

**Proposal of a methodological sequence for the spatial-temporal analysis of
real estate developments: Application in Natal/RN**

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ABSTRACT

The objective of this study is to analyze the spatial distribution of real estate developments, launched during the most intense years of the real estate of the city of Natal/RN. However, the lack of data related to the real estate production of several national capitals, based on the absence of clear procedures of the raising and organization of this kind of information, represents a limiting factor for the development of an analysis of this nature. To outline this limitation, this article conducted a proposal of a methodological sequence capable of raising, systematizing, and geo-referencing an ample variety of data referent to the real estate developments of any Brazilian city. The application of this new methodological itinerary in the capital of Rio Grande do Norte, reveals an asymmetric spatial distribution in the city territory, having in mind that 86% of the real estate developments are concentrated in 4 areas, that correspond to only 19% of the territorial extension of the city in issue. In 3 of these locations a connection between the type of real estate development and some physical and social-economic characteristics found in them is tangible, such as tourism and environment, urban equipment, besides the purchasing power of the population. At last the action of the State as a real estate development inductor of and outskirts region through a housing program promoted by the Federal Government was identified.

KEY WORDS: Methodological sequence. Spatial analysis. Real estate market. Natal/RN.

INTRODUCTION

The location in urban space is one of the main factors that influence the decision process of the agents that work in the real estate market of a city. Understanding the type of production and the position of the real estate developments within the city territory may be of great value, both for the private sector, that can use this knowledge to analyze its successful strategies, strengthening the knowhow for future decisions, as well as the public sector, that may use this information to adopt practices that maximize the offer of the infrastructure and the efficiency of the local urban plan.

Within this ambit, the studies of spatial distribution have been consolidated as an important tool to understand the real estate dynamics of a city. Kuntz; Helbich (2014) and Dambon et al. (2021), for example, used spatial analyses to study the price of real estate in Vienna, capital of Austria and in the main cities of Switzerland, respectively.

Still within the European ambit, Seixas et al. (2020) expanded the utilitarian horizons of the spatial analyses when evaluating the perception of the Portuguese population about the city in which they reside through georeferenced maps. These studies used a questionnaire containing some questions about the locations where they feel safe, the regions they visit with their families, the places in the city that they like, among other similar questions. This way, the authors were able to resume in spatial distribution maps the location preferences of the inhabitants of a specific city.

Migrating to the Asian real estate Market, georeferencing also has been used to analyze the spatial distribution of specific real estate developments, especially in China. Liu et al. (2017) promoted a spatial analysis related to the development of mixed use, identifying the peak hours of use of these properties. Still within the Chinese context, Zhang (2014) used the maps of spatial distribution to identify the areas of the city of Shenzhen that concentrate the greatest number of commercial buildings. For this, the author divided the territory of the city in several segments, identifying the commercial level of the regions of the city, through the quantity of commercial developments contained in each division.

Within a national ambit, Hoyler (2016) and Rosseto; Pastrelo (2019), studied the spatial distribution of real estate developments launched at a specific moment of the Brazilian

economy. Both studies concentrated on the Metropolitan Region of São Paulo and used data from the Brazilian Company of Patrimony Studies (EMBRAESP), which has a variety of information from real estate incorporations of the region.

Whereas in other Brazilian cities, such as Porto Alegre/RS and Fortaleza/CE, some researchers developed models that aim to predict the values of the residential properties, considering the influence of some variables such as location. (GONZALEZ; FORMOSO, 2006; NUNES, 2016; MOREIRA, 2020). For this, these studies captured a restrict quantity of information from some sources, such as: real estate transactions supplied by the city offices and data from the Market, made available by local real estate agencies.

However, despite the efforts employed by these researchers, the lack of information about the real estate market has been limiting a series of spatial analyses within a national and an international ambit. In the case of Brazil, this gap of knowledge is justified by the non-existence of a methodological sequence that helps the gathering and systemizing of information of the real estate developments of the main Brazilian cities.

In the current scenery, the gathering and systemizing of this information is a complex procedure, since only two Brazilian capitals have a consistent gamma of information of the built real estate production of their territory. Besides the Metropolitan Region of São Paulo, mentioned previously, the city of Natal/also has a data bank containing the most varied information of their buildings. This capital of the Brazilian Northeast holds a databank with all of the real estate incorporations of its history, result of the work of some local¹ researchers that aim to maintain updated and georeferenced this conglomerate of information.

Looking into this databank it is possible to conceive some historic series, such as in Figure 1. This graphic represents the annual history of the quantity of housing units launched in the city of Natal/RN during 50 years. Within this ambit the information bank existent in this city may be of great value, both for the development of a methodological pattern that may be replicated in other Brazilian cities, as well as in the conduction of the actual spatial analyses.

By observing the real estate production of all of the years that compose this historical series, a productive superiority that begins in 2005 and finishes in 2014 is perceived. Among the aspects that favored this moment of expansion, the stable inflation and interest rates, regulatory changes that offered greater legal safety to developers, besides an increase of credit for real estate financing are highlighted.

