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**MAPPING URBAN
TRANSFORMATIONS
AND BUILDING DENSITY
IN THE CENTRAL AREA
OF THE EAST VECTOR
OF THE METROPOLITAN
REGION OF SÃO PAULO**

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INTRODUCTION

RESEARCH CONTEXT

The research in question is part of a line of studies on the “Densification and Verticalization of Brazilian cities”, started in 2017 by the group “Processo de Produção do Espaço Construído”, which emerged with the objective of understanding and analyzing urban transformations through morphological classifications. The analysis of buildings based on classifications of degrees and forms of compactness and verticality gives clues about city development patterns and agents of these urban transformations. Axis 2 of the project – Densification and Verticalization of the Metropolitan Region of São Paulo (RMSP) – concentrates the analysis for this region and its results have shown the need to deal with the duality between densification and the spread of human occupation in the outskirts of the city — urban sprawl—.

The association between urban phenomena linked to the production of buildings is what configures the dynamism of the RMSP and its rapid growth and constant densification in a large part of its extension. This research proposes to analyze this process and find relationships between urban development and building typologies, taking as reference the case of the central area of the eastern vector of the metropolitan region of São Paulo. It must be noted that the phenomena of densification and spreading are distinct, not directly related and do not follow a chronological or causal rule, however they act together in the process of formation of cities. This research proposes to identify and territorialize these processes, in order to reflect on their overlaps, concentrations and absences.

The work produced here is the unfolding of a pre-existing research, based on the mapping of morphological transformations

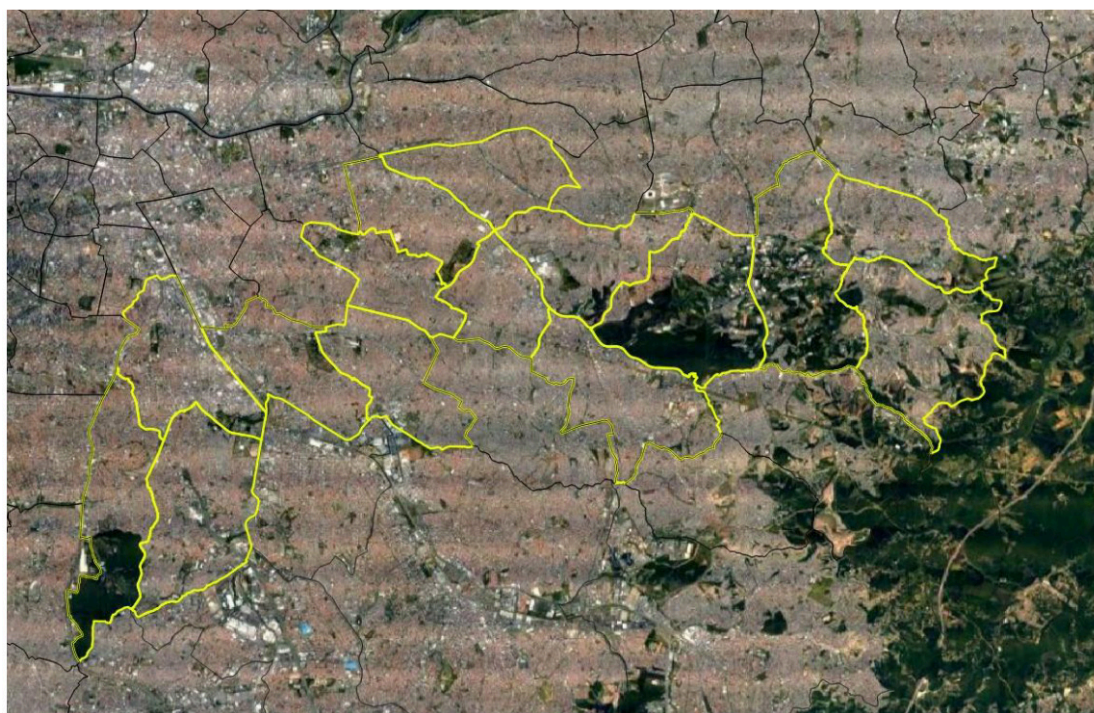


Figure 1: Satellite top view of east side centerline.

Source: Google Satellites.

in the RMSP. The west, south and north regions were mapped last year by colleagues, while the east, more extensive, is on the agenda for this year's mapping, part of which had already been completed, but was lost and had to be redone. Understanding the real estate dynamics that are present in the east zone, through bibliographic or journalistic means, can in fact facilitate the mapping activity. This process is, by nature, purely visual, however prior knowledge of the areas prepares a more attentive and targeted look. The next stages of the research will include a deeper analysis of the data presented here and the maps produced.

EAST VECTOR

This research on the *urban sprawl* process will be based on a case study: the central area of the east vector of the RMSP. This theme proved to be relevant precisely because of the cartographic observation and mapping, that is, the empirical observation raised the hypothesis of a movement pattern relating densification and spreading in the process of urban transformations. Thus, this mutual and parallel movement can be seen between the construction of buildings in already consolidated urban areas and new subdivisions and occupations on the outskirts of the city.

The east zone was worked on in isolation in this research, but without leaving aside reflections and the identification of points of tangency between it and the other regions mapped by other members of the research group. The Brazilian intra urban space presents a logic that repeats itself, with similarities and certain tendencies in the organization of its space and in the reasoning of its development (VILLAÇA, 2001). Therefore, it is expected that the reflections raised here will also collaborate with the analysis of other cities and other capitals in

Brazil where these phenomena also occur.

