Programa de Pós-Graduação Desenvolvimento Regional mestrado e doutorado

DOI: 10.17058/redes.v28i1.18418

Socio-economic spatial correlation of small towns: Brejo Paraibano (PB) and Médio Vale do Itajaí (SC)

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Abstract
The historical constitution, socio-economic activity and spatial correlations of small and medium-sized towns have a bearing on how to give thought to regional development. This article proposes an intraregional socioeconomic spatial correction and a comparison between the Brazilian regions of Brejo Paraibano (BP) in the Northeastern state of Paraíba and Médio Vale do Itajaí (MVI) in the Southern state of Santa Catarina. The methodology applied consisted of modelling a socio-economic development index, which was applied to two Brazilian regions. Subsequently, the Global and the Local Moran's Index was calculated to assess the intraregional spatial association. The results identified a spatial correlation in the MVI and consequently identified a medium-sized city, Blumenau, given its socio-economic relevance within the region. In BP, the results presented no spatial correlation. Based on the statistical measurements and the findings regarding the historical events that led to the present situation of spatial correlations, it was concluded that the contexts studied require different approaches in terms of targeting subsidies to leverage regional development.
Keywords: Small and Medium-sized Towns. Brejo Paraibano. Médio Vale do Itajaí. Socioeconomic Development. Regional Development.

Correlação Socioeconômica Espacial de cidades pequenas: Brejo Paraibano (PB) e Médio Vale do Itajaí (SC)

Resumo
A constituição histórica, a atividade socioeconômica e as correlações espaciais de cidades pequenas e médias implicam sobre como pensar o desenvolvimento regional. O artigo propõe uma correção espacial socioeconômica intraregional e um comparativo entre as regiões do Brejo Paraibano na Paraíba e do Médio Vale do Itajaí (MVI), em Santa Catarina. A metodologia aplicada consiste no modelamento de um índice de desenvolvimento socioeconômico. O índice foi aplicado para duas regiões brasileiras. Posteriormente, o Índice de Moran Global e Local foi calculado para aferição de associação espacial intrarregional. Os resultados encontrados identificaram uma correlação espacial no MVI e por consequência a identificação de uma cidade média, Blumenau, dada sua relevância socioeconômica na região. No Brejo Paraibano os resultados não apontaram correlação espacial. A partir das aferições estatísticas e das constatações acerca dos eventos históricos que levaram a presente conjuntura das correlações espaciais, concluiu-se que os contextos estudados demandam diferentes abordagens quanto ao direcionamento subsídios para alavancar o Desenvolvimento Regional.
Palavras–chave: Cidades Pequenas e Médias. Brejo Paraibano. Médio Vale do Itajaí. Desenvolvimento Socioeconômico. Desenvolvimento Regional.

Correlación espacial socioeconómica de pequeñas ciudades: Brejo Paraibano (PB) y Médio Vale do Itajaí (SC)

Resumen
La constitución histórica, la actividad socioeconómica y las correlaciones espaciales de ciudades pequeñas y medianas implican cómo pensar el desarrollo regional. El artículo propone una corrección espacial socioeconómica intrarregional y una comparación entre las regiones de Brejo Paraibano, en Paraíba, y Médio Vale do Itajaí (MVI), en Santa Catarina. La metodología aplicada consiste en la modelización de un índice de desarrollo socioeconómico. El índice se aplicó a dos regiones brasileñas. Posteriormente, se calculó el Índice de Moran Global y Local para evaluar la asociación espacial intrarregional. Los resultados identificaron una correlación espacial en el IVM y, en consecuencia, la identificación de una ciudad de tamaño medio, Blumenau, dada su relevancia socioeconómica en la región. En Brejo Paraibano, los resultados no mostraron correlación espacial. A partir de las mediciones estadísticas y de los hallazgos sobre los acontecimientos históricos que condujeron a la actual situación de correlaciones espaciales, se concluyó que los contextos estudiados requieren enfoques diferentes en términos de focalización de subsidios para apalancar el Desarrollo Regional.
Palabras clave: Pequeñas y Medianas Ciudades. Brejo Paraibano. Valle Medio de Itajaí. Desarrollo socioeconómico. Desarrollo regional.

1 Introduction

Development is a process of social transformation that requires the mobilization of resources in order to achieve predefined objectives. From a socio-economic viewpoint, this is related to having access to basic rights so as to ensure a dignified life. However, development does not occur in a uniform manner, which is why regionalization is essential for understanding the particularities of each inhabited space. In territorial terms, Brazil is a profoundly diverse and extensive country. From a historical perspective, the first major landmark of anthropic action on the landscape occurred with the arrival of the European colonizers. The first

settlements became urban centers concentrated along the coastline, many of which today constitute major centers, such as Rio de Janeiro and Salvador. However, as the occupation consolidated, it also spread to the inland regions of the country, creating a significant number of small towns and medium-sized cities[1] .

Although small towns and medium-sized cities build their own hierarchical networks and market dynamics, they often need subsidies from higher federal levels in order to overcome socio-economic adversities and prosper. These subsidies may support public policies and other initiatives aimed at reducing inequalities and prosperity. Creating practical strategies for directing resources is, however, a complex task. Managing Brazil's socio-economic development requires a set of procedures that may be replicated, but which are sensitive to both regional realities, considering the specificities of each territorial area, and intraregional realities, considering the relationships between small municipalities, medium-sized cities and their urban networks.

This requires the creation of mechanisms to measure the current state of socio-economic development. Identifying spatial correlations between the results measured within the urban network enables resources to be directed toward municipalities that may radiate socio-economic development, thereby leveraging regional development as a whole. It also enables priority contexts to be identified, directing resources toward reducing inequalities. Within this context, the aim of this article is to analyze intraregional spatial correlation in order to identify the existence of a medium-sized city that is able to radiate regional development.

The choice of inland regions in the Northeast and South of Brazil is justified by the fact that in these regions there are small towns and medium-sized cities, where the difference between their contexts helps to confirm the central hypothesis. The hypothesis is that historical and occupation factors are responsible for the presence or absence of a spatial correlation between small towns, and that this correlation stems from historical factors of occupation and exploitation of the territory, as well as the type of territorial fragmentation to which the region has been subjected. In this study, historical and occupation factors underpin the discussion on the results of the spatial correlations measured. It may be observed that the differences between the scenarios surveyed facilitate this understanding.

The article is divided into six sections. The first consists of this introduction and the second corresponds to the theoretical framework that contextualizes the theme historically and conceptually in Brazil, including a subsection on the Brejo region of Paraíba within the context of the area known as the Agreste, and another that examines the socio-economic activity in the Itajaí Valley. The third section explains the methodology of the study and the fourth presents the results. The fifth section discusses the spatial socio-economic correlation between the cities and towns analyzed and the validation of the research hypothesis. The sixth section presents the conclusions.