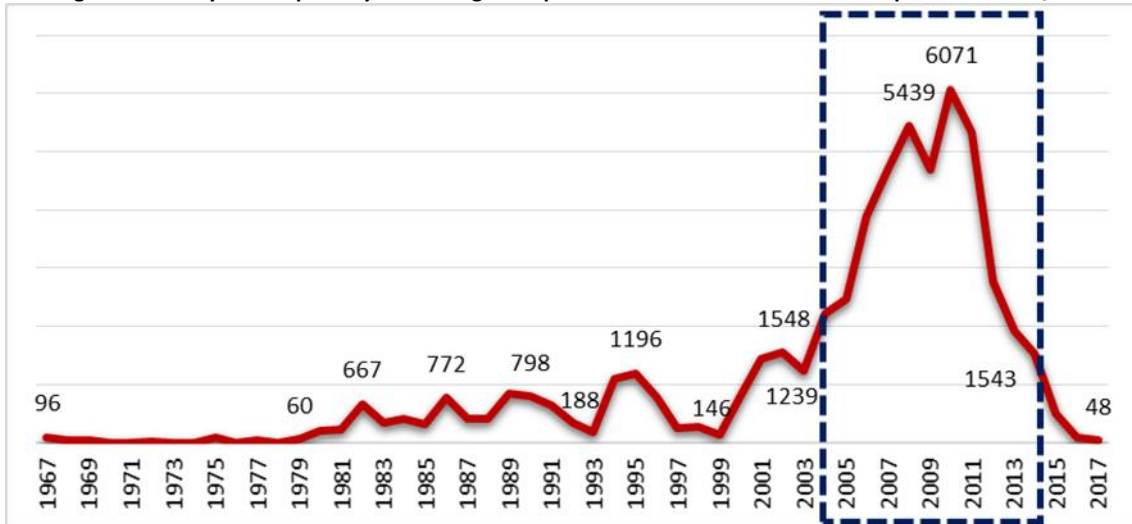
Whereas among the aspects that collaborated to the decrease of the national real estate Market, the following items are highlighted: the inflation above the limit of the goal and the consequent elevation of the interest rate, changes in the macroeconomic model in force since 1994, an adverse international scenery, besides the political crises that ravaged the country, especially since 2013.

In face of this issue, the present research intends to develop a methodological pattern, that can be replicated in other Brazilian cities, aiming to uniform the gathering and systemizing of this information, as well as enable a series of spatial analyses of the real estate Market of any

¹ The construction of a databank, containing data from real estate incorporations, was started in the city of Natal/RN by Ferreira (1996) and Queiroz (2012), both raised the material referent to the period of 1967 to 2010. Posteriorly (2017) complemented this information, performing this raising of data until 2017. At last, Costa (2017), Rolim (2019) and Torres (2019) conducted the georeferencing of these real estate developments.

national city, To validate this methodological proposal, this study aims to analyze the spatial distribution of the real estate developments launched in Natal/RN during the 10 years mentioned above. At the end of these operations it is hoped to be able to identify probable factors that collaborate to the elaboration of specific spatial arrangements within the city territory.

Figure 1: History of the quantity of housing units produced under the form of development in Natal/RN.



Source: AUTHORS, 2022.

Before starting the description of the proposed method, it is timely to point out that this method is applied to the real estate developments, or, in other words, the real estate production of private companies, that work in the commercializing of the of the autonomous units of these developments. This fact represents an important delimiting factor for the understanding related to the slice of the real estate production that this research proposed to analyze, since there is an expressive number of properties that are not built under the regimen of real estate development, such as: unifamily housing units (that generally are built by the actual residents), the informal settlements (communities/ slums), and even allotments built by the Federal Government.

METHODOLOGY

The methodological sequence proposed by this study is based on Law n° 4.591/1964, which regulates the registry of real estate development, to therefore be apt to commercialize the autonomous units of this undertaking. This guideline determines that the developer must register his/her respective development in a property registry office, in order to become able to commercialize the independent units of this development. In a complementary manner to the above quoted law, NBR 12721/2006 establishes criteria for the realization of this registration, favoring this way a documental pattern to be followed.

This documental pattern is made up of 40 categories, such as: name of the real estate development, promoter, date of registry, number of housing units, number of pavements, private area, area of the land, and cost of the land, among others.