In addition, along the line of reasoning developed here, it is suggested that the centralities and also what are called here "consolidated areas" - referring to areas, generally residential, old and traditional, in general, closer to the center in the case of the east zone - play a relevant role in urban transformations and, above all, in the relations between densification and sprawl. In addition to a search for patterns typical of the eastern zone dealt with here, the research intends to leave the particular field of diagnosis and look for generalization trends.

OBJETIVES

The radical objective of mapping urban transformations in the eastern sector of the RMSP is to add to the survey being carried out by other collaborators (students and professors) started with an axis of the line of research "Densification and Verticalization of Brazilian cities", "Densification and Verticalization of the Metropolitan Region of São Paulo (RMSP)". This part of the research was responsible for mapping the east zone, a section whose data was lost and had to be redone.

With the analysis of the transformations found from the making of the maps and the raising of some hypotheses, the objective of this research is to verify if there are and what would be the possible associations to be pointed out between the phenomena of densification and spreading of the urban transformations, in order to contribute to readings on intra-urban transformations in cities, based on a case analysis of the east vector of the RMSP. Therefore, another objective is precisely to identify the specificities of this part of the city in relation to its totality and what is repeated throughout the entire length of the RMSP.

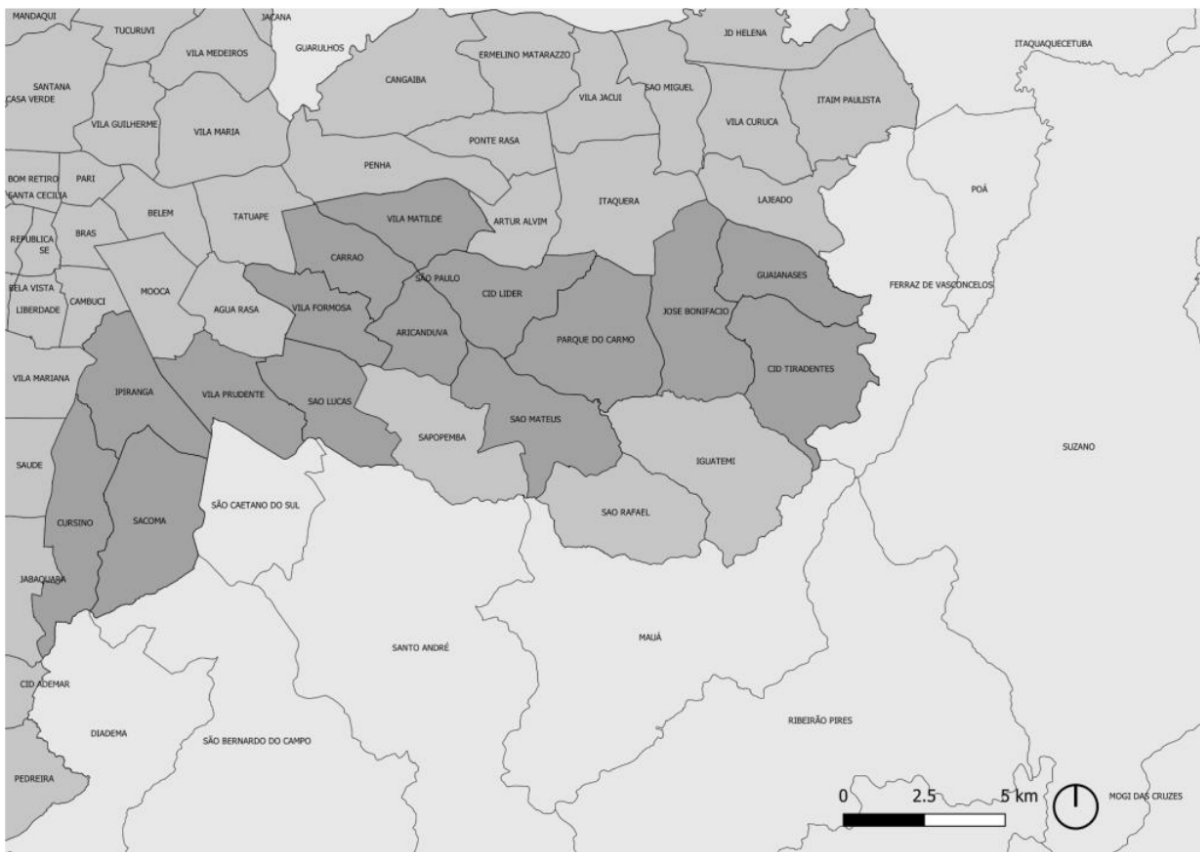


Figure 2: Labeled map of the worked area.

Source: Own authoring via QGIS.

METHODOLOGY

In order to understand the urban processes of transformation, it is proposed to identify these and classify them into morphological types, which are associated with specific agents and different forms of provision, in addition to different spatial distributions. In this sense, maps of the transformations of the different urban sectors analyzed according to their morphological type, mode of occupation and form of provision were produced. The research in question is part of a larger one, involving the analysis of other vectors of the RMSP and, as a strategy to make all sections of this work compatible at the end, the methodology used to map urban transformations is the same in all sectors studied. The advantage of this mapping

pattern is that it makes possible comparisons, joint analyses, data crossing or even the addition of other classification criteria in the future without harming previous surveys. However, there is a disadvantage: the standardization of the methodology can make it difficult to identify specificities in each region.

