



THE PERFORMANCE OF MUNICIPALITIES IN COMPLYING WITH THE 2030 AGENDA: THE CASE OF RIO GRANDE DO SUL (BRAZIL)

**O DESEMPENHO DOS MUNICÍPIOS NO CUMPRIMENTO DA
AGENDA 2030: O CASO DO RIO GRANDE DO SUL (BRASIL)**

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ABSTRACT

Although the execution of this broad program is the subject of several studies, most of them focus on a national level, neglecting the intranational, especially the municipal scale. Therefore, the study's objective was to highlight the territorial approach, considering the case of the municipalities of Rio Grande do Sul (Brazil). The central database of the investigation was the Municipal Performance Mandala, which proposes indicators segmented into four dimensions – economic, social, institutional and environmental. The application of the methods of spatial analysis and determination of agglomerations indicated exciting results, such as the centrality of the economic dimension in determining the overall performance of the municipalities, to the detriment of the remaining dimensions; the critical synergy between the economic and environmental dimensions; and the reciprocal synergy in the environmental dimension. The conclusions indicate directions to improve compliance with the 2030 Agenda, especially in leaving no one or nowhere behind.

Keywords: Sustainable Development Goals (SDG); sustainable development;
territorial synergy; spatial analysis; cluster analysis.

RESUMO

A Agenda 2030 vem promovendo a implementação e a discussão de ações e políticas para o enfrentamento dos principais desafios da humanidade na atualidade. Apesar da execução desse amplo programa ser objeto de vários estudos, a maioria centra-se na escala nacional, negligenciando, assim, a intranacional e, sobretudo, a municipal. Logo, o objetivo do estudo foi realçar o enfoque territorial, considerando o caso dos municípios do Rio Grande do Sul. A base de dados principal da pesquisa foi a Mandala de Desempenho Municipal, que propõe indicadores segmentados em quatro dimensões – econômica, social, institucional e ambiental. A aplicação de técnicas de análise espacial e de determinação de aglomerações, indicou aspectos interessantes, como a centralidade da dimensão econômica na determinação do desempenho geral dos municípios; a importante sinergia entre as dimensões econômica e ambiental; e a sinergia recíproca na dimensão ambiental. Tais conclusões fornecem caminhos para a melhoria do cumprimento da Agenda, principalmente, no sentido de não deixar ninguém ou nenhum lugar para trás.

Palavras-chave: Objetivos de Desenvolvimento Sustentável (ODS); desenvolvimento sustentável; sinergia territorial; análise espacial; análise de clusters.

INTRODUCTION

The current climate crisis has directly and negatively impacted the well-being of the world's population. The effects are particularly perverse in the most vulnerable groups, in which low purchasing power is associated with a lack of good public services (such as education and health) and adequate infrastructure (sanitation, housing and transport). Thus, several nations and supranational organizations have sought to make economic development compatible with environmental sustainability and social inclusion.

In this direction, in 2000, the 2030 Agenda was created, guided by eight goals – the Millennium Development Goals (MDG) (UN, 2020). Nevertheless, the worsening of the climate crisis, frustration with the pace of MDG results and numerous criticisms (such as technical reprimands on data sources and the choice of variables and the orientation of neoliberal policies) (Liverman, 2018), led to a reevaluation of the Program. Given this, in September 2015, a new strategy guided by 17 intentions¹, the Sustainable Development Goals (SDGs), was presented. A specificity of the SDGs was

1 The SDGs: 1-Eradication of poverty; 2-Zero hunger; 3-Good health and well-being; 4-Quality education; 5-Gender equality; 6-Clean water and sanitation; 7-Affordable and clean energy; 8-Decent employment and economic growth; 9-Industry, innovation and infrastructure; 10-Reduction of inequalities; 11-Sustainable cities and communities; 12-Responsible consumption and production; 13-Fighting climate change; 14-Life under water; 15- Life on earth; 16-Peace, justice and strong institutions; and 17-Partnerships in support of goals (UN, 2020).



to highlight elements associated with both the structural nature of production and consumption (in this case SDGs 7, 8, 9, 11 and 12) and the institutional nature of governance instances (such as SDGs 13, 16 and 17).

The strategy was demarcated by 169 goals, linked to 241 monitoring indicators. On the one hand, the central idea of the 2030 Agenda and the SDGs is to leave “no one left behind” (Cochrane; Thornton, 2018), that is, all countries and regions must be able to meet the goals, if otherwise, the entire collective will be affected. On the other hand, the exclusion of some places in development processes, generating regional inequalities, is something that must be observed, regardless of the country’s stage of development.

Therefore, understanding the socioeconomic development trajectories of a given region and seeking new opportunities from the perspective of sustainable development is fundamental. Thus, the 2030 Agenda adopted a focus on Sustainable Development (SD). Given this, support from the scientific community has a lot to contribute. The objectives must be achieved with more social justice and ethical engagement, which is a concern of decision-makers, politicians, and academics (Sultana, 2018). In other words, the contributions of the academic community in proposing new techniques for analyzing the implementation of the SDGs are extremely relevant.

In the case of Brazil, the challenges to implementing the 2030 Agenda are enormous. In addition to its population and territorial size, regional and intra-regional specificities and inequalities are very pronounced. Added to this are the lack of regularity in the collection and the reliability of available empirical data. Consequently, this set of aspects has imposed difficulties on studies that seek to jointly analyze the socioeconomic and environmental sustainability of development, based on the performance of municipalities in achieving the Sustainable Development Goals (SDGs).