[1] According to Sposito (2010), medium-sized cities are those that play an intermediary role between small towns and large, metropolitan cities within the same urban network. Small towns, on the other hand, make up the economic territory, and often the political power, of the medium-sized city to which they are a tributary.

2 Theoretical Reference

Brazil is a country of continental dimensions, and is the fifth largest in the world (Brazilian Institute of Geography and Statistics (IBGE), 2022). The breadth of its territory makes the country diverse in its geography, culture and politics. However, this heterogeneity leads to disparities in terms of quality of life and, consequently, the regional development (RD) itself. Inequality has become deeply rooted, and is related to the contexts of slavery, social exclusion and a lack of effective public policies to combat poverty. Nonetheless, when inequality is analyzed from the viewpoint of spatial distribution, how the territory is occupied and the concentration of land, these factors may prove to be determining variables.

> In general, throughout the Brazilian territory, it is possible to identify major social disparities, including in the distribution of income and land, and in the education and health indices, among many others. However, many of these disparities in Brazil are not circumstantial, but rather the result of a chain of actions that has been taking place since Brazil's inception. With regard to the land issue, (...) there has been a highly concentrated distribution of land ownership since the formation of property (Alcantara Filho and Fontes, 2009 p. 64)[2].

In order to understand the inequality that has arisen from the occupation of Brazilian lands it is necessary to analyze Brazilian history. With the arrival of the Portuguese in 1500, Brazilian lands came under the public domain of Portugal. Initially, territorial demarcation and the process of forming private property occurred through captaincies and the granting of large portions of land, called *sesmarias*, to those chosen by the Portuguese crown. However, it was in 1530 that the formation of estates began to be consolidated and the *sesmarias* were demarcated more systematically. The use of colonial land during this period was based on the export of sugarcane in a monoculture regime with enslaved labor. Thus, the territorial division was characterized by large estates that directed their production toward the foreign market. This economic model lasted until 1850, when the Land Law (Law 601) led to the demarcation of vacant lands (Alcantara Filho and Fontes, 2009; Rodrigues, 2012).

At the same time, however, the Land Law legitimized the ownership of the *sesmarias* and encouraged the entry of immigrants into Brazil, especially since the end of slave labor was already foreseen. Immigrants contributed to the colonization of wastelands, especially in the south of the country, where the land was divided into smaller portions, and the colonies were used for settlement purposes, no longer merely for export (Herédia, 2021). During the period between the Proclamation of the Republic in 1889 and 1964, the problem of land distribution was put to one side. It was only in 1964, with the Land Statute, that discussion on agrarian reform began. However, although this seemed to be a step forward in terms of land distribution and a modernization of the countryside, the economic aspect prevailed over that of the social. Access to credit promoted modernization, but little was achieved with regard to agrarian reform (Alcantara Filho and Fontes, 2009).

[2] This and all other non-English citations hereafter have been translated by the authors.

Although large estates have persisted, particularly in the North and Northeast regions, remnants of the historical condition described above, many large plots of land have fragmented into smaller administrative territories. This occurred after the colonial period and has been even more significant since the 1988 Constitution, which regulated the creation of new municipalities.

> The pace with which municipalities were created in Brazil varied from the colonial period to the Republic, over time and over its vast territory. However, it was during the Republic that the greatest absolute growth in Brazilian municipalities was observed. Two federal constitutions stood out as "municipalist", the 1946 and 1988 constitutions, which contributed to the main emancipationist outbreaks of the republican period (Nunes and Matos, 2022 p. 3).

On the one hand, the creation of these new municipalities provided small towns with autonomy, although on the other, it made them dependent on services and products from geographically close urban centers, but which were better structured from a social and economic viewpoint. These regional centralities, which provide specialized products and services, become the articulators of the entire regional urban network. According to Correa (2007), these cities, understood as "hubs", characterized by a high concentration of suppliers of goods and services for a regional hierarchy, function as a center for absorbing and consuming land revenue and space for specialized activities, and are called "medium-sized city".

In the regional context, medium-sized cities articulate and centralize the economic dynamics of adjacent small towns. This complementarity between small towns and medium-sized cities leads to specific RD dynamics with varying degrees of economic integration and spatial complementarity (Silveira and Faccin, 2021). Therefore, the impact of medium-sized cities on intraregional economic and social issues - of the small towns surrounding them - makes them strategic in terms of the possibilities of public policies for RD.

> It is understood that the economic, political and social relevance of the medium-sized city in the regional context makes it a protagonist in the development of innovative public policies capable of influencing regional networks and dynamics (Staviski Júnior, 2021 p. 409).

Identifying the links and socio-economic dynamics between a medium-sized city and an adjacent small town enables public policies to be promoted on a regional level. According to Keuler (2020, p.2672) "the development of a region involves the analysis and understanding of its social and economic characteristics" and the spatial dependence observed indicates that projects to combat poverty may be intraregional in nature and have effects that may transcend municipal boundaries. In terms of the progress of studies regarding the subject of inequalities and local RD, Resh et. al. 2020 employed a quantitative approach, using an index to indicate socio-economic disparities. Souza and Maraschin (2019) reported how statistical models and analyses help to visualize the socio-spatial interrelationships between nearby towns and cities in terms of RD. Along these lines, Keuler (2020) used spatial correlation methodologies to demonstrate that the economic and social indices of a

municipality influence the indices of its surrounding neighborhoods, and Silveira and Faccin (2021) linked this influence to the concept of the medium-sized city.

Similarly, it is possible to measure the socio-economic development of the municipalities that form part of an analyzed region, in order to highlight critical points. It is also possible to identify the spatial complementarity of the results obtained by identifying clusters (Scherer and Amaral, 2022). Lastly, it is possible to discover the high significance of a city on the socio-economic development of the analyzed region, i.e. the behavior may be deduced of a medium-sized city on the part of a municipality in relation to the urban network.

Starting from this premise, from the concepts of a medium-sized city, revealing the historical marks on Brazil's regional formations, and their implications for economic and social development, two territorial sections have been described and subjected to spatial correlation analysis and then compared. These two regions are in the states of Paraíba, in the northeast, based on the Brejo Paraibano (BP) region, and Santa Catarina in the south, - in the Médio Vale do Itajaí (MVI) region (Figures 1 and 2). These territorial cross-sections were chosen because of the geophysical and historical differences between the regions. The comparison allows us to assess how these factors bring to bear a greater or lesser spatial correlation between small towns, as well as the significance of the medium-sized city in the region.