MAPPING

The main software used was QGIS, in which layers of polygons were created that delimited the places where transformations could be observed. To enable the comparison in different time periods, two databases were needed: the satellite images from the Geoservice (WMS/WMTS) of Google Earth Pro from 2018 and the Orthophotos 2010

& 2011 made available by EMPLASA. In previous stages of this same research, the methodology used differed by using the overlapping of two orthophotos, from 2010 & 2011 and 2018. However, with the extinction of EMPLASA, the group managed, in contact with the Institute of Geosciences of USP - which stayed with the old EMPLASA archives - the 2010 & 2011 orthophoto, but not the 2018 orthophoto. This change of comparison material did not evoke significant problems for the identification of transformations. It can be pointed out that in areas with high constructive density, the difference in resolution and colors between the image provided by EMPLASA and the image via Google Earth caused some confusion, but nothing that actually compromised the comparison between the images. Another point of greatest difficulty is identifying the exact location of a certain transformation to annotate it as a polygon in QGIS, since the Google Earth screen remains parallel to the QGIS screen containing the EMPLASA orthophoto, and it is not possible to superimpose them.

MORPHOLOGICAL TRANSFORMATIONS

The first stage of analysis is focused on the search for changes that occurred between 2010 and 2018 that can be observed on a scale of 1:2000 and categorization of these according to their shape, that is, height, built-up area on the lot, afforestation and others. At times when the satellite image view was blurry or unclear, we used Google's Street View tool, in which it was possible to more clearly identify the building's morphology.

To classify the transformations identified in the analyzed perimeter, the polygons created were categorized according to classifications adapted from Stewart and Oke (2012), and the terms were also translated

into Portuguese, shown in parentheses after the original terms: Compact verticalization with elevator (Compact Highrise - High Compact), or without elevator (Compact Midrise - Medium Compact), Compact occupancy at low height (Compact Low-rise - Low Compact), Open verticalization with elevator (Open Highrise - Alto Aberto) and without elevator (Open Midrise - Medium Open), open low-rise occupation (Open Low-rise - Baixo Aberto), small occupation at low height (Lightweight Low Rise - Baixo Precário), large occupation at low height and heavy industry (Large Low Rise & Heavy Industry - Big Bass), Sparsely Built (Sparsely Built), Reforestation and Empty Lot.

This form of categorization was used as a standard throughout almost the entire research process, but at the end, with the other stages already completed, the way to classify this first stage was considered. In order to make these categories more clearly compatible with those already used by Quapá, in order to facilitate dialogue and data crossing, the polygons were reclassified into: V - verticalized lots (High Compact; Medium Compact; High Open; Medium Open), H1 - low residential (Low Compact; Low Open, Low Precarious; Sparse Occupation), H2 - warehouses and industries (Low Large), ANC - unbuilt area (Reforestation; Empty Lot) and Enclave (Enclave). Thus, there are, in the end, two maps that correspond to step 1 of categorization, the first following parameters adapted from Stewart and Oke (2012) and the second that makes these compatible with the typical classification of Quapá.

OCCUPATION MODES

After the conclusion of the first stage, therefore, with all the polygons that indicate transformation finished, a new category of classification of these is started: Occupation Modes. As a way of making it compatible with