Given the above, the objective of the research was to analyze the performance in fulfilling the SDGs and the standard for the implementation of the 2030 Agenda in the municipalities of Rio Grande do Sul. More specifically, four intentions guided the study: evaluating the action of municipalities about the execution of goals; examining the extent to which socioeconomic, institutional and environmental factors interfere with this result; observing whether spatial proximity affected the performance of neighbouring municipalities; and, using a statistical group typification



tool, identify agglomerations of municipalities with similar characteristics, according to their stages of performance in meeting the SDGs.

For this, the indicators proposed in the Municipal Performance Mandala (MDM) were used, a monitoring tool composed of 30 indicators, grouped into four dimensions: economic, social, institutional, and environmental. MDM was an original initiative of the Localizing the SDGs in Brazil project, an action in partnership between the National Confederation of Municipalities (CNM) and the Territorial Network Articulation Program of the United Nations Development Program. The project intended to consolidate monitoring and accountability systems to achieve the SDGs at the local level; involve municipalities in the adoption of the 2030 Agenda; instruct local governments on integrating the SDGs into municipal plans; and encourage discussion in Latin America and internationally (CNM, 2022).

The article uses the indicators proposed in the MDM, between 2017 and 2020. The evaluation of municipalities based on the application of statistical techniques of spatial analysis and agglomerations (*clusters*) allowed the identification of the territorial pattern and five stages of performance in fulfilling the SDGs. An important contribution was the use of statistical and spatial techniques to better understand the performance of municipalities, allowing the organization and dissemination of territorialized statistical data on the SDGs. In this direction, the OECD (2022) highlights the territorial approach to the SDGs, that is, the breakdown of the differential performance of the SDGs on the most detailed intranational scale possible, at the level of cities or municipalities.

In addition to this introduction, the article presents four more sections. The following discusses sustainable development based on the theoretical framework used in the study and its relationship with the 2030 Agenda. The third describes the methodology applied. The fourth presents the results, highlighting the spatial pattern and the five identified performance stages. Finally, the fifth section presents the final considerations about the study.

SUSTAINABLE DEVELOPMENT AND THE 2030 AGENDA

The United Nations (UN), when presenting the 2030 Agenda, proposed a set of objectives (SDGs) linked to five axes: people, planet, prosperity, peace and alliances. The conjunction of these axes guides the notion of Sustainable Development (SD), which comprises ensuring a dignified and prosperous life, without poverty or hunger, through sustainable forms of production and consumption for present and future generations, ensuring justice and inclusion, and combating fear and violence (UN, 2015). The expectation is that achieving SD guided by these axes will result in a major social, economic and institutional transformation, in line with environmental preservation.

Although the degradation of the Planet's ecosystems and the harmful impacts of underdevelopment were important issues at the beginning of the second half of the 20th century, it was in the 1970s that these issues gained greater importance. In particular, the year 1972 was marked by two important events: the publication of the Limits to Growth report, prepared by the Club of Rome, and the first major international conference on the environment – the Stockholm Conference – which established the Program of Nations United Nations for the Environment (UNEP). On that occasion, the UN defended the adoption of criteria and principles common to all nations, aiming to improve and preserve the human environment (UN, 1972).

The Club of Rome's projections indicated a global catastrophe in the year 2050, driven by the increasing scarcity of non-renewable natural resources, increased environmental degradation and continued population growth. The combination of these trends would lead to unsustainability and poverty.

non-economic factors in the functioning and transformation of economic systems were realized in a more lucid and evident way. Therefore, the increase in productive efficiency, generally presented as an indicator of development, is no longer a sufficient condition for the population's primary needs to be satisfied (Furtado, 2000). More than that, the very notion of economic growth needed to be reformulated to foresee that harmful environmental impacts were minimized and that growth was also a function of socially desirable objectives (Sachs, 2001).

The theoretical framework adopted in the study that generated this article is based on the understanding of Sustainable Development (SD) as a complex challenge that involves the integration between economic growth, environmental preservation and social inclusion. If, on the one hand, the



popularization of the terms sustainable development and sustainability gave more visibility to the exhaustion of the current production and consumption model, on the other, there is an imprecision in these terms (Bandola-Gill, Grek and Tichenor, 2022), sometimes limited to erroneous notion of associating sustainability only with the environmental dimension.

The expression “sustainable development” was used publicly for the first time in 1979, at a United Nations Symposium on the Interrelationships between the environment and development (Veiga; Zatz, 2008). However, it was after the publication, in 1987, of the Brundtland Report (“Our Common Future”) that the concept of Sustainable Development (SD) began to have great repercussions (Calegare and Silva Júnior, 2011; Veiga, 2005). The concept of SD was legitimized at the Rio-92 Conference, as a development that can satisfy the needs of the present without compromising the ability to meet the needs of future generations (UN, 1987).

According to Almeida (1996), the notion of SD has as its starting point the idea of socioeconomic and environmental inadequacy in the development pattern adopted by contemporary societies. For Abramovay (2010), DS comprises a process of permanent expansion of individuals’ substantive freedoms, in conditions that encourage the maintenance and regeneration of services provided by ecosystems to societies.

Therefore, the end of development is no longer exclusively economic growth, which is a necessary but not sufficient condition, given that we aim for a better, happier and more complete life, guided by the values of equality, equity and solidarity in all areas. places (Calegare; Silva Júnior, 2011). The notion of Sustainable Development (SD) involves economic, social, and ecological concerns, which are part of a development pattern that strives to ensure intergenerational equity in material, social and environmental well-being (Aoyama, Murphy and Hanson, 2011).

