. Each portion of the city is designed within a zoning district, which can be residential, commercial, industrial, or mixed. Additionally, there are *Special Purpose Districts*, created to address areas with unique characteristics, such as historic districts, coastal areas, or environmentally protected areas²³.

Residential districts²⁴ are the most common in New York City, representing about 75% of the city's total area. They were created to ensure health, safety, and welfare by regulating building size and shape, population density, and the relationship between buildings and the street. There are 10 basic types of residential districts, from R1 to R10. Density increases progressively with number, ranging from low-density single-family homes (R1) to high-density (R10). Districts R1 to R5 are considered low-density, while R6 to R10 are medium-density and high-density. Residential districts are further divided into two main categories based on building shape. *Non-contextual* districts, created in the 1961 Resolution, allow for a wide variety of building shapes and are still used in locations without a uniform scale. *Contextual districts*²⁵ expanded into the 1980s and are designed to maintain or establish a scale and form that resemble older or more uniformly developed neighbourhoods. The rules in these districts determine permitted uses, building density and shape on plots, as well as parking and open-air areas. Most residential districts also allow community facility use. Massing and shape are regulated by the FAR. Most new buildings require a minimum number of parking spaces. These requirements decrease as the district's density increases. In high-density areas, parking requirements are low and may be waived for small plots. The applicable rules in the law ensure light and air access to residents by requiring backyards, patios, or roofs.

²³ NYC Special Purpose Districts: <https://zr.planning.nyc.gov/article-x>.

²⁴ See the rules for residential districts at: <https://zoningresolution.planning.nyc.gov/article-ii>.

²⁵ For a more detailed explanation of contextual and non-contextual districts click: <https://www.nyc.gov/assets/planning/download/pdf/plans-studies/zqa/contextual-vs-non-contextual.pdf>.

Commercial districts²⁶ are spaces where plots are used for business and retail, serving both the daily needs of a neighbourhood and those of large business centres. These districts allow for a wide range of uses, including residential and community facilities, reflecting the city's mixed-use nature. There are eight basic types of commercial districts, from C1 to C8, which can be grouped into three general categories. Neighbourhood commercial districts (C1 and C2) are often found on local shopping streets or in overlaps with residential zones, house shops, services, and restaurants that meet residents' daily needs. General business districts (C4, C5, and C6) mapped to regional and business centres such as downtown Manhattan or Brooklyn. These districts allow for a wider range of uses, such as large department stores, cinemas, offices, and hotels. Land use density and intensity increase as the number increases. Specialized districts (C3, C7, and C8) were created to accommodate specific commercial needs. C3 is intended for waterfront recreational activities, C7 for large amusement parks like Coney Island, and C8 for automotive and heavy-duty services that often act as a bridge between commercial and industrial zones. The rules in these districts shape how buildings are constructed and how they interact with the street. In addition to residential and community uses; commercial districts allow a mix of commercial uses (listed in the Use Groups²⁷). There are size restrictions for certain stores and a ban on residential use in locations below commercial activities, for example. The FAR offers a wide range of densities, from 0.5 in a C3 zone district to 15.0 in high-density districts like C5 and C6. Commercial districts do not require front or side setbacks, but rear setbacks are permitted. Building heights and setbacks are controlled by inclined sky plans, ensuring light and air for the streets. In commercial districts, parking regulations vary greatly depending on the type of use and location. In low-density districts, a minimum number of spaces is generally required, while in high-density areas, such as downtown Manhattan, parking may be optional or have a maximum number of spaces.

Industrial districts²⁸ house a range of activities, from traditional factories and warehouses to production studios and essential facilities such as power plants. M1 (*Light Manufacturing*) zones are designated districts for a wide variety of light industrial, commercial, and community uses. In some cases, they act as transition zones between residential and heavier industrial areas. M1 zones have more stringent performance standards for noise, vibration, and smoke. M2 (*Medium Industry*) zones are targeted in port areas and along the waterfront. These districts allow medium intensity uses, with less stringent performance standards than in M1 zones. M3 (*Heavy industry*) were created to accommodate essential but potentially noisier or more polluting industrial uses, such as power plants and other functions. These districts are typically located in isolated waterfront areas, away from residential neighbourhoods. Industrial district land use regulations focus on enabling economic activity while protecting environmental areas. While industrial zones allow a wide range of industrial uses, they also include many commercial

²⁶ See the rules for business districts at <https://zr.planning.nyc.gov/article-iii>.

²⁷ The NYC Zoning Resolution classifies the types of uses that can be installed within buildings, which have been classified and combined into 10 separate use groups with similar characteristics. For more information click <https://zr.planning.nyc.gov/article-ii/chapter-2>.

²⁸ See the rules for industrial districts at <https://zr.planning.nyc.gov/article-iv>.

uses, with some size restrictions. The primary size control is through the FAR, which ranges from 1.0 in low-density M1 districts to 10.0 in high-density M1 districts. There are no front or side setback requirements, and rear setbacks are only 20 feet on interior parcels. The law requires industrial uses to meet minimum performance standards to control noise, vibration, smoke, and other pollutants.

Additionally, in response to historical land use patterns and to revitalize older areas, mixed-use districts were created in the law²⁹. The goal is to allow light industries, which are less intensive and noisy, to coexist with housing in areas undergoing transition. The concept behind these districts is to revive former industrial areas, allowing for new residential development, while preserving a base of light industrial activities and essential services. Density is regulated to ensure that residential buildings fit within the industrial scale. The FAR may be different for residential and non-residential uses, allowing for flexibility in development. Furthermore, in these zones, to protect residents, stricter performance regulations are applied to industrial uses. These may include limits on noise, pollutants, and traffic emissions, as a deterrent to residential areas. The goal is to allow light industries, which are less intensive and noisy, to coexist with housing in areas undergoing transition.

Special purpose districts include regulations that modify the underlying zoning rules for specific areas of the city. They serve to implement a specific planning plan for the area, such as preserving a neighbourhood's character or supporting revitalization efforts. The *NYC Zoning Resolution* outlines over 50 such districts, each with unique regulations. Some examples are as follows. The *Coastal Risk District*, for example, was created to protect sensitive natural areas and infrastructure, ensuring that new construction is consistent with flood resilience. The *Enhanced Commercial District*, was designed to enliven street activity and maintain local commerce in established commercial corridors. It includes several rules regarding use, transparency, and parking that can be applied in different ways. The *Limited Commercial District* was created to preserve the character of commercial areas within historic districts. It only allows commercial uses compatible with the historic context and requires them to be located within fully enclosed buildings. The *Natural Area District* directs new development in areas with unique natural features, such as forests, rock formations, and steep slopes, to protect these ecosystems. The *Scenic View District* is designed to prevent development from obstructing scenic views of parks or other public spaces.

In addition to these examples, each borough also has special districts. Some examples are presented here. In Brooklyn, these are *Coney Island* and *Downtown Brooklyn*. The first is part of a long-term plan to reestablish Coney Island as a year-round entertainment and recreation destination. The second supports the mixed-use development of its business district, with regulations that preserve the area's historic character. In Manhattan, there are the *Hudson Yards* and *Midtown*. The former aims to extend the Midtown business district westward, offering new opportunities for substantial commercial and residential development, as well as new public spaces. The latter aims to guide long-term development in the high-density financial district to improve the working and living environment. In Queens, there are the *Long Island City Mixed*

²⁹ See the rules for special mixed-use districts: <https://zr.planning.nyc.gov/article-xii/chapter-3>.

Use and the *Southern Hunters Point* district. The former supports the continued growth of a mix of long-standing residential, commercial, industrial, and cultural uses in the area. The latter aims to transform the waterfront area into a high-density mixed-use development with parks and waterfront open spaces. In The Bronx, there are the *City Island* and *Grand Concourse Preservation* districts. The former aims to preserve the neighbourhood's nautical heritage, commercial character, and residential scale. The latter aims to protect the scale and distinctive composition of the apartment buildings that line this boulevard. Staten Island has two districts: *Hillsides Preservation* and *Stapleton Waterfront*. The former aims to reduce erosion and stormwater runoff in areas with steep slopes while allowing for development. The latter aims to encourage mixed-use, walkable areas on the borough's north shore.

In addition to establishing guidelines and parameters for each area of the city, with specific definitions for each plot, the *NYC Zoning Resolution* also addresses public participation as a fundamental component of all zoning law implementation processes in the city. To this end, public review processes for zoning changes are in place. For example, the *Uniform Land Review Procedure Uniform Land Use Review Procedure* (ULURP) is a formal public review process, established by the *City Chapter* ³⁰, for actions such as zoning map amendments and major project approvals. ULURP sets strict deadlines for public participation and decision-making by bodies such as the City Planning Commission (CPC) and the City Council. The process lasts approximately seven months and includes public hearings at various levels. Additionally, there are Discretionary Actions, which require a government agency's judgment and can make changes such as zoning designations for an area, introducing new rules, or modifying existing zoning regulations. There are also *Variances*, processes requested by companies to facilitate approval due to specific plot conditions.

The Department of City Planning (DCP) is the central agency that formulates, implements, and manages zoning regulations. It was created in 1936 with the task of planning the city, ensuring that its development reflects current and future needs. The DCP's role includes promoting strategic growth, transit-oriented development, and sustainable communities, focusing on key challenges such as housing shortage, job creation, and an aging population. The DCP extends its reach across a variety of areas to achieve long-term planning goals. For example, its activities include leading planning initiatives like *City of Yes*³¹, which seeks to create more housing, revitalize commercial corridors, and promote sustainability throughout the city. The DCP also develops sectoral plans for neighbourhoods, such as the *Midtown South Mixed-Use Plan*³² and the *OneLIC Neighborhood Plan*³³, which aim to transform areas with new jobs and housing. Furthermore, this department is responsible for the NYC Zoning Resolution, with its maps,

³⁰ To see the New York City Charter click here:

<https://codelibrary.amlegal.com/codes/newyorkcity/latest/NYCcharter/0-0-0-1>.

³¹ To know more about this initiative click here: <https://www.nyc.gov/content/planning/pages/our-work/plans/citywide/city-of-yes-housing-opportunity>.

³² To know more about *Midtown South Mixed-Use Plan* click here:

<https://www.midtownsouthplan.nyc/>.

³³ To know more about *OneLIC Neighborhood Plan* click here:

<https://www.nyc.gov/content/planning/pages/our-work/plans/queens/lic-neighborhood-plan>.

rules, monitoring and reviewing proposed changes. This department also seeks to strengthen the city's economy by supporting job creation and meeting the ever-changing needs of businesses. The DCP provides valuable resources for the public and professionals. *Zola* (Figure 100), for example, is an online application that allows anyone to search for a property's zoning framework and find planning initiatives (see planned information at *ZoLa – NYC Zoning and Land Use Map*³⁴).

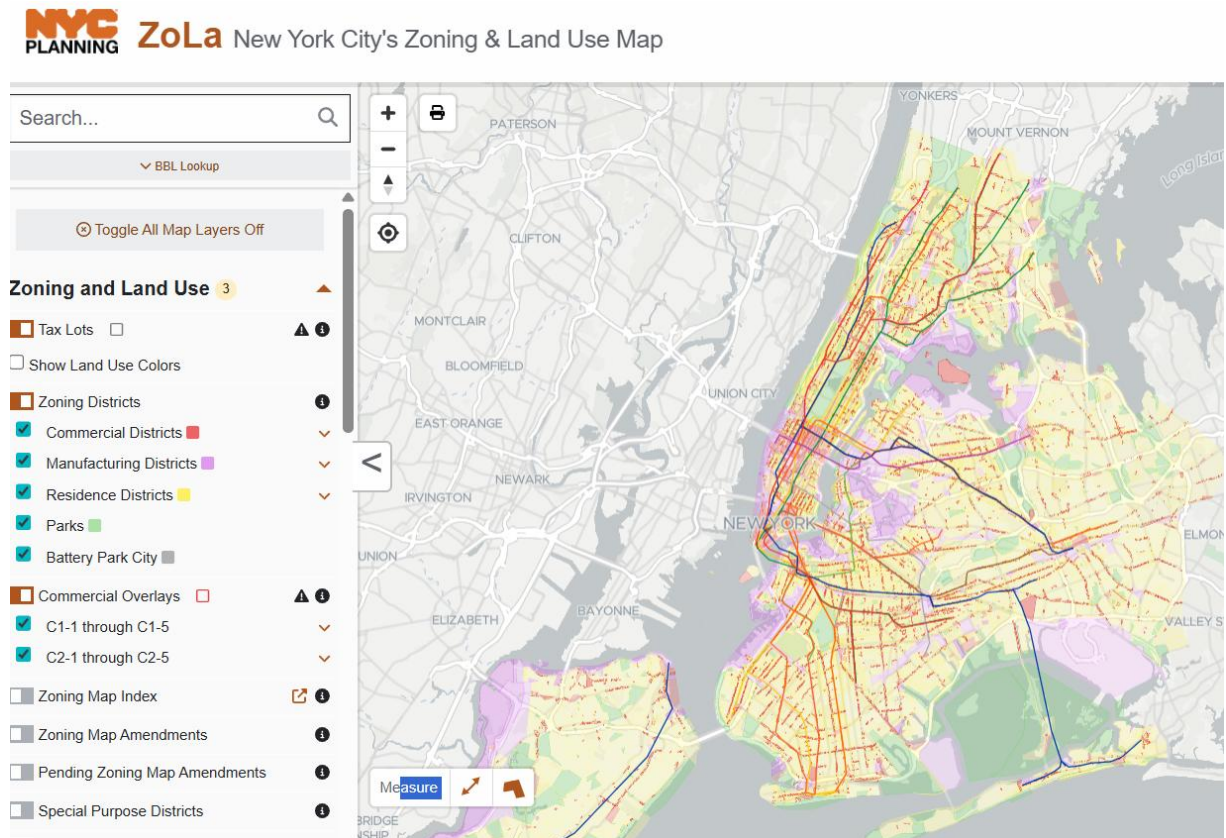


Figure 100 – *Zola* – New York City's Zoning and Land Use Map. Source: <https://zola.planning.nyc.gov/>.