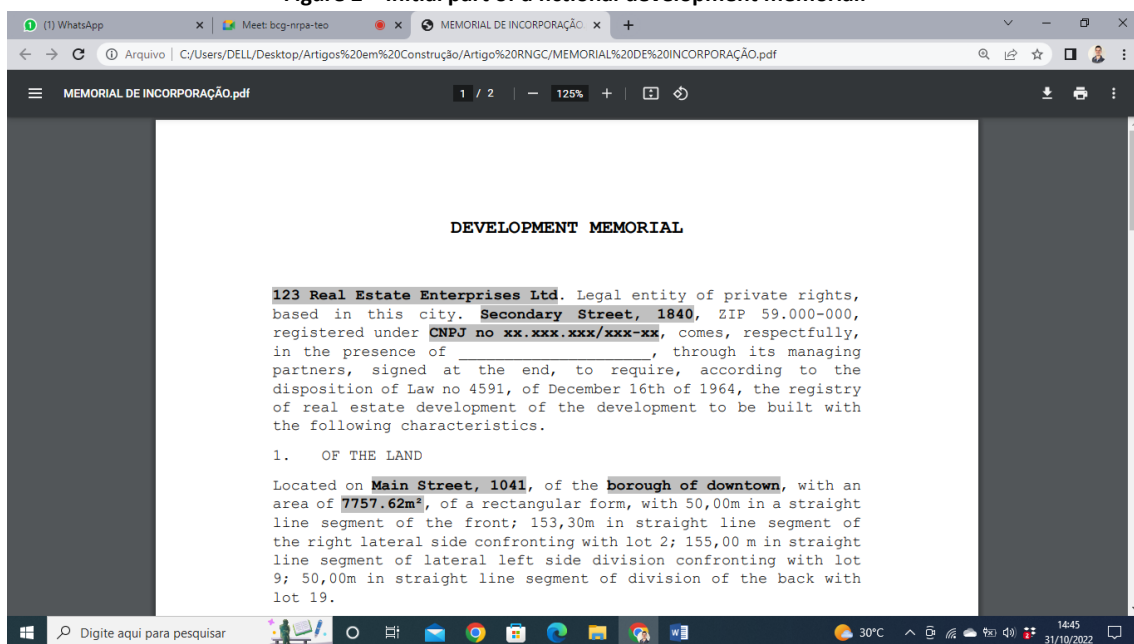
These categories in common, present in the registries of the development, favor the application of the category method. This technique consists in the segregation of information from the documental sources, such as the intention to do a categorization through the regrouping of the attributes of the same nature, being this the most used of the techniques that compose the analysis of content (BARDIN, 2016).

For the full development of this analysis technique, Bardin (2016) describes a chronological itinerary formed by three phases. The first is related to the pre-analysis, where the identification, inspection and selection of the documents to be used by the research are done. The procedures that compose this phase are performed in the physical archives of the notary offices of the city, through the selection of the registries referent to the 10 years analyzed.

Within this context, the first task to start the application of this methodological sequence consists in identifying and locating the notary offices of the city as well as scheduling visits to them. It is important to point out that the registry of real estate developments is composed by a series of documents, such as: statements, architectural Project, title of ownership of the land, social contract and development memorial. Within this gamma of items, the adoption of the development memorial and the architectural Project is recommended, having in mind that the information contained in both of the documents are essential for the full development of a spatial analysis of the real estate development of a city.

The exploring of the material, the second phase of this sequence, corresponds to the categorization of the information contained in the chosen documents. This procedure is based on the selection of fragments of text (called “units of registry”) referent to the categories mentioned previously. In Figure 2, it is possible to visualize some of these “key-words” present in a development memorial.

Figure 2 – Initial part of a fictional development memorial.



Source: AUTHORS, 2022.

These units of registry are captured through an electronic form, filled out repeated times according to the number of documents contained in the chosen time cut. Afterwards this information is exported to an electronic spreadsheet, with columns referent to the categories, and lines that correspond to the data of each real estate development, as expressed in Figures 3 and 4.

Figure 3 – Form containing the fields for filling in the categories that you want to capture.

Fonte: AUTORES, 2022.

Figure 4– Spreadsheet resulting from completing the electronic form.