2.2 The Brejo Paraibano

In terms of geophysical aspects and climate, Brejo Paraibano (BP) (Figure 1) has historically struggled for access to water, principally in the most socio-economically disadvantaged communities, which are affected by a context of droughts, the characteristics of the region, and the commercialization of water at a high cost. The unequal distribution of scarce water resources has constituted local political disputes and conflicts (Goetzinger et al. 2020; Fernandes et al, 2020). The distance between BP and an expressive level of socio-economic development is, however, aggravated by a history of social inequalities and economic disparities, related to the unequal distribution of the territory, even during the period of colonization.

The anthropogenic impact on the region's landscape began with the great drought of 1692, when the Brejo served as a refuge for the retreating *sertanejos* (those from the hinterland). With the expansion of cattle ranching in the hinterland, Brejo effectively became occupied and its land donated to landowners. With colonial occupation, the large farm became the standard unit of territorial division. These properties enabled socio-economic domination by a landowning elite characteristic of the interior of the Northeast region. The agrarian space of the Northeast was based on the tripod: latifundia, monoculture and slave labor (Torres, 2020). Sugarcane and subsistence crops became dominant on the landscape, and manioc flour and rapadura became the main commercial products (Marques, 2005). Within this scenario of slavery, large estates and the use of land for large-scale sugar production for export, it may be noted that here, the beginning of colonization was more exploratory than settlement.

With the crisis in the sugar industry during the second half of the seventeenth century, the purchase of slaves became very expensive for the sugar mill owners who, in debt, began to facilitate the establishment of residents on their properties. The workers on the large estates were allowed to cultivate a piece of land and, in exchange, they provided days of free labor to the mill owner, constituting a system of servitude (Torres, 2005). In addition to the production of sugar itself, there was also the production of brown sugar, and later rum and rapadura. Sugar cane was produced in the mountainous region of BP and processed in sugar mills, which culminated in the beginning of the "economic cycles of Brejo" (Rodrigues, 2012). During the period after the peak of sugar production, production in the Agreste and Brejo Paraibano turned to livestock farming. In the interior of Paraíba, the herdsmen and their households combined work on the farm and family food production. It was a double journey of subsistence and supplying the large establishments run by the landowner. In the workers' domestic units, corn and beans were grown, along with raising goats, especially in the wetter areas. On the large farms, cattle and work horses predominated (Marques, 2005).

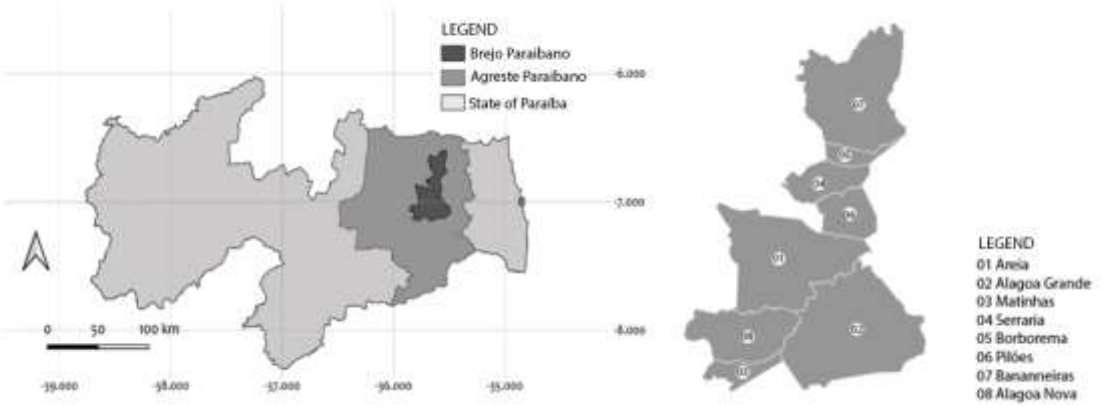
> (...) the development of capitalism in agriculture in Paraiba, in the same way that it contributed to expanding the advance of wage-earning employment, in contrast, capital also enabled the reproduction of peasant forms of production, such as the system of housing, partnership and leasing (Torres, 2020 p. 200).

With the decline of the sugar market, cotton cultivation came to the fore, with the advantage of being compatible with the cultivation of corn and beans (Rodrigues, 2012). Thus the new tripod of the *sertaneja* economy was established: cattle-cotton-food crop farming (Torres, 2020). With the decline of cotton production, sugar cane production returned to prominence. Finally, after 1850, coffee came onto the scene, and the leading role of coffee agriculture lasted around two decades, until the arrival of pests. Agriculture in BP once again returned to sugarcane production, with the creation of the region's first sugar mill in 1928. It also turned to food production with bananas, cattle breeding and sisal production. However, profound changes only took place in the 1970s, which were marked by the sisal crisis, and in 1975 the National Alcohol Program (Proálcool) was created to replace the use of oil derivatives with fuel alcohol. The modernization of agriculture and the possibilities generated by the credit granted to the sector also led to a new technical level of production, the use of machinery and fertilizers. On the other hand, this process also led to the expropriation of rural workers (RODRIGUES, 2012). The 1980s saw the development of the chemical industry and heavy mechanics. Lastly, with the Proálcool crisis (1986) and a prolonged period of drought, the economy went into stagnation.

In the 1990s, farming took a technological leap forward, introducing a new feeding pattern for livestock, with the use of artificial pastures, feed and pharmaceutical products. As a result of this process, there were further expulsions and expropriations of peasants and an intensification of wage labor. In recent times, activities such as tourism and the luxury real estate market have become present in the BP region, especially in the municipality of Bananeiras (Rodrigues, 2012). Even so, the socio-economic implications of poor territorial distribution have had repercussions on the region's development indices. With regard to the

fragmentation of the territory and the creation of new municipalities, of the 8 municipalities belonging to the micro-region, Bananeiras is the oldest, founded by Provincial Law in 1835 and elevated to the category of municipality in 1879. Areia was separated from Mamanguape in 1846, followed by Alagoa Grande, separated from Areia in 1856. The municipalities of Serraria (1893) and Pilões (1953) are a complex series of dismemberments of the same district. Borborema was dismembered from Bananeiras in 1959 and Matinhas only became a municipality in 1994, following the dismemberment of the municipality of Alagoa Nova.

Figure 1 – The Agreste region of Paraíba, highlighting Brejo Paraibano, and the cities and towns of Brejo Paraibano



Source: Own elaboration based on the IBGE territorial grid (2022)

It may be observed that the territorial fragmentation of Brejo Paraibano predates that of Southern Brazil, and is far more complex in terms of the social factor. Beginning with the *sesmarias*, which became latifundia, the region is still marked by strong socio-economic inequality.

