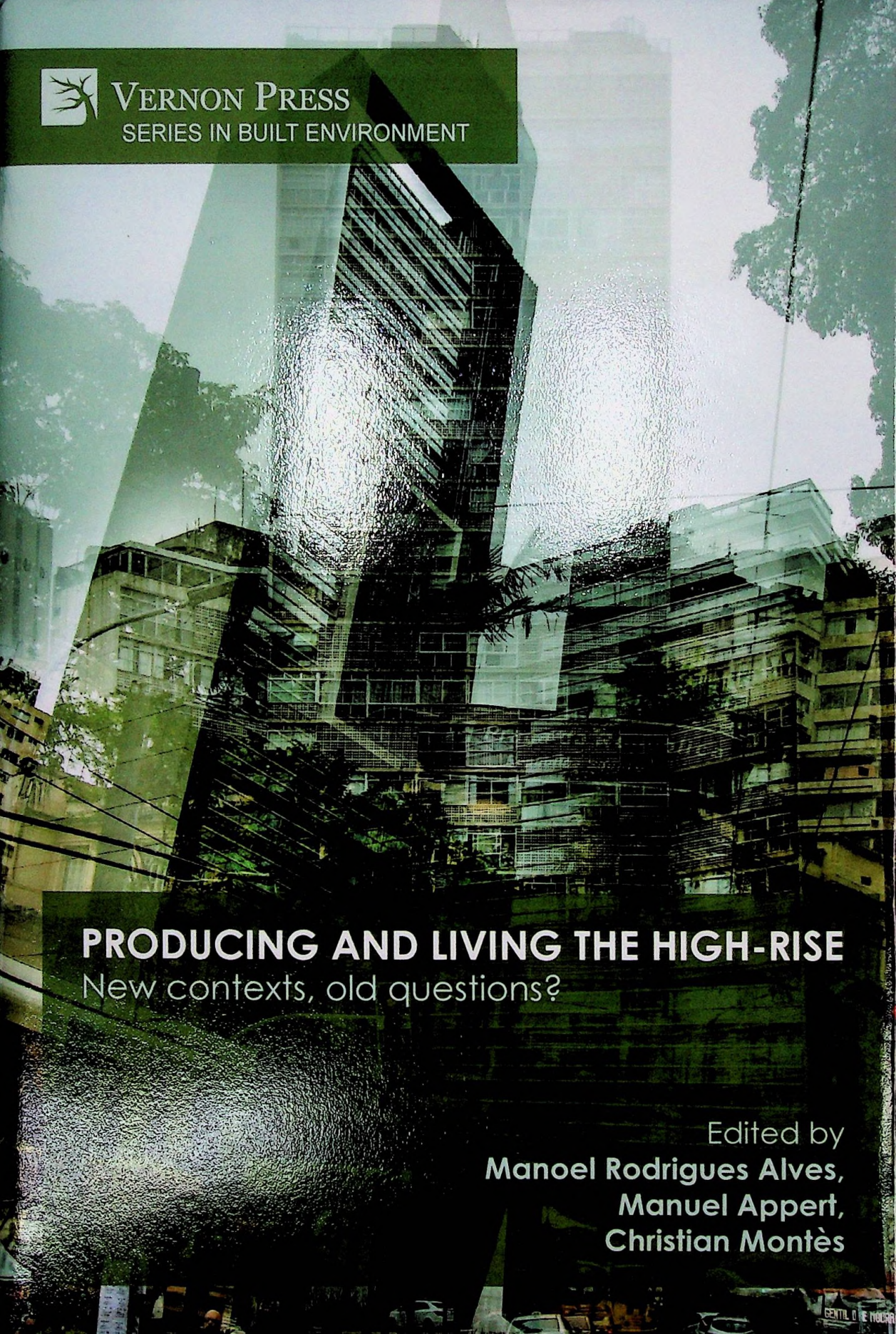
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New contexts, old questions?
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Chapter 13

Urban investigation and verticalization in São Paulo

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Abstract

Contemporary urban space is characterized by neoliberal political and economic dynamics, in which the city in itself, not only the urban land, is considered a financial asset. Cities are guided by the logic of capital reproduction and private investment, where high-rise buildings may be considered commodities, and urban policies related to the real estate market can promote gentrification and socio-spatial segregation. High-rise buildings in São Paulo date back to the early decades of the twentieth century, intensifying during moments of economic growth and the implementation of policies to incentivize the building industry. In São Paulo, the Strategic Master Plan (Plano Diretor) presents urban instruments, such as the Structuring Axes of Urban Transformation – SAUT (Eixos de Estruturação da Transformação Urbana - EETU), that encourage the construction density in specific regions of the city. In this context, high-rise buildings have become more and more a new strategy for capital valuation. Adopting different procedures, stages, scales, and reading parameters and based on territorial units of analysis, this work presents a methodology designed to investigate verticalization that allows for quantitative and qualitative analysis of the urban space and its configurations.

Keywords: Verticalization, high-rises; territorial units of analysis, methodology, São Paulo

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Introduction

Transformations in the contemporary urban space are largely reflections of neoliberal political and economic dynamics based on financial capital and financialization processes. In this context, where urban land is understood as a financial asset and high-rises[1] as commodities, cities are guided by a logic of capital reproduction that determines an ever-growing replacement process, once departing from the triad "city-work-politics" to "city-management-business."(Alves and Daitx 2021)[2]

Therefore, there has been a significant increase in the participation of private companies in urban interventions, while the State takes on the role of manager and promoter, usually fostering investments in specific areas of the city. Such policies, when associated with the real estate market, end up favoring the interests of private agents at the expense of social interests in a movement of valuation of use and exchange from which profits and the expansion of capital and companies are fueled (Medeiros 2019, 143-163).

In São Paulo, the recent Strategic Master Plan of 2014, and its review in 2023, introduces important legal urban instruments based on public-private partnerships (Fix and Arantes 2022) such as Consortium Urban Operations (OUC, Operações Urbanas Consorciadas), Urban Intervention Projects (PIU, Projetos de Intervenção Urbana); and Structuring Axes of Urban Transformation (SAUT - in Portuguese EETU, Eixos de Estruturação da Transformação Urbana)[3]

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[1] In the Highrise Project, the working definition for a high-rise is a residential building, which can be of mixed use, with ten or more floors or a height equal or over 30 meters. "Highrise Living and the Inclusive City," binational French Brazilian project financed by two research agencies: the Brazilian FAPESP, FAPESP-2016/50278-3; and the French ANR, *ANR*-16-CE41-0010-01.

[2] For more about this, see also the following chapters: Alves, Appert and Montés; Carvalho and Simoni; Daitx; and Rufino.

[3] Structuring Axes of Urban Transformation (SAUT) – according to the municipal law 'Structuring Axis of Urban Transformation Zones' (Zona de Eixo da Estruturação da Transformação Urbana), an urban mechanism implemented in the Strategic Master Plano of 2014, are linear areas alongside public transportation corridors – 150m wide on each side – and close to metro stations and bus terminals – maximum distance of 600,00m. Conceptually, its objective is to provide a better and mixed urban environment, accessible to low income people in different areas of the city, representative of a more equitable city, by means of developing mixed areas (commerce, services and housing). Therefore, joining employment and housing and reducing the use of cars. However, the results have been quite different. Besides, important changes to SAUTs, favoring the real estate market, were approved in 2023, such as: the linear areas alongside public bus corridors is now 200m wide on each side (not anymore 150m); the radius from metro stations is now of 700 meters, but allowing the verticalization in all the block touched by

that encourage densification and verticalization in strategic regions of the city, arguing that verticalization in these areas would bring benefits to the city as a whole, whether by revitalizing areas considered obsolete or by providing greater accessibility to the main transport and service networks, but with significant impact in the public space (Abascal and Alvim 2013).

However, it is worth noting that the process of verticalization in São Paulo is not new. Since the early decades of the twentieth century, verticalization has been an important element in the configuration of the urban space in São Paulo. Over the years, the verticalization process in São Paulo has been characterized not only by moments of intensification and implementation of policies to encourage the building industry, associated with moments of economic growth, but also by the development of heterogeneous territories of socio-spatial segregation (Arretche and Marques 2015).

13.1. Verticalization in São Paulo: A brief history

The city of São Paulo, nowadays qualified as a large forest of buildings, had its intense verticalization originating from an intense urbanization process dating back to the early decades of the twentieth century. Later, from the 1950s on, with new levels of industrialization and its prominence in the economy, the urbanization of São Paulo took on a particular form that can be characterized, on one hand, from bottom to top, as a streets-and-sidewalks walkscape contained by views that reach the high buildings, and in the other, from top to bottom, from the terraces to an infinite landscape of buildings, floors and windows juxtaposed and overlaid on the streets.

Although verticalization is understood as a process from the 1920s onwards, there were already verticalized buildings in São Paulo since the 1910s, such as the Casa Médici (1912). Located on the corner of Líbero Badaró Street and Ladeira Dr. Falcão Filho, according to Okano (2007), it was the first one intended for offices and erected on reinforced concrete structures.[4]

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the radius (in fact, in some situations extending the radius to close to 1,000 meters); garage spaces for car will be allowed even for micro apartments below 30 sq.m. See Alves, Appert and Montès and Daitx chapters for more.

[4] The use of reinforced concrete in buildings would become much more common from 1926 onwards, with the installation of the cement industry in the country.

Figure 13.1 Photomontage made by overlapping a photographed view from the 28th floor of the Copan Building and a view from São João Avenue (both in the downtown area), framing the Martinelli Building on the left and the Banco do Brasil Building on the right.

Source: Personal and public archives. Highrise Project Collection.

Figure 13.2 Casa Médici under construction, early 1910s.

Source: National Archive.