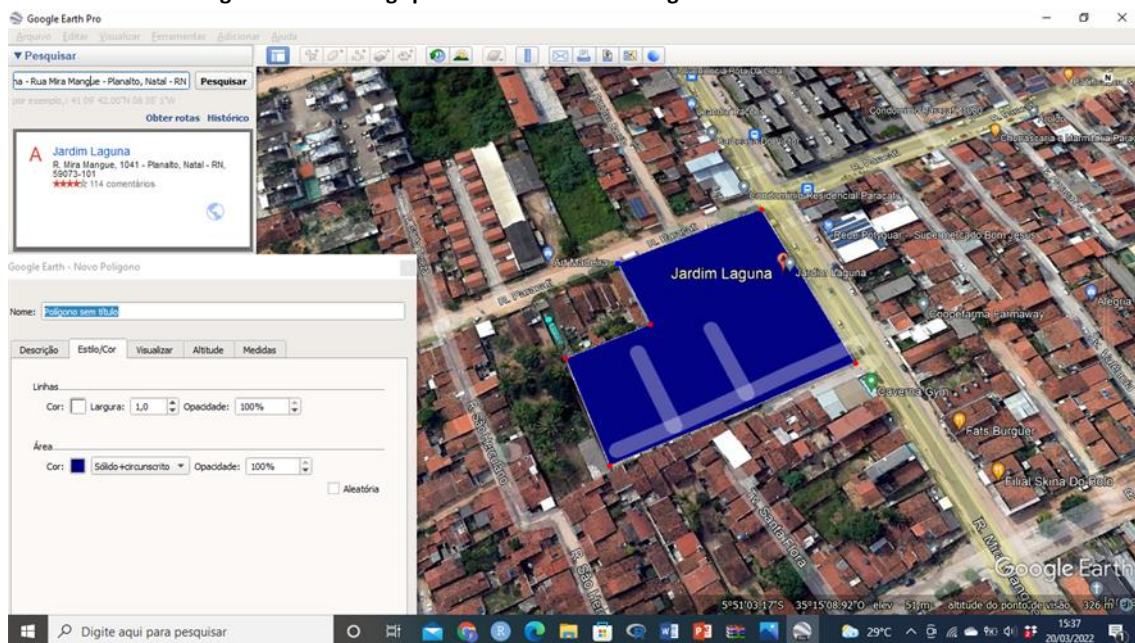
	A	B	C	D	E	P	Q	
	REAL ESTATE DEVELOPMENT NAME	TYPE	DATE OF REGISTRY	ADDRESS	DISTRICT	NUMBER OF PAVEMENTS	NUMBER OF HOUSING UNITS	UH
797	CONDOMÍNIO PROF. JESSÉ CAVALCANTI	RESIDENCIAL VERTICAL	7/25/2010	Rua Gal. Gustavo Cordeiro	Ribeira	32	107	4
798	EDIFÍCIO SOLAR CAMPO BELO	RESIDENCIAL VERTICAL	7/29/2010	BR-101 (8085)	N. Sª da Apresentação	4	144	8
799	RESIDENCIAL PLANALTO I	RESIDENCIAL VERTICAL	7/29/2010	Rua Jardim do Eden	Planalto	4	96	8
800	RESIDENCIAL PORTO MADEIRO	RESIDENCIAL VERTICAL	8/13/2010	Rua Antídio de Azevedo	Lagoa Nova	17	42	3
801	EDIFÍCIO SOLAR DAS PETÚNIAS	RESIDENCIAL VERTICAL	8/24/2010	Rua das Petúncias	N. Sª da Apresentação	2	20	6
802	EDIFÍCIO ALAMEDA CAPIM MACIO	RESIDENCIAL VERTICAL	8/25/2010	Entre as Ruas Aldo de	Capim Macio	21	60	3
803	ALAMEDA DOS PÁSSAROS	RESIDENCIAL HORIZONTAL	8/26/2010	Rua Abreulândia	Planalto	0	10	0
804	EDIFÍCIO JOÃO MACHADO	RESIDENCIAL VERTICAL	10/7/2010	Rua Açu, 419	Tirol	22	51	3
805	RESIDENCIAL EAST PARK	RESIDENCIAL VERTICAL	10/15/2010	Rua Santa Inês, Gleba	Pajuçara	4	160	4
806	CONDOMÍNIO RESIDENCIAL ATLANTA	RESIDENCIAL VERTICAL	10/15/2010	Rua da Algaroba, 186	Pitimbu	4	64	4
807	CONDOMÍNIO PROF. JOSÉ GURGEL	RESIDENCIAL VERTICAL	11/4/2010	Rua Joaquim Câmara	Tirol	15	22	2
808	TIROLO WWV	RESIDENCIAL/COMERCIAL	11/16/2010	Av. Sen. Salgado Filho	Tirol	29	488	4
809	EDIFÍCIO RESIDENCIAL CARLOS SILVA	RESIDENCIAL VERTICAL	11/17/2010	Rua Jaguarari, 1203	Barro Vermelho	15	24	2
810	INFINITY AREIA PRETA	RESIDENCIAL VERTICAL	11/25/2010	Av. Gov. Silvío Pedrosa	Areia Preta	21	30	2
811	RESIDENCIAL VILLAGE DAS DUNAS	RESIDENCIAL VERTICAL	12/1/2010	Av. Amintas Barros, 11	Nova Descoberta	5	48	6
812	MIRANTE LIMA E SILVA RESIDENCIAL	RESIDENCIAL VERTICAL	12/3/2010	Rua Ten. Petronilo Dias	Bom Pastor	4	168	10
813	EDIFÍCIO ALAMEDA LAGOA NOVA	RESIDENCIAL VERTICAL	12/3/2010	Rua Francisco Borges	Lagoa Nova	25	61	3
814	RESIDENCIAL MARIA ISAURA/GENTIL FERNANDES	RESIDENCIAL/FLAT	12/9/2010	Av. Antônio Basílio, 42	Nova Descoberta	4	40	4
815	RESIDENCIAL PLAZA REAL	RESIDENCIAL VERTICAL	12/12/2010	Rua Vereadora Maria	Lagoa Nova	24	38	2
816	CONDOMÍNIO RESIDENCIAL CORAIS DE LAGOA NOVA	RESIDENCIAL VERTICAL	12/18/2010	Rua dos Botimares, 31	Lagoa Nova	18	48	2

Source: AUTHORS, 2022.

At last, the phase of the treatment of the results consists in the transformation of the categorized data in presentable information. Among the most common treatments the conception of spatial distribution of maps is highlighted.

To obtain maps of this nature the conduction of two operations is necessary. The first consists in the use of *Google Earth* as a search tool, with the objective of locating all of the incorporations present in the spreadsheet, through the category “address”. Once located and identified, each development is identified through a polygon referent to the shape of the land where the building is located, as expressed in Figure 5.

Figure 5 – Resulting spreadsheet from the filling out of the electronic form.