2.3 The Médio Vale do Itajaí

The Médio Vale do Itajaí (MVI) (Figure 2), as opposed to the scenario of water shortages in Brejo Paraibano, is a region that suffers from an excess of water. The region is affected by floods, landslides and torrential downpours with recurring cycles, which cause social and economic impacts, such as expenses arising from the increased need for health services and loss of property (Goetzinger et al. 2020). This adverse scenario is caused by the way the territory has been occupied. The occupation of the floodplains of the Itajaí-Açú River and its tributaries that cut through the region has occurred since the time of colonization, and while this has boosted and consolidated the economy through the use of hydroelectric power for industry, it has also generated social impacts from rising water levels in the urbanized areas (Seibert 2006). The sprawl of the urban center, especially in the city of Blumenau, has led to the occupation of areas susceptible to landslides (Fernandes et al, 2020). Nonetheless, land distribution is still more equal than in other regions of Brazil, where socioeconomic inequalities are much greater.

Occupation of the MVI began with a settlement colony in 1850. German, and later Italian, immigrants began to change the landscape previously inhabited by traditional peoples. With the arrival of immigrants, the territory took on a smallholding structure, based on subsistence polyculture. The MVI did not employ slave labor, but family labor. This differed from the rest of the country, which had an agro-export economy based on large estates, monoculture and slave labor. This model of occupation led to a better distribution of income than in contexts such as the Northeast (Seibert, 2006). In terms of socio-economic dynamics, capitalist relations in the MVI region began with the sale of state land to colonizers, made possible by the Land Law (1850). Timber harvesting and the sale of agricultural surpluses were the first sources of income (Santos and Garrote 2022). In the colonial MVI, RD was understood as economic development and, consequently, social development, with the creation of urban facilities and spaces for socializing. Other aspects of RD such as environmental preservation and respect for geophysical and climatic conditions - which today are an adversity given the way the territory has been occupied - were left in the background, due to the abundance of resources and the need to build settlements (Seibert, 2006; Santos and Garrote, 2022).

Socio-economic development came hand in hand with prior craftsmanship and industrial experience. The possibility of using hydroelectric power from the Itajaí-Açú River led to the development of industry in the vicinity of Blumenau, which spread to the other municipalities along the valley. With industry, since the 1930s, the economy has shifted from rural, agricultural areas to urban areas. In terms of production activities, the importance of the textile and weaving sector has made the region a benchmark on the national scene. The metal-mechanics industry also became significant, not only in Blumenau, but also in neighboring cities. In the 1970s, the textile sector expanded to other states, especially in the Northeast. In the 1980s, however, the MVI market suffered from the effects of globalization, and textile companies opted to diversify their activities. The dispersal of the industry coincided with population increases in the small towns surrounding Blumenau (Seibert, 2006).

Currently, although it is not yet possible to mention conurbation, the integration between the cities of the MVI has become evident. The economy has focused on the service sector, tourism and the technology sector, such as the software industry (Corrêa, 2021). The BR-470 highway, which cuts through the region's municipalities, has also contributed to regional integration. The highway facilitates the flow of people and goods to the port of Itajaí, on the coast of Santa Catarina, thereby facilitating imports and exports. This factor, together with the robust development of industry and the return on capital generated for the region itself, has contributed to socio-economic development and RD. Lastly, in view of the fragmentation of cities, which occurs concomitantly with the strengthening of the economy, the MVI initially broke away from the same municipality, Itajaí, which gave rise to the municipalities of Brusque and Blumenau. All the municipalities that exist in the region today originate from the dismemberment of these two municipalities. From 1930 to 1936, Gaspar, Indaial and Timbó were separated from Blumenau, and Rodeio was separated from Timbó. Between 1958 and 1964, Pomerode was dismembered from Blumenau, and Guabiruba and Botuverá from Brusque. Rio dos Cedros was separated from Timbó, Rodeio and Ascurra from Indaial, and Benedito

Novo from Rodeio. Finally, between 1989 and 1992, Dr. Pedrinho was dismembered from Benedito Novo and Apiúna from Indaial (Seibert, 2006).

The fragmentation of all the municipalities in the MVI into Blumenau (10) and Brusque (2) signifies that Blumenau, the urban center of the colonial period, has consolidated its position as a city of significant influence in the MVI.

Figure 02- The Vale do Itajaí highlighting the Médio Vale do Itajaí, and the cities of the Médio Vale do Itajaí

Source: Own elaboration based on the IBGE territorial grid (2022)

The territorial fragmentation of the MVI, unlike BP, occurred in parallel with the creation of trade routes and roads, which in turn led to the socio-economic integration of the region's towns.

2.3 Similarities and Differences between the MVI and BP

In order to summarize the similarities and differences between the towns, cities and regions analyzed, Table 1 was produced. The aim of this systematization is to contribute to the discussion on the results, the presence or absence of spatial correlation and the significance between the towns and the presence of a medium-sized city in the studied regions.

TABLE I - Synthesis of Similarities and Differences between Brejo Paraibano - PB and Médio Vale do Itajaí -SC

	Brejo Paraibano	**Médio Vale do Itajaí**
Region	Northeastern Brazil	Southern Brazil
Climate vulnerability	Droughts	Floods and landslides
Colonization pattern	Exploration Colony	Settlement Colony
Type of occupation	Landowners	Smallholdings
Morphology	Mountain	Valley
Socio-economic development	Not High	Higher
Fragmentation	Municipalities emancipated from different municipalities (territories).	Municipalities emancipated from the same municipality (territory).
Similarities: Inland region of the respective state. Regions supposedly made up of small towns and medium-sized cities. Presence of climatic vulnerabilities that affect the population. Significance of the agricultural and farming sector. Economic development linked to the textile industry.		

Source: Own elaboration.

In relation to differences and similarities, we return to the initial concepts of spatial correlation and significance, which have led to an aggravation of territorial disparities, regional interdependence and the creation of medium-sized cities. Using an unconventional strategy, we sought support in the analysis of statistical data to understand the functionality of the medium-sized city in the regional context.

> Exploratory data analysis is often overlooked or dismissed in studies that seek to identify or better understand spatial dynamics. This is because there is an idea that such studies are dispensable, and yet they have a significant potential to demonstrate relationships of spatial dependency and/or to help select more robust statistical models that are more appropriate for the type of event being expressed there (Pereira et al. 2020 p. 3-4).

Faced with this problem, the Moran's Index of spatial autocorrelation is a widely used technique for understanding processes and their relationship with space. The Global Moran's Index estimates the level to which a variable is expressed in a geographical region. In this study, the socioeconomic development index is the variable under analysis. The basic idea is to estimate the magnitude of spatial autocorrelation between areas. In this case, the tools used are linked to the global Moran index, as indicated by Câmara (1996).