The glimpse of a social, economic, and technological transformation, which can establish this more sustainable development pattern, has motivated the appreciation of other elements, such as the seven ways to think about the 21st-century economy – the Donut Economy (Raworth, 2018). This proposal proposes a change in economic orientation, highlighting the collective synergies between human beings (needs and desires) and the planet’s other riches (multiple ecosystems, formed by a diversity of animals, vegetables, and minerals). The doughnut is the symbol of the balance between



the social basis of well-being and the ecological ceiling of planetary pressure. The idea is to ensure that while the social base expands (taking people out of vulnerable situations) ecological limits can be respected.

The countless advances in science, technology and innovation make it possible to establish new guidelines to mitigate the economic, social and environmental impacts of the climate crisis. While new social and environmental innovation goals should guide economic growth trajectories, the respective policies and evaluation measures will need to be reformulated, and no longer limited to conventional business models and instruments (Schot et al., 2018).

Another relevant aspect of this process is to guarantee a healthy political system, which promotes the delivery of necessary actions for SD. In more democratic societies, with strong and transparent institutions, public actions and policies are supposedly more sustainable due, above all, to the pressures exerted by different actors (civil society, unions, and government, among others) (Silva, De Benedicto and Mastrodi Neto, 2021).

Therefore, as pointed out at the beginning of this discussion, compliance with the 2030 Agenda implies a major social, economic and institutional transformation. Given this, it seeks a conception of economic and social development dependent on natural resources and the environment, also being a purpose of shared responsibility (Boto-Álvarez; García-Fernández, 2020).

Therefore, a likely hypothesis is that nations that manage to meet the greatest number of SDGs will inherit the most advantageous development trajectories. Both in economic and technological as well as social and environmental terms. Another important point concerns the capacity and real possibilities of different countries and regions to achieve the SDGs; in other words, this process may be reproducing old regional inequalities, or creating new ones.

With a better understanding of the global environmental system (*Intergovernmental Panel on Climate Change* [IPCC], 2019; Steffen *et al.* , 2015) – climate, biodiversity, land use, etc. – it is clear that no region can be left behind in terms of sustainable development, otherwise the entire system will be compromised. Therefore, achieving the SDGs must be a goal for all nations and regions.



METHODOLOGICAL PROCEDURES

The study methodology followed two stages and the database was the Municipal Performance Mandala (MDM). The MDM is a resource that allows checking the performance of municipalities about the SDGs, through 30 indicators distributed across dimensions: economic, social, institutional and environmental (CNM, 2022). The study analyzed the years from 2017 to 2020 and covered the municipalities of Rio Grande do Sul. Each dimension, formed by different indicators, has the following characteristics. The economic dimension shows the level of economic growth and competitiveness of municipalities; relating to SDGs 8, 9, 10 and 12. Social, the various aspects of social development such as poverty level, health, education, and security, among others; are in line with SDGs 1, 2, 3, 4, 5, 7, 11 and 16. The institutional exposes the institutional capabilities of municipal management, mainly about the transparency of the implementation of public policies; SDG 17. Environmental SDG, which reveals the effectiveness of environmental management such as disaster prevention measures, sewage treatment, environmental policies, etc.; SDGs 6, 13, 14 and 15.

The first stage – data collection and processing – consisted of calculating the percentage of performance (growth or decrease) for the set of indicators for each of the four dimensions. Subsequently, municipalities with a sufficient number of indicators in each dimension were selected. This election was justified because there were municipalities that did not have the 30 indicators. To overcome this problem, 127 municipalities were selected from a total of 497, based on the following criteria:

- have at least 23 MDM indicators and
- existence of indicators in all four dimensions.

It is noteworthy that, although the set of municipalities corresponded to 25.5% of the number of municipalities in Rio Grande do Sul, it reached a significant 68.2% of the population, corroborating the representativeness of the analyzed group².

The second stage comprised the application of descriptive statistics methods, correlations, spatial pattern indicators (spatial dependence) and *heatmaps* (groupings). The first step was to describe the set of statistical information to verify the distribution in the four dimensions of analysis regarding their means,

² The explanation for these percentage differences is that the municipalities with the highest number of Mandala indicators, in general, are those with the largest population and, therefore, the largest administrative structure, and, therefore, with the greatest capacity to monitor these indicators, since This capacity largely depends on these local structures.



quartiles, maximums and minimums. Afterwards, the correlation coefficients (*Pearson*) were determined between the different dimensions to investigate the statistical relationships between the variables.

The analysis of spatial patterns sought to verify how municipalities influenced their neighbouring counterparts, thus determining the degree of spatial dependence or spatial association between municipal units (Anselin, 1988).³ The concept of spatial dependence is based on the assumption that in geographic space all elements (aspects, characteristics or indicators) have relationships with each other, however, the elements that are closest territorially are more related than those that are more distant. However, the socio-spatial behaviours of some variables (social, demographic, and economic, among others) may deviate from this premise (Tartaruga, 2015). For this reason, spatial dependence analysis techniques are essential for determining the relationships between variables distributed in a region.

For this, the global spatial autocorrelation index (IGAE) (Moran statistic) was calculated, an indicator that reflects the average behaviour of the influence of a certain variable of a spatial unit on another unit (Anselin, 1988, 1995; Griffith, 2005; Tartaruga, 2015). In this case, the IGAE shows the degree of influence of each dimension of the MDM (economic, social, institutional and environmental) in spatial terms. In other words, how much of a dimension is responsible for the concentration or territorial dispersion of groups of municipalities with similar characteristics in the studied region?