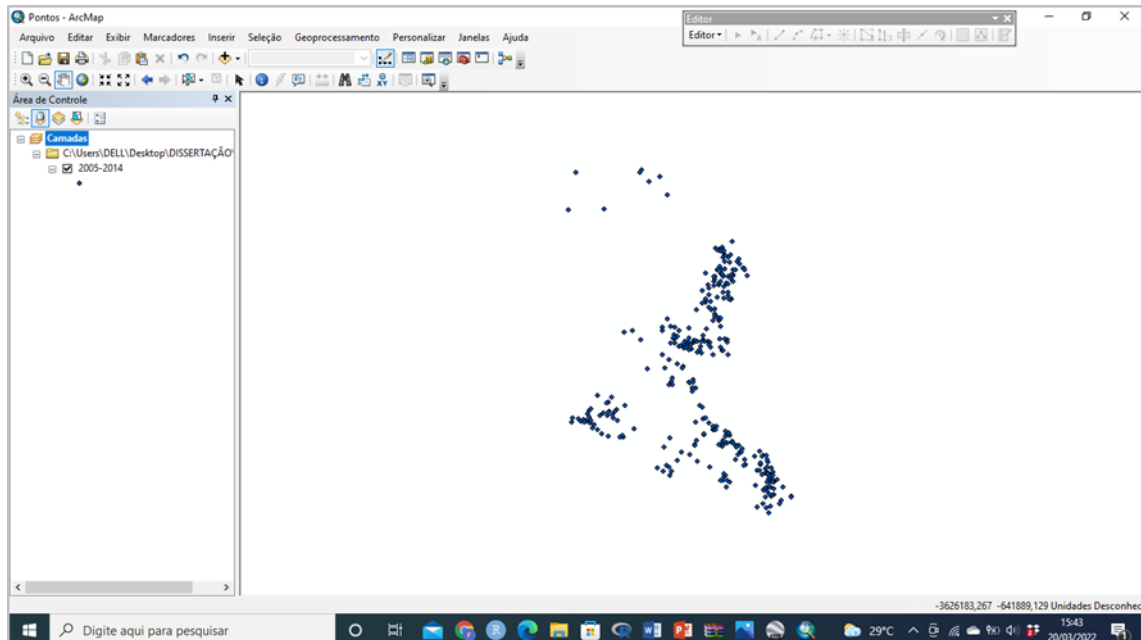


Source: AUTHORS, 2022.

The second consists in importing these georeferenced polygons for the conception of spatial distribution maps in the *ARCMAP* software, as indicated in Figure 6. Through this app it is possible to visualize, analyze and edit georeferenced information, as well as to conceive several types of maps. One of them is the density map of *Kernel*. This instrument uses a pallet o colors that demonstrates the intensity of the phenomenon studied within a defined spatial territory. The methodology of *Kernel* estimates rays around the development. When these rays overlap due to their proximity, the region overlapped acquires the value of the sum of these overlappings.

Another type of map that will be used by this research is the choropleth map. For the obtaining of both, it is necessary to connect the electronic spreadsheet containing all of the attributes categorized, with each georeferenced point. This way it is possible to select an attribute such as “year of the development” and visualize the developments in different colors, corresponding to its respective period of registry. This way, it is expected, for example, to visualize the real estate production of the city in each phase of a time interval.

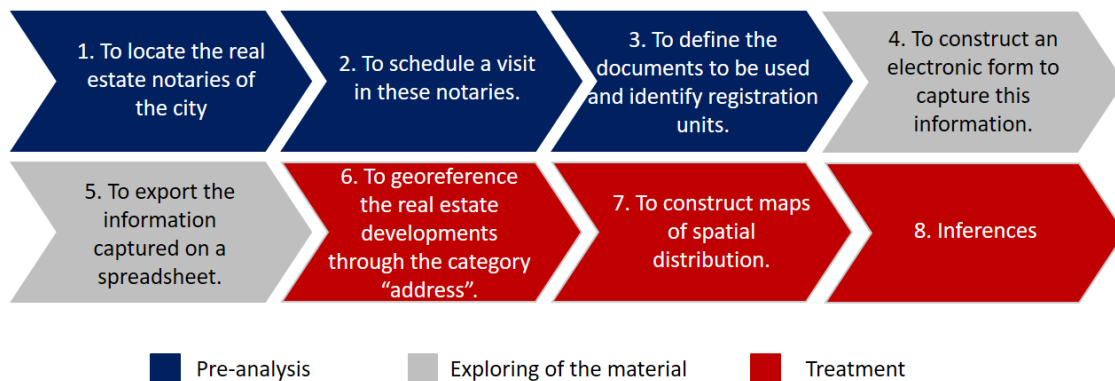
Figure 6 – Points referent to the geometric center of each georeferenced polygon.



Source: AUTHORS, 2022.

With the establishment of the methodological procedures referent to the development of the spatial distribution maps, it is possible to obtain the methodological sequence demonstrated in Figure 7. It is worth pointing out that this methodological pattern is liable to be replicated in other Brazilian cities, having in mind that Law 4.591/1964 and NBR 12721/2006 are in force in all of the national territory, assuring that the documents that compose the registry of real estate development are found in the notary offices of the Brazilian cities.

Figure 7 – Methodological sequence.



Source: AUTHORS, 2022.

The methodological sequence, present in Figure 7, is finalized with the inferences. This last item consists in a controlled interpretation, where the causes of the phenomenon that are desired to be captured are investigated. These inferences, as well as the georeferenced maps are disposed in the next section of this article.

RESULTS AND DISCUSSION

When performing the phases of the methodological sequence mentioned previously, a total of 33 registries of real estate developments built during the time cut adopted by this research, as expressed in Table 1. It is worth pointing out that the resulting data bank of this operation also contains information about the non-residential developments that were not used for this study, since the focus is to evaluate only the spatial distribution of the housing condominiums and its respective spatial distribution. This way, the number of developments included in the universe of analysis of this study correspond to 321.