> When a large number of areas are available, resulting from detailed spatial scales for example, the nature of the processes involved is such that it is very likely that there will be different spatial correlation regimes in different sub-regions. Local indicators of spatial autocorrelation and

> Moran's scatterplot can be used to highlight these spatial regimes (Camara et al. 1996, p.33).

If there are clusters in the region, there is an intraregional relationship. When the relationship is homogeneous, i.e. a relationship of joint growth in the socio-economic development index, public policies at any point in the cluster help the development of the entire cluster. A heterogeneous relationship, in the case of socio-economic development and RD, is not expected, as public policies in one municipality are unlikely to have a negative impact on the neighboring municipality. Lastly, a final effort is made to verify the significance of the index of the medium-sized city in relation to the others. This involves using the Local Moran Index (LISA Map) to identify the city that has the most influence in the analyzed region. A high significance index is expected for cities that are considered medium-sized, i.e. they genuinely influence the cluster to which they belong.

3 Methodology

This was a qualitative-quantitative study, based on an adaptation of the Regional Development Index (RDI) by Resch et al. (2020), in turn based on Ferrera de Lima et al, (2011), Oliveira and Piffer (2016) and Oliveira, Piffer and Strassburg (2019). The index is used as a basis for analyzing the socioeconomic conditions of these two distinct Brazilian regions made up of small towns and medium-sized cities. Therefore, the indicators used in the index were selected because of the need to analyze social and economic issues together. The variables that formed the indicators were selected based on the criteria of the availability of recent data at a municipal level and a clear relationship with the proposed indicators.

For the economic indicator, the following variables were selected: gross domestic product (GDP) per capita in Brazilian Real, total revenue collected as a percentage, jobs with a formal contract and jobs with no formal contract, also as a percentage, data on IPVA (motor tax) and ICMS (service tax) collection in Brazilian Real, and the Gini index. For the social indicator, the variables were: the percentage of vaccination coverage, the percentage of rural population and urban population, the percentages of households with electricity, sewage treatment, garbage collection and running water, and finally, the expectation of years of schooling. The maps and figures used to illustrate the regions and the results of the article were drawn up using the public domain georeferencing software QGis, RStudio for data analysis, and Excel was used to produce quantitative tables and charts.

The following steps were taken to construct the index:

1. Define the variables to be assessed;
2. Calculate the share of each municipality in the regional total;
3. Calculate the partial indices for each variable for each municipality;
4. Construct the social and economic indicators: whereby, different weights must be assigned to the indicators, and the sum of the weights in the module is equal to 1;
5. Create the Socioeconomic Development Index.

To calculate the index, a weighted average of the indicators multiplied by their respective weights was used. The following steps were taken:
1. Define the relative importance of each dimension;
2. Define the relative importance of each indicator within each dimension.

This was followed by an analysis of the distribution and spatial correlation of the data obtained:
1. Classify municipalities by means of a histogram focusing on percentiles, based on the created Socioeconomic Development Index (IDSi) and present the results on a quartile map.
2. Apply the Global Moran's Index;
3. Apply the LISA statistic to measure the local spatial association.

The procedure adopted to create the indicators and, finally, the index, consisted of collecting the variables from all the municipalities in the micro-regions analyzed, i.e. the 14 municipalities in the Médio Vale do Itajaí and the 8 municipalities in Brejo Paraibano. The variables were then grouped into their respective social and economic indicators. The participation of each municipality was calculated using the formula below, where Part is the participation of variable W in municipality I, and ∑Wi corresponds to the total value of the region analyzed.

$$\textbf{Part} = Wi \,/\, \sum Wi$$

Another formula was applied to determine the index of variable W in municipality i. In this formula IPWi is the index of variable W in municipality i; Wi is the share of variable W in municipality i; Wmin corresponds to the share of the municipality with the lowest value and Wmax corresponds to the share of the municipality with the highest value.

$$\textbf{IPWi} = Wi \; - \; Wi\, mín \,/\, Máx - Mín$$

Furthermore, within each indicator, the variables were given different weights, as presented in Table II. Lastly, the indices for the Brejo Paraibano and Médio Vale do Itajaí (MVI) regions were compared. The discussion is based on the indicators obtained and the influence of the geophysical, historical and occupation factors that led to the present condition of each location.

TABLE II - Weights of the Variables assigned to each indicator

Social Indicator		**Economic Indicator**	
Variable	Weight	Variable	Weight
% of vaccination coverage %	0.10	Gini Index	0.05
Rural population	0.05	GDP per capita	0.30
Urban population	0.05	Total revenue collected	0.05
Poor population %	0.10	Total IPVA	0.05
% of population in households with electricity	0.10	Total ICMS	0.15
% with sewage treatment	0.10	Registered jobs %	0.20
% of population in households with garbage collection	0.15	Unregistered jobs %	0.20
% of population in households with piped water supply	0.15		
% of expected years of study	0.20		

Source: Own elaboration based on: ATLAS BR (2010), IDSC-BR (2010), DETRAN PB (2021) DETRAN SC and SEFAZ PB (2021) and SEFAZ SC (2021).

The index was calculated using the formula below, where IDSi is the Socioeconomic Development Index; ISi is the economic indicator for municipality i, and IEi is the social indicator for municipality i. As previously mentioned, the SDI is estimated from a weighted average, with the social indicator given weight (0.4) and the given weight of the economic indicator (0.6). According to Oliveira and Piffer (2016), the higher weight for the economic indicator is explained by economic growth, which may consequently increase its social indicator, since a healthy, prosperous economy may provide benefits such as job creation, increased income and investments in social areas such as health, education and basic sanitation. Considering the results obtained and taking into account the classification proposed by Ferrera de Lima et al. (2011), the IDSi is classified into three categories that represent the level of development of the municipalities under study.

$$IDSi = (ISi * 0,4) + (IEi * 0,6)$$

In order to classify the municipalities, an approach was adopted which enabled the identification of socio-economic development categories based on intervals of values corresponding to the calculated percentiles, with a view to comparing and differentiating between the regions. The percentile analysis was used to classify municipalities as: "advanced", "in transition" and "laggard". For each category, ranges of values were defined for the socio-economic development indices corresponding to the percentiles calculated, allowing municipalities to be classified in the respective categories.