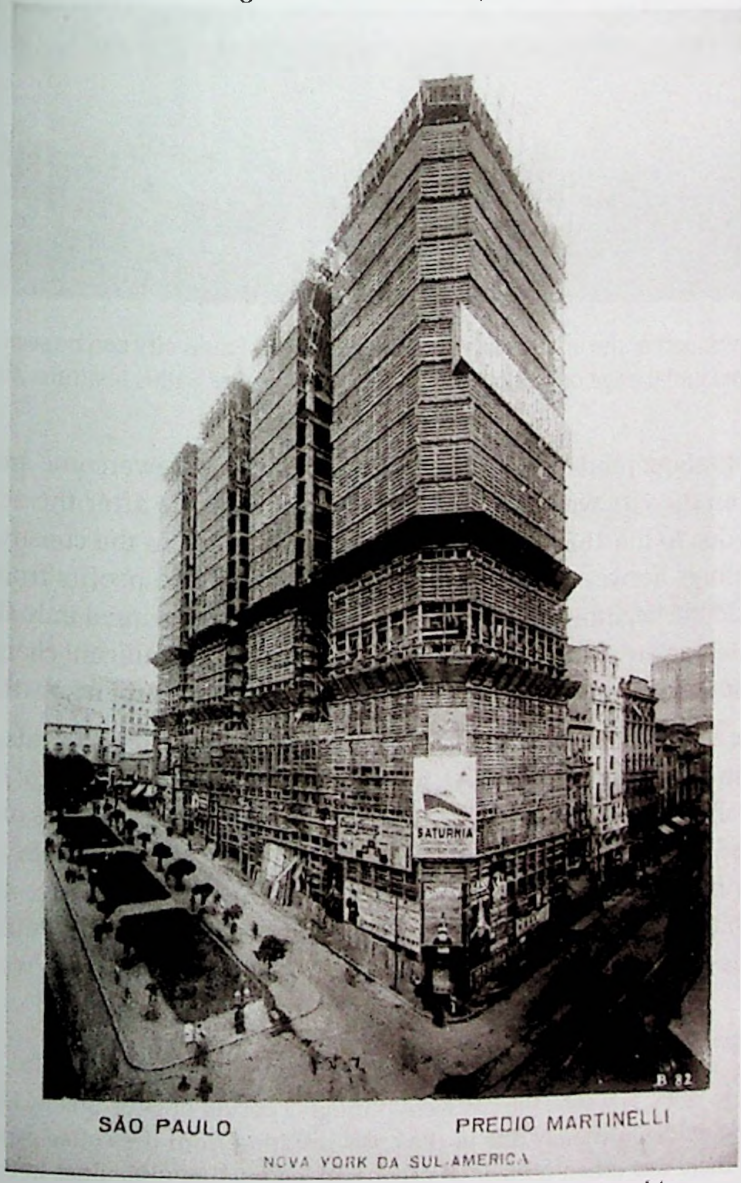
In the 1920s, the country was the setting for an intense struggle among the most diverse contenders around a central issue: modernization (Tolipan 1983). The first moment of verticalization in São Paulo, up to 1929, occurred in the historical triangle[5] and the new center,[6] featuring high buildings for tertiary

[5] Special section of the historic center of São Paulo, where the city's main historical buildings are located, including Largo São Bento, Pátio do Colégio, and Largo São Francisco.

[6] Starting from Chá's Viaduct, the "Centro Novo" comprises the blocks between: Ramos de Azevedo's Square, República's Square, Largo do Paissandu, and São Luiz Avenue.

use alongside residential ones. At that time, it was possible to see along São João Avenue when arriving at Júlio Mesquita Square (1927), a prominent building with 13 floors. Nearby D. Pedro Park and 25 de Março Street, a preliminary residential verticalization could be seen. However, the main highlight of this period is the Martinelli Building, fundamentally the first residential mixed-use high-rise in São Paulo. Initially designed to have 12 floors, it went up to 24 floors in 1928, later reaching 30 – the last 5 intended for the residence of Comendador Giuseppe Martinelli, owner and creator of the building.

Figure 13.3 Martinelli Building under construction, covered with wooden fences, 1928.



Source: Moreira Salles Institute, unidentified authorship.

Figure 13.4 Flight of the airship Graf Zeppelin over the city center, with the Martinelli building standing out.

In the lower part of the image, the morphology of São Paulo city can be seen still in 1938, with an initial stage of verticalization. Source: Moreira Salles Institute, Authorship Alfredo Krauz.

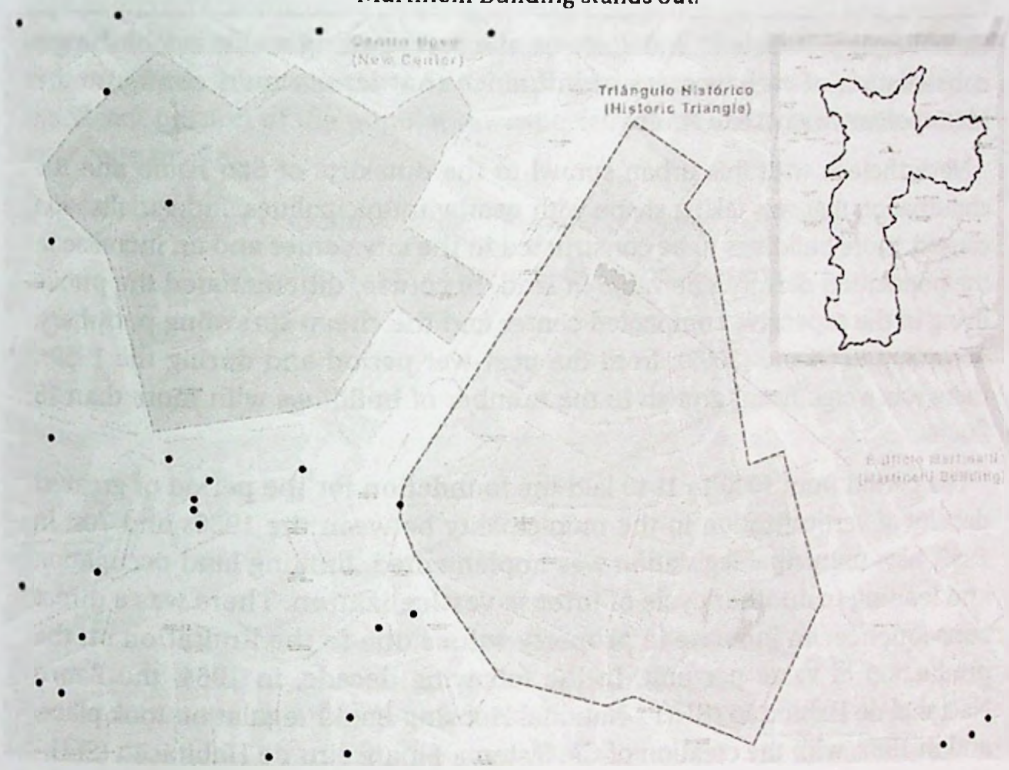
The battle about modernization was, in many regards, overcome around the 1930s when the city was already seen as a metropolis after the economic recession due to the 1929 crisis. There was an increase in the construction of new buildings between 1920 and 1928, mainly due to profits from coffee exports and the beginning of industrialization, which resumed only after 1933 when the real estate market was reactivated, but with a significant change when urban production processes became determinant to the urban growth.[7]

After the early 30s, there was a residential vertical expansion towards Arouche Square (in the new center) and neighborhoods such as Santa Efigênia, Higienópolis, and Liberdade, focusing on the southwest urban axis until 1939. This period is characterized by two major aspects: a tertiary verticalization and a change in architectural style from eclecticism to a derivative of proto-modernism; widespread use of concrete, allowing apartment buildings to emerge as a solution for collective housing, which until then was highly

[7] In the early 1930s, however, the city went through a period of poor-quality housing for low-income residents, mainly due to the crisis resulting from the coffee-export-based economy. There was urban horizontal expansion, generating difficulties in connecting the emerging peripheral neighborhoods with the city center.

rejected by both popular taste and middle class that associated multifamily buildings with tenements for the poor (Leme 1977).

Figure 13.5. To the west, the New Center; to the East, the Historic Triangle, where the Martinelli Building stands out.



The black dots mark the high-rise buildings identified in EMBRAESP's database, showing that constructions in these two areas date back to earlier periods. Source: Highrise Project Collection, elaborated by the authors.

Verticalization, initially accepted reluctantly, would multiply in the 1930s and 1940s, constituting a great innovation in the residential sector with the emergence of apartment buildings (Reis Filho 1978). These were the most intense periods of industrialization in the country: the post-1929 crisis recovery and World War II, during which import restrictions policies were established, allowed for a great focus on the national industry. In a practical sense, the construction industry definitively employed reinforced concrete from then on, a fundamental aspect of the potentialization of verticalization.

The origin of the São Paulo metropolitan region would come after the implementation of national development policies after 1945 and industrial development programs starting from 1955, which raised national production and generated intense effects at the regional level. The city of São Paulo would become the main industrial hub of the country, with large investments in infrastructure and services capable of meeting the new demands of urban

logic. In addition to the old railway, the connection of the metropolis to the rest of the territory was also made through extensive highways. It was during this period that industrial clusters emerged in nearby municipalities less densely populated than São Paulo – such as ABCD (Santo André, São Bernardo, São Caetano, and Diadema) and others like Osasco and Guarulhos. The city of São Paulo began to radiate its influence on the surrounding areas, establishing a constellation of various areas of influence that later would configure the Metropolitan Area of São Paulo.

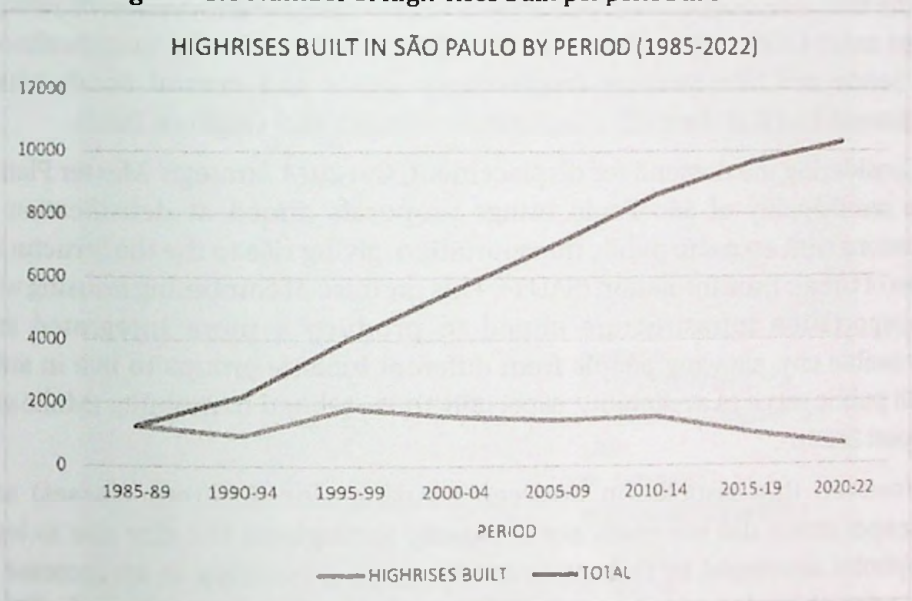
Nevertheless, with this urban sprawl to the outskirts of São Paulo and the conurbation that was taking shape with nearby municipalities, industrialization caused: more buildings to be constructed in the city center and an increase in the population density. The value of land, of course, differentiated the public living in the expensive compacted center and the cheap sprawling periphery. According to Okano (2007), from the post-war period and during the 1950s, there was a significant growth in the number of buildings with more than 15 floors.

The period from 1920 to 1940 laid the foundation for the period of greatest density of verticalization in the municipality between the 1960s and 70s. In 1957, new municipal legislation was implemented, limiting land occupation and leading to another cycle of intense verticalization. There was a direct consequence: an increase in property values due to the limitation on the production of value per unit. In the following decade, in 1964, the Banco Nacional de Habitação (BNH - National Housing Bank) regulation took place, and in 1967, with the creation of the Sistema Financeiro de Habitação (SFH - Housing Financial System), the release of credit for building financing accelerated the production of affordable apartments for low-income populations. Although a very significant percentage of the residential high-rises financed by SFH / BNH were built in middle-class areas provided with services and infrastructure, it is in this period that verticalization began to make its presence in more remote areas – nevertheless not properly provided with services and urban infrastructure.