The IGAE varies from -1 to 1, whereby: values close to 1 indicate positive spatial autocorrelation (the variables in the set of spatial units are similar the closer the units are, which indicates an agglomerative propensity in the region); close to -1, negative spatial autocorrelation (variables from contiguous units are disparate); and close to zero, no spatial autocorrelation (the values of local units are presented randomly). Therefore, the existence of spatial autocorrelation, positive or negative, is a strong indication that there is some spatial pattern in the region under study. It may be a pattern of spatial distribution of the variable with a tendency towards agglomeration, in the case of positive autocorrelation, or dispersion, in the case of negative autocorrelation.

Within the scope of IGAE, two spatial autocorrelation analysis models were applied. That of univariate spatial autocorrelation (analysis of a variable), in this case, the verification of autocorrelation

3 Spatial dependence analysis is one of several techniques in the field of spatial statistics that emerged in the early 1950s (Tartaruga, 2015). This field complements conventional statistics by considering the spatial aspects of the variables analyzed (distance, location, proximity, neighborhood, etc.).



between municipalities based on the same variable, one of the four dimensions (economic, social, institutional and environmental). And bivariate spatial autocorrelation, which verifies the spatial correlation between two different variables across the dimensions of the research⁴.

Finally, to identify groups of municipalities that shared a similar level of performance in meeting the SDGs, the *heatmap cluster statistical tool* was used. This method is used in large data matrices, to visualize patterns and create dendrograms to define groupings (clusters). Based on hierarchical cluster analysis, it is the program's algorithm that defines the number of groups. The logic applied in the study was the complete linkage method, according to which the distance (or dissimilarity) between two groups is defined by the distance between the two most distant objects in each group. Carrying out this procedure follows three steps (Galili *et al.* , 2018; Storme *et al.* , 2019): organization of data and preparation of a standardized matrix formed by the 127 municipalities and the four dimensions (economic, social, institutional and environmental); definition of the type of similarity between the observations of each cell (column and row); and definition of data serialization in rows and columns (dendrogram). The ordering of the data (scale) was carried out according to its distribution in the columns. Thus, the colours⁵ and order of observations are distributed to highlight the municipalities that present the best and worst performances in each MDM indicator.

THE PERFORMANCE OF MUNICIPALITIES IN THE 2030 AGENDA: ANALYSIS OF RESULTS

The success of the 2030 Agenda directly depends on achieving the 17 SDGs globally. For many countries, achieving these goals means overcoming historical structural problems – especially those related to socioeconomic conditions (such as the elimination of poverty, universal access to health services, social assistance and education, or equal opportunities between men and women) – which also, in different ways, manifest themselves on regional and local scales. From this perspective, some interesting research questions arise, such as: has the performance of municipalities in Rio Grande do Sul been satisfactory in implementing the goals? Does the achievement of goals differ in economic, social, institutional or environmental terms? Is it possible for performance in one dimension to

4 Here the mathematical formulations are similar to those of the univariate model, however, with the difference that the degree of association between a variable and the values of neighboring municipalities of another variable is sought.

5 In this work it was defined that lighter colors (tending towards yellow) indicate positive performance (percentage increase) and darker colors indicate negative performance (percentage decrease).



interfere with action in another? In spatial terms, is it credible that neighbouring municipalities have similar performances? Furthermore, according to the dimensions above, which municipalities show the biggest (and smallest) differences in performance? The set of these research questions seeks to profile the municipalities of Rio Grande do Sul and bring to light the synergies and impasses involving the fulfilment of the SDGs (Kroll, Warchold and Pradhan, 2019).

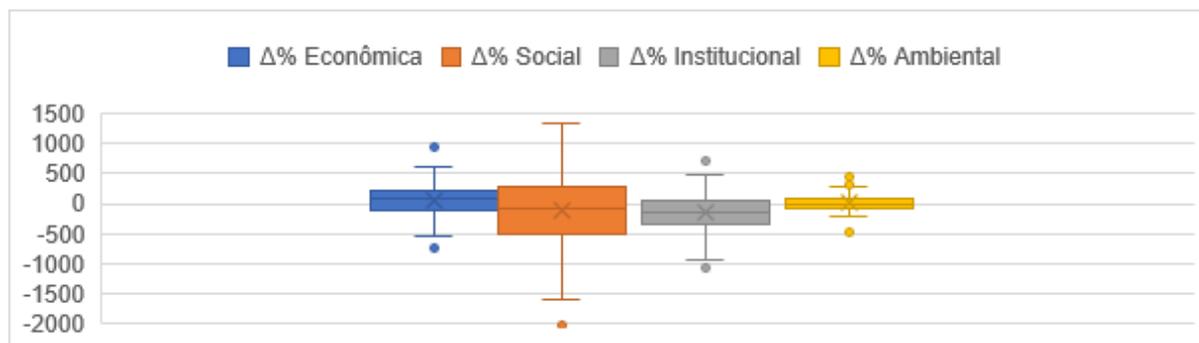
Performance visibility: descriptive statistics and correlations

To analyze the performance of the SDGs in the 127 selected municipalities, it was important to verify, firstly, the statistical distribution of data for each dimension of the study. This examination makes it possible to identify the representation of good and bad performances. When observing Figure 1, in general, all dimensions tended to present negative performance, except the economic dimension. Therefore, the performance of the economy appears better compared to the other dimensions. Another relevant characteristic is variation. While the social dimension showed the greatest variability (which means that this dimension has a stronger influence on the variation of the total set of dimensions), the environmental dimension showed the least variation (i.e., less power of influence on the total variation). The remainder showed an intermediate capacity to influence global variation.