Table 1: Raising of the quantity of real estate registries from 2005 to 2014.

Year	Flats	Vertical Residences	Mixed use developments	Horizontal residences
2005	12	13	01	01
2006	16	21	01	01
2007	11	34	00	01
2008	24	20	00	01
2009	04	29	02	01
2010	01	43	01	01
2011	02	26	01	00
2012	03	19	00	02
2013	00	15	00	02
2014	00	11	00	01
Total	73	231	06	11

Source: AUTHORS, 2022.

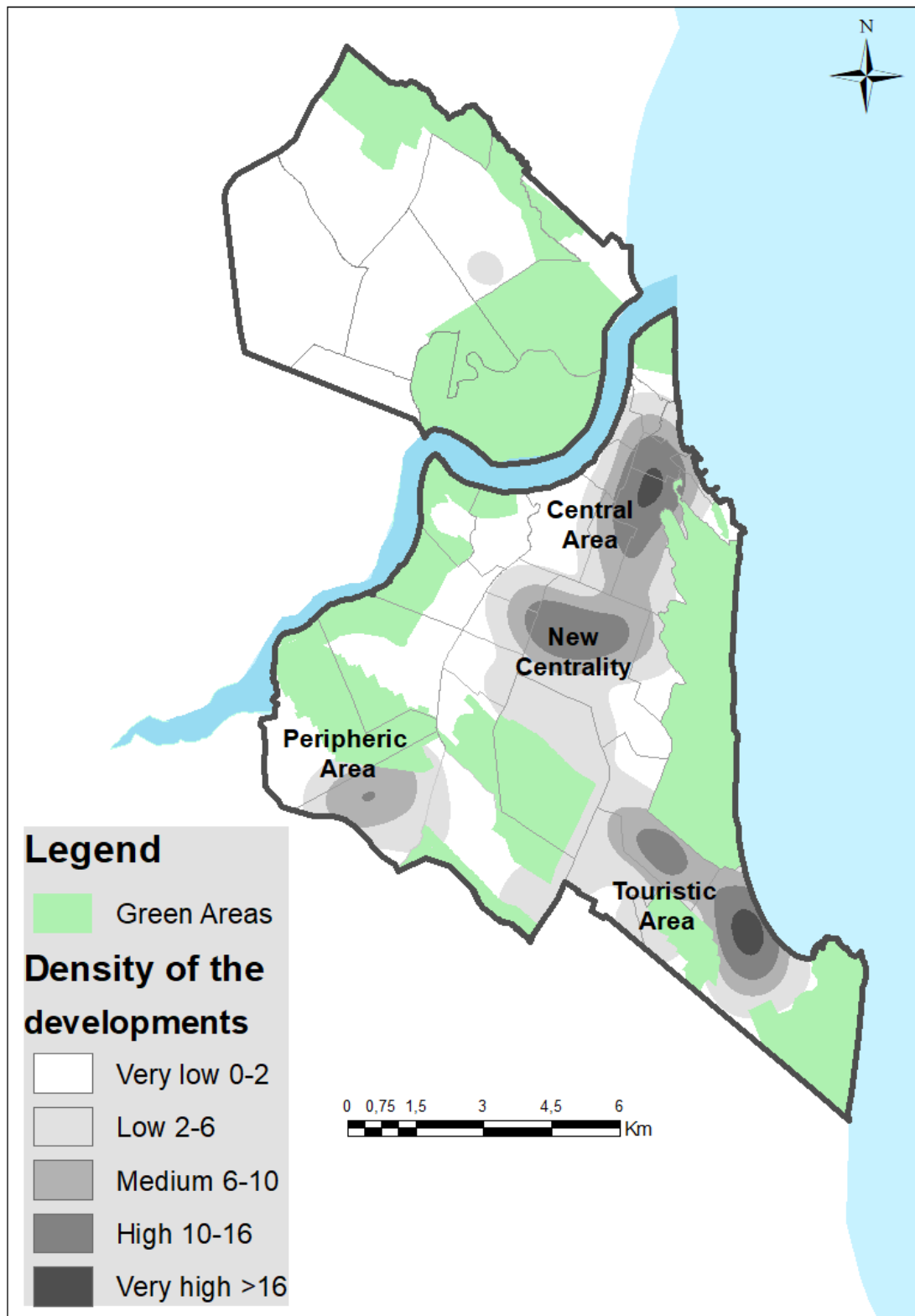
Preferential Targets of the real estate developers.

The developments included in this study served as a base for the production of the density map of *Kernel*, whose methodology was explained previously. In it, it is possible to visualize the indicator “density of developers”, that uses a pallet of colors to differentiate the intensity of the phenomenon analyzed, as explained in Figure 8. This way, it is expected to identify the preferential targets of the real estate developers within the city territory.

By performing the analysis of this map, the existence of 4 urban agglomerates are perceived, which concentrate 85% of the real estate production in only 19% of the city territory. In agreement with this behavior, some authors point out that the real estate Market represents an important agent for such an uneven production, making the social and economic inequalities even more striking within the urban space (NASCIMENTO; MATIAS, 2011; CASTILHO, 2011).