Verticalization is one of the main elements of the built environment, but it is important to understand that its emergence results from the combination of a series of factors. Industrial production generates an urban configuration resulting from its articulation with other capitalist sectors. The real estate capital, then in its constituting phase, demanded the multiplication of urban land (verticalization) as an innovation to land subdivision (plotting) in a new strategy of capital valorization. The high price of land and its optimization does not explain, by themselves, verticalization, but exactly this new real estate capital strategy. In addition to land, the urban form becomes a commodity. The state regulates the actions of producing agents, stimulating capital accumulation (Somekh 1994).

The 1972 Zoning Law[8] resulted in changes to the utilization coefficients throughout the urban network: in most of the city, construction was restricted to two times the area of the real estate (plot), except in some zones that allowed for construction of four times. Similar to 1957, one of the outcomes was the expansion of verticalization, leading to an increase in demand for land and the overvaluation of land prices. Despite appearing to be a strategy to control verticalization, the consequence of this price escalation was the exclusion of a significant portion of the population, especially those with low income, to the real estate market.

Figure 13.6 Number of high-rises built per period in São Paulo.



Source: Highrise Project Collection (Data Source: EMBRAESP database.)

The following decade marks the end of the BNH and the changes brought about by the new constitution, such as the new limits to property rights. This is the period of Consortium Urban Operations (OUC – Operações Urbanas Consorciadas), which aimed to encourage verticalization that was hampered by land prices and construction limits. The criterion used was once more to allow flexibility to urban parameters (Performance Coefficient and Occupancy Rate and others), creating the possibility of buying the right to build.

[8] Law No. 7805/72 - Regulates the Subdivision, Use and Occupation of Land in the Municipality, and provides other provisions. The famous Adiron's Formula was introduced in this legislation, defining that urban coefficients could be increased and an inverse proportion between lot's 'Performance Coefficient' and 'Occupancy Rate,' allowing for their increment and an urban development characterized by a verticalization of thin isolated buildings in the lot (also a heritage of Modern Architecture).

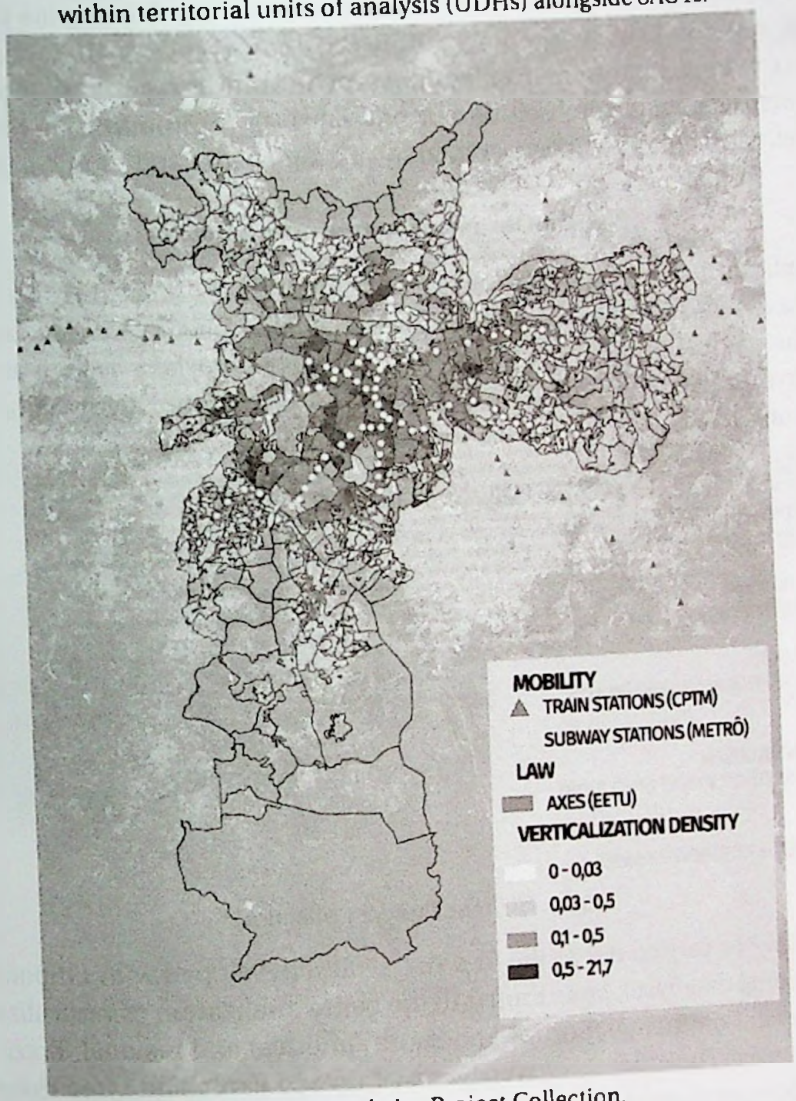
The turn of the century, especially the period from 2002 to 2004, was marked by a review of zoning laws and of the Strategic Master Plan, which promoted not only another cycle of verticalization but also the overflow of properties and occupation beyond the municipality limits. This directly affected the demand for transport, services, and infrastructure (demand already present before) as distances between residential and work areas increased. Until December 2011, verticalization could already be observed in about 72 neighborhoods (out of 99) in the municipality of São Paulo. What characterizes this period is the scattered presence of buildings throughout the city instead of focusing on the southwest expansion. The neighborhood of Moema (central south zone) registered 5.17% of the total construction between 2004 and 2011; the neighborhood of Tatuapé (east zone) 4.83%; Santo Amaro (south zone), 4.48%; while the neighborhoods of Saúde and Vila Mariana (respectively south and central south zone), registered 4.14% of the total. (Gagliotti, in Somekh and Gagliotti 2013).

Considering the demand for displacement, the 2014 Strategic Master Plan of the municipality of São Paulo brings proposals aimed at densification in locations with access to public transportation, giving rise to the the Structuring Axes of Urban Transformation (SAUT). This premise of combining housing with transportation infrastructure aimed to produce a more integrated and accessible city, allowing people from different income groups to live in areas with public services availability, especially those related to mobility (Mollè and Appert 2020).

However, this association between housing (for different classes) and transportation did not really occur equally throughout the city due to legal loopholes developed by real estate entrepreneurs, resulting in an increase in the price of lots located alongside SAUTs and close to surroundings facilities, whether they were metro and train stations or bus corridors. This increase, consequently, made these locations less accessible to different income groups, contrary to the premise of the 2014 Strategic Master Plan.

In 2018, only 22% of the city's households were located within a one-kilometer radius of a public station or terminal managed by the state government (metro, trains, and bus corridors). The analysis of per capita income of families allowed us to verify that those with 3 or more minimum wages concentrated in 44% of these residences (Scheuer 2020). Scheuer concludes that it would be necessary to make further adaptations to the SAUTs with other mechanisms to approach, for example, Social Interest Housing with more valued areas and job offers. Above all, it is also necessary to analyze the support capacity and the densification of a Zona de Eixo da Estruturação da Transformação Urbana (EETU - Structuring Axis of Urban Transformation Zones), which varies from place to place, integrating the planning of these infrastructure networks and the land use policies themselves.

Figure 13.7 Density of verticalization, ratio between the number of high-rise buildings within territorial units of analysis (UDHs) alongside SAUTs.



Source: Highrise Project Collection.

In the face of these issues, the Highrise project[9] investigated the capacity to produce a more inclusive city in a context of accelerated verticalization under the logic of the production of contemporary cities. Although densification is often justified to accommodate urban growth and limit urban sprawl,

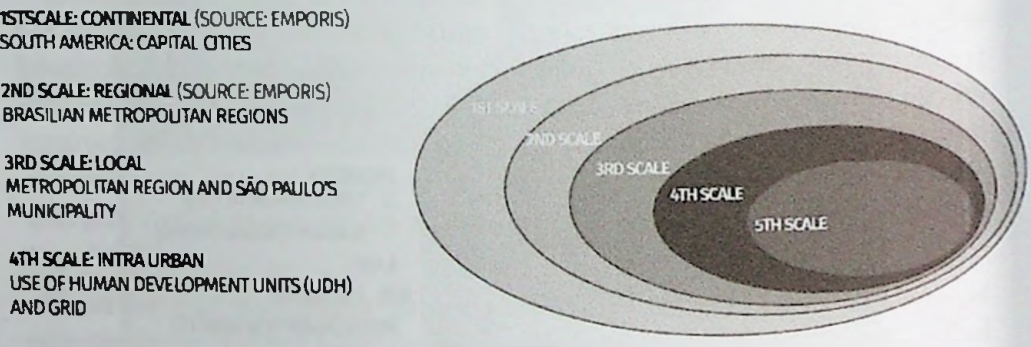
[9] 'Highrise Living and the Inclusive City', a project developed on a transdisciplinary theoretical framework to evaluate the notion of inclusivity due to the production of high-rises, investigating aspects of verticalization process from different scales, using methodological procedures of spatial and territorial analyses and construction of post-representational critical cartographies and space-time narratives. (https://highriseproject.net/).

verticalization, especially residential verticalization, is questionable in a context where regulatory capitalism and entrepreneurial municipalities create favorable conditions for private agents to control urban space. In fact, in our understanding, high-rises (residential verticalization), regardless of whether they were an architectural solution or not, became commodities in the global market, with capital flows determined by private agents and municipalities.

13.2. Designing a methodology

A significant part of the Highrise research focused on analyzing São Paulo's process of verticalization. Through the manipulation of georeferenced databases and the production of graphic and cartographic materials, as well as urban narratives for different contexts and portions of the territory, five reading scales were considered.