Other interesting results are observed when examining the general performance averages and the types of positive and negative performances separately from the dimensions (Table 1). The question of averages showed good performance in the economic dimension, followed by the environmental one, while the others showed very unfavourable performances. As for the type of performance, economic performance stood out on the positive side. This is corroborated by the coverage of the indicator of the percentage of the state's total population. The social organization also demonstrated a territorial scope of notable positive performance, as it reaches 40% of the total population. In contrast, the unfavourable performance of the institutional dimension is highlighted, which affected more than half of the population (Table 1).



Figure 1 | Boxplot of the four dimensions (economic, social, institutional, and environmental) of percentage variation in the performance of the selected municipalities.



Source: Own preparation.

Table 1 | Description of the four dimensions (economic, social, institutional, and environmental) of the respective performances of the selected municipalities.

Dimensions	Performance type	Counties (%) *	Population (%) *	Performance Average
Economic	Positive	14.7	51.2	53.9
	Negative	10.9	17.0	
Social	Positive	11.7	40.0	-107.1
	Negative	13.9	28.2	
Institutional	Positive	8.1	15.4	-158.4
	Negative	17.5	52.8	
Environmental	Positive	11.9	33.9	27.2
	Negative	13.7	34.3	

* Percentages refer to the state's total.

Source: Own preparation.

Another essential aspect concerns the (statistical) relationship between the four dimensions (Table 2). The correlation analysis shows that there is only a positive relationship with some statistical significance for the pair of economic and social dimensions (coefficient of 0.203).⁶ Regarding the other dimensions, unfortunately, no relationship, positive or negative, can be assumed, as no statistical

⁶ Despite the statistical significance of 0.05 (95% confidence), this coefficient has a p -value of 0.074 (or 7.4%) which, unfortunately, does not guarantee the non-randomness of the result. Therefore, the coefficient has partial statistical guarantee.

significance was found between them. Thus, with a relative degree of statistical security, it can be said that within each municipality, economic and social aspects influence each other positively, that is, improvements in the economy tend to have repercussions on social improvements and vice versa.

Table 2 | *Pearson correlations* between economic, social, institutional and environmental dimensions. The upper triangle shows the correlations and the lower triangle shows the corresponding p-values.

	Δ% Economic	Δ% Social	Δ% Institutional	Δ% Environmental
Δ% Economic		0.203*	0.040	0.049
Δ% Social	0.074*		0.018	0.046
Δ% Institutional	0.548	0.857		0.015
Δ% Environmental	0.954	0.545	0.463	

* statistical significance < 0.05.

Source: Own preparation.

Territorial synergies: spatial dependence analysis (spatial autocorrelation)

To verify how a given dimension of a municipality influences the performance of this or another dimension in different neighbouring municipalities, understanding synergies and contradictions, the IGAE was calculated. According to Table 3, all dimensions have some spatial association, but only two types of associations have high significance. In addition to moderately robust correlations, the first group does not present interesting indices because these values are relatively low (the highest reaches 0.1, while the maximum is 1). Therefore, considerations cannot be safely inferred about these associations.

Table 3 | Global indices (Moran) of spatial autocorrelation of the economic, social, institutional and environmental dimensions.

	Δ% Economic	Δ% Social	Δ% Institutional	Δ% Environmental
Δ% Economic	-0.086 (0.208)	-0.056 (0.228)	0.099 (0.085)	0.125 (0.032)
Δ% Social	-0.048 (0.244)	0.057 (0.245)	0.002 (0.469)	0.034 (0.308)
Δ% Institutional	0.100 (0.077)	0.077 (0.145)	0.074 (0.182)	0.026 (0.355)
Δ% Environmental	0.051 (0.228)	0.070 (0.168)	0.047 (0.253)	0.165 (0.034)

Note: Statistical significance < 0.05. Indices in bold indicate those that were statistically validated by p-value (in parentheses).

Source: Own preparation.



However, the second group of spatial associations with robust significance and substantial indices brings some important aspects to this study. The first of these associations, between the economic and environmental dimensions (with an index of 0.125), indicates that, in general, the good economic performance of a municipality can positively influence the environmental performance of neighbouring municipalities. Therefore, it could be said that the good economic development of a region can influence the good environmental sustainability of nearby regions. This result corroborates the proposition of the Environmental Kuznets Curve, which points to the situation in which the increase in *per capita income*, or approximately economic growth, occurs simultaneously with the decline in pollution (Grossman; Krueger, 1995). Therefore, there is an indication of territorial synergy between the economy and the environment.

The second important spatial association occurs exclusively in the environmental dimension, with a coefficient of 0.165, the most robust of all possible correlations. A municipality with a good performance in the environmental dimension probably has neighbouring counterparts with similar environmental performance. This result is partially explained by the fact that nearby municipalities must have a similar environmental structure (fauna, flora, soil and climate conditions, etc.), which presupposes a spatial association in the environmental dimension. This situation is corroborated by the classic 1st law of geography (Tobler, 1970), establishing that spatially close elements are more related than distant elements. As this law occurs more frequently with natural variables than socioeconomic ones (Buzai; Baxendale, 2006), the environmental dimension of the study in question seems to follow it, as the specific indicators of this dimension depend, intrinsically, on the environmental context.