The first area that has a high concentration of real estate developments is comprehended in some neighborhoods of the east zone of the city. This zone hosted the beginning of the process of occupation of the city territory and the first effort of planned urban expansion of the capital, through the development of urbanistic plans. Since then, this location occupies a position of centrality in relation to the other areas of the city, presenting a good infrastructure and diversity as to the offer of services.

Figure 8 – Density of developments launched during the period.



Source: AUTHORS, 2022.

A little south of the central area, another location is found that also presents a high concentration of real estate developments. This portion of the city territory stands out in

relation to the great offer of urban real estate developments, such as shopping centers, hypermarkets, universities and multi-use arenas. The high variety of attractive, as well as the easy access through the main avenues of the city, collaborates for this area to share the role of centrality with the region mentioned previously, having in mind that the installation of the urban equipment's contributes to the creation of new centralities within the city territory (SILVA; SPÓSITO, 2006; LOPES JÚNIOR; SANTOS, 2009).

The third portion of the city, which disposes of a high density of real estate developments, is located in the extreme South of the state capital. This region has a strong connection with the touristic potential, having in mind that it has the most visited beaches of the Brazilian Northeast, besides the great offer of bars, restaurants and hotel. It is worth pointing out that the real estate interest in this region is not old, having in mind that most of its real estate development, occurred after the year 2000 (QUEIROZ, 2012).

Within this ambit, the fourth and last area that presented a significant concentration of buildings, disposes of a real estate development even more recent. Located in a peripheral region of the west zone of the capital and disposing of large free lots of land with prices below the average, this area received emphasis in the local real estate dynamics through the construction of developments financed by a governmental program.

Type of housing promoted in each one of these areas

Once knowing the preferential targets of the developers, it is timely to study the type of production practiced by them in each of these locations. In this sense, the attribute "private area" may contribute to reveal the profile of consumer that absorbed the distinct types of housing offered by the real estate promoters. Besides the *flats*², which present specific characteristics, the present research developed 3 categories of analysis with the objective of capturing these productive variations of the local real estate Market, as demonstrated in Figure 9. The development of these classes is based on previous studies that suggest zones of private area referent to properties of low, medium and high standard (MACHADO, 2005; PESSOA, 2009; SILVA, 2014).

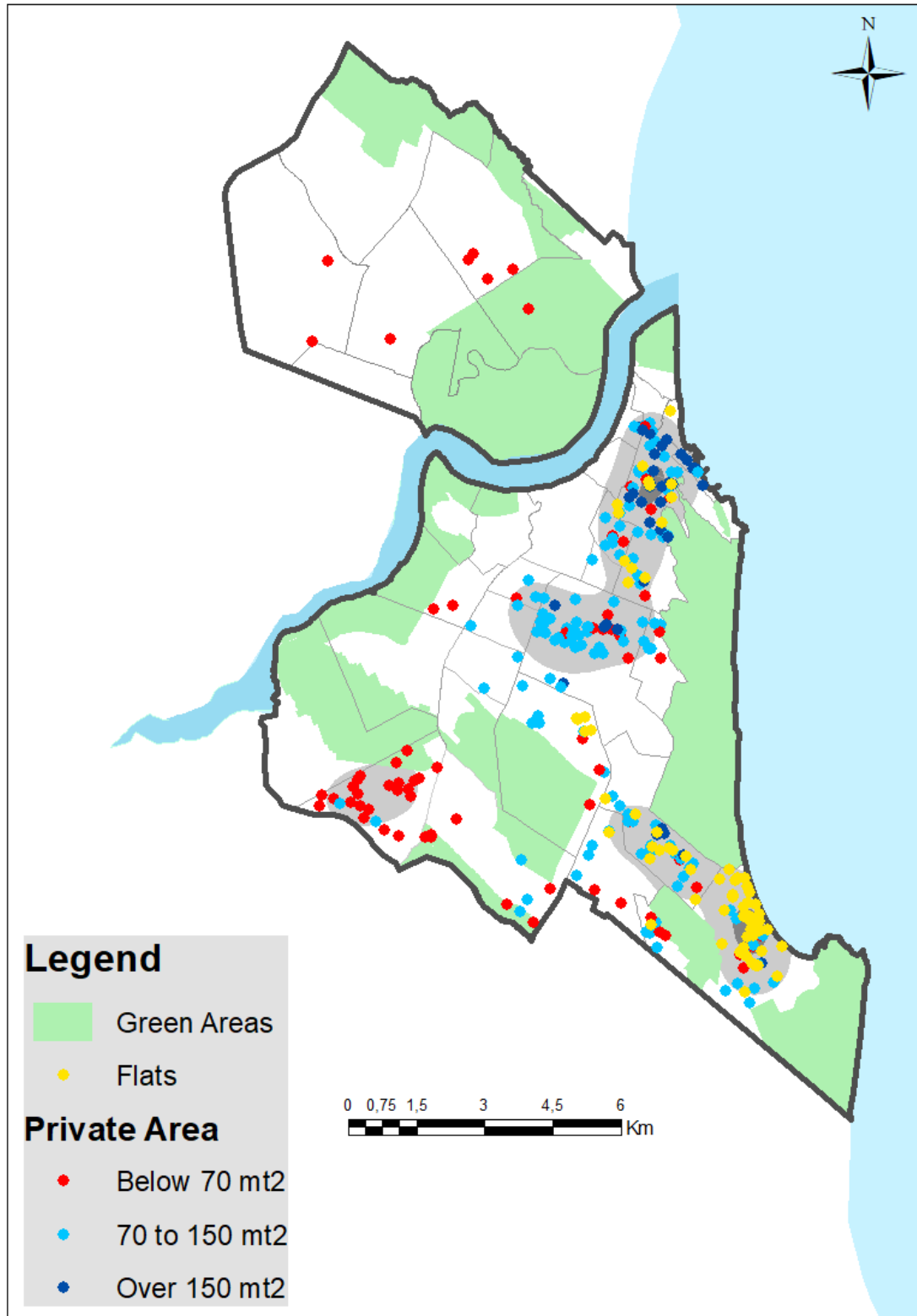
By analyzing Figure 9, it is possible to observe an agglomerate of buildings that have housing units of high standard in the central area. Another type of production very common in these areas are the developments of intermediate private area, besides a moderate presence of *flats*. This way, it is possible to suggest a diversification of the public of consumers of buildings located in this part of the city.

