

Geotechnologies Applied to Evolution in Urban Design in a City in Southern Brazil

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Abstract: The evolution process of urban design is the result of transformations due to population increase along the expansion of cities on a global scale. Geotechnologies applied to forms of mapping make it possible to understand the changes that have occurred in urban spaces in relation to temporal space. The general objective of this study is to analyze the change that occurred from the year 2010 to 2021, in the evolution of urban design, in the city of Marau (southern Brazil). The identification of urban evolution in the years 2010 and 2021 was carried out. These data were modeled using the QGIS software, in the SIRGAS (Geocentric Reference System for the Americas) database, related to the evolution of urban design in Marau. The results demonstrate the need to apply geotechnologies not only in the city of Marau, but in other cities worldwide, because city halls need precision maps, avoiding the fragmentation of the urban fabric, a result of population expansion not projected in the built environment.

Key words: Urban evolution, urban grid, remote sensing, urban design.

1. Introduction

The expansion of urban design has several characteristics that can be detected through a precision spatial mapping, enabling the understanding of its changes over the period studied [1, 2]. In this context, the understanding of urban space makes it possible to understand the morphology and economic processes that occur in the urban environment [3].

The urban space is produced by the population, based on transport, displacement and basic needs, such as: housing, food, leisure and work [3]. The urban space is structured to meet the needs of the population through trade and services [4], thus, enabling the expansion of urban space, generating tensions that change the morphology of cities within regionalized

historical contexts and spatial consolidation, contributing to segregation [4, 5].

The segregation in Brazilian cities directly affects the poorest population, generating scenarios of social inequality [6]. In this case, urban expansion divides the city into sectoral plans, where the population with greater purchasing power is concentrated in central spaces, and the low-income population resides in the most isolated spaces, increasingly closer to the urban edge [6].

This study considers the transformations in the urban space in a constant way, following its evolutionary and transforming process [6-8]. It is necessary to seek ways to produce visual elements that show urban transformations, creating a planning tool for cities, in an orderly manner [7, 8]. The general objective of this study is to analyze the change that occurred from the year 2010 to 2021, in the evolution of urban design, in the city of Marau (southern Brazil).

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2. Method and Materials

The city under study is Marau, located in the state of Rio Grande do Sul, in the south of Brazil, with a land area of 646.770 km², where 44,858 inhabitants live [9]. The justification for choosing the city of Marau, as the object of this study, is due to the fact that the city is in full regional development, which has driven a high increase in inhabitants in recent decades, due to the need for labor to industrial.

This study used the free software Quantum Gis—QGIS—licensed by the GNU (General Public License), based on GIS (Geographic Information System), combined with remote sensing, enabling studies, generating maps, for the assessment of urban transformations. The SIRGAS 2000-22S management system can create “shapes”, which are nothing more than images modeled by data that portray the real world, at a certain scale, through colors, shapes and location, obtaining the design of the region occupied [10].

Spatial phenomena are portrayed by three-class elements: point, line and polygons, the difference between them is expressed by dimensionality [10]. This is expressed as follows: the point is zero, the line is one, the polygon is two, and the surface is represented by three dimensions.

This research used data from the IBGE (Brazilian Institute of Geography and Statistics), to carry out a comparative analysis of the urban grid between 2010 and 2020 [9]. This study is divided into the following methodological steps: Stage I: identification of IBGE data from the 2010 and 2021 censuses; Stage II: using QGIS in SIRGAS 2000 database, the mapping of the urban area of Marau was carried out; Stage III: analysis of the urban evolution process in the target city, referring to the generated maps.

3. Results and Discussions

Based on IBGE data, it is noted that the population of Marau/RS-Brazil increased from 33,364 to 44,858 thousand inhabitants in the period 2010 to 2021.

According to the IBGE census, with a population increase of 11,494 thousand inhabitants, corresponding to 35% in 10 years, average of 1,150 thousand inhabitants annually [9]. It can be observed that the urban network of Marau/RS-Brazil grew on several sides, extrapolating the limit according to the 2010 and 2021 IBGE census map (Fig. 1). In 2010, according to IBGE data, the urban grid occupied a total of 16,142.74 km². In 2021, a total area of 17,561.39 km² is obtained, resulting in an increase of 1,418.64 km² (Fig. 1). The lack of urban planning becomes evident, as the growth of this city (the object of the study) generally follows the urban edge, contextualizing the insistence of specific expression. The lack of specific expansion areas can lead to urban problems, referring to the lack of infrastructure service by the government, which in Brazil would have to be the right of everyone [11-13].

In the northern region of the city of Marau, there are extensive growth potentials. In this area of growth, one can observe the formation of the Industrial District, close to the RS324 highway, responsible for the connection between Marau/RS and other neighboring cities, being a strategic point for the installation of industries, facilitating the transport of products. To the east, there is a movement of the urban network, with the emergence of new installations and expansions of subdivisions (Fig. 2). This study demonstrates that Brazilian cities can grow naturally, in relation to the possibility of existing land for these expansions. Real estate speculation can be one of the agents that impel the expansion of urban borders in Brazil [14, 15].