New York's urban planning has consolidated and widely used instruments – such as the above-mentioned *NYC Zoning Resolution* and the interactive tool *ZoLa* (*Zoning and Land Use Application*). These instruments provide a highly accurate normative and cartographic framework that guides public and private agents in the interpretation and application of land use and occupation rules. *ZoLa* translates the complexity of urban regulations into an accessible platform, allowing anyone interested to view official data on zoning, special districts, and private or public properties. It is, therefore, a system of normative definition and static representation of the city's legal and cadastral conditions. Its main virtue is to ensure transparency, predictability, and legal certainty in urban development, offering detailed data at the plot level. However, this tool limits itself to reproducing already established normative, data, and cadastral frameworks, without interpreting the dynamic processes that unfold across

³⁴ *ZoLa – NYC Zoning and Land Use Map* - <https://zola.planning.nyc.gov/>.

the territory based on urban plots. This is where the *Plotter method* can significantly expand both analysis and intervention in planning.

8.2 The *Plotter method* as a central tool for planning practice

The *Plotter method* is an essential tool for planning practice because it fills a critical gap in the literature and practice: the lack of a systemic and integrated understanding of the meaning of the plot system as a multifaceted territorial structure. This contribution is crucial because it relocates the plot system at the centre of urban planning, as a strategic tool for analysing the city continuously and from multiple perspectives - the different dimensions of urban life associated with each plot, and their specific characteristics. This argument draws on three main foundations: a) the integrative process of the *Plotter method*, based on the typology and taxonomy of the plot system; b) the multiscale scope of the analysis; and c) the method's long-term contribution potential.

The first aspect that makes the method relevant to planning practice is its integrative process, based on the construction of a typology and taxonomy of the plot system. The typology laid a solid theoretical foundation for understanding the complexity of the plot system by identifying its main characteristics and dimensions through a literature review. The taxonomy allowed the conversion of different attributes identified in the review into empirical classifications, enabling systematic comparisons. This process allowed to overcome a restricted view of plots, recognizing their role as a system endowed with multiple meanings and potentialities.

When developing urban plans, this approach can significantly contribute to comprehensive and accurate diagnoses of reality. Through an integrated understanding of the multifaceted nature of the subdivision system, it becomes possible to simultaneously identify structural patterns of use and occupation, areas of greater social, economic, or environmental vulnerability, territories subject to speculative pressure, processes of intense transformation, etc. This allows to understand the role of each dimension and characteristic in each plot within the urban system and how the results of these different indicators impact each other. Based on these diagnoses, urban plans can be modified to better adapt to the reality of each part of the territory.

In the daily practice of planning departments, the method can also be a highly valuable tool. By translating cadastral information into objective profiles, the *Plotter method* allows technical teams to quickly assess the territory, facilitating scenario analysis, defining intervention priorities, and developing specific policies. This integrated systematization of the method reduces information fragmentation and improves decision-making efficiency.

Furthermore, this method can contribute to tax justice and citizen participation. In tax justice, the ability to evaluate plots based on different dimensions and characteristics creates the conditions for defining tax rates that are more consistent with the potential that each plot is meeting, for each dimension and characteristics, during the evaluation period. In citizen participation, the *Plotter method* allows complex data to be translated into accessible information. This transparency can broaden the population's understanding of how decisions made in each plot impact urban life, potentially stimulating public engagement in public debates.

More specifically, Table 22 highlights some aspects about the importance of how each dimension and characteristic of the plot system, with their respective integrated profiles, can contribute to decision-making in planning.

Table 22 – How can each attribute of the Plotter method contribute to urban planning practice?

Dimensions	Attribute	How can it contribute to urban planning?
	Social	It contributes to greater transparency of information and a conceptual framework for the importance of property owners in strengthening social cohesion and policy. It helps also identify plots with the greatest potential for community use - such as squares, parks, and schools - promoting greater accessibility and urban integration.
	Economic	It contributes to a detailed understanding of the processes of appreciation, stagnation, and economic inequality in the territory. This allows for guiding planning strategies that promote greater economic balance in the territory, such as defining tax incentives to attract economic activity in peripheral areas and stimulate local economies.
	Environmental	It contributes to a strategic understanding of the importance of permeable areas in each plot, as it informs decisions on flood mitigation, heat island reduction, and climate adaptation policy guidance. This dimension allows for the definition of minimum permeable land levels or cultural solutions such as gardens, green roofs, and draining pavements, through disciplines in specific areas of the city.
	Morphological	It contributes to the understanding of urban plot design and occupation patterns. Plot design, including shape, size, façade and density, helps identify areas most likely to benefit from different development strategies. Plot design influences the construction of buildings and façades, the movement of people and the most attractive plots.
	Legal	It helps identify land structure patterns by identifying the intensity of property rights per plot and the types of ownership associated with each plot. This dimension helps understand the concentration and fragmentation of power within each plot.
	Institutional/ Planning	It contributes to understanding how planning rules and urban parameters influence city development. This dimension highlights the role of urban laws as an agent that defines the potential of each urban area.
	Multidimensional profile	It provides a comprehensive understanding of urban reality at the plot level and identifies areas with greater or lesser multidimensional intensity. It allows us to understand which plots utilize the greatest potential of their main dimensions. This helps assess whether the dimensions of each plot are being utilized in accordance with the city's objectives and international instruments for sustainable urban development.

Characteristics	Transformation	It helps identify changes in the physical boundaries, land values, and functions of each plot. This characteristic is crucial for understanding where and how these dynamics are altering the urban system over time and, consequently, their impacts.
	Location	It helps identify the potential of each plot based on its location. Plots that are more integrated into the urban system, home to or near economic activities, services, or community facilities such as schools and parks, are more valued. Understanding the role of location can help understand the dynamics of other characteristics and dimensions of urban life at the plot level.
	Occupation	It allows mapping the intensity of land consumption by buildings and the life cycles of each plot. This characteristic is crucial for understanding building density patterns, identifying areas where infrastructure overload exists, underutilized areas, or potential for densification.
	Control	It contributes to understanding the concentration of control over land, identifying areas with greater or lesser agents of transformation. Understanding the amount of land controlled by each agent is crucial to identifying areas of greater concentration of power. On the one hand, the fewer agents within a small plot, the easier decision-making. On the other hand, the fewer agents within a larger plot, the greater the concentration of power over the land.
	Function	It contributes to mapping the different types of existing uses and understanding the areas where there is greater diversity or greater homogeneity of uses on the plots.
	Multicharacteristic profile	It provides an integrated understanding of the main characteristics of urban plots. This profile allows you to identify areas with greater or lesser multicharacteristic intensity, it allows you to identify the location of these plots and how the intensity of each characteristic can impact the immediate surroundings.

The second aspect is the method's multiscale scope. The method was designed to operate simultaneously at different scales - individual plot, local and city scales. This approach is essential because urban dynamics are not limited to a single level of analysis. For example, replacing a small house by a larger building alters not only the plot's use and density but also impacts mobility, shading, ventilation, the street block's landscape (etc.), influencing real estate values and the area's socioeconomic profile. Similarly, decisions made at the municipal level, such as zoning revisions or the implementation of a new public corridor, directly impact the behaviour of property owners and investors on each plot, encouraging or restricting certain types of transformation. Thus, the method seeks to understand and articulate these interactions across scales, recognizing that change is a chain of processes, in which each local action contributes to a broader configuration of the city, and vice versa.

At the city level, the analysis provided by the *Plotter method* is crucial for identifying territorial patterns. Issues such as real estate pressures, environmental and social impacts, and variations in different types of densities, for example, can be identified at this scale. Analysis at this scale provides important input for the formation of master plans, zoning strategies, and public policies, allowing decisions to be based on evidence analysed at each plot unit.

At the local or neighbourhood scale, the method reveals specific aspects that often go unnoticed in larger-scale analyses. Elements such as spatial vitality and diversity, community relations, and environmental impact become more visible in local needs. This analysis is important for understanding the role of plots in strengthening the identity and cohesion of neighbourhood areas, allowing for the identification of specific issues in each part of the city that contribute to planning practices.

On the individual plot scale, *Plotter* offers the level of detail necessary to understand the city from its smallest unit. A qualitative analysis and the specific profiles of each plot allow to identify unique characteristics that enable us to guide development guidelines more precisely according to needs, with the possibility of identifying how watch plot can contribute to urban development objectives. This analysis is crucial for guiding land use regulation, licensing, and incentive definition processes, as well as raising awareness among landowners about their responsibilities in urban development processes.

The *Plotter method* is also important because it can operate continuously and over the long term. Consolidating a structured database based on the different indicators proposed by the method, along with its historical data, allows *Plotter* to perform a systemic reading and monitoring of urban dynamics and evolution. This long-term perspective allows to observe how gradual changes, in land use, building patterns or property rights, accumulate and generate structural impacts on the city. This type of analysis and monitoring offers concrete insights into preventive territorial management. This allows professionals to monitor land transformation processes, real estate appreciation, changes in use, and environmental pressure, providing the ability to anticipate future scenarios and propose more balanced and sustainable development strategies.

8.3 The *Plotter method* as an interactive analysis and monitoring tool for planning practice

This thesis also argues for the relevance of the *Plotter method* consolidating itself as an interactive, intuitive tool oriented towards continuous monitoring, capable of integrating different scales of analysis and communicating the complexity of the plot system in an accessible way. This interactive dimension, when incorporated into planning practices, can offer practitioners an easy-to-read platform for analysing and monitoring the dynamics of the plots system in urban space. In this context, the *Plotter Explorer* is proposed as an interactive digital tool capable of translating the method into a visual and analytical experience, allowing the integrated exploration of urban data at different scales, and which can be explored over different time periods - through the periodic application of the method.

The main objective of *Plotter Explorer* is to expand the analytical and operational potential of the plot system. It aims at consolidating the method as a tool to support urban research,

management, and planning. Furthermore, this platform seeks to stimulate interactive exploration and critical thinking about the city, bridging the gap between a technical analysis of the territory and a broader, more participatory understanding of urban processes.

The platform's structure is based on the logic of visual and analytical exploration, organized from different layers and dimensions of information. The first level consists of two main interactive maps: the multidimensional map and the multicharacteristic map of the plot system. From these two maps, the user can navigate between different scales and indicators of the plot system. This configuration allows for manipulation and deepening of spatial understanding, through access to specific maps that represent each profile of the dimension and characteristics of the plots analysed individually. The user can also explore each profile separately, both the individual profiles on the main dimensions of urban life associated with the plots, and the individual profiles on the main characteristics of the plots.

The platform provides basic information about each plot, including data on location, borough name, and plot area. Analysis graphs complement spatial visualization, showing the number of plots classified into low, medium, and high profiles, and revealing how each dimension and characteristic behaves within the urban system. This articulation between maps and graphs makes it possible to identify patterns that contribute to analysis and decision-making. Furthermore, the tool allows for the identification of information at the local level. In New York's case study, *Plotter Explorer* brings together a sample of ten urban plots from New York City, two areas in each borough, offering a more detailed view of the plot system in different intra-urban contexts. These ten plots represent the case study developed at the local scale, in which it is possible to identify specific attributes that can contribute to understanding what the plots represent for the locality under study.

The *Plotter Explorer* interface provides users with data on the main dimensions and characteristics of mapped plots, which can be analysed, with pre-organized layers and elements. The primary way to explore it is through visual navigation. Users can zoom in and out, move through different zones, and click on elements to view details. Each plot polygon is configured to reveal attributes when selected, making the reading process similar to interacting with a live information panel. The interface can be used on both computers (Figure 101) and mobile phones (Figure 102).

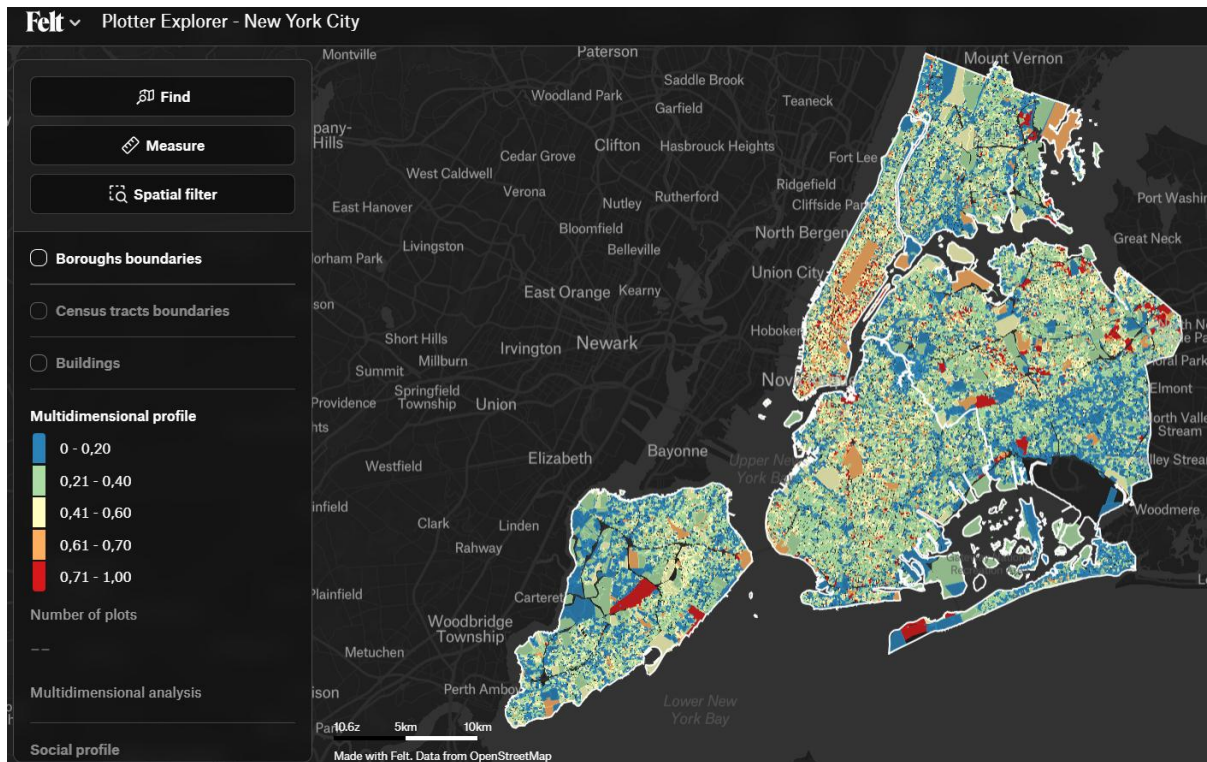


Figure 101 – Plotter Explorer – desktop interface. Source: Developed by the author with Felt platform, 2025.