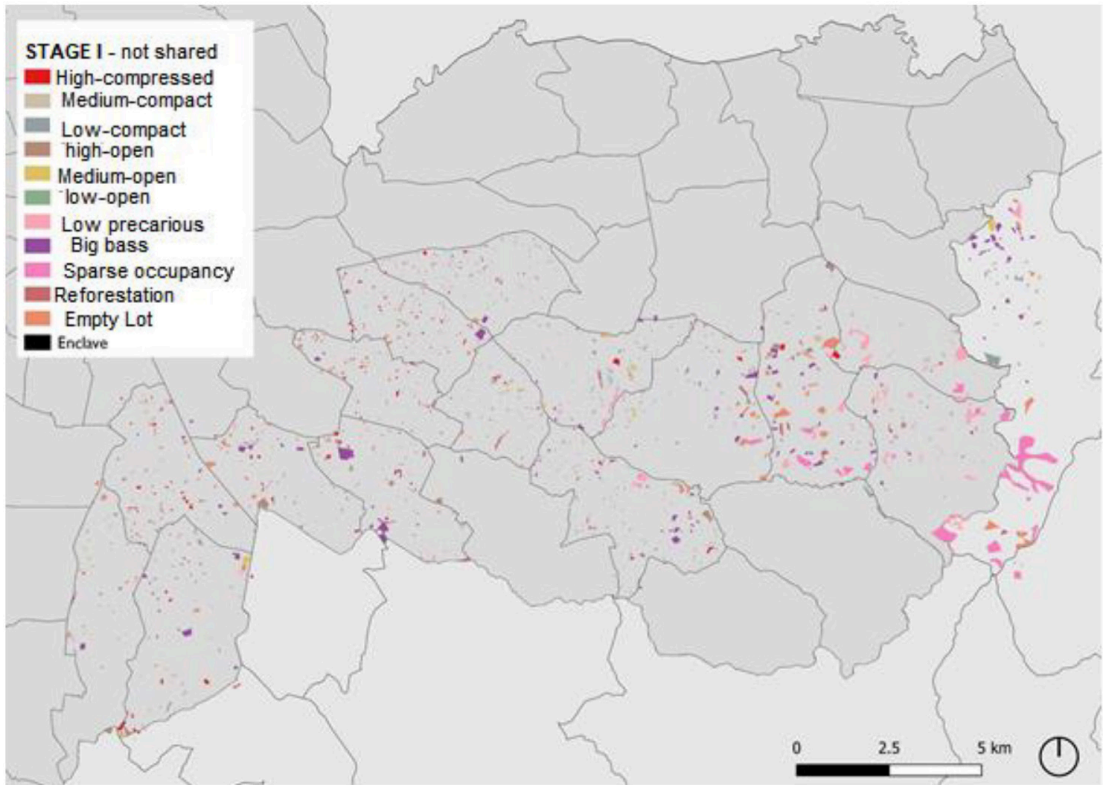


Figure 3: Map of Morphological Types not compatible with Quapá nomenclatures.

Source: Own authoring via QGIS.

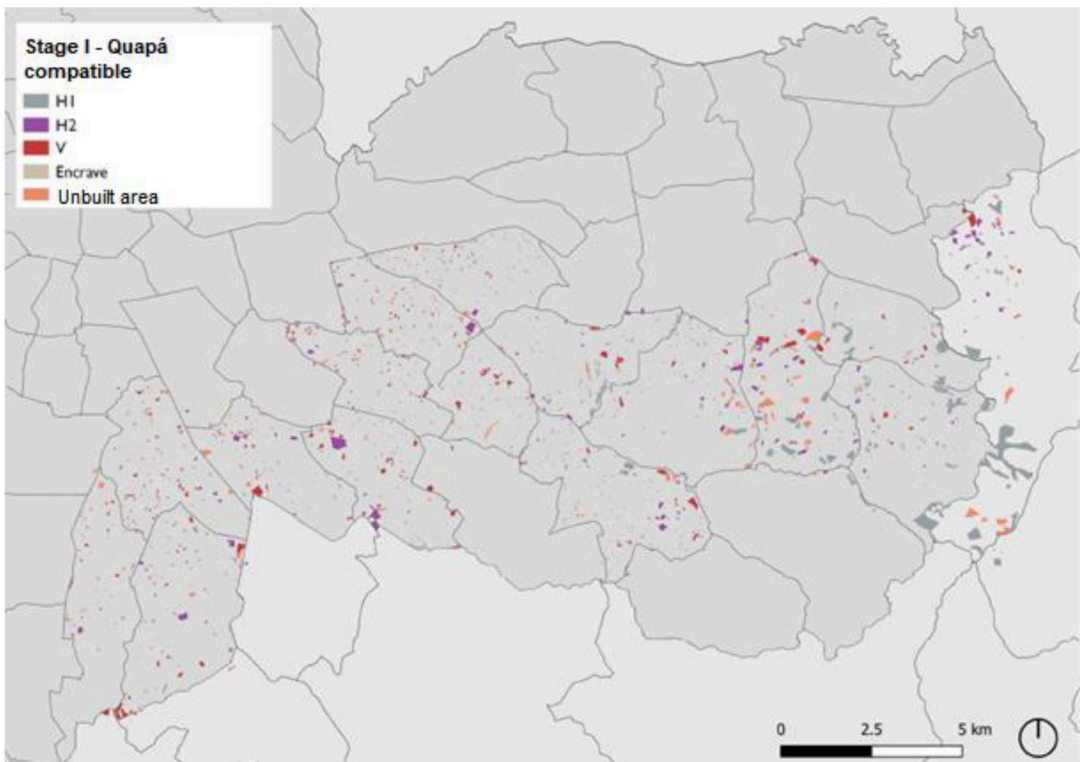


Figure 4: Map of Morphological Types compatible with Quapá nomenclatures.

Source: Own authoring via QGIS.

what already defined by Quapá, we adopt: Addition, Consolidation and Substitution. To these categories, the Leap of Urbanization category was added, important for the characterization of urban sprawl, proposed by Biderman and Hiromoto (2019). Thus, there is a map with four distinct categories that indicate the nature of the identified transformation, where Addition is defined as that building appears on the city limits, as an expansion already linked to the perimeter of the urban area; Consolidation of everything that is established within the urban area in previously empty lots or former unoccupied free areas; Replacement when an old building is demolished giving way to a new one; and Salto na Urbanização all that construction that is done far from the urban area, disconnected from the intra-urban space.

FORMS OF PROVISION

The third and last stage has the function of categorizing according to eight possible types of use that can be identified in urban transformations: Precarious Allotment - Self-construction; Formal subdivision; Formal self-production; Housing Complex of Houses; Townhouse; Vertical Incorporation/ Investment; Production for Trade and Services; Production for Industry, Warehouses and Logistics; Public Production and Community Equipment; and Unidentified. In order to facilitate the crossing of data between stages, this categorization follows a different pattern from the others. The polygons were transformed into points, marking them as centroids in which each color defines a form of provision and each point format defines an occupation mode, that is, in a single map it is