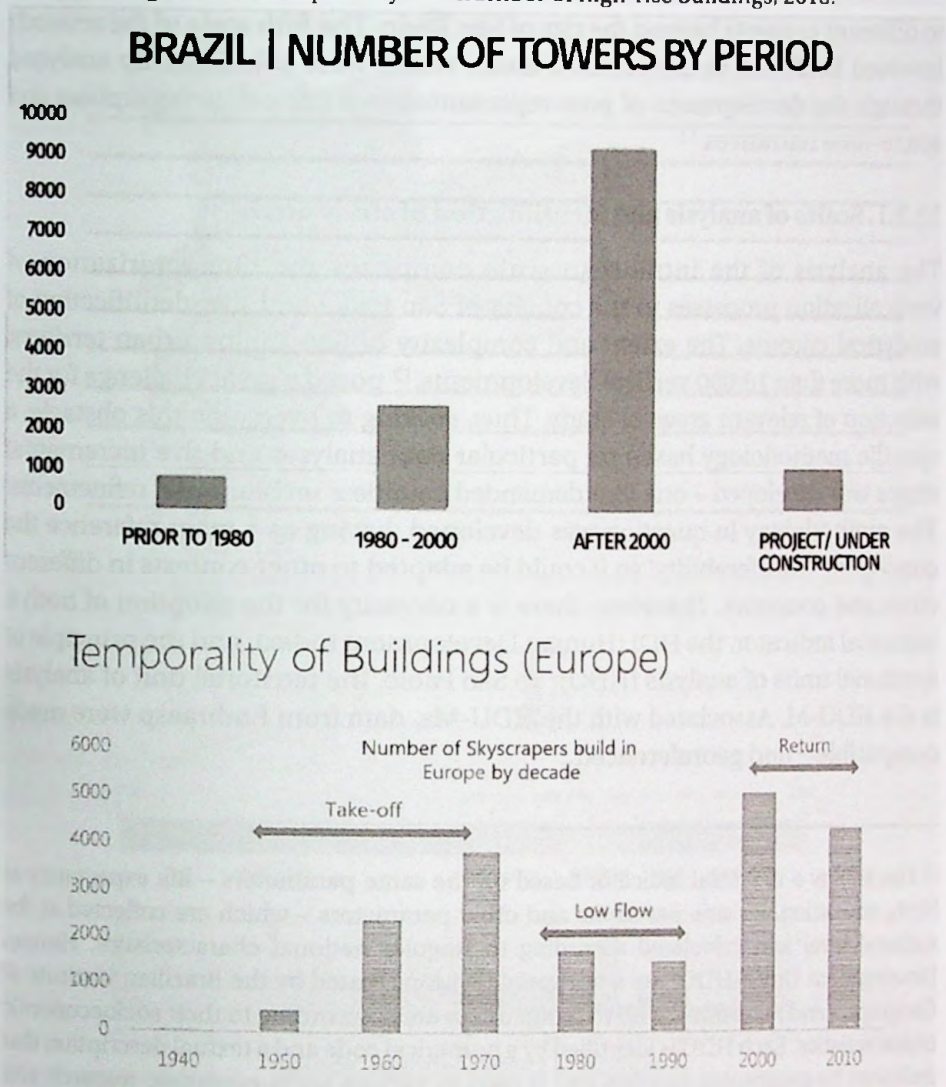
Figure 13.8 Highrise Project analytical scales.



Source: Highrise Project Collection.

The analyses carried out at the first two scales, developed with Emporis (an international database), contributed to the contextualization of verticalization processes in Continental (Europe and South America) and regional (Brazil and France) terms. The other three were focused on São Paulo and Lyon. However, the aim was not to establish a direct comparison between both cities but rather to consider their specificities and differences in normative, economic, social, and cultural terms, interrogating to what extent the hegemonic global logic of city production promotes or not an increasingly homogeneous urban space, regardless of its geographical location and socio-cultural characteristics.

Figure 13.9 Temporality and number of high-rise buildings, 2018.



Source: Highrise Project Collection (Data source: Emporis.)

To analyze the fourth and the fifth scale, the focus of this chapter, a specific methodology of its own, was designed, given the size and complexity of the city of São Paulo, in order to develop criteria to identify relevant areas of study. In this stage, data from EMBRAESP associated with the HDI and HDI-Ms (Human Development Index and Municipal Human Development Index) in their respective HDU and HDU-Ms (Human Development Territorial Units delimited by the HDI-M, grouping areas that share similar socioeconomic

characteristics)[10]. Since the HDI is a universal indicator, its use can be applied to different contexts beyond the city of São Paulo. The fifth scale of the research involved fieldwork in the selected areas, which were subsequently analyzed through the development of post-representational critical cartographies and space-time narratives.[11]

12.2.1. Scales of analysis and identification of study areas

The analysis of the intraurban scale comprises the characterization of verticalization processes in the context of São Paulo and the identification of analytical cutouts. The extent and complexity of São Paulo's urban territory, with more than 18,000 vertical developments,[12] posed a great challenge for the selection of relevant areas of study. Thus, seeking to overcome this obstacle, a specific methodology based on particular data analyses and five incremental stages was developed – one that demanded countless revisions and refinements. The methodology in question was developed, having as a main reference the concept of 'transferability' so it could be adapted to other contexts in different cities and countries. Therefore, there is a necessity for the adoption of both a universal indicator, the HDI (Human Development Index), and the principle of territorial units of analysis (HDU). To São Paulo, the territorial unit of analysis is the HDU-M. Associated with the HDU-Ms, data from Embraesp were made compatible[13] and georeferenced.

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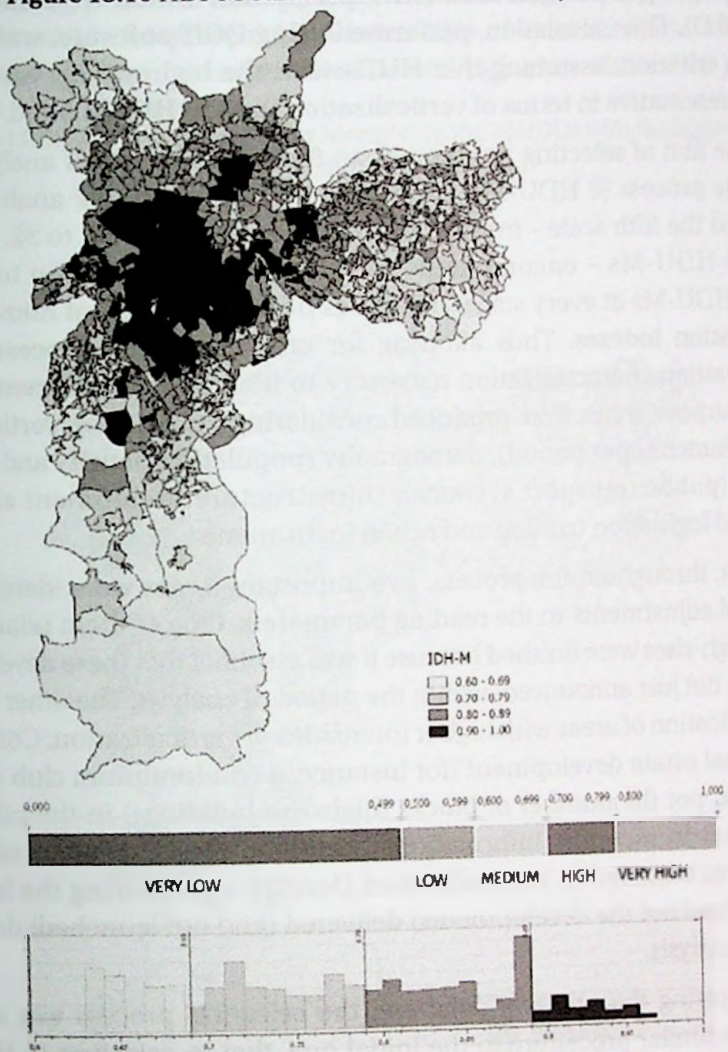
[10] The HDI is a universal indicator based on the same parameters – life expectancy at birth, education, income per capita and other parameters – which are collected at the national level and calculated according to singular national characteristics. Human Development Units (HDU) are a territorial division created by the Brazilian Institute of Geography and Statistics (IBGE) to group urban areas according to their socioeconomic characteristics. Each HDU is identified by a numerical code and a textual description that indicates its geographic location and is used in various socio-economic research and studies for analysis and monitoring of the living conditions of the population. HDU-M are municipal territorial units of analysis. There are 10,593 in the city of São Paulo.

[11] See Moreno, Rolindo and Saraiva chapter 'High-rise Mapping: cartographies and story maps of São Paulo's vertical urbanism' in this publication.

[12] Data related to condominiums cataloged in the Lello database, a company specialized in the administration, sale, and rental of real estate in São Paulo. However, according to the Embraesp database, from 1985 until mid-2022, more than 9,000 high-rise buildings were built. According to recent market studies, 46,.000 new apartments will be built in 2023 and, by the end of 2025, São Paulo will have 2,000 new high-rise vertical condominiums (most of them with more than one building).

[13] The data about high-rises provided by Embraesp was filtered by means of a "cleaning" process developed with Python and R programming languages and Google API key for georeferencing the points and integrating this data into the project's database.

Figure 13.10 HDI-M bands distribution in the city of São Paulo.



Source: Highrise Project Collection.

Initially, the territory was subdivided into HDI bands using two classification methods within the QGIS software: quantile distribution and equal interval distribution.[14] Then, residential high-rise launches were overlaid onto the polygons of Human Development Units (HDU-Ms) to determine the number

[14] The first one distributes the IDH-M ranges so that each range contains the same number of HDU, the territorial unit in which HDI-M is distributed. The second one, on the other hand, distributes the range of the city's HDI-M in equal intervals, regardless of the number of HDUs contained in each interval. Each of these tools can have a variable number of ranges. Tests were performed with 5 and 7 ranges to verify the differences in the division.

of enterprises per polygon area (enterprises/ha), which we called Launch Density (LD). This calculation, performed using QGIS software, was used as a selection criterion, assuming that HUDs with the highest LDs would be the most representative in terms of verticalization in each HDI-M band.[15]

With the aim of selecting not more than 8 territorial units of analysis at the end of the process (8 HDU-Ms, 2 for each HDI-M band), the analyses at the fourth and the fifth scale - from 80 to 60, subsequently to 40, to 32, to 16 and then to 8 HDU-Ms – encompassed new layers of information to the pre-selected HDU-Ms at every stage: high-rises density, number of housing units, verticalization indexes. Thus allowing for an incremental process of intra-urban situation characterization necessary to identify specific areas of study. For this purpose, maps were produced considering 4 main axes: verticalization (vertical launches per period), demography (population density and income), mobility (public transport systems), infrastructure (equipment and green areas), and legislation (zoning and urban instruments).

However, throughout the process, two important issues were identified that influenced adjustments to the reading parameters. One of them related to the year the high-rises were finished because it was essential that these developments were built, not just announced, within the period of analysis. The other concerns the identification of areas with higher intensities of verticalization. Considering only the real estate development (for instance, a condominium club with four blocks) and not the number of blocks (high-rise buildings) in the calculation would result in incorrect information. Therefore, the calculation of Launch Density was adjusted to Verticalization Density, considering the high-rise buildings (and not the developments) delivered (and not launched) during the period of analysis.