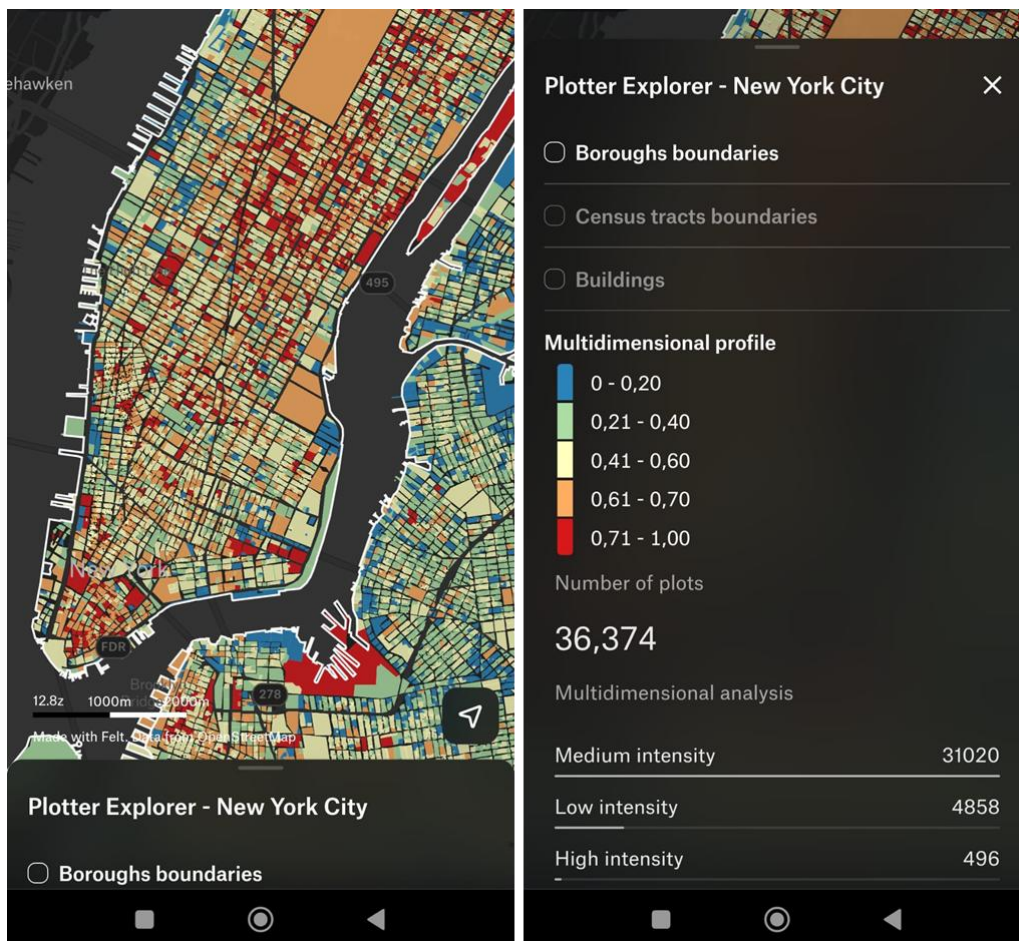


Figure 102 – Plotter Explorer – mobile phone interface. Source: Developed by the author with Felt platform, 2025.

At the city-wide analysis level, each profile can be viewed and analysed to identify general city patterns (Figure 103 and Figure 104). The sidebar allows data manipulation and interpretation of plots based on classification: low, medium, and high intensity. Each submap presents a specific thematic profile, and each colour represents a range of values, which can go from low to high intensity. Thus, instead of seeing only the raw territory, the user sees patterns: zones with social fragility, areas with great economic value, regions with striking environmental characteristics, denser urban forms, distinct legal specifications, or urban planning patterns.

Plotter Explorer combines these elements with a side panel displaying automatically generated statistics for each profile: the total number of plots analysed, how many are in low, medium, or high intensity, and numerical limits that explain the colour distribution. This means that users don't just see the map, they receive a quantitative context that reinforces spatial interpretation.

The main map at the top shows the multidimensional analysis, where all dimensions are combined into a single aggregate index. This map highlights areas where various pressures or characteristics accumulate. Below it, the remaining maps break down these dimensions one by one, showing what contributed to that result. The user of the *Plotter Explorer* method can thus manipulate the view of the territory in several ways: they can compare themes side by side, observe how different geographical dimensions overlap or diverge, identify territorial patterns, locate areas of greater vulnerability or potential, and understand how characteristics change from neighbourhood to neighbourhood or within the same district.

The *Plotter Explorer* method allows a complex indicator to be broken down into different intensity levels, which are represented by value ranges. Each range is translated into specific colours and can be visualized separately on individual maps. In Figure 105, we see exactly this process applied to the multidimensional profile of New York, which can be applied to the other profiles as well. The side panel displays the defined ranges for the indicator, and each map shows only the elements that fall within the corresponding range. Thus, instead of observing all intensity levels on a single map, the user can activate only one class at a time. Furthermore, the side panel automatically updates the statistics whenever a range is isolated. The user can see the total number of units in that class, as well as how many belong to the remaining intensities. This provides immediate quantitative context, helping to interpret the relative weight of each range.

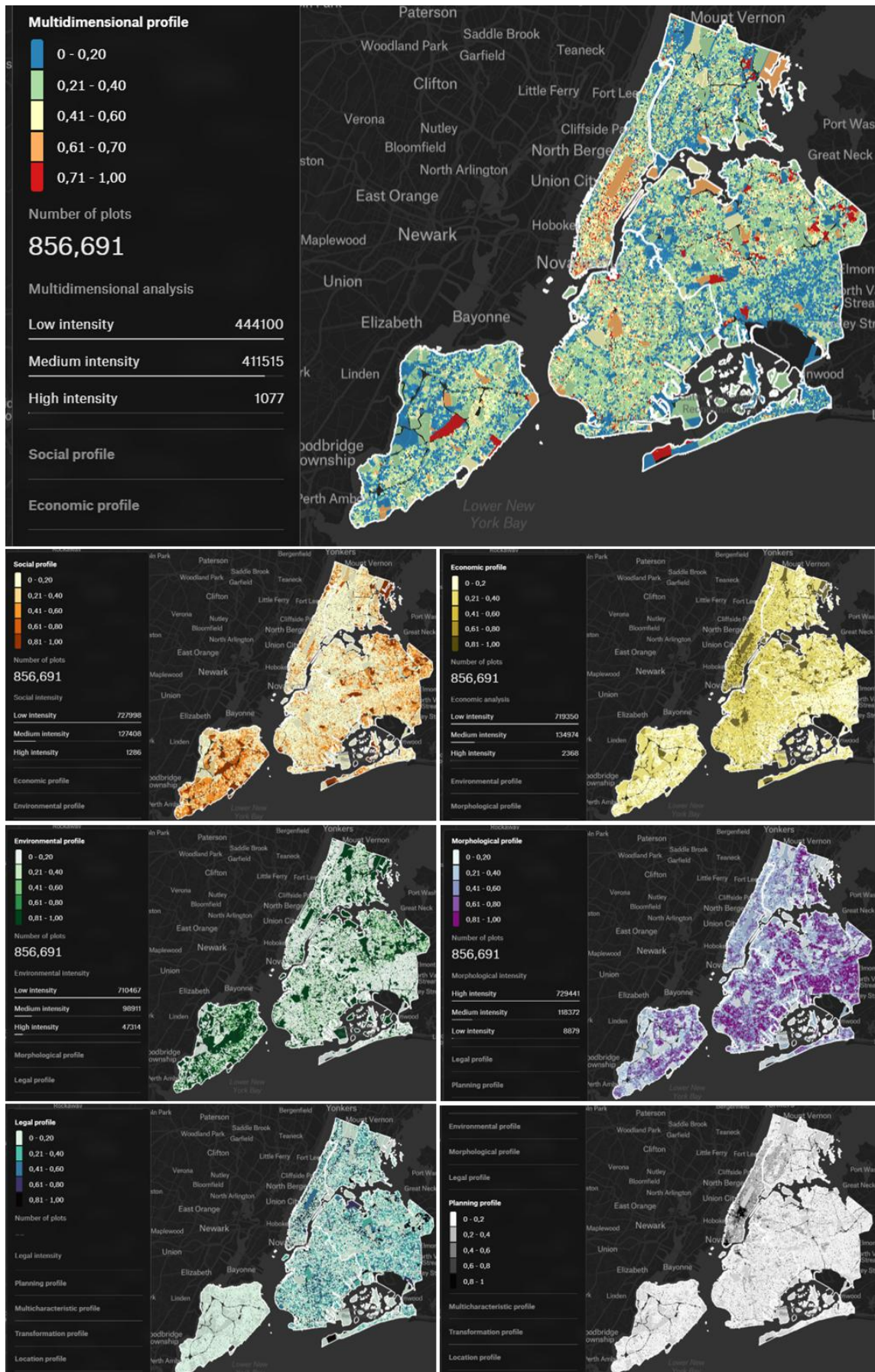


Figure 103 – Plotter Explorer, different possibilities for viewing and analysing the urban dimensions.
Source: Developed by the author with Felt platform, 2025.



Figure 104 – Plotter Explorer, different possibilities for viewing and analysing the plots characteristics. Source: Developed by the author with Felt platform, 2025.

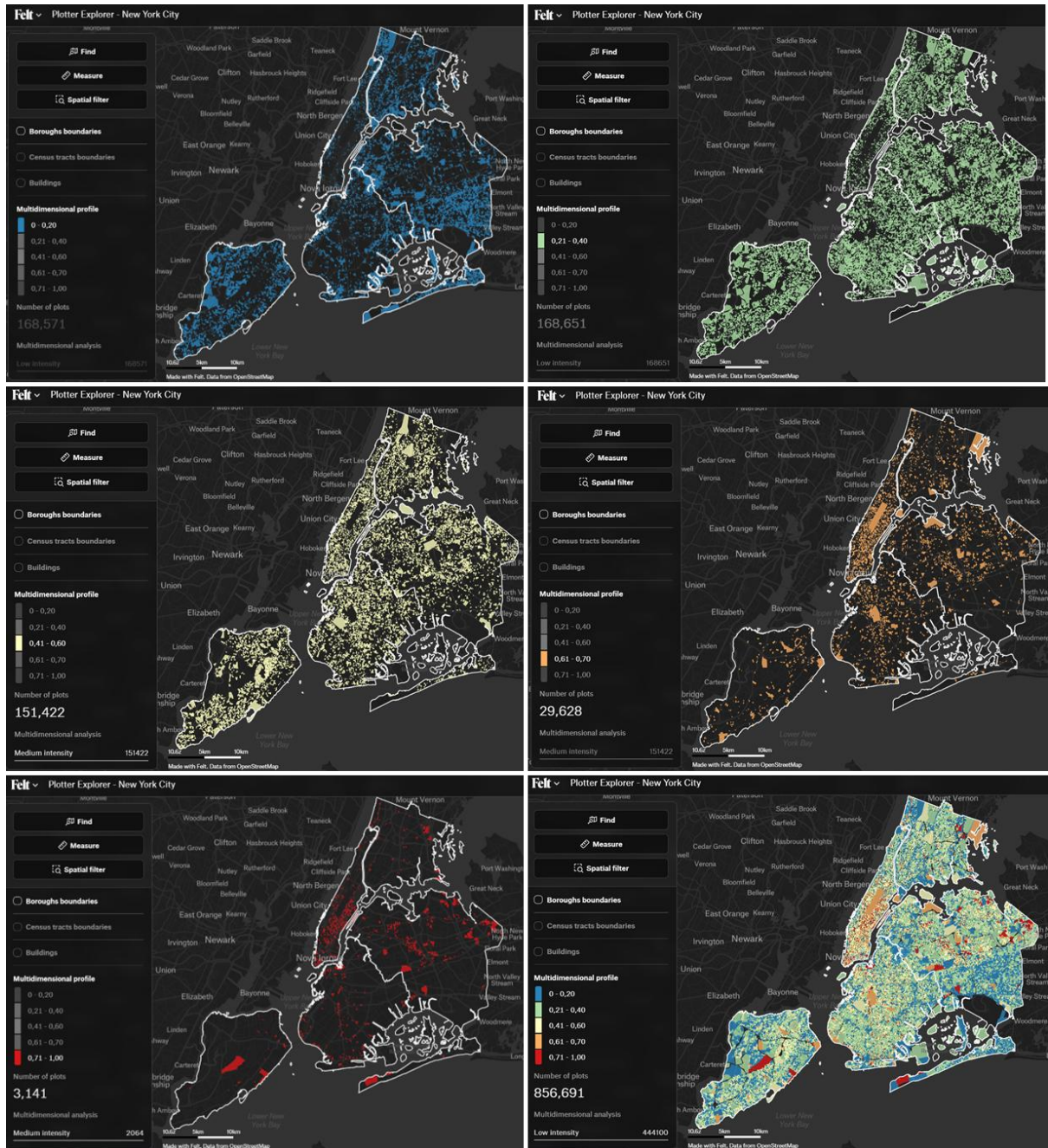


Figure 105 – Plotter Explorer, example of value-based analysis. Source: Developed by the author with Felt platform, 2025.