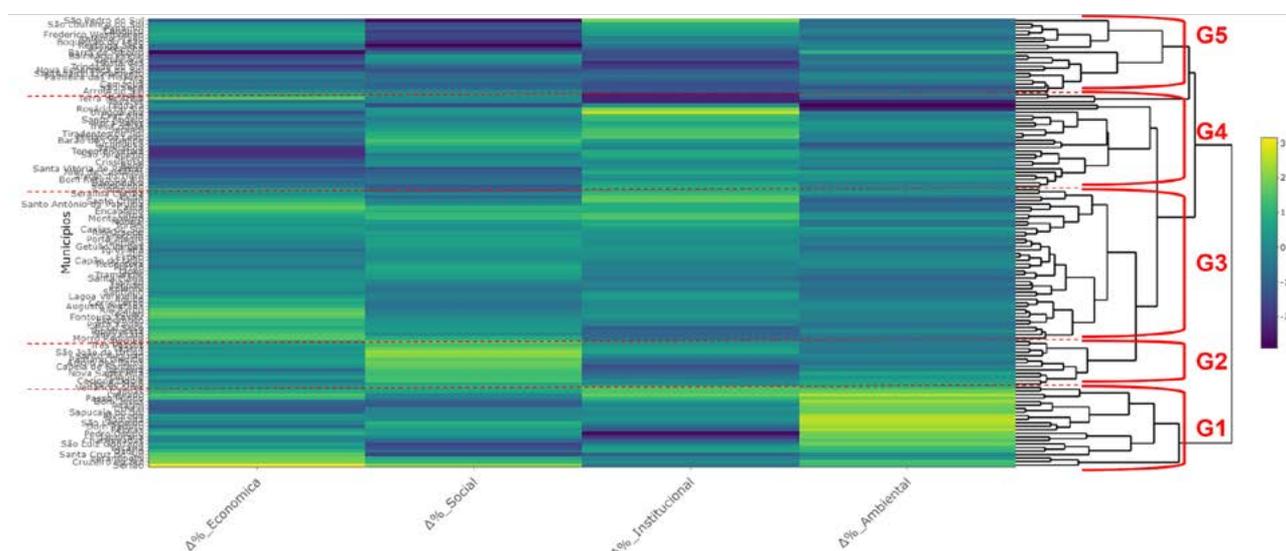
Municipal performance standards: cluster analysis (*cluster heatmap*)

Another way to verify the implementation of the SDGs is through the average performance of homogeneous groups of municipalities. The analysis of clusters allows us to identify, for example, which and how many groups of municipalities would be necessary to express the diversity of performance standards in meeting the SDGs; or even, how each group is characterized in terms of SDG performance and also in other socioeconomic aspects. For this, the statistical technique of *cluster heatmaps (CH)* was applied, which allowed the identification of sets of homogeneous (heterogeneous) municipalities between groups. The configuration of five groups of municipalities

was observed (Figure 2)⁷ G1 to G5.

This configuration has different representations about the general calculation of the state of RS, in terms of several municipalities and population. The proportions of the groups (Table 4) vary, mainly, in the population. This situation gives extremely different territorial coverage between the five groups.

Figure 2 | Cluster Heatmap of the four dimensions – economic, social, institutional and environmental – of percentage variation (performance) of the selected municipalities and identification of the five groups of municipalities.



Source: Own preparation.

Table 4 | Description of the five groups of selected municipalities.

Groups	Percentage of municipalities relative to the state's total	Percentage of inhabitants relative to the state's total
G1	4.6	18.6
G2	2.6	2.1
G3	8.7	33.0
G4	4.8	7.2
G5	4.8	7.3
Set of groups	25.6	68.2

Source: Own preparation.

⁷ In the figure, each cell has a color, with the lighter ones representing the best performances and the darker ones representing the worst. The value scale indicates the standard deviations above and below the average (zero value) with respect to performance.

Regarding its characterization (Table 5), it is possible to observe which dimensions are highlighted in each group. Thus, we can see the great diversity of SDG performance typification about dimensions (economic, social, institutional, and environmental). Furthermore, the spatial distribution of the groups is shown in Figure 3.

Table 5 | Characterization of the performance of the five groups of selected municipalities about economic, social, institutional, and environmental dimensions.

Groups	Statistics	Δ% Economic	Δ% Social	Δ% Institutional	Δ% Environmental	Typification (main focuses)
G1	Average	179.0	-150.5	-194.4	329.1	1st Environmental (+) 2nd Economic (+)
	Standard deviation	307.7	635.6	349.2	120.8	
G2	Average	102.2	926.1	-261.3	15.3	1st Social (+) 2nd Institutional (-)
	Standard deviation	119.3	247.8	210.4	82.3	
G3	Average	201.6	8.9	-90.3	-36.5	Economical (+)
	Standard deviation	187.5	346.3	220.9	61.6	
G4	Average	-225.9	-142.1	94.3	-39.4	Economic (-)
	Standard deviation	173.7	509.3	227.2	139.3	
G5	Average	-76.8	-798.0	-442.7	-75.0	All (-)
	Standard deviation	281.7	592.4	362.2	102.9	