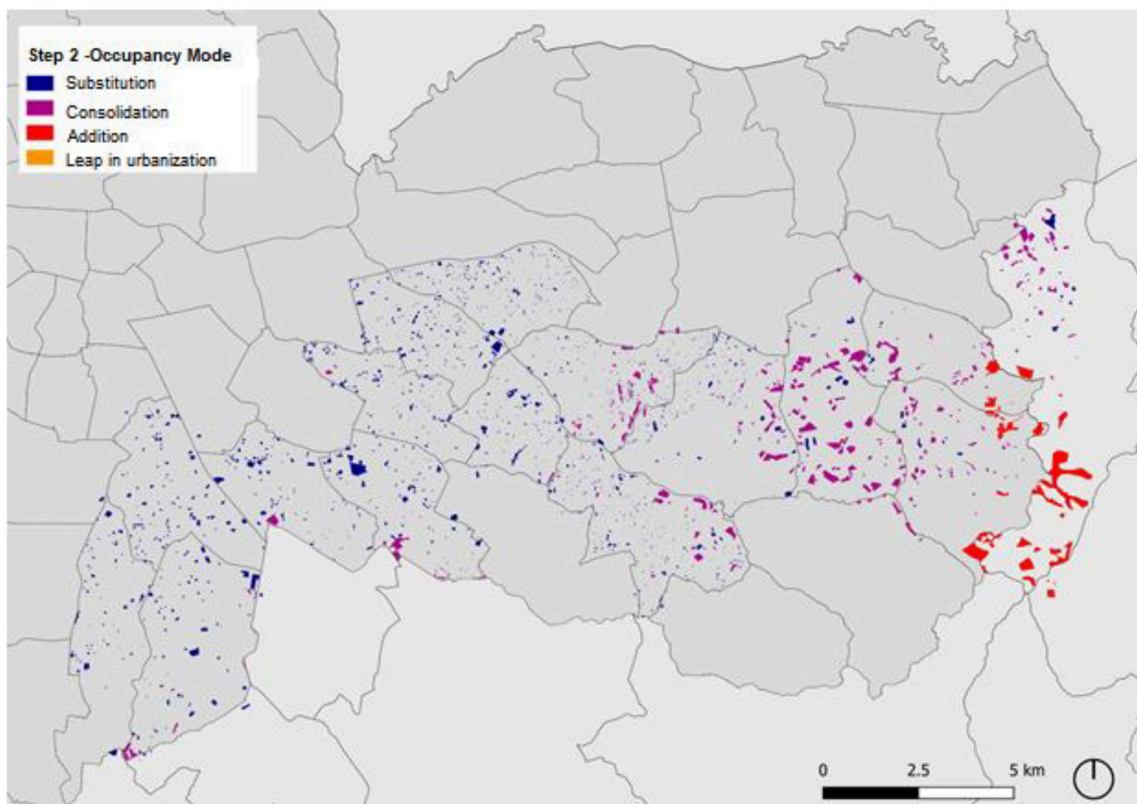


Figure 4: Map of Occupation Modes compatible with Quapá nomenclatures.

Source: Own authoring via QGIS.

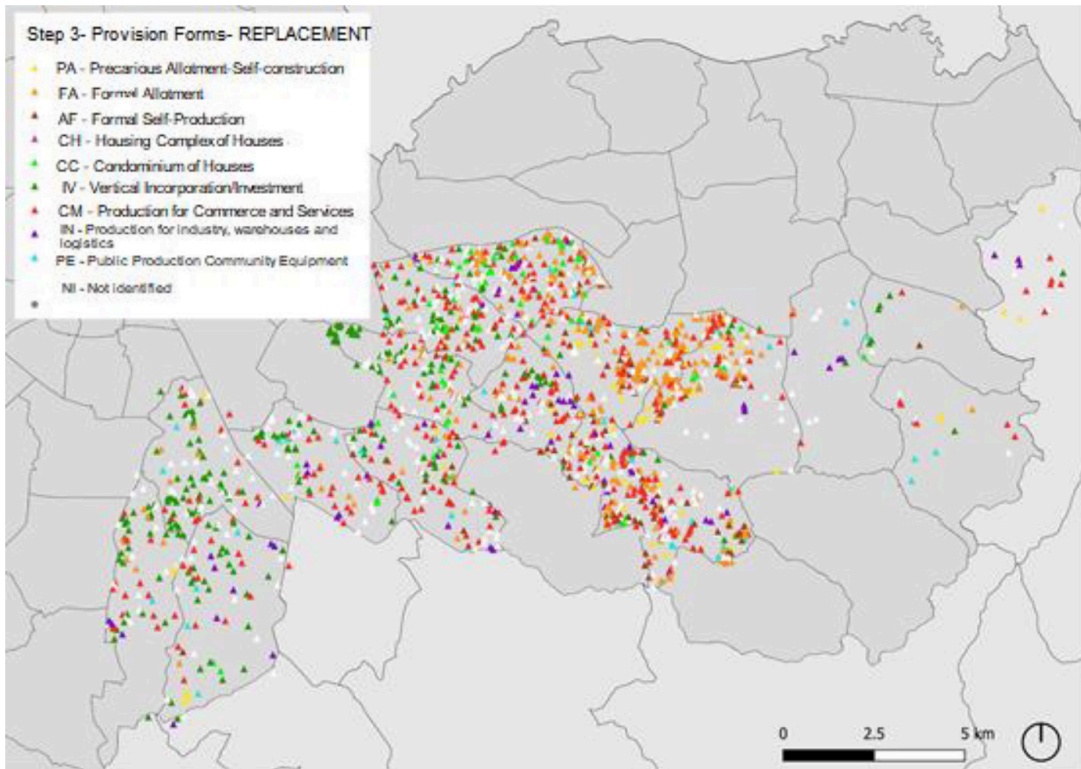


Figure 5: Map of Forms of Provision - Substitution Polygons.