Local-scale analysis on the Platform involves the ability to narrow the view to the area of interest and use selection tools located in the left sidebar (Spatial filter). Figure 106 illustrates this capability. With the spatial filter, it is possible to draw the polygon of the area of interest or use an analysis radius within a specific area. This allows for the analysis of the area's profiles. Furthermore, it is possible to perform this type of analysis in more than one area simultaneously. The intensity analysis results for each profile will automatically change for the plots within the analysis area.

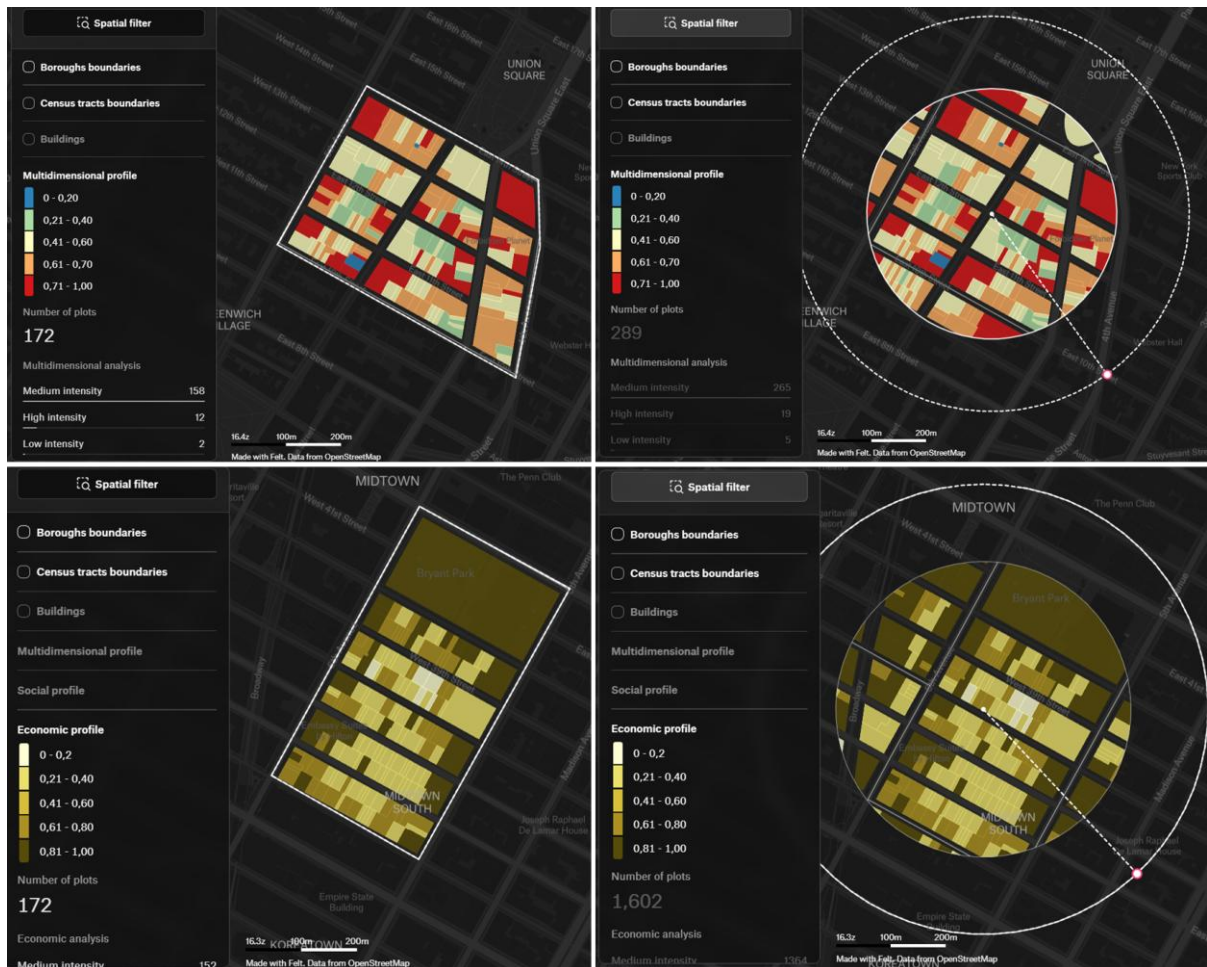


Figure 106 – *Plotter Explorer*, local analysis capability. Source: Developed by the author with Felt platform, 2025.

In *Plotter Explorer*, it is also possible to perform plot-level analysis. This can be done in two ways: by clicking directly on the plot on the map or by using the *Find* function in the sidebar to search for a specific plot. When a plot is selected, a panel automatically opens with all the indicators associated with that plot. Each indicator appears with its numerical value and intensity rating, allowing for a quick interpretation of the specific condition of that plot. With *Find*, the user can enter information such as the borough, block, plot number, or the specific name of a point of interest associated with the plot. The map automatically centres and highlights the selected plot, showing the same detailed attribute panel (Figure 107).

Watch the explanatory video on how to explore *Plotter Explorer* at this link: <https://drive.google.com/drive/folders/14EcX4GminUbWVUTylb4owRtMa95ORnLy?usp=sharing>.

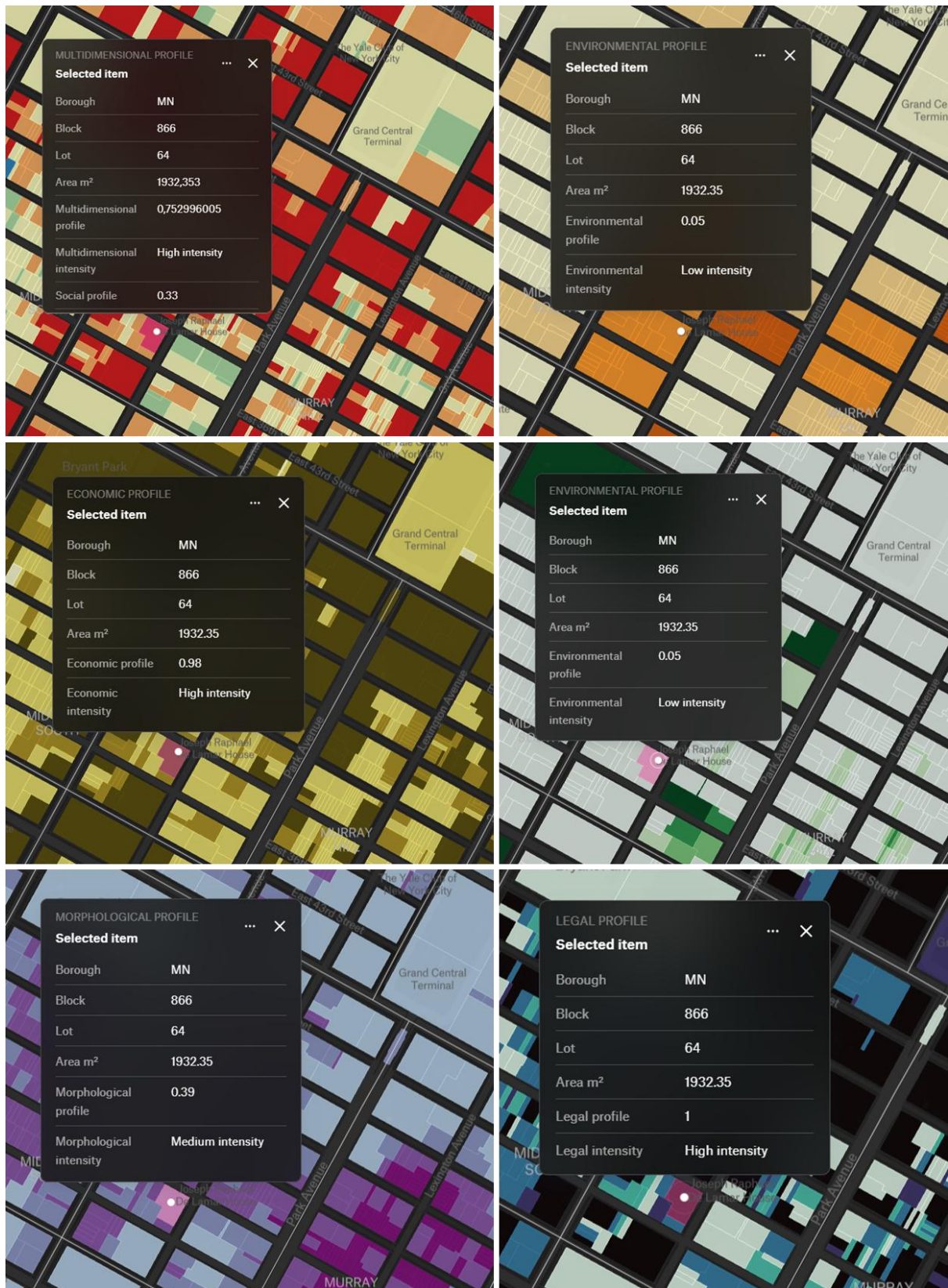
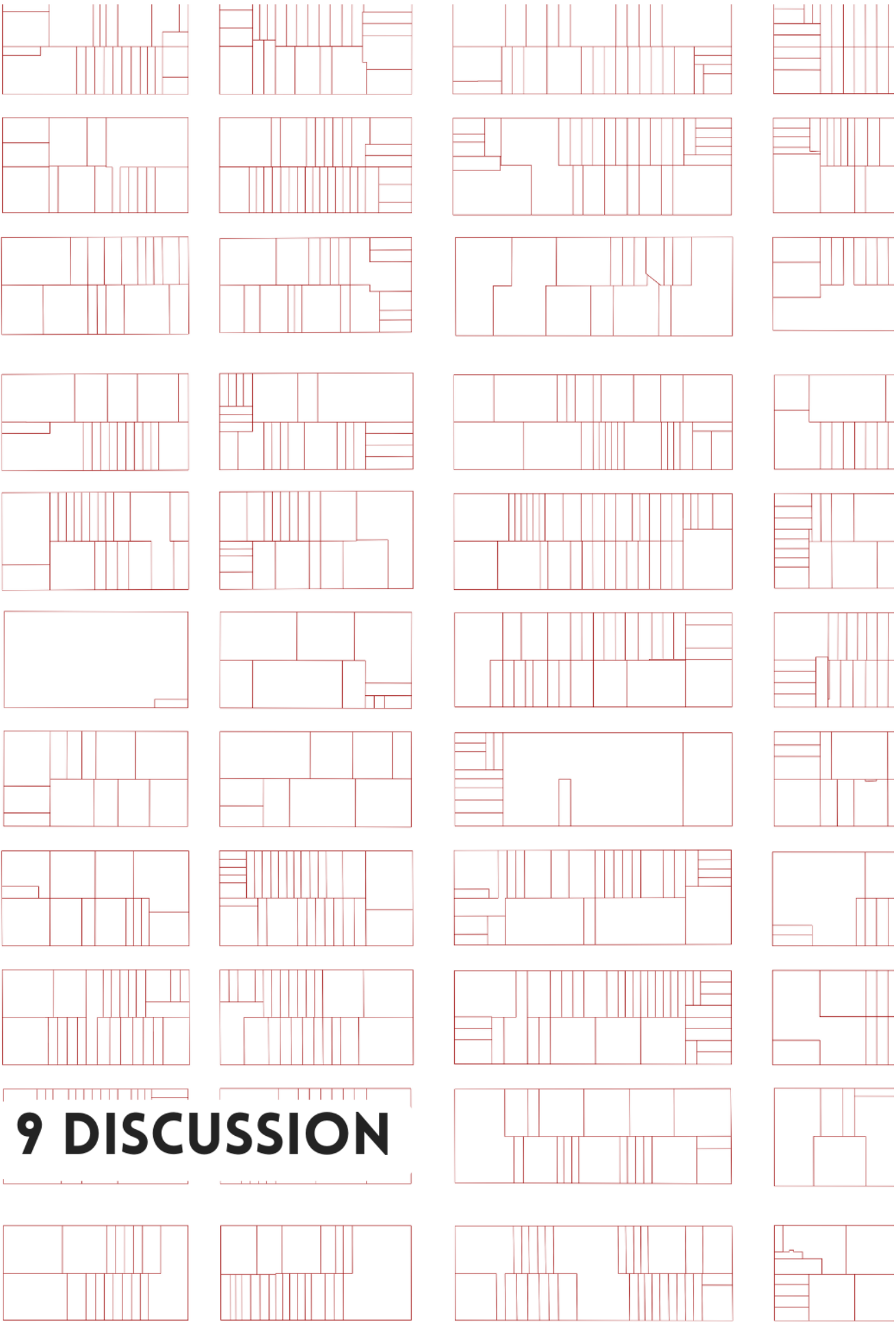


Figure 107 – Plotter Explorer, plot analysis capability. Source: Developed by the author with Felt platform, 2025.