After adjusting the project's database, the selection process was restarted following a similar procedure to the initial one, that is, selecting 10 HDUs for each IDHM range that contained the highest densities of verticalization in the analyzed period (1985-2020). However, when observing the results of the selection, it was noticed that the different territorial extensions of the HDU-Ms could influence the result of the Verticalization Density index. That is, an HDU-M delimited by a small area could present a high intensity of verticalization even if it contained only a small number of high-rises within its perimeter. The

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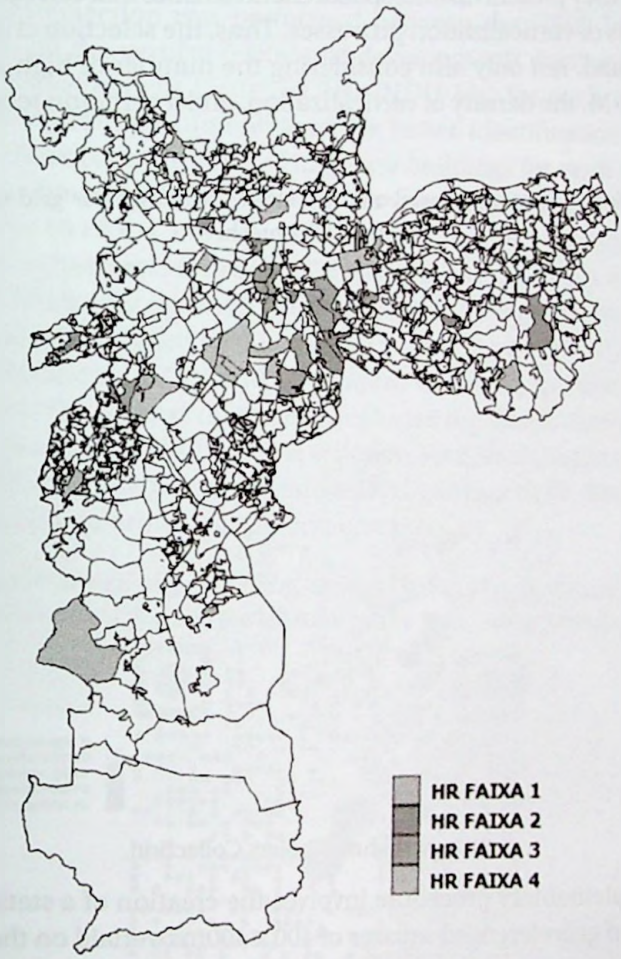
[15] The procedure adopted divided the HDI-M into four bands, considering a predefined classification by the responsible agencies, with specific adaptations for the reality of São Paulo. Considering that HDI-M in the city varies from 0.63 to 0.97, four distinct bands were established: (0.60 to 0.69 - low); (0.70 to 0.79 - medium); (0.80 to 0.89 - high); and (0.9 to 1.00 - very high). Within a sample universe of 1,593 HDUs, 10 HDUs with the highest LDs were identified for each of the four HDI-M bands.

same could happen with the opposite; HDU-Ms that occupy larger territorial extensions could not present high intensities of verticalization, even if they contained a significant number of residential high-rises within their perimeter.

Figure 13.11 Example of cartography identifying the 40HDUs with the highest number of high-rises.



Source: Highrise Project Collection.

As already mentioned, the process continued with the aim of reducing the initial sample to a maximum of 8 HDU-Ms. To achieve this, new layers of information related to reading scales were gradually incorporated in stages, allowing the continuous filtering of the territorial units of analysis.[16] As a result

[16] A technique called "Image Mosaic" was then implemented. This technique consists of a closer analysis of the selected HDU-Ms, observing the location of these areas with respect to the urban fabric and morphology, urban legislation (more specifically, urban

of these analyses, the new filter based on the Image Mosaic Technique allowed the reduction of the number of HDU-Ms from 40 to 16 (4 for each IDH range). However, during a new analysis of the process, the need for further refinement in the method of selection and definition of the territorial unit of analysis was identified. The reason for this is that, although the UDHs present homogeneities in some criteria, they present distinct spatial characteristics that can cause distortions in the analysis of verticalization processes. Thus, the selection criteria of HDU-Ms were refined, not only also considering the number of high-rise buildings in each HDU-M, the density of verticalization, and a common territorial unit of analysys.

Figure 13.12 Kernel Heat map based on the count of buildings per 'grid square' overlaid on the UDH mesh.

Source: Highrise Project Collection.

This complementary procedure involves the creation of a statistical GRID,[17] composed of georeferenced squares of 400 x 400m overlaid on the cartography

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instruments that promote urban restructuring and stimulate constructive densification), and attractive elements (equipment, squares, and parks). In addition, the geographical location of these HDU-Ms was also considered, identifying units in different regions of the municipality. This information was analyzed through maps and satellite images produced for each HDU-M.

[17] The use of a 400 x 400 meter grid and QGIs software enabled: the georeferenced checking of the 'points' (high-rises) distributed in the overlay of the territorial unit of analysis (municipal HDU-M); the analysis of areas with the same territorial extension); and a better identification of areas of greater verticality. Afterwards, using the same

of the city of São Paulo. This GRID is then converted into a shapefile using QGIS software and programmed to count the number of highrise buildings within each square. This allowed the elaboration of a new heat map (Kernel) that highlights the squares with higher concentrations of built high-rises (residential blocks, eventually mixed-use) between 1985 and 2020 in the city of São Paulo.

Next, an intersection was performed between the GRID layer (containing information on the vertical residential developments database) and the layer of Human Development Units (HDUs) (HDU-Ms) for each of the four HDI bands. This superimposition allowed for better identification of the squares with the highest concentration of high-rise buildings for each of the four HDI bands. From this material, territorial units were filtered based on three distinct criteria: i) the 10 HDUs with the highest verticalization densities (blocks/area of HDU-Ms in hectares) for each HDI band; ii) the 10 HDUs with the highest number of blocks for each HDI band; iii) the 20 squares with the highest number of blocks for each HDI band and with at least ONE high-rise building in the corresponding HDI band. Afterward, we based the analysis on the 40 HDU-Ms with the highest number of high-rise buildings, associated with the 80 squares also selected by the same criterion. As a result, maps were produced observing the location of both the selected HDU-Ms and the 400x400m squares and information on urban legislation perimeters.

Figure 13.13 Cartography with the 40 selected HDUs plus the 80 selected squares juxtaposed with a Heat Map on the left and, on the right, urban planning instruments.

Source: Highrise Project Collection.

platform, the classification of the polygons in the 400x400 grid by the number of high-rises accounted allowed the elaboration of heat maps that spatially reveal the concentration of high-rises in wealthier areas of the city (see also Alves, Camargo and Cardozo 2020 and Alves, Appert and Montès chapters).

These data were analyzed using new reading parameters defined for the next stage of selection including a) Location / Spatiality, aimed at selecting territorial analysis units with the same HDI range in different areas of the municipality; b) Proximity to areas with higher verticalization densities (KERNEL Map); c) Proximity to areas of urban interest or to urban instruments such as SAUTs; d) Proximity to different IDH ranges; e) Urban Morphology of the HDU-M; and f) Higher density of highrise buildings. As a result, 56 squares were filtered – exceeding the expected quantity of 40 squares.[18]

Continuing with the process of filtering possible territorial units of analysis, the objective for the next stage was to select 16 polygons (four to each of the HDI-M range). In order to do so, new information was incorporated, and new materials were produced for analysis. First, of tables containing data related to the selected squares, separated by IDHM range: square grid ID; corresponding UDH name; the total number of blocks in the square; total number of floors in the square; average number of housing units per block in the square; and Verticality Index (the number of floors divided by the number of blocks). The systematization of this information allowed the identification of squares with higher Verticality Indexes for each IDHM range, as well as those with higher averages of housing units per block (highrise buildings), which were sometimes coincident.

Subsequently, graphs were produced associating the Verticality Index, the average number of units per block, and the number of squares per HDI-M range. The analysis of these graphs confirmed the initial evaluation that the highest averages of housing units would be present in the polygons of ranges 1 and 2 (with IDH-M of 0.6 to 0.7 and 0.7 to 0.8, respectively), which is consistent with the differences in architectural typologies between these IDH-M ranges. Regarding the verticality indexes, it was observed that, although there is considerable variation between ranges 1, 2, 3, and 4, mostly the polygons in range 1 present the lowest indexes, and those in ranges 2 and 4 are the highest.[19]

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[18] When overlaying the selected squares and HDU-Ms, a considerable amount of coincident areas were found - squares that were within one of the 40 previously selected HDU-Ms. In these cases, these squares were selected for analysis. On the other hand, in cases where selected squares did not correspond to any of the previously selected HDU-Ms, the HDU-Ms corresponding to these squares were analyzed. If there were more than one square contained in the same HDU-M and that HDU-M was one of the pre-selected ones, these squares remained for future analysis in the next stage.

[19] It is important to highlight that, despite the identification of IDH ranges associated with each analyzed square of the grid, there is a significant number of squares that contain two or three UDHs-M from distinct ranges. This indicates that these polygons

Additionally, the Highrise Timeline was also adopted as a reading parameter that relates to legislation, vertical residential launches, and political and social context (Brazilian and worldwide) in the period of analysis (1985 to 2020) in São Paulo. Based on this material, which reveals peaks of verticalization in three distinct moments in the city of São Paulo (1985-1990, 1995-2000, and 2005-2010), heat maps were produced with the high-rise launches in each of these three periods. These maps allowed the identification of squares that are inserted in areas with a higher concentration of residential high-rises during these moments.

Figure 13.14 Highrise Timeline. QR code to access to the Highrise Timeline.

Source: Highrise Project Collection.

Although the objective was to select 16 squares, the process resulted in 22 squares. This was due to the existence of similar cases regarding the Verticality Index, Average Housing Units, and whether or not they were located in areas with the highest incidences of verticalization. The decision was to discriminate these cases in subsequent stages based on additional criteria and analysis. Therefore, for the selection of the final eight squares, a deeper analysis of the intra-urban scale was carried out, bringing the reading scale closer to each polygon and its expanded surroundings. Thus, a graphic material, which we refer to as 'Summary Sheets,' was produced for each of the 22 squares and their immediate and expanded surroundings. This material allowed the gathering and joint analysis of information related to verticalization processes, legislation, mobility, infrastructure, urban facilities and services, green areas, and unique elements (SESCs, Shopping Centers, and Parklets). Additionally, socioeconomic

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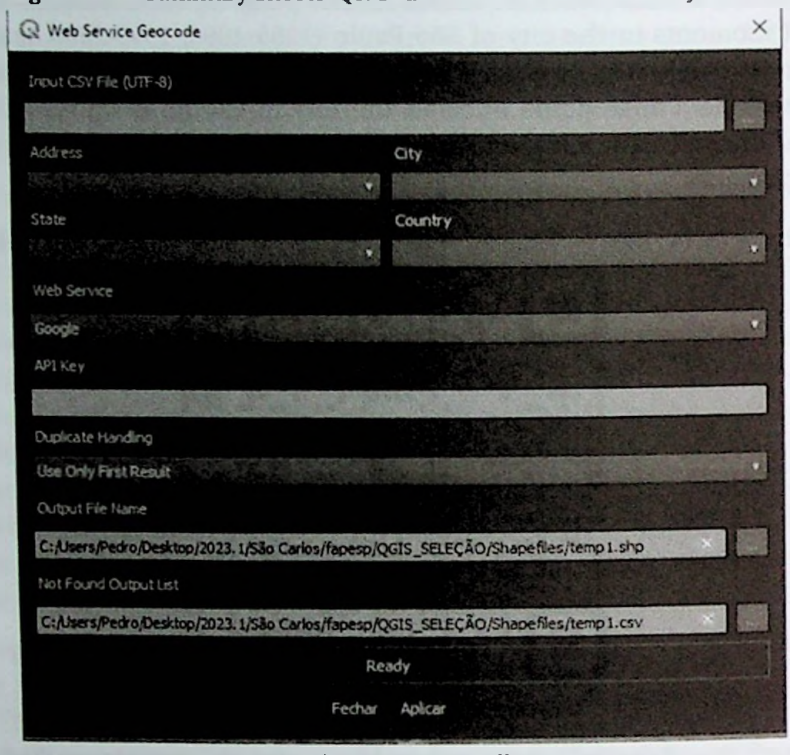
have developments that fit into more than one of the analyzed IDH ranges, requiring additional verification of this information through other means.

data from the HDU-Ms present in the respective squares were collected and incorporated in the analysis materials.