Source: Own authoring via QGIS.

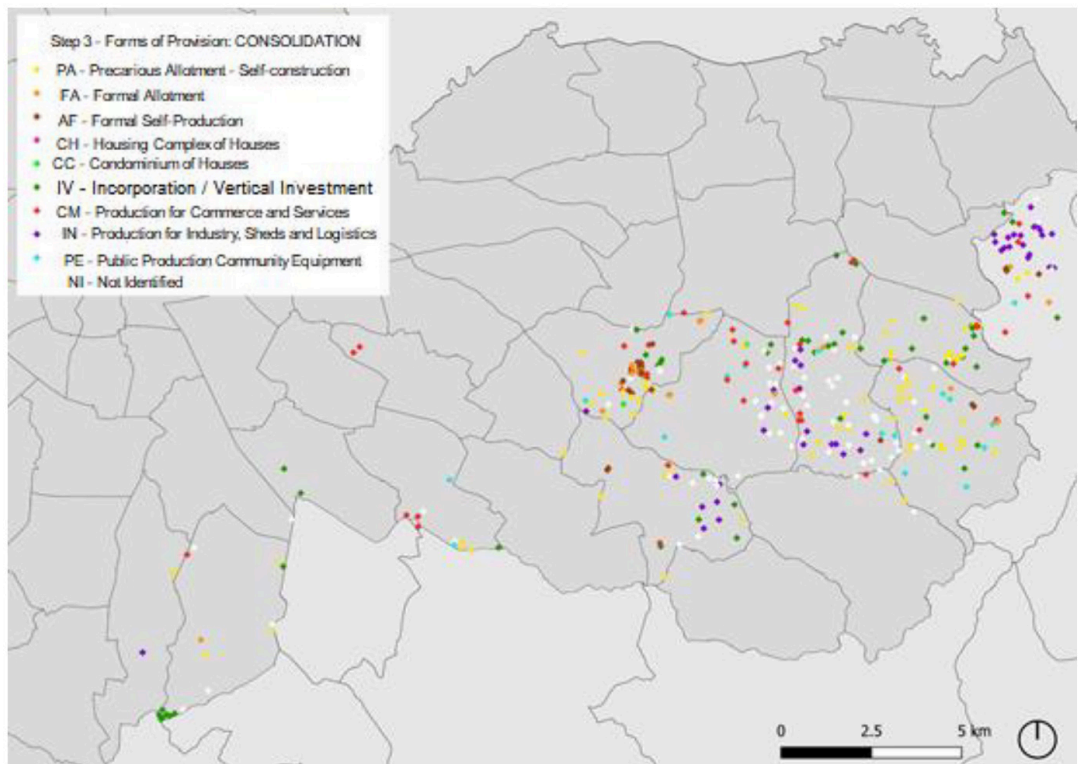


Figure 6: Map of Forms of Provision - Consolidation polygons.

Source: Own authoring via QGIS.

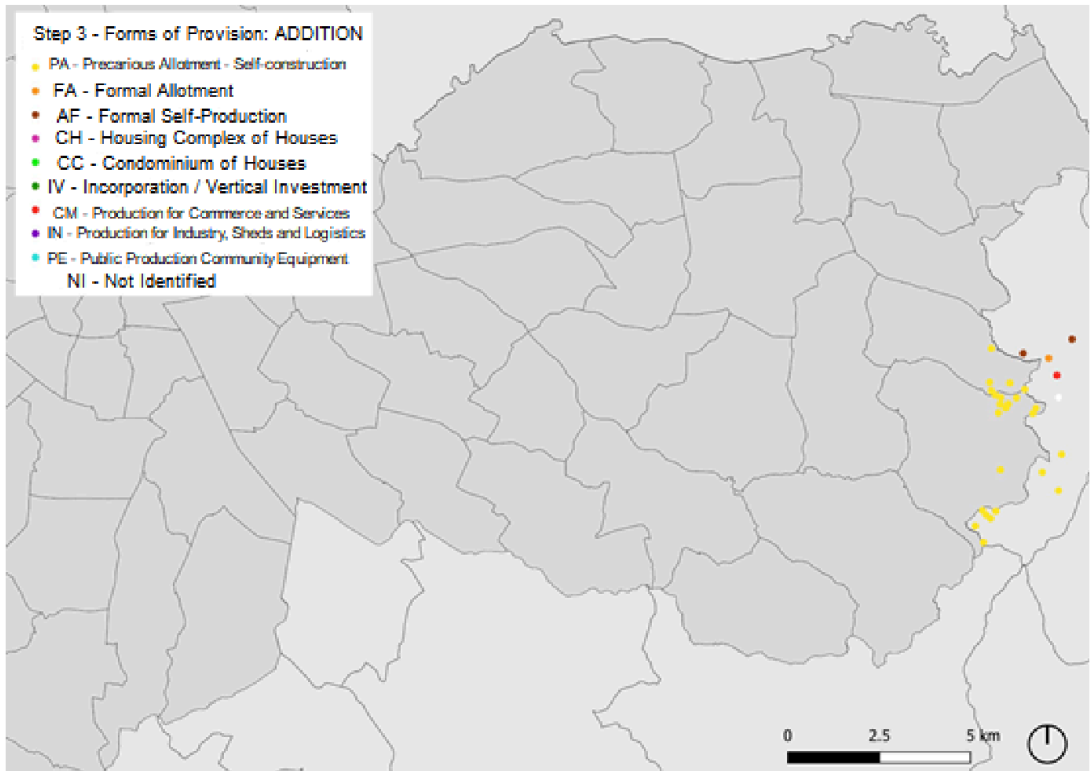


Figure 7: Map of Forms of Provision - Addition polygons.