To the west of the urban network of the city of Marau, we have RS324, large industries and businesses have been located in this region of the city, possibly due to the access for the flow of goods. Fig. 2 shows an urban formation on the banks of RS324 with a commercial and industrial character, spreading to the west, thus forming the Vila Bella subdivision, with a residential character. Although the city has specific neighborhoods for the industrial context, it can be

seen in the analysis that this type of context (Figs. 1 and 2), does not adhere to a specific location but seeks

favorable conditions for its installation, where the flow of production is practical.

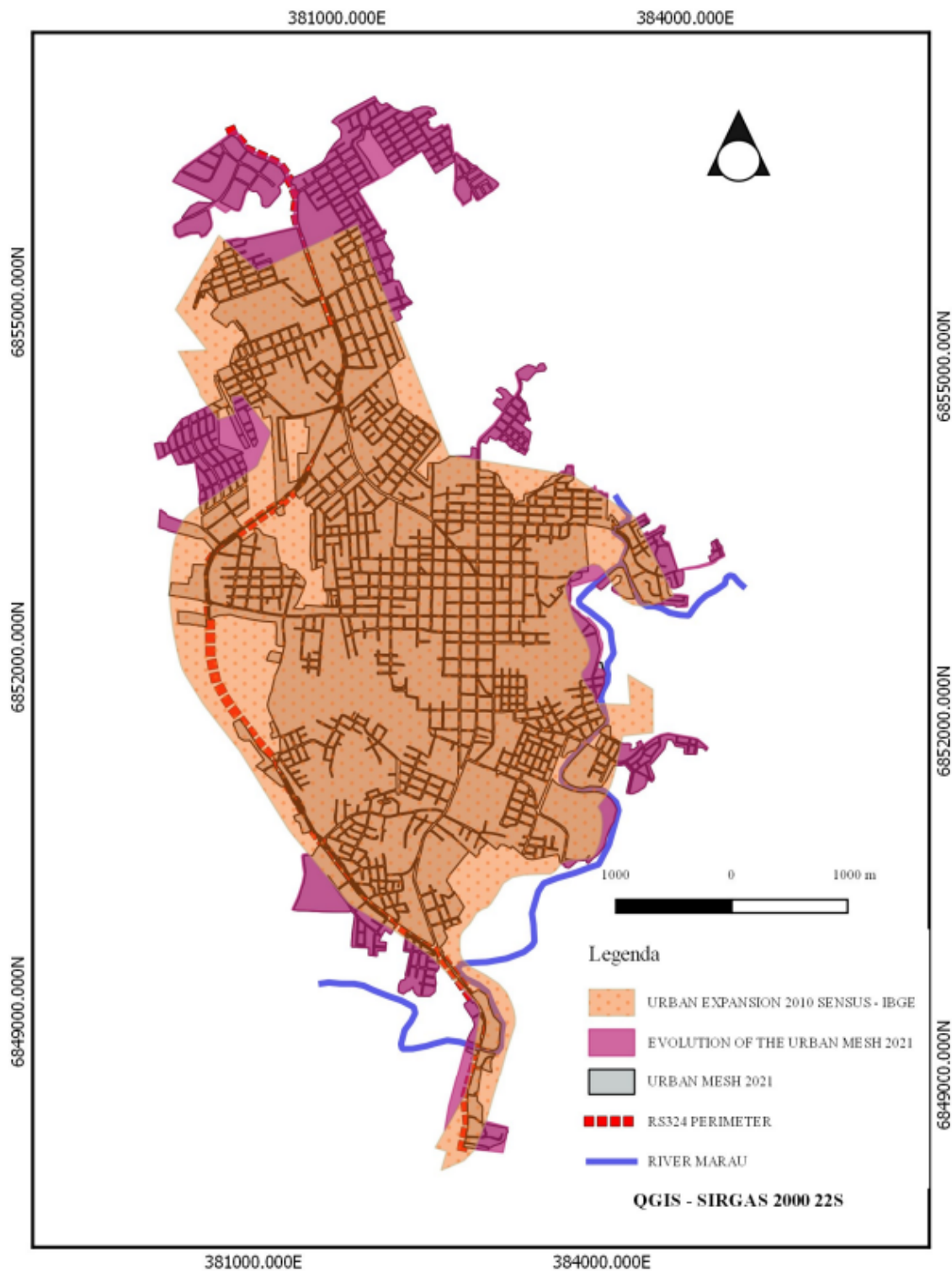


Fig. 1 Stains resulting from the urban evolution of Marau/RS (Brazil).