Figure 13.15 Summary Sheets. QR code access to the Summary Sheets.



Source: Highrise Project Collection.

The analysis of this data set led to the definition of new analytical parameters for the territorial units of analysis: (i) the presence of Human Development Units (HDU-Ms) with different ranges of Municipal Human Development Index (HDI-M); (ii) the concentration or dispersion of high-rise buildings constructed; (iii) the location of high-rise buildings, considering the pace of verticalization throughout the entire period of analysis; (iv) the variation of HDI-M between the 2000 and 2010 Censuses; (v) the presence of urban mobility infrastructure; (vi) population density; (vii) zoning legislation and the presence of strategic urban planning instruments; (viii) public facilities, green areas, and singular elements; and, finally, (ix) recent transformations in the urban structure.

Although all these aspects were considered, some were attributed a greater weight in the selection of the final squares, such as the presence of HDU-Ms with different ranges of IDHM, which suggests heterogeneity in the socioeconomic profiles. Greater relevance was also given to the proximity of strategic urban instruments, indicative of ongoing or imminent processes of urban requalification.

often accompanied by verticalization. Another relevant criterion for the selection of the territorial units of analysis was the presence of qualified public spaces, such as squares and parks, possible spaces for sociability, and analysis of socio-spatial practices at the scale of analysis five. Furthermore, among these public spaces, those corresponding to adopted squares were identified - in many cases, as part of the actions of the real estate market in urban space[20]. These procedures indicate the importance of approaching and analyzing the region rather than limiting the analysis to individual squares.

Regarding the last scale of analysis, the selection of high-rises for field research, emphasis was placed on those constructed in the last ten years and located near qualified public spaces for the study of socio-spatial practices. Additionally, developments were selected in each of the four IDHM ranges to investigate social-spatial practices in regions with different economic and socio-cultural characteristics[21]. One development in the Republic neighborhood, in the central area of São Paulo, was arbitrarily selected, even if in an area discarded by the methodology for reading the urban territory, considering its significant process of building typology modification related to a recent and singular moment of verticalization. Four developments were selected from this process: i) Dez Penha, located in a UDH in range 1 in the Penha region, in the eastern zone of São Paulo; ii) Praças da Villa, located in a UDH in range 2 in the Vila Prudente region, also in the eastern zone of the city; iii) Settin Downtown, located in a UDH in range 3 in the Republic, central region; and iv) RG Domingos, located in a UDH in range 4 in the Vila Suzana region, western zone of São Paulo.

12.2.2. Development of the methodology

The methodology considered the implementation of procedures developed for the selection of their analytical cutouts. In the context of investigating contemporary urban transformation processes related to verticalization, it is considered essential to use data that allow for a historical understanding of these processes over time. Analytical sources such as EMBRAESP and IBGE (Instituto Brasileiro de Geografia e Estatística – Brazilian Institute of Geography and Statistics) data allow for period readings, as they contain information that can be spatialized for different moments in São Paulo. However, the most recent research from the Demographic Census, which serves as the basis for

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[20] The Public Squares Adoption Program, after its last review (Law 61770, 03/22/2022), counts already with more than 1,050 squares adopted. Many of these squares, close to new high-rises, are temporarily adopted by the responsible real estate developer.

[21] See Moreno, Rolindo and Saraiva chapter.

calculating the Municipal Human Development Index (HDI-M) nationwide, is from 2010, which results in an outdated reading. Therefore, a survey of alternative sources of more up-to-date information was conducted, which would allow for the investigation of verticalization processes associated with other urban transformations, such as changes in the profile of the resident population and processes of gentrification. These phenomena are intertwined, especially when fostered by urban requalification projects.

Initially, the São Paulo Subway Origin and Destination (OD) survey met this requirement, as it contains socio-economic information structured by OD Zones for the years 1997, 2007, and 2017. These data were integrated into the georeferenced layer of OD Zones and associated with all the previous databases in the QGIS environment. One important information obtained from the OD survey was the average family income in each of the analyzed periods, allowing to identify possible changes in the profile of the resident population in areas of high verticalization. However, one of the challenges in analyzing this data is related to inflation and the variation of the value of the Brazilian currency over time. Although an attempt was made to adjust the data to the current value of the currency, the maps generated for 2007 suggest a systematic decrease in average family income compared to 1997, indicating inconsistencies in the data.

Another information considered significant for the identification and analysis of transforming areas in the city of São Paulo was the population density per territorial units of analysis (HDU-Ms) from a historical perspective. These data are mainly obtained from the Demographic Census research, with the most recent edition occurring in 2010. As an alternative, a survey was conducted on the São Paulo City Hall webpage, where a table with projections of the demographic density in the municipality for the period from 2008 to 2040, provided by districts, was located. These data were checked and associated with their respective territorial units in the QGIS database, allowing the spatialization of this information by periods as well. However, a difficulty was identified to build a coherent set of related information from different sources, each of them using different definitions of territorial units as a base: the HDU-Ms for the IDHM, the OD Zones for the OD survey data, and the districts for the demographic projections.

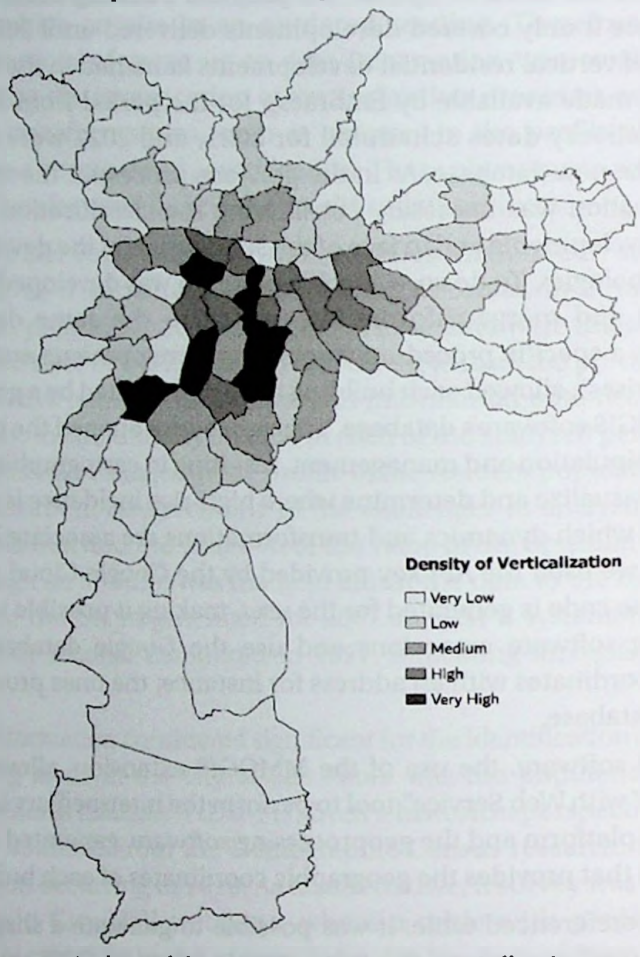
The adopted solution considered districts as the primary territorial unit of analysis since they represent units with larger territorial extensions and may contain one or moreHDU-Ms or OD Zones within their limits. Thus, based on districts, new point counts (high-rise buildings) were carried out per polygon (districts) through the QGIS software, and Verticalization Density was calculated for each district in the municipality of São Paulo, analogous to what was previously done for the HDU-Ms.

At this point, the need to update the project's building database was also identified since it only covered developments delivered until 2020. Using the spreadsheet of vertical residential developments launched in the municipality of São Paulo, made available by Embraesp for the period from 1985 to 2020, those with delivery dates scheduled for 2021, and 2022 were filtered and included in the new database. As in the previous processes, the reconciliation of the information was necessary considering the classification of high-rise residential developments and in face of the subdivision of the developments by apartment typologies. To do so, a specific program was developed to clean the spreadsheets and merge information related to the same development. Subsequently, a specific procedure associating developments and number of blocks (high-rises), allowed each building to be represented by a georeferenced point in the QGIS software's database. This procedure opened the possibility to database manipulation and management, resulting in cartographies that made it possible to visualize and determine where high-rise incidence is more or less common and which dynamics and transformations are associated with it. For this purpose, we used the API key provided by the Google Cloud platform, in which a unique code is generated for the user, making it possible to apply it in geoprocessing software extensions and use the Google database to relate geographic coordinates with an address for instance, the ones provided by the EMBRAESP database.

In the QGIS software, the use of the MMQGIS extension, allowing the the "Geocode CSV with Web Service" tool to perform the intermediary between the Google Cloud platform and the geoprocessing software, generated a new table in CSV format that provides the geographic coordinates of each building.

With this georeferenced table, it was possible to generate a shapefile (shp) layer to be superimposed on the cartographic bases in QGIS, enabling the manipulation of these data, based on the observation of specific urban areas. We adopted a specific period of time, from 2010 on, considering that the field activities goal would be to identify and assess the presence of areas undergoing a recent transformation – transformation here understood not only as urban landscape verticalization but also as a change in socio-spatial practices of living in the surroundings of the analyzed high-rises. The handling of digital layers by the georeferencing software makes possible a proper visualization of new residential high-rises in relation to other information. For example, urban instruments like SAUTs and socioeconomic and demographic indicators available in public databases. This process of cross-referencing allowed for the combination of different sets of information and, consequently, for a broad understanding of the social-spatial relationships present in urban scenarios.

Figure 13.16 Window of operation of the MMQGIS extension, Web Service Geocode option.



Authors elaboration. Highrise Project Collection.