9 Discussion

This chapter aims to debate the importance of the plot system considering the theoretical and empirical evidence produced by this research. It proposes to critically discuss the main findings of this research work, articulating them with the fundamental objectives outlined in early phase of the investigation. The chapter is in three parts, corresponding to the three main objectives of this research (see section 1.2). First, the discussion addresses the importance of plots as multifaceted elements. Second, it focuses on the application of the *Plotter method* in New York, as well as on its ability to reveal patterns and interdependencies between the different dimensions and characteristics of the plots. Third, the importance of reintegrating the plot system as a central element for urban science and planning practice is discussed.

9.1. Plots as multifaceted elements

The relevance of the multifaceted approach stems from the way different fields of knowledge converge on the plot system, allowing it to be recognized as a central element of urban life. This research demonstrated that plots simultaneously articulate morphological, legal, economic, social, environmental, and planning dimensions, and they hold critical characteristics of transformation, location, occupation, control and function (identified in the typological analysis of the literature review and applied in the method – see section 2.1 and chapters 6 and 7). All these dimensions and characteristics do not act in isolation but are in constant interaction. This recognition is not merely a matter of conceptual scope, but of analytical capacity, because the plot cannot be reduced to a single dimension or characteristic without losing a significant part of its constitutive nature (Kropf, 2018). The interrelation between the dimensions of urban life associated with the plot system and its main characteristics confers a structuring role in the organization of the urban territory, since it is in this system that most of the processes that shape cities over time manifest themselves.

Considering this interdependence, the multifaceted approach enriches thinking about its meaning, moving from a technical and fragmented understanding (associated separately with registration, measurement, economics, or property, for example) to highlighting, in the foreground, its ontological (reflexive - *about what it is*), integrative, and strategic condition (*what it can do*). The ontological and integrative condition refers to the set of meanings associated with the plot and defining what it signifies, which allows to reveal the diversity of ways in which the division of urban land is related and connected (chapters 2 to 5). The strategic condition concerns the capacity of a plot to be manipulated, organized, and transformed over time (as seen in the application of the method, in chapter 7). This understanding is crucial, as it is the starting point for considering how planning observes, interprets, and intervenes in the system of plots and urban space.

In the field of philosophy, *ontology* refers to the study of being as it *is*, that is, the investigation into nature, existence, and fundamental structure of reality. Heidegger (1927) proposed a fundamental ontology centred on understanding the human being as the one who questions and gives meaning to *being*; ontology as a core of metaphysical reflection, oriented towards understanding what exists, how it exists, and what the relationships are between being and what exists. This philosophical reflection can be applied to planning, considering that the urban space is not merely a set of physical objects, but a set of meanings and human relationships that have defined, and will continue to define, how the urban manifests itself and is lived (Conzen, 1960; Whitehand, 1977; Samuels, 2008). In this way, the *ontology* contributes, in this work, to the understanding of what we comprehend as urban plots, how the urban plots exist, and what the relationship is between the plot and *being*; which in this case refers to the permanent user of the plot, the visitor, the owner, the temporary user, etc.

Although some authors, especially in the field of urban morphology, introduce the plot as an element with more than one dimension (section 2.1), this is the first work to defend its *multifaceted nature*. Supposedly, the lack of a multifaceted approach stems from its high complexity and the immense difficulty of developing a universal understanding of this element. However, this is the crux of the matter. Cities are not alike. Although there are elements that are transversal to any city – such as streets, street blocks, plots, buildings, and land uses – the same is true for plots. The plot system differs according to its context. It is not possible to have a universal understanding in the contemporary world capable of uniting all its meanings. But there are transversal elements in all plots, such as their main dimensions and characteristics, which can be identified, developed, and interpreted in most cities.

The *legal* dimension of a plot is a good example to illustrate this. Within each urban plot boundary, there is a legal dimension that manifests itself through land or building ownership (whole or parts), the right of use, possession, usufruct, agreements established between parties, among others. Each of these attributes is associated with a legal condition, whether formal or informal, that allows the development of the legal dimension differently in each plot, which directly interferes with the relationship between the plot and the individual. The same plot may have one owner, one or more tenants, and a right of usufruct. Another plot may have a single owner who is also its user. Other plots may be corporate property, among other aspects. Another example refers to *functionality*. A plot of land is inherently functional, serving a purpose that can be to satisfy housing needs, buying and selling, production, education, leisure, etc., manifesting itself in the territory through different types of commerce, industries, single-family houses, multi-family houses, institutions, universities, schools, etc. Each plot receives one or more types of functions, and the way these functions are distributed within each plot of a city significantly impacts the individual, who in this case is the user of the plot. This way of thinking can be extended to the other dimensions and characteristics of plots, making it possible to identify the quality of a plot by receiving multiple attributes. Recognizing the multifaceted nature of the plot system means recognizing that this system possesses different fundamental characteristics and dimensions that permeate most cities, although there may be distinct ways of developing and relating to the individual.

This makes the plot system an important strategic component of urban organization, since it is within (and from) its physical or symbolic boundaries that the practices, uses, and relationships that shape and give meaning to the city materialize. This strategic condition, when identified and applied, transforms plots into a powerful system for understanding and intervening in the territory, as it allows for their capacity to shape and influence urban dynamics. It was from this perspective that the Plotter method was proposed. Based on a reflective analysis of the different types and meaning of plots in a given context (typological analysis described in section 6.2), the method seeks to systematize the main existing indicators considering their multifaceted nature, to measure and interpret how each dimension and characteristic of the plot is manifested and developed (taxonomic analysis described in section 6.3). This approach allows understanding the performance and evolution of plots in the territory, revealing patterns, weaknesses, and potential.

9.2. *The application of the Plotter method in New York*

The application of at multiple scales, encompassing its diverse dimensions and characteristics, and demonstrated how the individual profile of the plot impacts urban life in general. In fact, these dimensions and characteristics do not always evolve harmoniously. They often follow distinct logic and directions, reflecting the tensions inherent to the city's complexity. Therefore, an integrated analysis becomes essential, since the physical and symbolic boundaries of plots act as points of intersection where different meanings and intensities manifest themselves. When observed together, these intersections reveal that the patterns of the plot system exert a significant influence on the structure and functioning of the city.

In New York, when analysing the city scale, the social and environmental dimensions develop in the opposite direction to the economic and legal dimensions, for example (see correlation analysis in the graphs in Figure 109). The greatest social and environmental intensity is in Staten Island and the peripheral areas of the other boroughs, with only specific points in the central areas of New York. The intense pursuit of the New York way of life and the rules of the American real estate market significantly disadvantage long-term social belonging linked to property; as well as the decrease in the percentage of permeable areas within the city's central parts³⁵.

In contrast, the intensity of property rights linked to urban plots is significantly greater in central areas, following the same pattern of concentration of the economic dimension (characterized by high land value, a high number of real estate transactions, and intense economic activity in each plot). These trends are deeply related to the location of the plot, the ability of a piece of land to acquire meaning and value based on its position in space.

In Manhattan, for example, a small plot on Fifth Avenue can reach millions of dollars in value due to its proximity to global financial and commercial centres, while similar sized plots in Staten Island or The Bronx have much lower values. Similarly, areas like the Hudson Yards or

³⁵ In New York, the Central Park was a great idea at the time of its implementation, promoting a considerable green and permeable area in the centre of one of the most densely built cities in the world

the surroundings of the Central Park exemplify how investment in infrastructure and the symbolic prestige of the location enhance land value and capital concentration. In Brooklyn, neighbourhoods like Williamsburg and DUMBO illustrate how urban redevelopment and the cultural enhancement of certain areas generate rapid socioeconomic transformations, altering the sense of belonging and land use. These examples demonstrate how location contributes as a powerful mediator, influencing not only the definition of land value but also the type of relationship that residents establish with each plot and the urban space.

Areas with privileged location are also positively related to transformation, occupation, and functional characteristics. Areas with high location intensity show a greater tendency towards transformation processes. Of course, this is reflected in the intense economic appreciation that contributes to the progressive change in land value and property transfers. Although the physical transformation of plots occurs on a smaller scale, it is in areas with greater location integration that the greatest number of plot divisions or amalgamations occur. High occupation intensity, in turn, is strongly associated with privileged location, but also with the degree of economic development and the intensity of property rights associated with each plot. In this pattern, it is also observed that location is associated with high functional intensity, favouring the concentration of activities and the capacity to attract flows.

Although the morphological dimension shows high intensity levels across New York City (section 7.2), it also reveals the lowest positive correlation with the other characteristics and dimensions analysed. However, this result should not be interpreted as a problem, but rather as a peculiarity of the structural nature of this dimension. The morphological analysis was conducted using three fundamental indicators widely recognized in literature: area, frontage, and density. In general, the smaller the area and frontage, and the higher the plot density, the greater the morphological potential of an area for urban development, reflecting a greater capacity for adaptation of the urban fabric. Although numerical results indicate inverse correlations between the morphological dimension and the control characteristic, for example, the relationship between the indicators of both reveals complementary and positive behaviour. This occurs because the smaller the area controlled by a single owner, the greater the capacity for local management and intervention in urban space tends to be, reducing the concentration of power over large tracts of land. In contexts where control is exercised over small plots of land and different agents, there is a greater possibility of more dynamic and diversified, urban processes emerging, favouring the mixing of uses and the vitality of space. However, this depends significantly on the institutional and planning interests of the city.