This diversity is also observed in the region that was conveyed to be called "new centrality", even if still in smaller intensity that what was observed in the central area of the city. However, despite this productive diversification, it is possible to notice a predominance of the buildings of intermediate private area in this location. Such fact suggest a synergy between

² Real estate development that mixes residential and hotel characteristics, with hotel services such as restaurant, laundromat, and reception. This type of housing is destined to a niche of a specific Market, or, in other words, consumers that do not wish to perform domestic tasks of a conventional house.

buildings of medium standard and areas of easy access that dispose of a relevant variety of urban equipment, such as the case of this portion of the city territory.

Figure 9– Spatial distribution of the housing developments: classification by private area.



Source: AUTHORS, 2022.

Another portion of the city in which it is possible to observe a uniformity as to the type of real estate production is the peripheral area. The presence of buildings of reduced size is almost unanimous in the location, suggesting a convergence as to the approach of the real estate developers, in what is related to the development of buildings destined to the low class segment in this location.

Among the plausible justifications for this uniform behavior of the developers the “Minha Casa Minha Vida” program is highlighted. This initiative was fundamental to create a demand for real estate, with a value between 60 and 200 thousand reals (OLIVEIRA; FONSECA, 2018). In this sense, it is possible to suggest that this demand created by the program, induced the developers to produce developments of the low class segment in peripheral urban areas, where the price of the land is usually inferior in relation to the central areas.

In a similar manner to what happened in the peripheral region, the tourist area also had its real estate production pushed by a specific demand. However, instead of residences of the popular segment, the promoters took advantage of the touristic potential of this locality to build developments that mix hotel and residence characteristics, or in other words, flats destined to international tourists interested in summer residences.

This constructive typology became so popular in the touristic area of the city, that it hosted 70% of all of the production of flats in the city during the period of time studied. This phenomenon was also observed by some authors that identified tourism as an important enhancer of the real estate development in the coastal area of Rio Grande do Norte (BEZERRA et al., 2013; SILVA; FERREIRA, 2011).

FINAL CONSIDERATIONS

In relation to the types of developments launched during the period in issue, the flats are highlighted, which represent 26% of the real estate production of the period and the “vertical residences”, which composed 65%. However, there is a mismatch, as to the behavior of these two kinds of buildings during the years of study. While the production of flats decreased from 2009 on, the number of developments of the vertical residence type only reached a recession in 2011. This precocious decrease in the production of flats is justified by the crisis of 2008 that affected the foreign public, especially the consumer of this type of development in the capital of Rio Grande do Norte.

As for the spatial distribution a heterogeneous behavior is notorious, having in mind that 86% of the real estate developments were concentrated in 4 urban agglomerates that represent only 19% of the city territory. It is worth mentioning that this percentage is applied to the portion of the territory available for construction, knowing that 30% of the territorial extension corresponds to the green areas, where the Law restricts or even forbids the construction of real estate developments.

In 3 of these 4 urban agglomerates a development was observed connected to intrinsic characteristics of these locations. The natural beauties that favor the touristic activity, the infra structure that attracts the middle and upper class, besides the privileged location that contributes to the construction of urban equipment and the development of the commercial activity, are examples of these characteristics.

However, the peripheral area did not count with attributes of this nature, being exactly the absence of these what created a favorable conjuncture for the “Minha Casa Minha Vida” program, having in mind that the area represented a portion of the territory that had a great availability of lots at low prices. In face of this fact it is tangible to infer that housing programs of the federal government represent an external stimulus to the construction of housing units in the peripheral areas.

To conduct these analyses, the present study had to research a collection gathered by local researchers quoted previously, with the objective of favoring the methodological standardization of researches of this nature, through the description and application of each phase of the method of categorical analysis.

The development of this methodological sequence opens the path for the implementation of this study of the real estate development, making future comparisons possible between the spatial distributions of the real estate development of distinct cities; being this, the main contribution of this study. In this sense, for future studies, the application of this methodological itinerary in other capitals of Brazil is recommended, to broaden the understanding related to the national real estate production.

As for the other contributions of this research, both the visualization of the spatial arrangements formed at a period of intense real estate production, such as the exhibition of the main building typologies practiced in the city, helping to identify the demand that absorbed these buildings, are highlighted.

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