Source: Own authoring via QGIS.

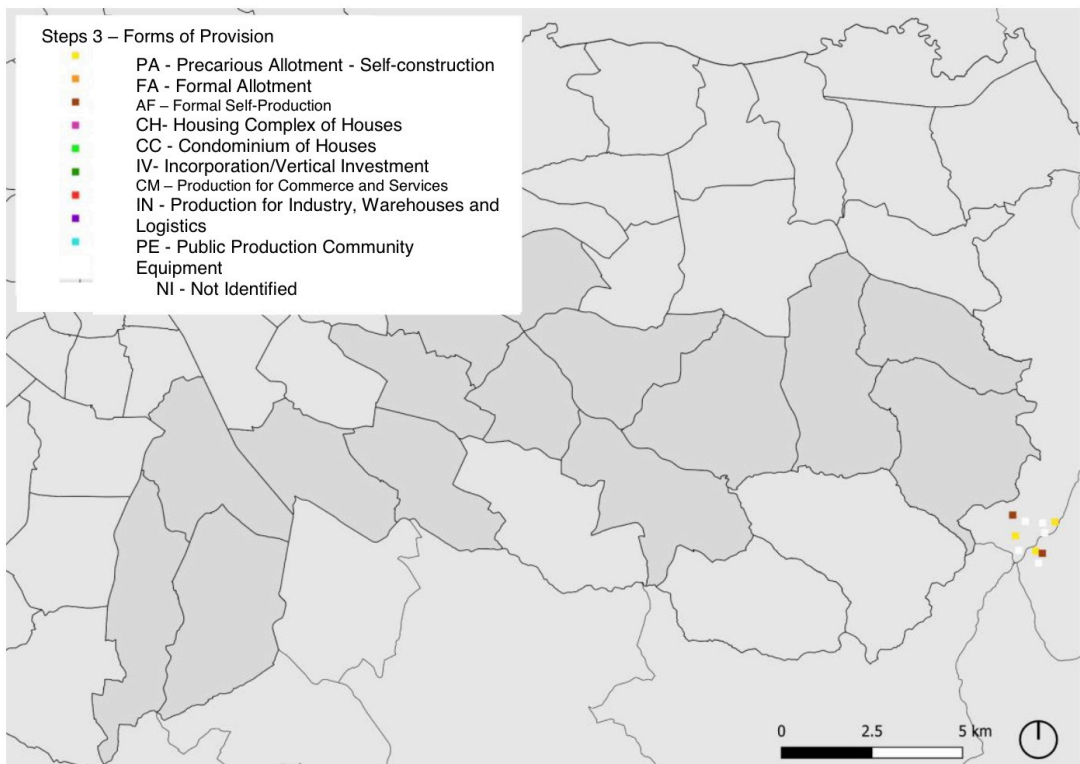


Figure 8: Map of Forms of Provision - Salto polygons in Urbanization.

Source: Own authoring via QGIS.

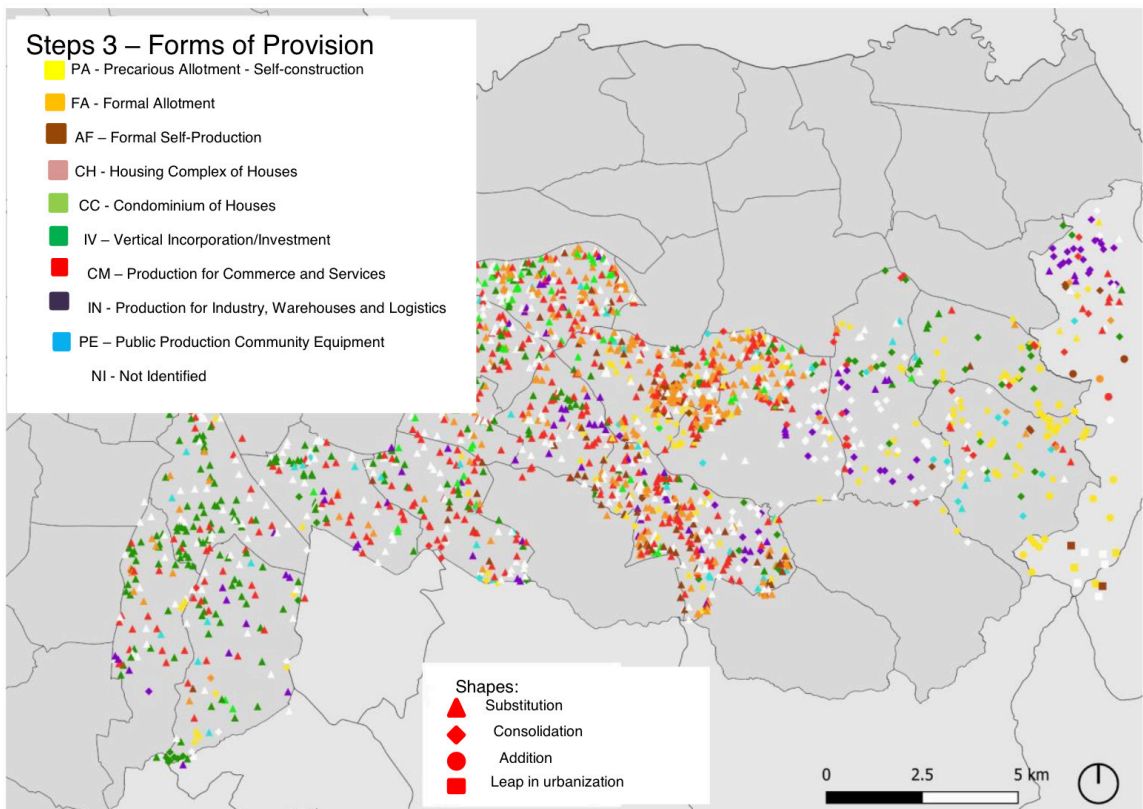


Figure 9: Complete Provision Forms Map.