TABLE III - IDSi indicators

Formulas	Indicators
$Part = \frac{Wi}{\sum Wi}$	W_i is the value of the municipality for the variable; $\sum W_i$ Corresponds to the total value of the region.
$IPW_i = \frac{Wi - Wmin}{Wmax - Wmin}$	IPW_i: index of variable W for municipality i; W_i is the share of variable W in municipality i; W_{min} corresponds to the share of the municipality with the highest value; W_{max} is the share of the municipality with the highest value.
ISi = (ICV x 0,10 + IPU x 0,05 + IPR x 0,05 + IPP x (-0,10) +IAEE x 0,10 + ITE x 0,10 +IDCL x 0,15 + IDAE x 0,15 +IEAE x 0,20)	ISi= Social indicator for region i; ICV = Vaccination Coverage Participation Index; IPU = Urban Population Participation Index; IPR = Rural Population Participation Index; IPP = Proportion of Poor Participation Index; IAEE = Population Participation Index in households with electricity;
	ITE = Sewage treatment participation index; IDCL = Participation Index of the Population in Households with Garbage Collection; IDAE = Population Participation Index in households with piped water supply; IEAE = Expected years of study participation index.
IEi = (IGDPper x 0,30 + IRA x 0,05 + IPVA x 0,05 + IG x 0,05 + IECC x 0,20 + IESC x0,20 + ICMS x 0,15)	IEi = Economic indicator of the region analyzed i; IGDP per = GDP Participation Index per capita; IRA= Participation rate of total revenue collected; IPVA= Total IPVA Participation Index; IG= Gini Index; IECC= Employee Participation Index; IESC= Unemployed Employee Participation Index; ICMS= Total ICMS Participation Index;

Source: Own elaboration based on Ferreira de Lima (2011)

Spatial statistics was used to analyze the behavior of variables in the territory, using exploratory spatial data analysis (ESDA), which demonstrates patterns of spatial distribution. The technique provides global and local measures of spatial autocorrelation, which may be verified using spatial association tests.

The presence of spatial autocorrelation, a statistical measure that assesses the relationship between the values of a variable in different locations in a given geographical area, indicating the existence or non-existence of patterns of spatial similarity or dissimilarity in the data, is detected using global statistics, in which the data is analyzed in a generalized manner, assessing the spatial association of a region as a whole, indicating the level of geographical interdependence between the variables of interest, their nature and the degree of relationship - Global Moran's Index. The index is between -1 and +1, testing the null hypothesis that there is spatial independence or absence of spatial autocorrelation (I=0). In the case of I≠ 0 there is spatial dependence or the presence of autocorrelation. Positive and significant values indicate a positive spatial dependence or autocorrelation, and negative and significant values indicate the presence of a negative spatial autocorrelation or dependence, i.e. opposite in relation to the neighbors. The index is expressed as:

$$I = \frac{n}{\sum\sum w_{ij}} \times \frac{\sum\sum w_{ij}(y_i - \bar{y})(y_j - \bar{y})}{\sum (y_i - \bar{y})^2}$$

Where: n is the number of spatial units or number of observations, yi and yj are the observed values of the variable for municipalities i and j, _y is the average of the observed value of the variable of interest for all municipalities, wij represents the elements of the spatial weight matrix that defines neighborhood relations, i.e. the spatial weight for the pair of spatial units i and j, measuring the degree of interaction between them, with i = 1, 2,..., n and j = 1, 2,..., n. However, according to Almeida (2012) there may be an absence of global spatial association that masks local patterns of association ..., n and j = 1, 2,..., n. However, according to Almeida (2012), in some cases there may be an absence of global spatial association which masks local patterns of association. To identify the occurrence of local autocorrelation, Anselin (1995) proposed a decomposition of the Moran's Index indicator:

$$I^{m} = \frac{n}{\sum\sum w_{ij}} * \frac{\sum\sum (x_i - \bar{x}) w_{ij} (y_j - \bar{y})}{\sum (x_i - \bar{x})^2}$$

Where z = y -_y i i and z = y - _y j j are standardized variables and the sum over j is such that only the values of the ij J neighbors are included. The set ij comprises the neighbors of observation i .

$$I_i = \frac{(y_i - \bar{y}) \sum_j w_{ij} (y_j - \bar{y})}{\sum_i^n \frac{(y_i - \bar{y})^2}{n}} = n \frac{z_i \sum_j w_{ij} z_j}{\sum_i z_i^2}$$

One of the indicators capable of capturing these effects is the LISA indicator. According to Anselin (1995), a LISA indicator may be considered to be any statistic that meets the criteria where: a) for each observation there is an indication of significant spatial clusters of similar values around the observation and b) the sum of the LISAs for all regions is proportional to the overall spatial autocorrelation indicator. From the results generated by the LISA statistic, four patterns of spatial autocorrelation may be determined, which indicate the formation of clusters. These patterns are defined as High-High (HH) and Low-Low (LL), which indicate regions with a homogeneous spatial association. The High-Low (AB) and Low-High (BA) patterns indicate heterogeneous patterns of spatial association.

A georeferenced information system (GIS) was used to interpret the results. According to Câmara et al. (1996), with GIS it is possible to characterize the way in which space is organized; however, as the authors point out, it does not capture the function of each of the components. While the method makes it possible to establish the structure of the space, it is difficult to establish the dynamic nature of the processes, whether natural or social. The relationship between structure and process may only be resolved when the combination of analytical techniques and the conclusions of the expert, who understands the dynamics of the process, are combined. Therefore, a critical analysis of the results obtained is also sought. The data analyzed was obtained from the Atlas of Human Development in Brazil (ATLAS BR), the Sustainable Development Index for Cities - Brazil (IDSC-BR), the State Transport Department (DETRAN PB), the State Departments of Finance (SEFAZ PB) and (SEFAZ SC). The study area was analyzed using data for the years 2010 and 2021.

4 Results

The following tables present the IDSi classifications used, as well as the ranges of IDSi values corresponding to each classification for the two regions under study:

TABLE IV - Classification of the IDSi Index for Brejo Paraibano

IDR ≥ 0,462	Advanced
0,34 ≤ IDR ≤ 0.461	In transition
IDR ≤ 0.33	Laggard

Source: Prepared by the authors.

Table IV shows the IDSi values considered for Brejo Paraibano.

TABLEV – Classification of the IDSi IIndex for the Médio Vale do Itajaí

RDI ≥ 0,47	Advanced
0,27 ≤ RDI ≤ 0.46	In transition
RDI ≤ 0.26	Laggard

Source: Own elaboration.

Table V shows the IDSi values considered for the MVI.