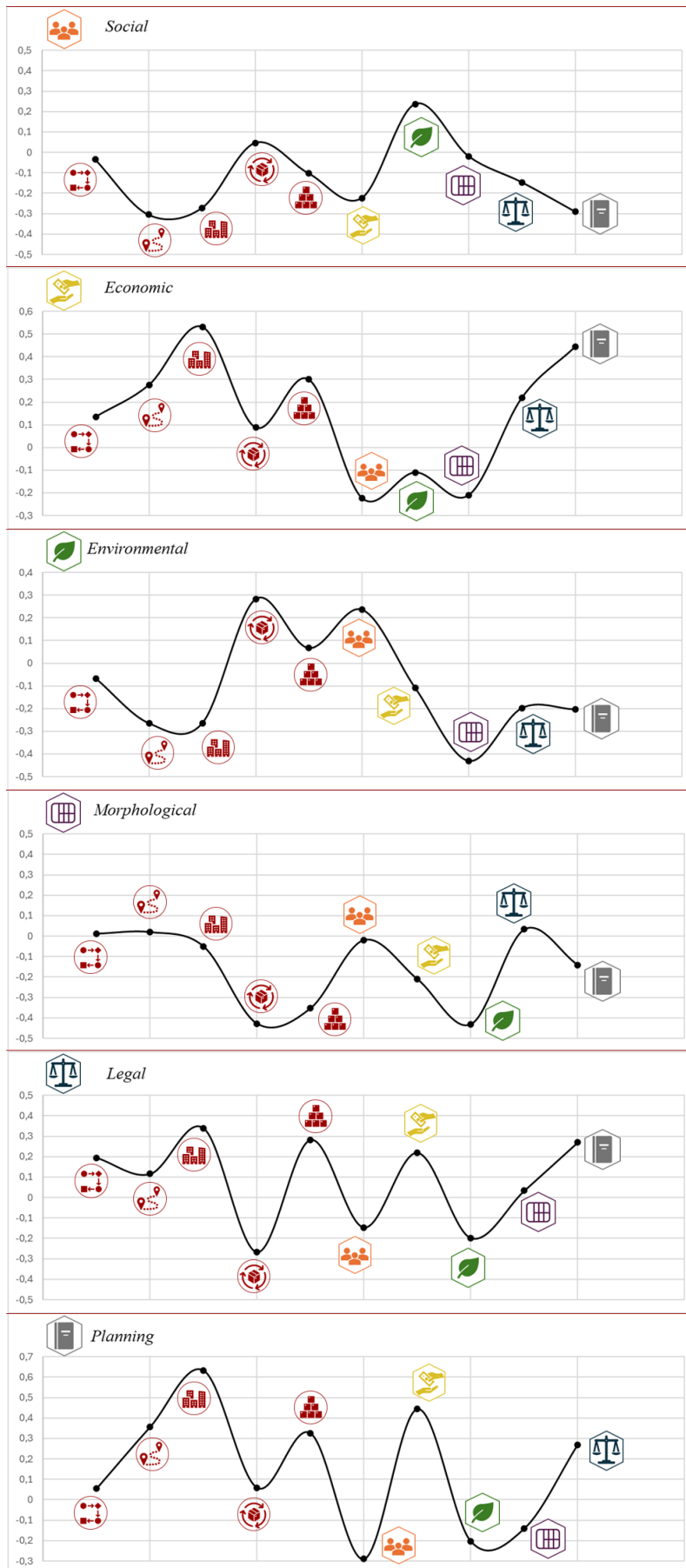


Figure 108 - Correlation analysis – dimensions

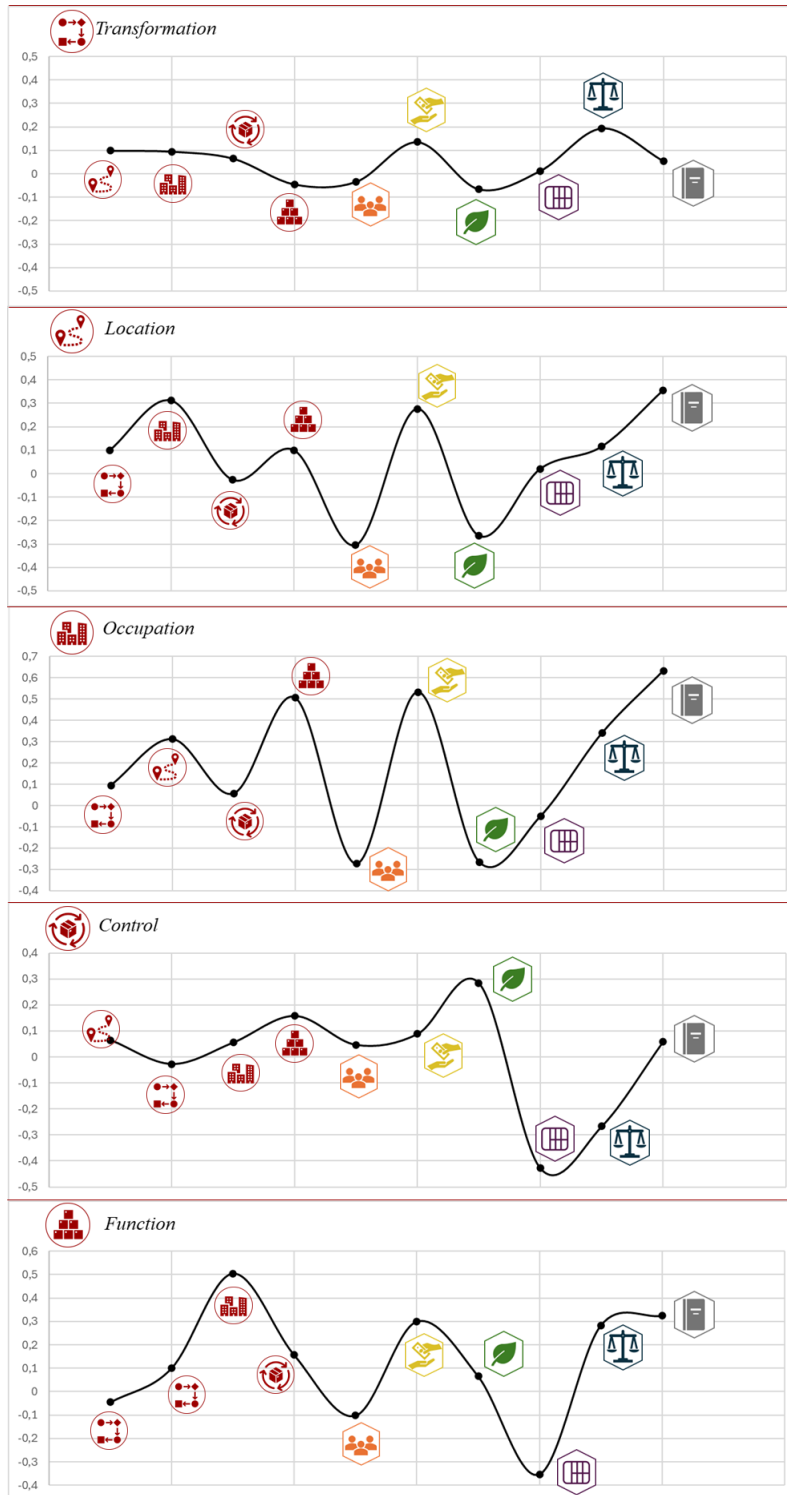


Figure 109 - Correlation analysis – characteristics

The planning dimension, at the city scale, demonstrated by the utilization rate, highlights the areas with the highest intention to use land for building construction. The highest intensity, particularly in Manhattan and parts of Brooklyn and Queens, coincides with regions of high economic, legal, occupational, and functional intensity. This overlap shows how urban planning can contribute to strengthening the potential location, land value, intensity of property rights, and functions of each plot.

The objective of this method is not to determine cause-and-effect relationships between the dimensions and characteristics analysed (the relationship between each indicator may change depending on the context and indicators studied), but to highlight that they are intrinsically connected. It is essential to recognize that all these processes manifest themselves concretely in the physical plane of the city, with the arrangement of plots and their different forms of occupation, and that they directly shape daily practices. Discussing these general patterns at the city scale is, therefore, a way to understand how the physical and non-physical structures of the city directly influence how each plot develops and impacts, positively or negatively, the territory and the individual.

Local-scale analysis was fundamental for this research allowing for the detailed identification of the dynamics and specificities that structure daily urban life, which are not captured at broader observational scales. By focusing on the user level, the *Plotter method* makes it possible to understand how the physical and symbolic elements of plots are articulated and produce different modes of interaction with space. This scale of analysis makes contextual issues visible, such as the vitality of streets associated with the presence of active facades or the effects of control concentrated in property types. In Manhattan, for example, the presence of active and multifunctional facades, in the cases analysed, reinforces the vitality of the surrounding space. Another example is the high diversity of property forms identified in Manhattan, such as corporations, LLCs, and TRUSTs, compared to plots in more peripheral regions where individual ownership predominates.

Furthermore, the potential of the *Plotter method* also lies in its ability to integrate all the discussed indicators into a single unit of analysis, the plot. This integration allows for a comprehensive understanding of what each plot represents within the urban system and simultaneously assesses the intensity and balance of its attributes in relations to other plots. Plot-scale analysis becomes a tool to highlight the impact of each unit on the territory, functioning as an urban performance dashboard that visually and numerically translates how a single plot acts in terms of each evaluated dimension and characteristic, recognizing the role of each land unit in urban layout.

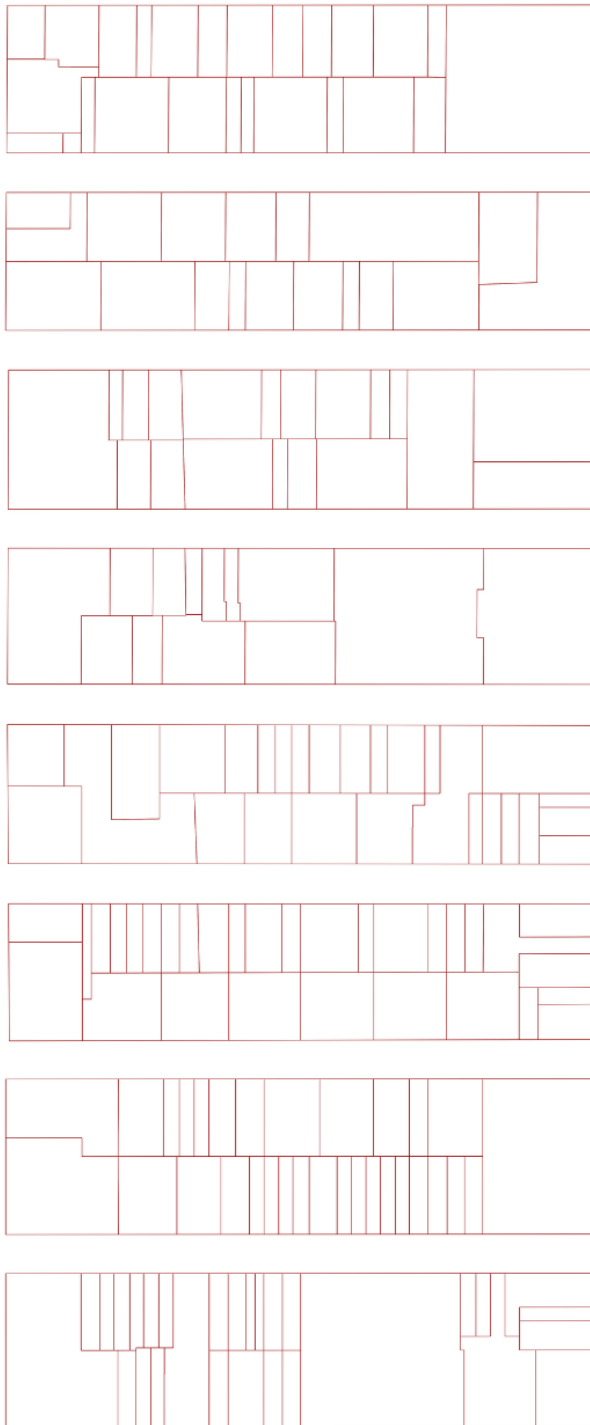
9.3. The importance of the plot system for urban science and planning practice

Throughout the evolution of urban planning, this discipline has sought to reconcile theory/research with practice. From rational and systemic models to collaborative and postmodern approaches (Taylor, 1998; Allmendinger, 2017), the field has transformed itself to respond to the growing complexity of contemporary urban life. Even so, despite theoretical and methodological advances, planning practice remains largely distant from the knowledge produced by the field or urban morphology (Samuels, 2013; Monteiro, 2019). This disconnects manifests itself in the undervaluation of the plot system, whose strategic relevance lies in its capacity to articulate, in each land unit, multiple dimensions and characteristics that structure and condition the urban territory, as argued in this thesis. Understanding the positive or negative impact that each plot exerts on the city as a whole is essential, because it is at this scale that daily decisions regarding land use, occupation, and transformation accumulate effects that shape long-term urban development.

As presented in the initial chapters of this thesis, urban morphology has demonstrated, since the studies of Conzen (1960), Muratori (1959), and Caniggia and Maffei (1979) - and more indirectly in the work of Castex *et al.* (1977) - that the urban plot constitutes an elementary and most persistent unit of urban form. However, although widely recognized in the field of urban morphology, this thesis demonstrates that this unit possesses also a multifaceted nature (not recognized and not used in planning), encompassing not only a physical analytical value but also an epistemological and strategic value. Traditional and widely used instruments, such as master plans, zoning regulations, and urban codes, operate, in most cases, on definitions of urban planning parameters applied to plots, defining how building will be developed within plots - such as maximum buildings heights, setbacks, floor area ratios, types of use, etc. However, these regulations are generally based on abstract and generalized categories, formulated from normative objectives and specific interests, without considering in depth how such decisions affect and impact the different dimensions of urban life; that is, without an interpretative analysis of what the land plot system represents at the time of intervention. This gap between urban plans and the land base limits the full effectiveness of urban policies and compromises the ability to respond to the real dynamics of the territory.

The results of this research aim to broaden the planning field by demonstrating the analytical, monitorable, and strategic potential of the plot system for planning practice. Reading the city from the perspective of the plot system allows for a deeper understanding of territorial processes and reveals dynamics that remain invisible in analyses based on aggregated units, such as zones or sectors. By adopting the plot as the unit of analysis, it becomes possible to capture with greater precision how the territory is produced, appropriated, and transformed. Furthermore, the possibility of continuously monitoring these transformations through analytical tools, such as the *Plotter Method* and the *Plotter Explorer* - with its interactive capabilities and ability to apply the method periodically for continuous monitoring - allows planning to act in a more coherent and informed way in response to the city's needs.

In this sense, this thesis seeks to highlight the importance of the plot system as a multifaceted and strategic structure, capable of offering science and practice a basis for interpretation, decision-making, and possibilities for intervention based on real information. Recognizing the central role of this structure in cities implies overcoming the abstract and sectoral vision that marked much of 20th-century planning, and recognizing that cities are, in the greater proportion of urban land, plots that are interconnected by the need for exchange and whose relationships define the conditions of human life - such as equity, resilience, and sustainability.



10 CONCLUSION

10 Conclusion

This thesis argued that plot systems possess a multifaceted nature that manifests itself and takes root in each territorial unit (physical or behavioural unit). It argued that it is precisely this inseparable fusion between the plot's delimitation and its multifaceted character that confers on it the structural capacity to influence and impact urban development. To explore this argument, the thesis proposed developing the integrated theoretical-conceptual basis on the different meanings of plot systems in various areas of urban life; and developing a spatial analytical method capable of quantifying this complexity. To this end, the thesis sought to answer the following general research question: How can the whole complexity of the plot system, in its interaction with urban development, be captured?

First, the research demonstrated that the plot system has different models that are created and developed according to context and culture. Second, the investigation showed that the plot system co-evolves as a multifaceted entity, with different meanings that guide the development of much of the urban land, based on the decisions made in each plot unit. Third, the research proved that the plot system is an entity capable of being analysed in an integrated way, across different scales and by distinct disciplines, and can be a strategic tool of great value for the science and practice of planning.

Despite the growing number of studies dedicated to the topic, there is still no consensus in the literature on *what a plot is* and how it should be conceptually understood. This lack of consensus reflects the diversity of disciplinary and cultural approaches that address the same object from different perspectives and that, often, are incommunicable with each other (as seen in the literature review chapters). Recognizing this diversity of interpretations, leads to acknowledge that plots do not have a single meaning, as their significances manifest themselves in different ways according to the historical, cultural, and institutional context; but there are dimensions and characteristics in plots that are transversal to any city – which allows to recognize that the plot is a multifaceted element.

These different manifestations were classified, in this work, in an attempt to integrate the understanding of their meaning, as *formal plots*, which are associated with property registrations and have a character closer to the idea of exchange value, and *non-formal plots*, which are associated with behavioural agreements (traditional communities), the non-existence of land as an economic and property element (such as countries where land ownership does not exist), or as urban areas that are organized through social decisions as a response to difficulties of social inclusion (such as informal plots in irregular urban areas, like favelas), which are more associated with the idea of use value.

In this research, the formal plots model was adopted as the central focus of analysis, since it constitutes the predominant basis of territorial organization in contemporary urban systems and allows for a more structured understanding of what the plot represents in different disciplines. The literature review, however, revealed that, even within this formal model, the plot system cannot be interpreted in a one-dimensional or purely technical way. This finding guided the theoretical and methodological development of the thesis, which sought to interpret the plot system as a structure with a strong ontological, integrative and strategic condition. Subsection 9.1 of the discussion chapter reinforced this understanding by arguing **the importance of recognizing the plot system as a multifaceted entity**.