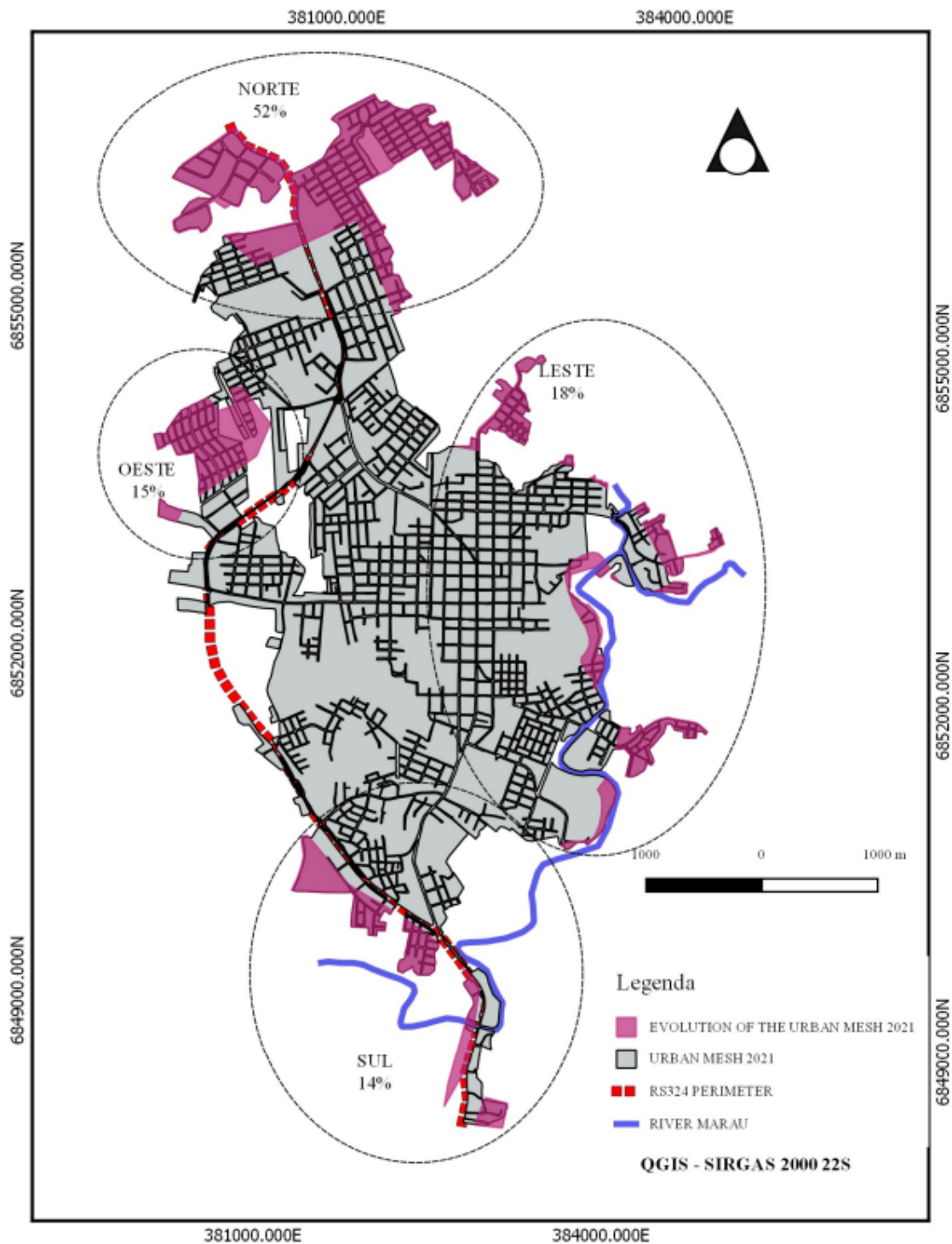


Fig. 2 Urban evolution of Marau/RS (Brazil) in 2021.

In this context, the contribution of this manuscript to the scientific community on a global scale is remarkable, in the sense of pointing out a disinherited urban expansion in a Brazilian city, reporting the

possibility of population expansion due to economic needs, applied to areas with residential and commercial relevance, thus, favoring that other underdeveloped countries, such as Brazil, can consider

urban growth, creating public policies that will improve urban expansion.

4. Conclusions

The understanding of the evolution of the urban fabric of Marau/RS-Brazil, fragmented due to disorderly urban expansion, without planning, generating deficiencies in meeting the infrastructure needs assigned by the government. In this study about the city of Marau, the importance applied to geotechnology aimed at mapping is highlighted, thus enabling an understanding of the fragmentation of this urban fabric. For future studies, the elaboration of heat maps (Kenner) is suggested, in order to assess the types of use, allowing the observation of these variations in relation to the city limits.

Acknowledgements

The authors sincerely thank the Center for Studies and Research on Urban Mobility—NEPMOUR, IMED and PPGARQ/IMED for supporting this research. We also thank the Fundação Meridional-IMED for the funding provided through the institutional productivity grant. Thanks to the National Council for Scientific and Technological Development of Brazil for the research productivity grant (Process: 313040/2020-6).

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