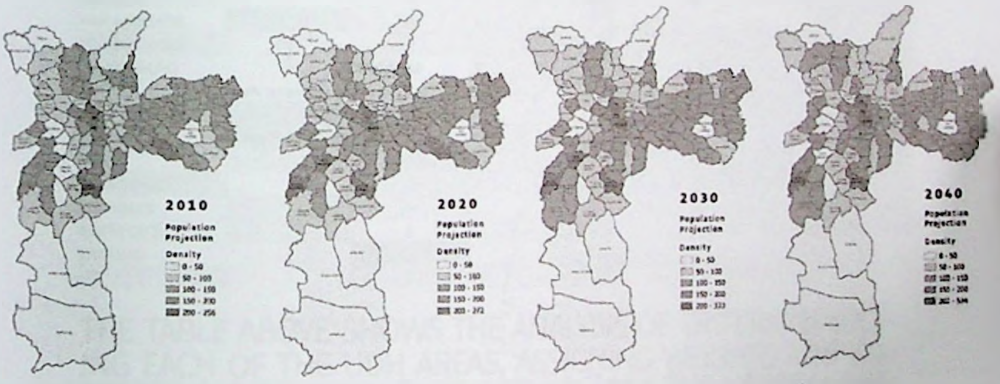
In conclusion, one last development

The potential of this cross-referencing system made it possible to work with Social Cartography, which departs from traditional mapping processes. It functions as diagrams that seek to give visibility to the internal relationships of the devices that permeate the contexts under investigation, allowing the analysis of tensions, disputes and heterotopias. To Foucault, spaces within spaces that normally go unnoticed, based on the subjectivity and objectification of the subjects imposed by dynamics - to him devices are "social machines" capable of producing subjectivities. These devices are, on one hand, the complex union of heterogeneous elements, generating internal paradoxes, and are, in the other, the union of discourses, laws, regulations, administrative decisions, scientific concepts, philosophical and moral propositions, the said and the unsaid are components of the device (Prado Filho and Montalvão 2013).

> What interests cartography the most in terms of its relations with heterotopias is the development of a critical perspective, of estrangement from our everyday spatializations, and, following the principles of heterotopology, producing an analysis and description that show their historical formation, the genealogy of their production, as well as enabling the creation of other spaces, of escape and resistance to this geopolitics of space. This stance implies the deterritorialization of fixed, demarcated spaces of reproduction, involving reterritorialization and openness to the new and different. (Prado Filho and Montalvão 2013, p.55)

Under this theoretical framework, a new stage of analysis was carried out, refining the previous method: a point count was carried out for high-rise buildings delivered between 2010 and 2022. Now, considering the districts instead of the HDU-Ms employed before and using the resources of the QGIS software, a calculation of the density of residential vertical buildings delivered per hectare (Verticalization Density) was performed, generating the following cartography as a result.

Figure 13.17 Density of high-rises per districts, ratio between the number of high-rises since 2010.



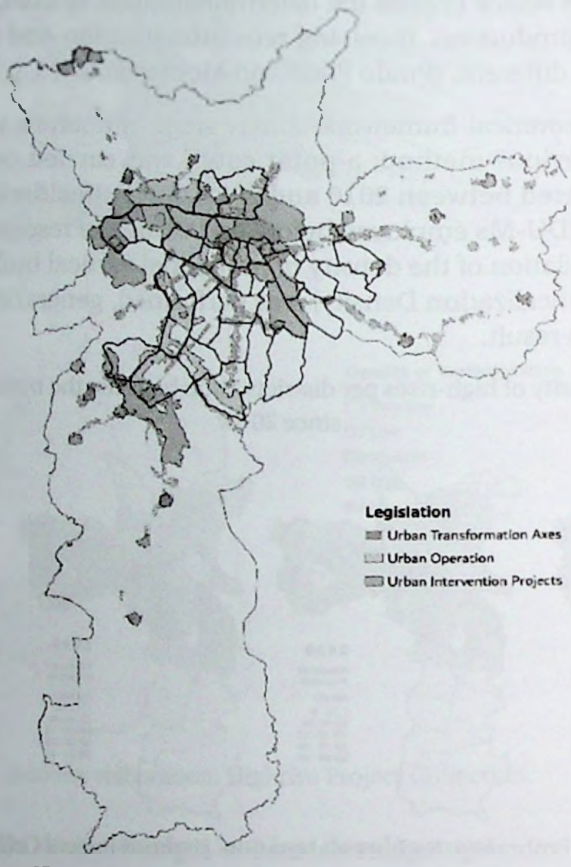
Source: Embraesp. Authors elaboration. Highrise Project Collection.

From this cartography, only districts with "Medium," "High," and "Very high" verticalization densities were filtered, totaling another 32 units of analysis. Additionally, a set of maps illustrating demographic projections by district in São Paulo for the years 2010, 2020, 2030, and 2040 was elaborated. The joint analysis of these cartography data enabled the identification of areas that presented or may present, changes in population density. This was understood as an indicator of a potential change in the profile of the resident population, especially in regions that concentrate a large number of high-rises in the period under analysis.

The production of vertical residential developments may or may not have a direct relationship with the increase in population density (as in processes of gentrification or emptying of metropolitan centers). In this sense, the search

for districts that experienced an increase in population allows for the investigating a possible relationship between high-rise buildings and population growth, high-rise buildings and gentrification processes, as well as urban transformations associated with these phenomena.

Figure 13.18 Demographic projections of the districts of São Paulo over the years 2010, 2020, 2030 and 2040.



Source: IBGE. Authors' elaboration. Highrise Project Collection.

Related to the analysis of demographic projections, four other aspects beyond the simple presence or absence of changes between 2010 and 2040 were evaluated. The first one refers to the frequency of population changes, which can occur in different periods analyzed. For example, if there was a demographic increase only between 2020 and 2030 in district "A," only one modification is recorded. In contrast, in district "B," if there was an increase between 2010 and 2020 and another between 2020 and 2030, two modifications are recorded in the analyzed period. The second aspect refers to the periods in which population changes occurred, considering the intervals of 2010-2020, 2020-2030, and 2030-2040. The third aspect concerns the characteristics of population change – for instance, increase or reduction, schooling, age, or

ethnicity. Finally, the fourth aspect, in addition to demographic trends and similar to the previous analysis, is related to the legal instruments that guide the production of urban space in the municipality of São Paulo.[22]

Figure 13.19 Pre-selected districts juxtaposed to perimeters of OUCs, PIUs and SAUTs.

DISTRITO	DENS.VERTIC.	DENS.DEMO.	OUC	PIU	EETU	LEGISLAÇÃO
ITAIM BIBI	3	A	X	X		2
VILA MARIANA	3	0			X	1
CAMPO BELO	2	0	X		X	2
PINHEIROS	2	0	X	X	X	3
MOEMA	1	A	X		X	2
SAÚDE	3	B			X	1
TATUAPÉ	2	0		X	X	2
SANTO AMARO	1	A	X	X	X	3
BARRA FUNDA	2	0	X	X		2
IPIRANGA	1	A		X	X	2
SANTANA	1	0	X	X	X	3
JARDIM PAULISTA	2	0			X	1
LAPA	1	0	X	X		2
VILA LEOPOLDINA	1	C		X		1
JABAQUARA	1	0	X		X	2
AGUA RASA	2	D				0
PERDIZES	3	0	X			1
VILA PRUDENTE	1	D		X	X	2
MOOCA	2	A		X	X	2
SACOMÃ	1	0				0
VILA ANDRADE	3	A	X	X		2
VILA FORMOSA	1	0				0
CONSOLAÇÃO	1	D	X	X	X	3
CARRÃO	1	0		X		1
BELA VISTA	3	0			X	1
REPÚBLICA	3	0	X	X		2
BRAS	2	B	X	X	X	3
CASA VERDE	1	0	X	X		2
LIBERDADE	2	A		X	X	2
SANTA CECÍLIA	2	0	X	X	X	3
CAMBUCI	1	C		X		1
SÉ	1	0	X			1

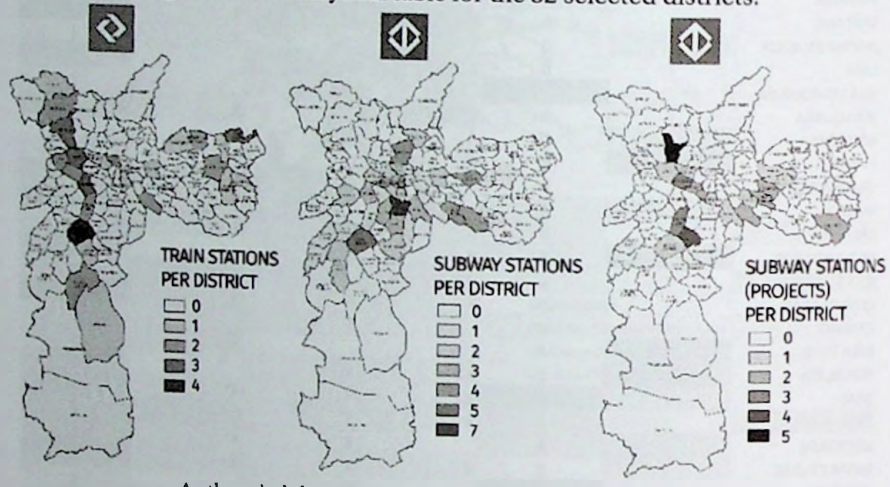
THE TABLE ABOVE SHOWS THE ANALYSIS OF CRITERIA INVOLVING EACH OF THE UDH AREAS, ASSIGNING WEIGHTS AND ENABLING THE SELCTION OF THE STUDY AREA. THE CRITERIA ARE: VERTICALIZATION DENSITY; DEMOGRAPHIC DENSITY; CONSORTIUM URBAN OPERATIONS; INTEGRATED URBAN PROJECTS; STRUCTURING AXES OF URBAN TRANSFORMATION AND LEGISLATION.

Authors' elaboration. Highrise Project Collection.

[22] Each of these legal instruments, such as a SAUT, is a tool used to guide and influence the production of urban space. Analyzing the occurrence of high-rise developments under the presence of these instruments enables an analysis not only of the results of state intervention in partnership with private initiatives, but also of aspects related to processes of production of the city. This approach allows for evaluating the effectiveness and feasibility of public policies and comprehensive political directives and, in itself, the resulting city.

To systematically organize these records, a table was developed that allows for simultaneous visualization of information related to the 32 selected districts based on the density of verticalization. Values or categories were established for each variable of analysis corresponding to the columns present in the table. Therefore, for the "Density of Verticalization" column, the districts were classified into three distinct levels, with values assigned as 1 (Medium), 2 (High), and 3 (Very High). As for the variation in population density, defined categories were adopted. In turn, the Urban Planning Instruments were individually recorded as OUC, PIU or SAUT and the number of these present in each district was also considered. This may indicate areas of greater interest to stakeholders, real estate agents, and municipal planning agencies.

Figure 13.20 Analytical table for the 32 selected districts.