The method developed in this thesis sought to understand how this multifaceted nature manifests itself and how it can be systematically studied in an empirical context. The case study allowed to observe how each main dimension and characteristic of the plot system is expressed in the territory and how the indicators are interconnected with each other and between different plots. Furthermore, the method makes it possible to understand, both quantitatively and qualitatively, how each plot presents different intensities in the manifestation of its characteristics and dimensions when compared to the other plots that make up the same system.

The distinction between dimensions and characteristics was adopted to differentiate broader analytical categories from aspects that can manifest simultaneously in different dimensions. While dimensions aggregate indicators related to a specific thematic field, characteristics were defined as cross-cutting attributes that can be expressed by different dimensions, depending on the context of analysis. For the same reason, the plot area was considered an indicator present in most dimensions and characteristics, since its influence is not restricted to a single aspect of the plot system, but conditions and relates to multiple processes analysed throughout the research.

This method is important for the science and practice of planning because it highlights, throughout the entire application process, the ontological, integrative and strategic character of the plot; and because it contributes as **a tool for reading and interpreting how the plot system is being developed – in its different characteristics and dimensions**. This is because it requires a prior exercise of interpretation (understanding what the plot represents within its geographic, cultural, and institutional context) to identify the indicators that best translate each of its dimensions and characteristics in the study area. Although the plot characteristics rarely alter its indicators, as they are essentially linked to its own nature, the dimensions may present variations according to the context, and may even include more than one indicator, given that they articulate multiple aspects associated with a dimension of urban life and the scale of the plot. This expanded reading highlights the strategic potential of plots, as argued in sections 9.2 and 9.3 of the discussion chapter.

Despite its potential, the empirical application has shown that the operational capacity of plot systems is strongly conditioned by the availability and quality of urban databases. New York City proved to be an excellent case study precisely because it has a historically consolidated planning structure and a rigorous cadastral system at the plot scale. Although this type of information seems to be a fundamental condition for planning any city, cadastral databases that

present plot systems and information on different themes at the plot scale are rare in the global context.

This finding reveals the first limitation of this method: its replicability depends directly on the existence of robust data. However, recognizing this gap also constitutes an important warning for urban planning departments, highlighting the need to develop and maintain more detailed and integrated territorial information systems.

Beyond this structural limitation related to data availability and quality, the second limitation of this thesis refers to the methodological dependence on specific contexts (although this is a limitation of most methods developed for urban studies). The method was tested in a city whose urban planning system is strongly institutionalized, with consolidated land use policies and a long tradition of land regulation. In urban contexts where these structures are fragile, non-existent, or marked by informality, the application of the method requires adaptations – going through each of its stages, considering the specific context and adapting it to meet the reality of the place. Thus, although the method presents great potential for replicability, critical and sensitive reading of the cultural, legal, and institutional specificities of each territory is necessary.

Multiple possibilities can open for the continuation and deepening of this multifaceted approach to urban plots. The first path for future research consists of expanding the ontological, integrative and strategic potential of the plot system, applying the method developed in this thesis in different geographical, cultural, and institutional contexts. Such expansion will allow understanding how the multifaceted nature of plots manifests itself under different conditions of land regulation, urbanization patterns, and social dynamics, contributing to the consolidation of a comparative framework, which can reach a global level, on the co-evolution of the different dimensions and characteristics of the plot system.

Another important path concerns the interdisciplinary approach, necessary to broaden the understanding of the complexity involved in the plot system. This system should not be treated as an object solely of urban planning (because, in fact, the plot is an interdisciplinary object), but as a field of intersection between different domains of knowledge. Each discipline connected to the plot system offers its own interpretative lenses, capable of identifying gaps in understanding its complexity, and enriching the understanding of what is understood today as its multifaceted nature. It is therefore recommended that future research from different areas of knowledge take the plot as a central element of analysis, observing it also from the logic of its own discipline (however, recognizing its role for urban planning).

Expanding the indicators for each urban dimension associated with plots constitutes another possible research axis. Identifying and analysing new indicators capable of capturing social, environmental, legal, economic, institutional and morphological aspects can allow for improved empirical interpretation. Such methodological advances can strengthen the method's potential to identify patterns and improve a shared understanding of the multifaceted nature of land plots.

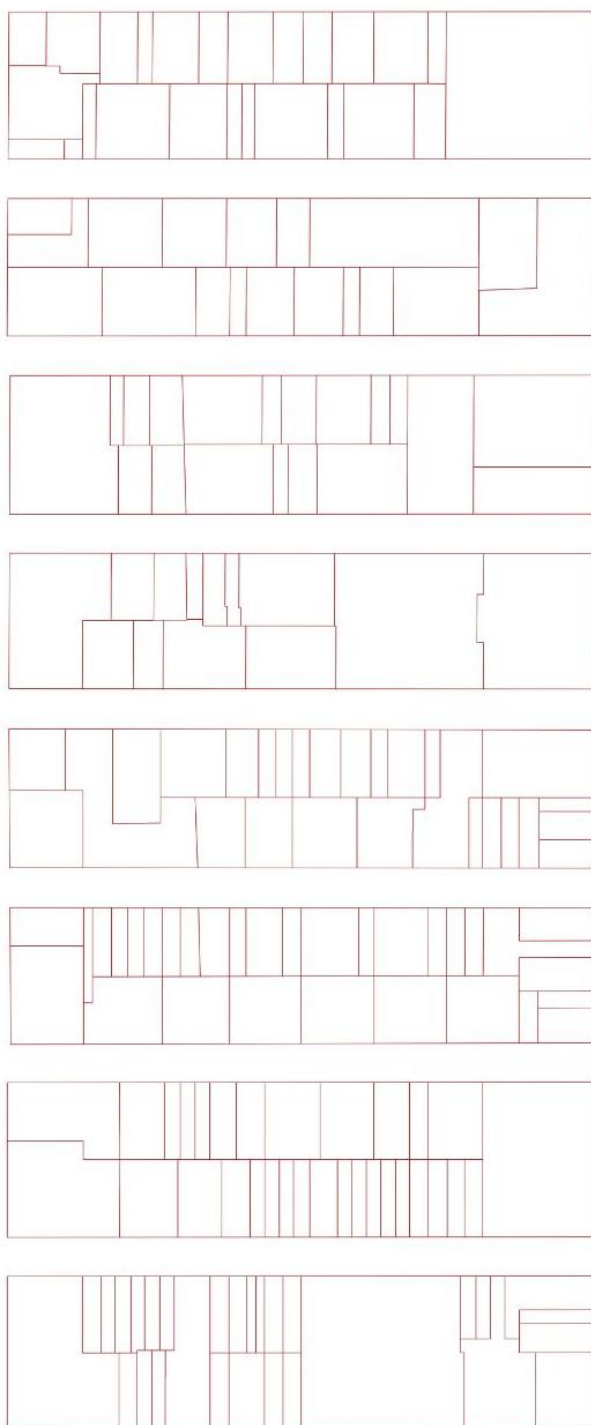
It is also important to promote comparative studies between cities with similar structural conditions. Applying the method to different realities that present structural similarities, such

as city plans or planning rules, can reveal convergent and divergent patterns in how the plot system manifests itself and influences urban development. These comparative studies can contribute to evaluating the adaptability and contextual sensitivity of the method, identifying which dimensions and indicators maintain more stable behaviours.

Another line of future research concerns the exploration of different plots models, which in this work were classified in a very incipient way as *formal* and *non-formal plots*. This distinction, even if incipient, proved fundamental to understanding the diversity of manifestations of the plot system and how different regimes of regulation, appropriation, and use shape the urban structure. Future research could deepen this classification and the way in which the multifaceted nature of plots manifests itself in each context.

Finally, it is recommended that urban planning processes incorporate the plot as a central component in the interpretation and formulation of urban policies. Before projecting future scenarios, it is fundamental to understand the existing structure from the most elementary level of the territory, the plot.

The main message this thesis seeks to convey is that the development of analytical capabilities focused on the detailed reading of the plot systems, the most elementary and determining scale of urban structure, constitutes an essential step in understanding how each plot unit contributes to the functioning and evolution of cities. The systematic identification of patterns that emerge from this territorial scale allows for a more objective recognition of the factors that contribute to both urban strengths and weaknesses, potentially revealing the dynamics that support or compromise equity, efficiency, sustainability, or any central urban development objective established by the city, starting from each plot unit.



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APPENDIX I – MAIN TERMINOLOGIES OF PLOTS

Terminology of the plots	
Terminology	Source
<i>Urban plot (s)</i>	Slomska-Przech, K. ; Slomski, M. (2022)
<i>Plot(s)</i>	Whitehand, J.W.R. (2001); Fialkowski, M. e Bitner, A. (2008); Ersland, G. (2009); Marcus, L. (2010); Diilenburger, B. (2010); Montenegro, N. e Duarte, J.P. (2011); Tarbatt, J. (2012); Oliveira, V. (2013); Oliveira, V. (2016); Kropf, K. (2014); Dovey, K. e Wood, S. (2015); Barbour, G. <i>et al.</i> (2016); Sevtsuk, A. <i>et al.</i> (2016); Stell, G. e Tait, R. (2016); Dovey, k. <i>et al.</i> (2016); Bobkova, E. <i>et al.</i> (2017); Scheer, B. C. (2018); Bobkova, E. (2019); Bobkova, E. <i>et al.</i> (2019); Liu, P. <i>et al.</i> (2020); AlSadaty, A. (2022); Song, L. <i>et al.</i> (2021); Tian, Y. <i>et al.</i> (2021); Zeynep, T. (2022); United Kingdom government.
<i>Burgage plot(s)</i>	Conzen, M.R.G. (1960); Penerai P. (1997).
<i>Parcel(s)</i>	Adams, D. <i>et al.</i> (2013); Demetriou, D. <i>et al.</i> (2013); ISO 19152 (LADM)
<i>Parcela</i>	Spain government.
<i>Parcelle</i>	Morocco government.
<i>Lot(s)</i>	Asami, T. e Okabe, A. (1994); Asami, Y. e Niwa, Y. (2008); United States government; New Zealand government.
<i>Lote</i>	Portugal government; Brasil government
<i>Land fragmentation</i>	Vicunha, M. e Rivas, L. (2022)
<i>Urban land</i>	Paasch, J.M. (2011); Souza, F. F. <i>et al.</i> (2018); Caasiano, M. <i>et al.</i> (2018); Song, X. <i>et al.</i> (2020); Kilkis, S. (2022); Zhang, Y. <i>et al.</i> (2022).
<i>Building lot(s)</i>	Usui, H. (2018); Usui, H. (2019).
<i>Construction land</i>	Li, S. <i>et al.</i> (2022); Ma, Y. <i>et al.</i> (2022); Wang, Q. e Xiao, Y. (2022); Zeng, T. <i>et al.</i> (2022); Zhou, J. e Zhu, Y. (2022); Zhang, C. <i>et al.</i> (2022); Li, Q. <i>et al.</i> (2022).
<i>Parcele cadastrale</i>	Code Général de la Propriété des Personnes Publiques, France government.
<i>Flurstück</i>	Germany government.
<i>Kadasterperceel,</i>	Netherlands government.
<i>Land parcel</i>	Australia government.

APPENDIX 2 – MAIN MEANINGS OF PLOTS

	Definitions	Source
Urban morphology	A piece of land that represents a land use unit defined by boundaries on the ground. It is a plan element.	Conzen (1960)
	The plot is considered a module of the aggregate, described by the authors as: the aggregate module is the plot – always tending towards a rectangular shape, with one of the short sides towards the front of the road and the long sides perpendicular to the road axis.	Caniggia and Maffei (1979)
	The plot constitutes the starting point from which it becomes possible to understand urban growth from a set of political, economic, and legal perspectives, each of which leads to specific conclusions, although they share with architecture and urban planning the same basic element: the plot.	Baird (1988)
	The primary cell of urban space, characterized by its length and narrowness, situated along a road, whose outer edges remained permanent once delimited, and whose ownership gave the bourgeois full rights.	Slater (1990)
	A burgage plot is a fragment of space separated by boundaries from the urban organism, together with the buildings that operate within it, constituting an independent economic complex.	Busko (1995)
	The plot is the smallest meaningful unit of spatial subdivision and a fundamental component for understanding the spatial structure of the common fabric of urban settlements.	Panerai <i>et al.</i> , (1997)
	The plot is a piece of urban land bounded by legally defined boundaries that constitute a basic unit of land control and use. Repetitions of plots in cities form a plot system that, at first glance, are invisible to the naked eye simply because they are immaterial.	Bobkova (2019)
	The plot, as a physical entity, is understood based on its size and its relationship to other elements of the urban form, and describes the spatial relationships between physical forms, such as containment, boundary, and separation. In terms of behaviour, the plot is understood based on the rights established by law regarding who can access, use, occupy, and/or conduct economic transaction with a specific area urban land.	Song <i>et al.</i> , (2022)
Law	The plot corresponds to two types of rights: the right of use and the right of possession.	Alchian (1965)
	Land ownership is structured in three ways: private property, communal property, and state property.	Demetz (1967)
	The right to use a portion of land grants the right to exclude other people.	Bromley (1991)
	The types of property rights for urban land are simple ownership or perfect ownership; leasehold; right of possession; life interest.	Dixon (1994)
	Urban land presents different types of ownership: zero legality, some degree of legality, and total legality.	Payne (2000)
	Urban land is property that confers economic and social power and wealth to its owners, who can then exert influence over urban planning policies and their consequences.	Dixon (2009)
	Land boundaries are lines that define and separate property or jurisdiction.	Cole and Wilson (2017)