Source: Own authoring via QGIS.

possible to observe and analyze two stages of mapping, in order to facilitate conclusions in group discussions.

TERRITORIAL AND TEMPORAL CUTTING

The territorial cut was based on the urban structure model of Villaça (2001), the delimitation of areas in sectors, constituted from regional circulation axes, adapting the limits to conveniences of division of groups of sectors between the PUB scholarship holders and PIBIC that are part of the project.

Each sector is delimited by physical barriers or circulation axes, such as highways and avenues, starting from the point located next to Marco Zero in Praça da Sé, continuing until where there is an urban area. The Metropolitan Region of São Paulo

was divided into nine sectors to be studied by one PUB fellow each: South, Southwest, West, Northwest, North, Northeast, Southeast, East 1, East 2 and East 3, the latter being claimed in the report in question. The sector to be analyzed in this project – East 3 – is located between the district of Ipiranga and the municipality of Ferraz de Vasconcelos. The mapping records transformations that occurred between the years 2010 and 2018.

DENSIFICATION AND SPREADING - URBAN SPRAWL

Densification and scattering are spatially opposed phenomena. While one is about increasing the occupation density of a certain space, the other brings the idea of “spreading” or even spraying. It is wrong, when thinking about “densification” in urbanism, to

exclusively associate “verticalization”, this is part of a phenomenon of densification in cities, but which is not restricted to it. The word densification refers, above all, to a process, that is, it can be said that in a sparse occupation area that became less sparse, even with horizontal buildings, there was a densification.

How they relate not only to each other, but also to another urban phenomenon: that of sprawl, which in turn can also suggest more than one form of the same process. Compact low morphologies can arise in a process of densification - when they appear in areas of consolidation of the urban area - or in a spreading process - in the case of located in more recent areas of urbanization. Therefore, it is necessary to contextualize these phenomena so that they make sense in the analysis of an urban vector.

THE DATA CROSSING

At the end of the mapping, with the maps of the area already produced, it is possible to draw parallels between the location of each morphological type within the eastern zone. It is clear that there is a greater concentration of replacement buildings in areas close to the center, since there are few remaining empty lots or unbuilt free areas. In the same line of reasoning, it appears that most of these replacement buildings are high and medium standard residential buildings, either because of the greater demand in the real estate market for housing in the areas most inserted in the urban area, or because of the designation of the master plan to area. Precarious self-construction is also seen in these spaces, however to a lesser extent and with greater density, generally close to floodplains of bodies of water and steep terrain, places where the formal market has greater difficulty occupying.

The incidence of precarious large-scale self-constructions increases the farther one moves away from the urban area, most formed in the process of consolidation or addition. This phenomenon is related to the existence of vacant lots and less inspection of irregular occupations and informal self-production in remote areas, since the market demand for these spaces is lower. It is in these areas, too, where the greatest concentration of new sheds and industrial buildings linked to the logistics and supply of the cities can be observed, which is due to the master plan itself, the ease of access to expressways for the distribution of products and the noise and diffuse pollution produced by certain industries that would be inappropriate in areas close to residential areas.

An interesting finding about the replacement phenomenon in the east zone was the quite intense appearance of small condominiums with semi-detached houses and also semi-detached houses connected directly to the street. These mostly replaced former lower standard residences or land occupied by small local businesses and were almost non-existent before 2010, a typology with recent advances. The new businesses were concentrated in the strip between Vila Matilde and São Mateus, becoming more sparse as they approached the municipality of Ferraz de Vasconcelos.

The in-depth analyzes of the data collected in this research will take place in the next steps, in which all the mappings of all the areas of the RMSP will be united and complete in a great general panorama. This preliminary stage generated data of great importance for the analysis of urban dynamics in São Paulo on a micro and macro scale, so that the particular city is capable of generating conclusions about the general cities and their development and consolidation processes.

CONCLUSIONS

What can be considered by superficially observing the maps produced by these three initial stages of the research is that there is an association between the phenomena of densification and sprawl in urban transformations, even though they are phenomena that manifest themselves in opposite ways, and that these associations can be noticed on a micro or macro scale in the East vector of the Metropolitan Region of São Paulo.

The typologies of buildings that emerged between 2010 and 2018 are directly related to their location and the process from which they are derived. Densification can be perceived both in already consolidated areas - as seen in verticalization by substitution - and in new areas of occupation - illustrated by the new industries arising from leaps in urbanization that are concentrated on the outskirts of the city -. Sprawling is also observed throughout the territory, in particular it is possible to mention the appearance of new areas occupied by irregular self-constructions in old forests and the new subdivisions formed by addition to the urban fabric.

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