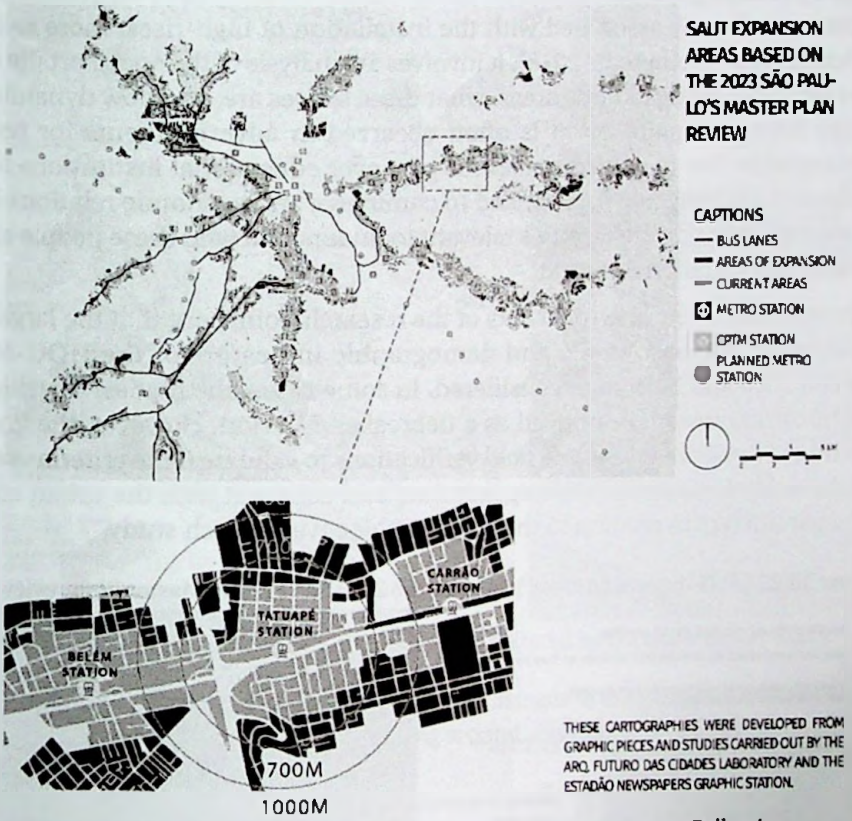


Authors' elaboration. Highrise Project Collection.

In the first stage of analysis, districts with low verticalization density and no significant demographic changes were excluded from the selection. The presence of urban instruments and their spatial extent within these districts was also considered. Next, a new reading layer was added regarding public spaces, mainly green areas including parks and squares in São Paulo, for the analysis of social-spatial practices, uses, and appropriations nearby residential high-rises. Thus, data from the Geosampa platform were manipulated through QGIS software, and cartographies were produced relating these spaces with areas of intense verticalization. To include recent public spaces and update the available information, a new point layer was built using resources from QGIS software and georeferencing sites such as Google My Maps. This update allowed the creation of a consolidated and updated base of public spaces that could not only integrate reading processes of the urban territory but also help in the selection of areas for field activities.

Secondly, we took into consideration the presence of collective transportation infrastructure[23] as an important factor in stimulating population growth and construction densification. These points were quantified for each district, enabling the identification of regions that are better served by mobility and transportation modes, eventually more attractive to the real estate market.

Figure 13.21 Maps of stations by district: CPTM stations; metro stations, built and planned.



Source: Geosampa. Authors' elaboration. Highrise Project Collection.

All these new data and analytical layers were then intermingled with the previous ones, reestablishing the HDU-M as the territorial unit of analysis, not only because they mostly cover smaller areas of the territory, but also because they present some homogeneity in terms of population profile. Therefore, allowing for a deeper analysis.

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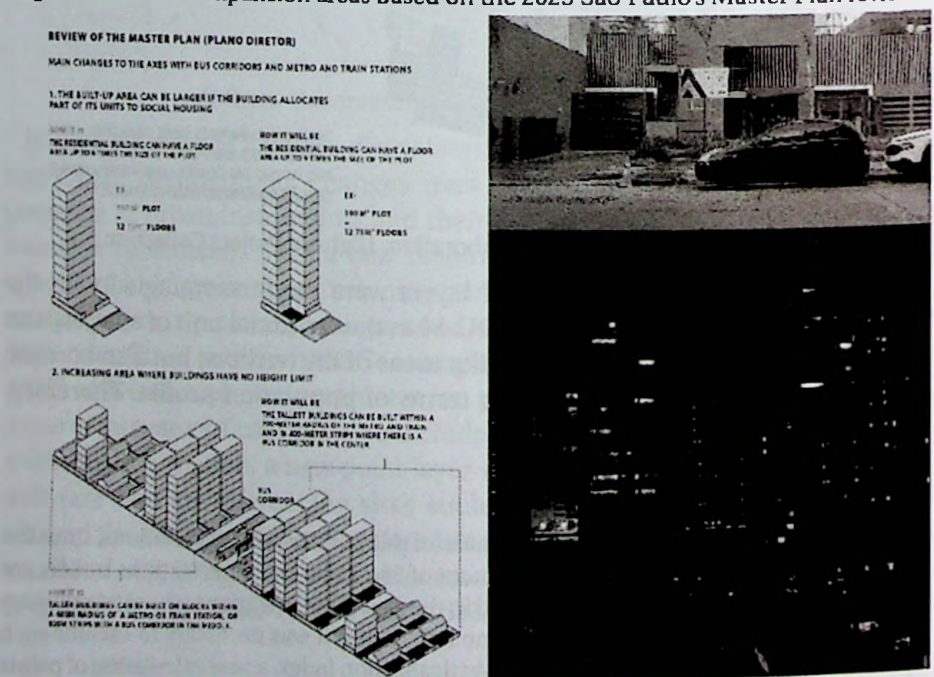
[23] A correction was necessary in the database of public transportation stations, since the information provided by the city government of São Paulo listed the stations by line, not by building/infrastructure, which resulted in the repetition of stations where transfers are made (stations common to more than one line). Thus, it was necessary to exclude such repetitions and, similar to the Density of Verticalization index, a new calculation of points per polygon was developed.

Although the reading layers were shared among the studies, they ended up assuming distinct weights according to the specific objects of each study. On the one hand, the presence of SAUTs (Structuring Axes of Urban Transformation), associated with a mobility network, was prevalent in the analyses when investigating the relation of this instrument to the verticalization, densification, and change of building typologies and housing patterns in these areas. This ended up revealing specific cutouts for the research. The analysis of verticalization processes is directly associated with the installation of high-rises, more so in particular areas (Nethercote 2018). It involves an analysis of the social profile of those who start living in these areas, what these spaces are, and how dynamics change from that point on. It is often observed in advertisements for new developments that prioritize spaces for pets over educational institutions for children, evidencing new logic linked to commerce and economic relations in these areas. Therefore, it becomes relevant to understand who these people are and how this variation occurred.

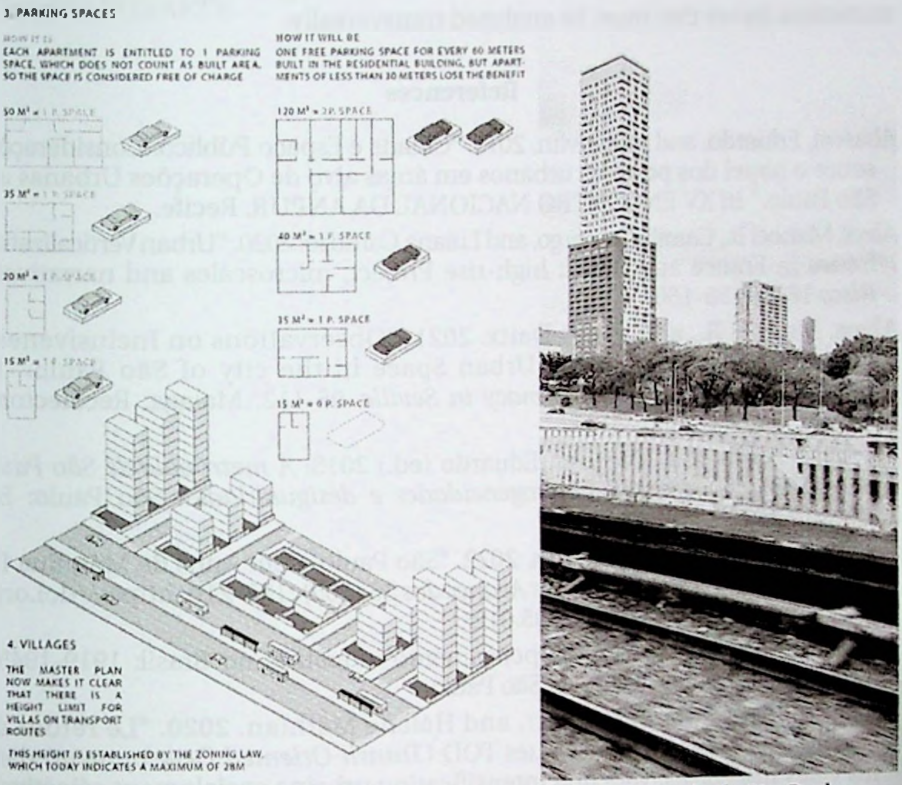
The selection of the analytical cuts of the research points out that the largest variations in socioeconomic and demographic indicators of the HDU-Ms between 2000 and 2010 were considered. In some cases, the highest densities of verticalization were prioritized as a tiebreaker criterion. However, the final selection of these areas required field verifications to validate if the criteria used and the analytical cutouts were appropriate and coherent with the urban and social parameters in relation to the specific objectives of each study.

Figure 13.22 SAUT expansion areas based on the 2023 São Paulo's Master Plan review.



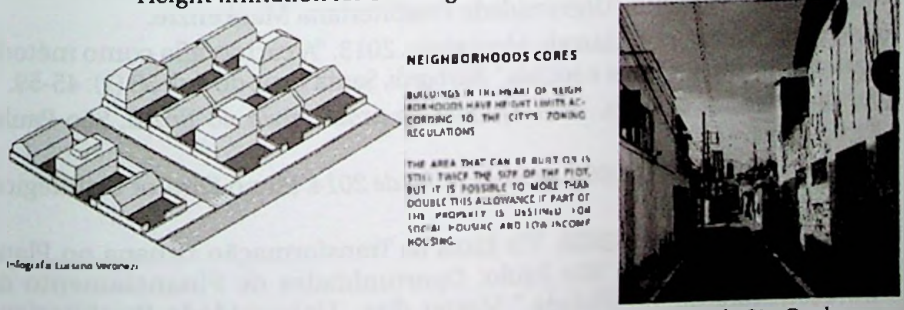
Source: Authors' creation based on graphic material by O Estado de São Paulo.

Figure 13.23 Changes to São Paulo's SMP: 1. Increase in the built-up area when destined for social housing / 2. Areas of influence of SAUTs with no height limit.



Source: Authors' creation based on graphic material by O Estado de São Paulo.

Figure 13.24 Changes to São Paulo's SMP: 1. Changes to the garage concession; 2. Height limitation for building around villas near the SAUTs.



Source: Authors' creation based on graphic material by O Estado de São Paulo.

One last comment. The São Paulo's Master Plan review, underway in 2023, clearly indicates a tendency for a more intense verticalization towards inner neighborhoods (in the middle of the blocks), especially around mobility infrastructures and the main transport axes throughout the city. A new analysis based on these changes will produce new results and needs to be understood,

maybe implicating adjustments in the developed methodology. This reinforces the fact that verticalization is not a linear and singular process: it involves numerous layers that must be analyzed transversally.

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