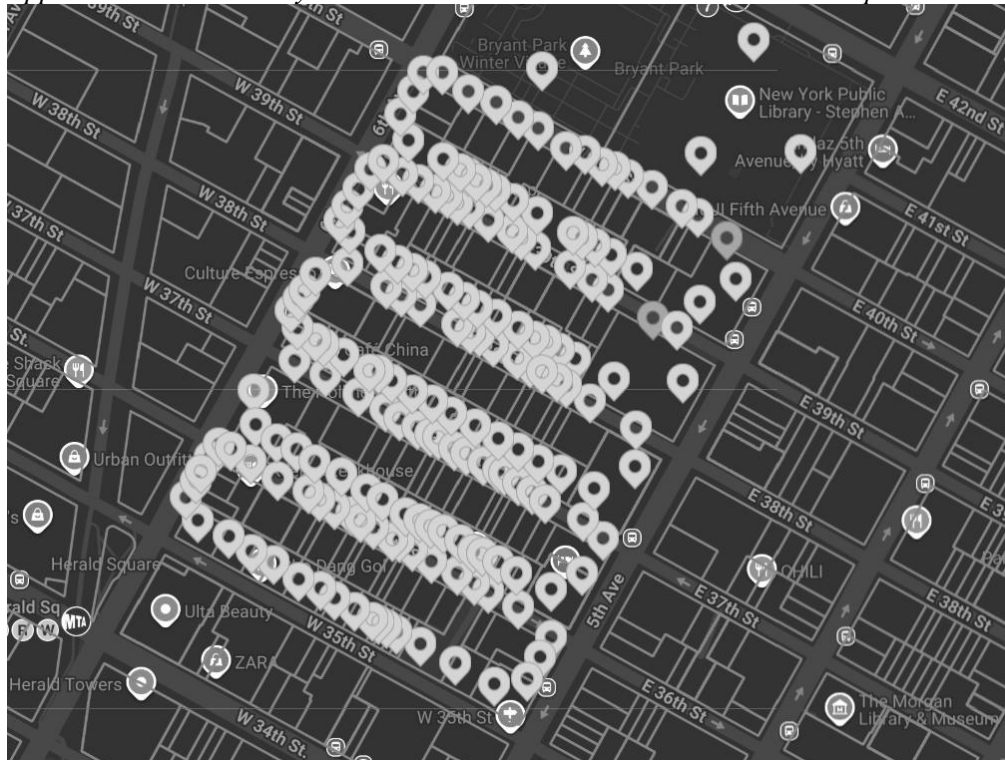
	Each plot of land has unique characteristics that differentiate it from other plots, such as location, topography, land and surroundings.	Vejchodská (2022)
Economy	The use of a plot of urban land influences that usability of neighbouring and agricultural sites, making the land a community resource. Urban land can be defined as land used or expected to be used for urban activities. Its attributes include location, space, ownership, grouping, heterogeneity, and immobility and indestructibility.	Qadeer (1981)
	A plot of land is a real property within urban space, a particular type of asset characterized by the land as a whole and the resources incorporated within the land. It is a product of the real estate market for the exchange of landownership between different owners and tenants.	Harvey (1985)
	The land plot is a source of capital accumulation through land rent.	Jager (2003)
	The plot is a unit for tax purposes and a generator of positive or negative externalities.	O'Sullivan (2003)
	Spatial clusters form, grow, change in use, mix and identity, decline and disappear as the benefits of combining shared positive externalities change.	Webster and Lai (2003)
	Different ways of structuring landownership rights result in different transaction costs.	Needham (2006)
Environmental	The horizontal structure of ecological ecosystems can be represented as plots of ecological unity within urban space.	Alberti (2008)
	Land use defines how efficiently living spaces are utilized, whether wastefully or effectively.	Hu <i>et al.</i> (2021)
	Urban land is a scarce resource.	Oliveira, (2021)
	The spatial shape of the plot influences the urban thermal environment.	Zhao <i>et al.</i> (2023)
Planning and institutional	Local and regional governments are the arbiters of how a plot of land should be used, built upon, and developed.	Qadeer (1981)
	Controlling the proportion of land use as a land use policy planning tool has broad implications for urban planning, property rights, and social equity.	Lin <i>et al.</i> (2022)
	Urban planning policies involving the division and merging of land plots can radically transform urban areas, favouring certain social groups.	Vicuña and Rivas (2022)
Social	A land tenure system sustains and is maintained by the social structure. The use of a portion of urban land influences the usability of neighbouring areas; this characteristic makes urban land a community resource.	Qadeer (1981)
	Physical boundaries that structure the urban community network.	Eysymontt (2009)
	The social justice has three principles: democracy, diversity and equity.	Fainstein (2014)

APPENDIX 3 – LANDGLID – FIELD SURVEY

Appendix 1 – Plots analysed on-site in Manhattan – Greenwich Village



Appendix 2 – Plots analysed on-site in Manhattan – Midtown – Times Square



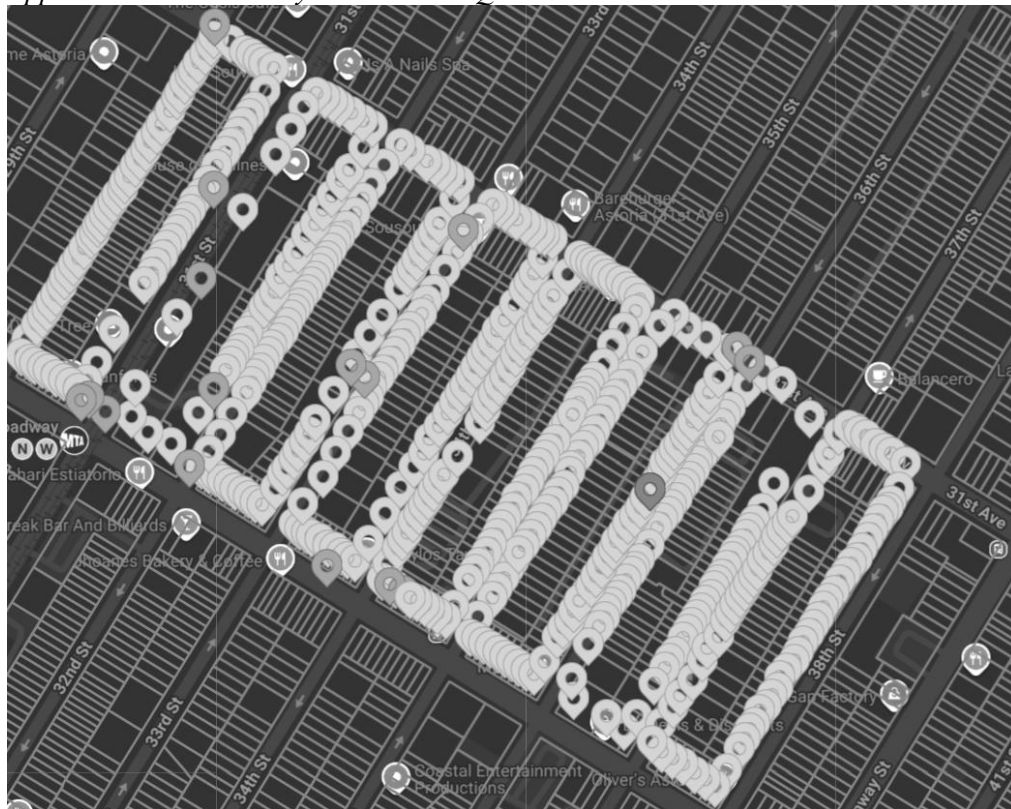
Appendix 3 – Plots analysed on-site in Brooklyn – DUMBO – Boerum Hill



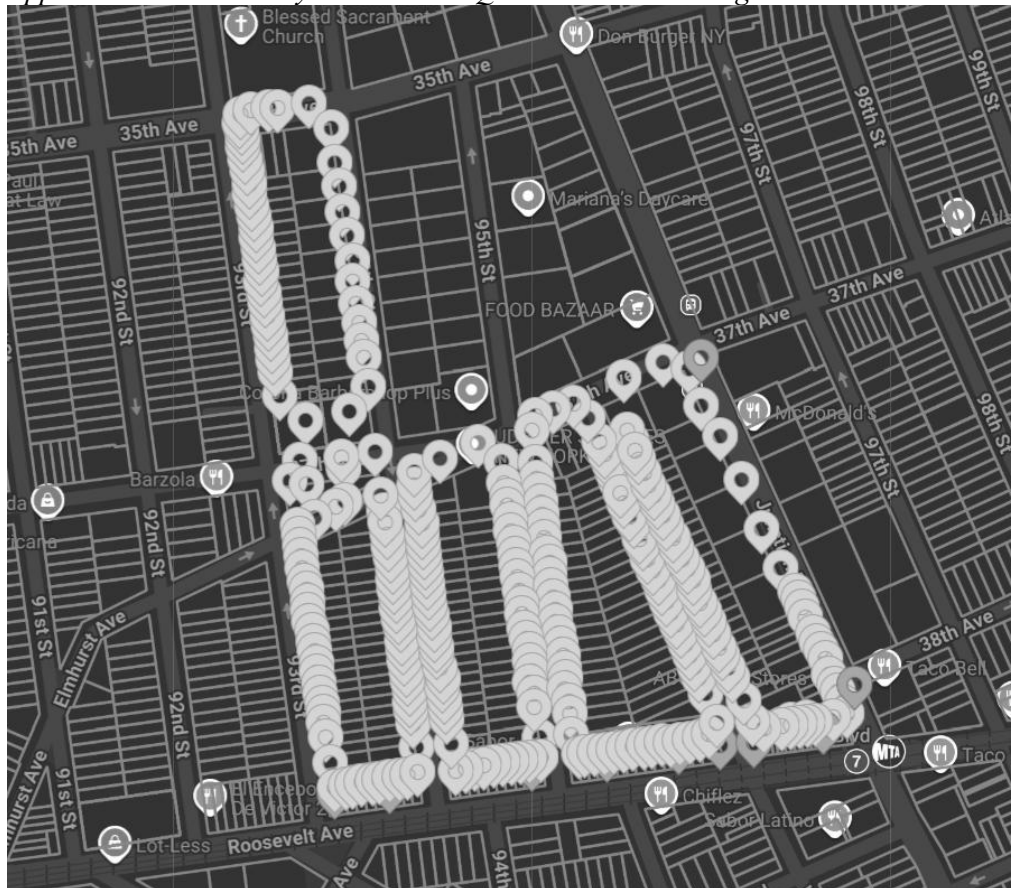
Appendix 4 – Plots analysed on-site in Brooklyn – Flatbush



Appendix 5 – Plots analysed on-site in Queens – Astoria Central



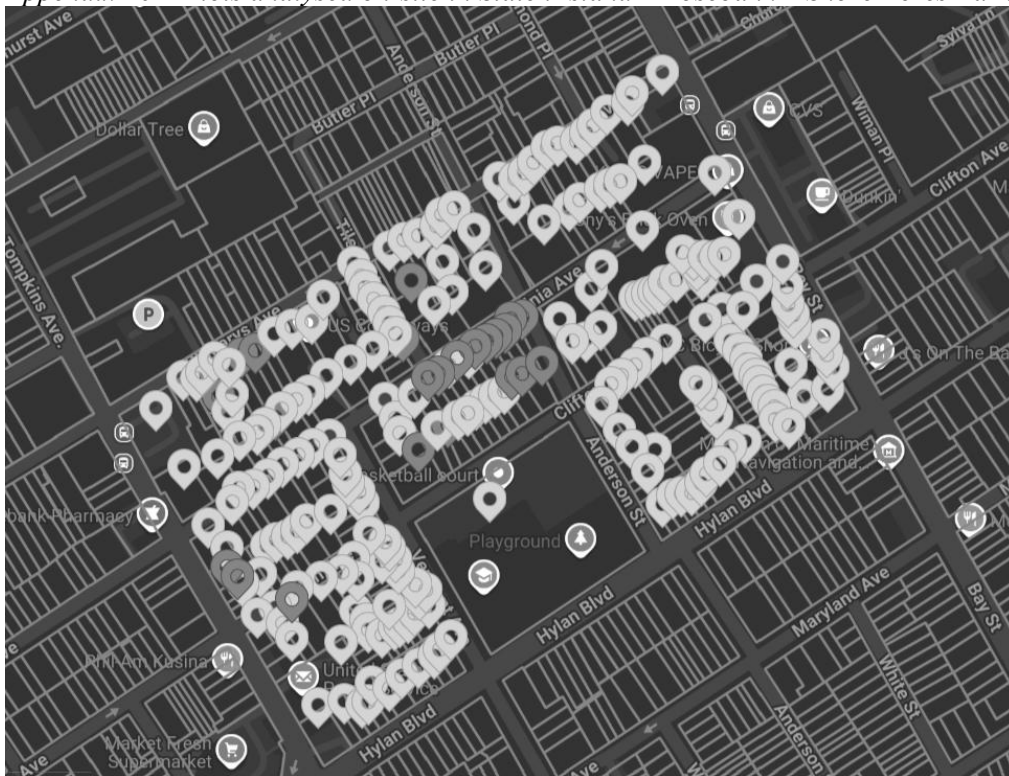
Appendix 6 – Plots analysed on-site in Queens – Jackson Heights



Appendix 9 – Plots analysed on-site in Staten Island – St. George – New Brighton



Appendix 10 – Plots analysed on-site in Staten Island – Rosebank – Shore Acres Park



Appendix 11 – Work interface for on-site data collection