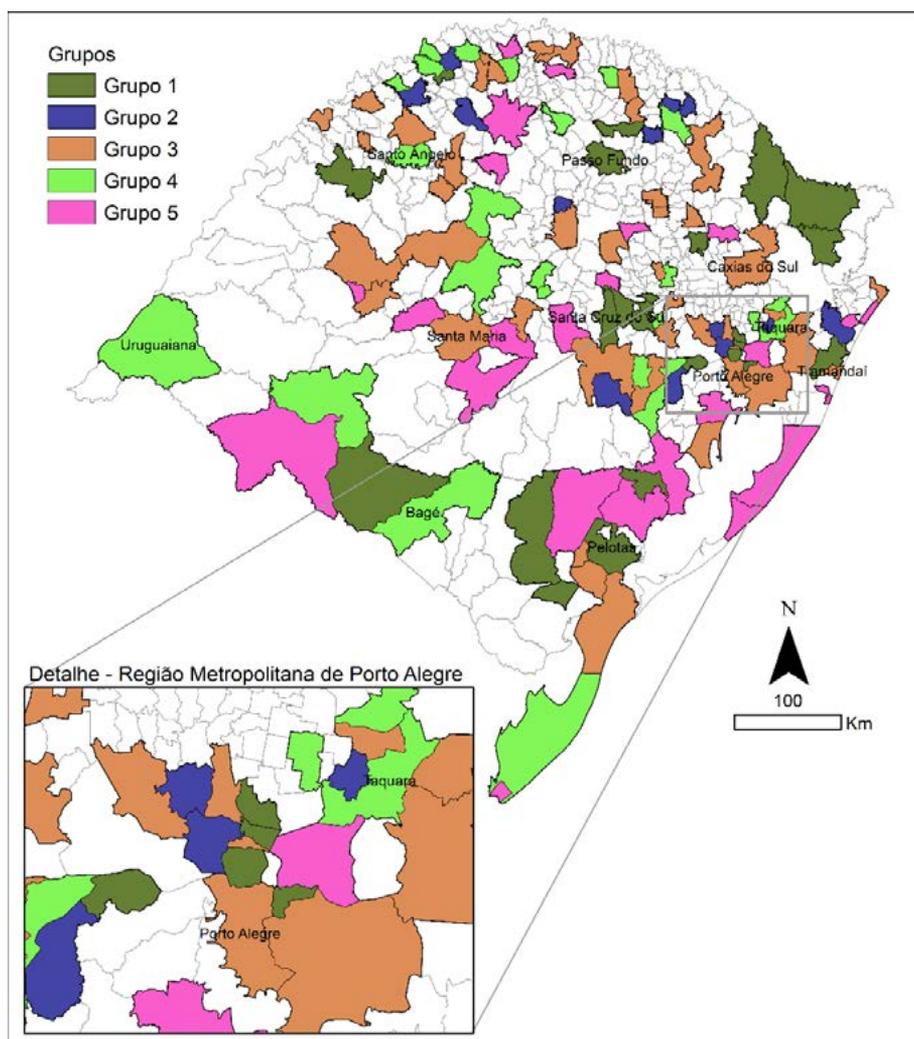
Indication of positive and negative performance, respectively, (+) and (-).

Source: Own preparation.

When examining each group, some points are highlighted. G1 is especially important because it covers almost 20% of the population of Rio Grande do Sul (Table 4). This group is made up of 23 municipalities, forming the second largest group in terms of population size – 2,125,138 inhabitants (IBGE, 2022), with approximately 51% women and 49% men. In this group, the environmental dimension stands out positively, with the best result of all groups (329.1 Δ%). In addition to this dimension, the economic dimension stands out, also positively, (179.0 Δ%), influenced mainly by the municipality of Sertão. This predominance of environmental and economic dimensions is in line with the previous finding of spatial autocorrelation. In this group, therefore, the economic growth of municipalities favourably affects the environmental components of their surrounding regions. Furthermore, this situation can be seen in the mapping (Figure 3), that is, some municipalities in this group are clustered in the territory. When pointing out the social dimension, the group presented

the second worst result with (150.3Δ%), behind only the G5 which had the negative expressive mark as its outcome (-798.0Δ%), followed by the Institutional dimension which also did not score positively (-94.4Δ%), placing it in the third worst result compared to the other groups.

Figure 3 | Territorial distribution of the five groups of selected municipalities.



Source: Own preparation.

In general, based on the results obtained by G1, it is understood that both positive and negative impacts are generated due to human activities. In the environmental dimension, possible actions such as the creation of innovative technologies, concern with tree planting or even adequate inspection can be considered as relevant items to be adopted, which, by extension, could generate a satisfactory result in this dimension. In the case of the economic dimension, it can be identified

that the data from the municipalities within this spectrum obtained adequate results in general. However, when observing the social and institutional dimensions, it appears that actions in favour of these approaches are still absent, indicating limitations in the implementation of the objectives of the 2030 Agenda. On the other hand, it is understood that social participation has been based on institutional instruments that require planned public policies that more effectively communicate the purposes of social well-being through actions in the fields of health, education, environment, housing, social assistance, leisure, transportation and security.

The most relevant group is Group 3 (Table 4), both due to the number of municipalities it brings together (43 municipalities) and the population it comprises (3,764,334 inhabitants, according to IBGE, 2022), distributed in small, medium, and large municipalities. The majority of the population (52.3%) is female. This group's most significant dimension is the economic one (201.6 $\Delta\%$), while the others are much less important (Table 5): social (8.9 $\Delta\%$), environmental (-36.5 $\Delta\%$) and institutional (-90.3 $\Delta\%$), presenting negative performances in these last two. Unfortunately, this group presents a one-dimensional focus on the economy to the detriment of social, institutional and environmental structures.

Therefore, the G3 appears as a type of traditional capitalism, very common in various parts of the world, in which environmental problems (pollution, reduction of biodiversity, deforestation, etc.) are minimized in the face of economic growth strategies. It is clear that in the G3 the environmental and institutional dimensions are those that require the most attention. For example, the low technical qualifications in city halls to manage public resources and interpret rules and regulations – particularly environmental ones – are deficiencies that contribute to this negative performance. In the same vein, the lack of public investment to create indicators, combined with the population's lack of interest, are weaknesses that can also compromise the good performance of the economic and social dimensions. In other words, good performance in all dimensions is crucial for collective well-being, and, therefore, for fulfilling the 2030 Agenda.

With little population expression (Table 4), the G2, G4 and G5 groups offer very different dimensional configurations, but with an unfavourable emphasis in general. On the one hand, G2 is the best-performing among the three groups. In effect, this group has important efficiency in



the social dimension and, to a lesser extent, in the economic one. However, it performs very poorly institutionally.