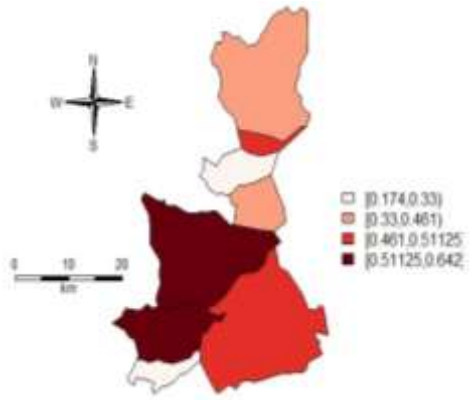
TABLE VI - IDSi Results

Brejo Paraibano		**Médio Vale do Itajaí**	
Municipality	**Index**	**Municipality**	**Index**
Areia	0.584	Apiúna	0.265
Alagoa Grande	0.487	Ascurra	0.303
Matinhas	0.147	Benedito Novo	0.251
Serraria	0.207	Blumenau	0.710
Borborema	0.466	Brusque	0.546
Pilões	0.371	Botuverá	0.546
Bananeiras	0.456	Doutor Pedrinho	0.205
Alagoa Nova	0.642	Gaspar	0.601
		Guabiruba	0.555
		Indaial	0.441
		Pomerode	0.697
		Rio dos Cedros	0.259
		Rodeio	0.215
		Timbó	0.479

Source: Own elaboration.

Table VI shows the IDSi values measured for Brejo Paraibano and the MVI.

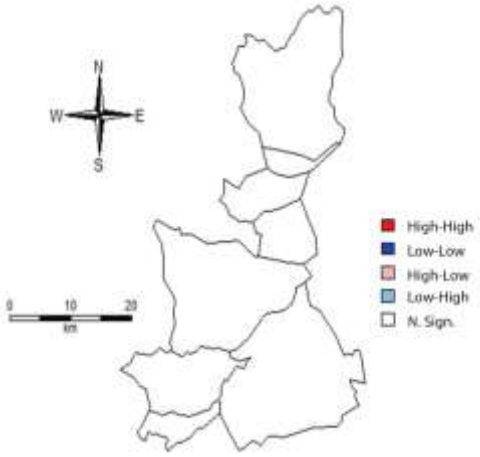
MAP I - Quartile Map for Brejo Paraibano



Source: Own elaboration.

The quartile map for Brejo Paraibano presents the municipalities based on the IDSi divisions. The darkest color represents the highest values and the lightest color represents the lowest values.

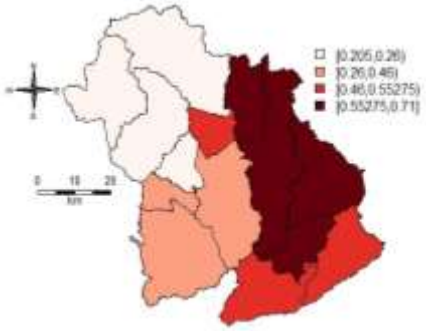
MAP II - Moran Cluster Map for Brejo Paraibano



Source: Own elaboration.

When applying Moran's Index, no spatial correlation was observed, and no clusters were identified.

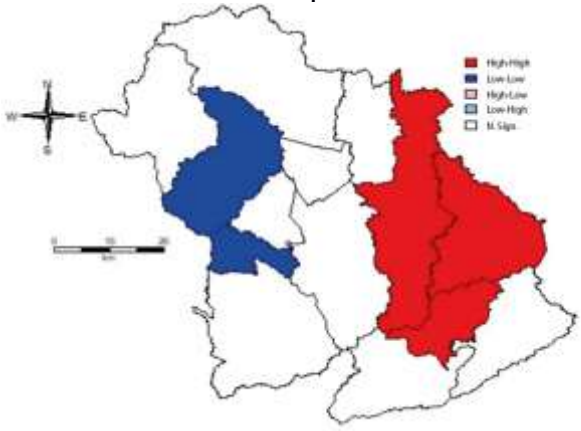
MAP III – Quartile map for Médio Vale do Itajaí



Source: Own elabooration.

The quartile map for the MVI also presents the municipalities based on the IDSi divisions. The darkest color represents the highest values and the lightest color represents the lowest values.

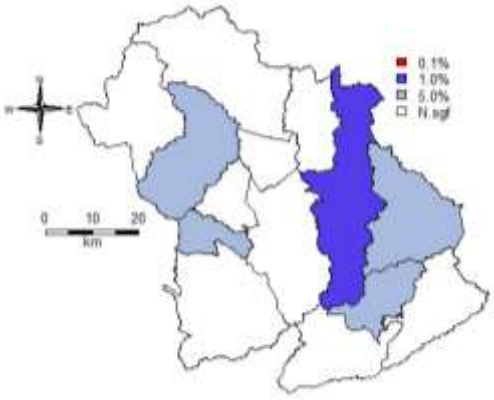
MAP IV - Moran Cluster Map for the Médio Vale do Itajaí



Source: Own elaboration.

In the case of the MVI, applying Moran's Index, spatial correlation was identified between the contiguous municipalities of Blumenau, Gaspar and Guabiruba (High-High) and Ascurra and Benedito Novo (Low-Low). Therefore, in the case of the MVI, the LISA indicator of local spatial association was used to assess the significance of each municipality, which resulted in the city of Blumenau standing out.

MAP V - Lisa Significance Map for the Médio Vale do Itajaí



Source: Own elaboration.

5 Discussion

Although the two studied regions present similarities, such as climatic adversities, the presence of an economy related to the agricultural and farming sector, economic development linked to the textile industry and an inland location in the respective state, they presented different realities in terms of the IDSi, the presence of spatial correlations and in significance. When comparing the regions, the IDSi demonstrated a higher level of socio-economic development in the MVI region compared to BP, in absolute numbers. Thus, the minimum IDSi values for the MVI were higher than the minimum values for the BP region and the maximum IDSi values for the MVI were also higher in the comparison.

With regard to the intraregional classifications, in the BP the result of the index for the municipalities of Areia, Alagoa Grande, Alagoa Nova and Borborema was advanced. In the MVI, the municipalities of Blumenau, Brusque, Botuverá and Gaspar presented the same classification. The municipalities of Pilões in BP and Ascurra and Apiúna in MVI were classified as in transition and the municipalities of Matinhos and Serraria (Brejo Paraibano) and Benedito Novo and Doutor Pedrinho (MVI) were classified as laggard. The application of the Global Moran's Index for BP revealed no spatial autocorrelation, i.e. there is no correlation between the values of the index in one municipality and the values of the variables in neighboring localities. When applied to the MVI however, spatial correlation was observed. The formation of clusters, both AA and BB, indicated a homogeneous spatial association. Heterogeneous patterns of association however, were not observed.

Also in the context of the MVI, the municipality of Blumenau presented greater significance, in this case, influence on the IDSi of neighboring municipalities.

Thus, the results of the MVI indicate that actions aimed at the socio-economic development of any municipality belonging to the cluster implies an improvement in the socio-economic development of the surrounding area. With this finding, i.e., that Blumenau is significant and has an influence on the growth of the variables of neighboring cities, it may be understood that it is possible to direct public policies toward this city in order to improve socio-economic development indices, and consequently the RD in the region as a whole.

The result of Blumenau in terms of significance is in line with the concept of a medium-sized city, which is defined as a city that both influences the smaller towns around it, and depends on them. The expressive degree of significance of Blumenau in relation to the others was expected. The process of occupation of the MVI region in the colonial period began in the part of the territory that today comprises the municipality of Blumenau. The division of the land into colonial plots and the first shops, services and industrialization radiated from this area. With a population increase in the MVI and following the national trend, Blumenau, which previously comprised the entire territory of the MVI, fragmented into the other municipalities. Even though several decades have passed since the creation of these new municipalities, the socio-economic significance of Blumenau has remained, proving once again that the historical processes of occupation, territorial division and land use have a long-term influence over RD.

On the other hand, a cluster of less developed municipalities in the MVI region was also found, corresponding to the municipalities of Ascurra and Benedito Novo. It could be speculated that this result stems from the territorial distance between these municipalities and the medium-sized city of Blumenau, thereby making access to products and services difficult. However, this hypothesis is not valid for the municipality of Doutor Pedrinho, which is even further away from Blumenau. Therefore, a second hypothesis is given: the relationship between Doutor Pedrinho and another medium-sized city outside the study area. To test this possibility, the methodology would have to be reapplied to a larger area.

The results for BP, in turn, demonstrated a lack of spatial correlation for the IDSi, which led to the hypothesis that the medium-sized city in this urban network is not contained within the region analyzed, but rather in its surroundings. One hypothesis is the influence of the municipality of Campina Grande, which is close to the territory studied, and whose influences in social, political and economic terms somewhat dilute any outstanding dynamism of the municipalities analyzed. Moreover, the territorial fragmentation that does not occur from this same city may be linked to this situation. Nonetheless, given the economic expressiveness of the municipality of Bananeiras, especially over recent years, considering that tourism and luxury real estate developments have been growing in this municipality, it was expected that this city would have a homogeneous spatial correlation with its surroundings and a certain degree of significance in terms of the IDSi, making it, like Blumenau, a medium-sized city. Bananeiras even had a lower IDSi than Areia, emancipated in 1846 from Mamanguape, a city outside the region analyzed. The lack of spatial correlation between cities in BP reveals that there is no direct relationship between the socio-economic development indices of a city and its surroundings. Therefore, a RD strategy for this region would be to reduce inequalities by directing public policies toward the development of priority contexts, i.e. those with the

greatest socio-economic deficiencies. By targeting priority municipalities, social inequality is reduced, which could lead to an increase in the RD indices.

Comparing the two realities, a possible explanation for the presence of spatial correlation in the MVI and the absence of spatial correlation in BP may be taken from the historical analysis of the occupation and fragmentation of the territory. The first difference comes from the territorial division: while the MVI was colonized through smallholdings, the landowning occupation of BP made it difficult to create an urban network. The spatial correlation between the municipalities around Blumenau has occurred because the urban network had already been consolidated when the territory was fragmented into new municipalities. The significance of Blumenau in terms of the region's socio-economic development index is explained by the fact that this city was the first settlement and was the protagonist of industrialization and commercial relations in the MVI. Regarding the criteria related to social inequality in BP, the landowning structure, slavery and the control over water resources by an elite are historical reasons for the lower socio-economic development index in relation to the southern region analyzed. Furthermore, the colonial export-oriented economy (e.g. sugarcane) and the failure to reinvest generated profits into social and infrastructure projects has led to a more adverse condition in terms of seeking RD.

6 Final Considerations

Differences in occupation, determining the land use and productive activities lead to milestones in socio-economic and regional formation, which are difficult to erase over time. Statistical measurement of the spatial correlation between socio-economic development variables and awareness of the historical events that have led to this scenario are fundamental for drawing up and implementing public policies. Considering that medium-sized cities play an articulating role in the urban network, fostering socio-economic development and consequently the RD of these cities, benefits the populations of all the surrounding small towns when a homogeneous spatial association is identified, as observed in this study for the municipality of Blumenau. On the other hand, directing resources to public policies in municipalities with a much lower level of socio-economic development, especially when the spatial correlation is not measured, as in the case in Brejo Paraibano, is a strategic necessity for increasing the levels of RD by reducing socio-economic inequalities.

The creation of an index to measure socio-economic development, an understanding of the relationships between the towns and cities that make up a region and intra-regional comparisons make it possible to understand the dynamics of the urban network. Spatial correlation, in turn, enables more assertive public policies, and makes it possible to target resources at clusters, rather than just a single federal unit. The identification of significance, in turn, allows the visualization of strategic municipalities at a regional level, the medium-sized cities. Lastly, comparing the indices between the different Brazilian regions makes it possible to identify priority contexts at a national level. The work undertaken in this paper does not exhaust the subject of creating indices for socio-economic development for RD purposes in small towns and medium-sized cities, nor does it deplete the discussion of how colonization and territorial division influence regional socio-economic situations. Even so, it is understood that it provides a contribution to the proposal for

paying particular attention to spatial correlations in order to determine strategic points for intervention, to promote public policies and reduce inequalities.

ACKNOWLEDGMENTS

The authors would like to thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) which, through the UNIVERSAL/MCTIC CNPQ/ 2018 call, made the project "ARENAS, DISPUTAS E DESAFIOS NOS MULTIPLOS ARRANJOS DE GESTÃO DAS ÁGUAS " possible (process 424330/2018-0 - current), to which this article is linked. The authors would also like to thank the Universidade Regional de Blumenau (FURB) for its institutional support and Universidade Estadual da Paraíba for defining the project's research team. They would also like to thank Jéssica Marciélly de Novaes Feldhaus (FAPESC) for her master's degree scholarship and Hellen Sonaly Silva Alves (FAPESQ/PB) for her research initiation scholarship. Authors Cristiane Mansur de Moraes Souza and José Irivaldo Alves Oliveira Silva would also like to thank CNPq for their research productivity grants.

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Submitted in: 27/04/2023 **Approved on: 31/10/2023**

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Funding sources: Bolsas produtividade em Pesquisa Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq); Chamada 28/2018 - UNIVERSAL/MCTIC CNPQ; bolsa de mestrado da Fundação de Amparo à pesquisa e Inovação de Santa Catarina (FAPESC); e bolsa de iniciação cientifica da Fundação de Amparo à Pesquisa da Paraíba (FAPESQ /PB).