On the other hand, in the G5 there are terrible performances in all four dimensions, mainly in the social and institutional dimensions. This group is in the worst situation with the deterioration of conditions to promote sustainable development. This group is made up of 24 municipalities that in terms of population had 832,395 people (IBGE, 2022) and a small predominance of women (50.93%). At the same time, the general performance of the municipalities that make up Group 5 in the four dimensions deserves attention. The negative percentages (Economic/-76.8 $\Delta\%$; Social/-798 $\Delta\%$; Institutional/-442.7 $\Delta\%$; and Environmental/-75.0 $\Delta\%$) point to the need for a better understanding of the reality of each municipality. As a reinforcement, it is believed that among all the groups of municipalities analyzed, this is the one that requires the most attention from public agents, especially about territorial dynamics.

In this sense, it is worth highlighting that the search for a better quality of life is expressed in the reduction of regional disparities. In other words, each location will have its territorial particularities, not nullifying its potential to offer conditions that enable a greater *amount* of capabilities necessary for people to be able to reach a better level when thinking in economic and social terms. Based on this, to highlight the different results in their respective dimensions, it can be observed that development is not uniform in the municipalities selected for the research.

At the same time, it is worth highlighting that thinking about development requires understanding that it is a process that is sometimes slow, time-consuming, subjective and diffuse. The proposal to offer better alternatives for society involves changing the stage common to many municipalities, that is, changing the *status quo* to a higher condition, however, with the perspective of being better than before.

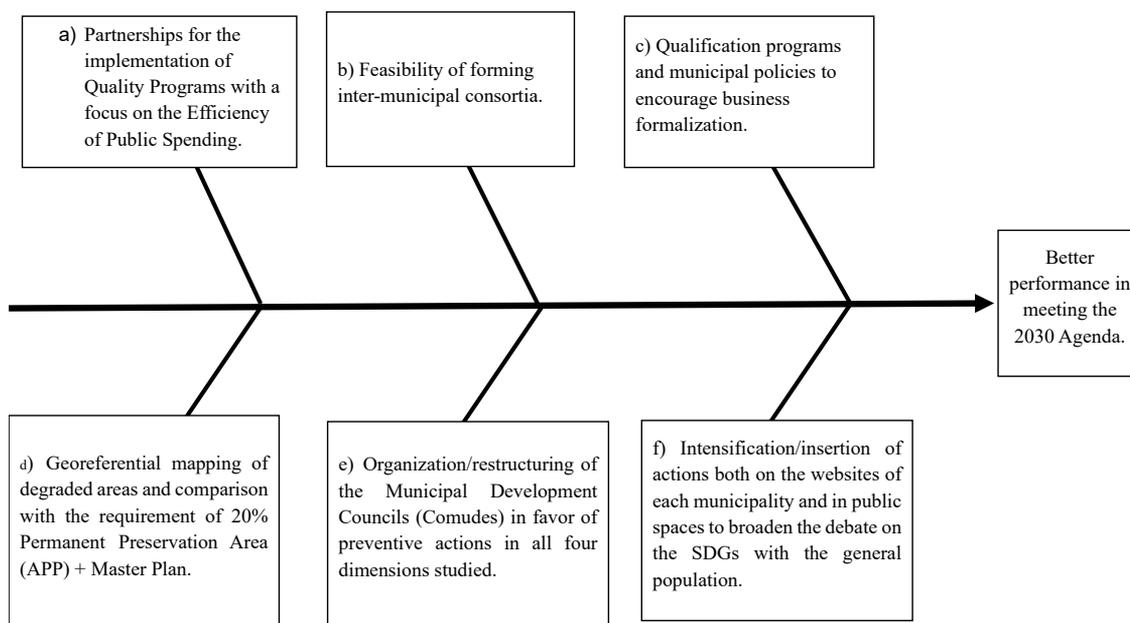
In this way, then, it encourages the elaboration of an agenda of actions, which can provide better performance for the fulfilment of the 2030 Agenda (Figure 4) and enable the implementation of an effective development process. As mentioned, the pressure and participation of local actors in a more democratic context make the results of actions more sustainable (Silva *et al.*, 2021).

Furthermore, in addition to this proposal, and returning to the objective of this analysis, we sought to identify synergies and contradictions between the different dimensions, and how one influences the other, positively or negatively. However, few associations with statistical significance were found, but even



so, these constitute important findings. Therefore, as warned by Kroll *et al.* (2019), studies on the SDGs, which seek synergies and *trade-offs* between their objectives, face the limited availability of statistical data as one of the main obstacles. In other words, the absence of indicators makes a more comprehensive analysis of the territory difficult.

Figure 4 | Suggested actions to improve the dimensions analyzed



Source: Own preparation.

In any case, the descriptive statistics show the prevalence of the economic dimension, in positive terms, compared to the other three. In this aspect, it is important to highlight the significant mutual influence between the economic and social dimensions between municipalities. In turn, the spatial analysis (neighbourhood) of the municipalities selected in the study provided important results: the synergy between the economic and environmental dimensions, that is, the good economic performance of a municipality leads to the good environmental performance of neighbouring municipalities; and the other specific spatial synergy in the environmental dimension, in which the good environmental efficiency of a municipality, in general, has repercussions on the good environmental performance of its neighbours.

Given this, in general, the concern about the implementation of the SDGs in the municipalities analyzed indicates that it is necessary to expand the debate and establish effective actions that, by extension, meet each of the items that make up the SDG Mandate.

FINAL CONSIDERATIONS

The results presented in this study reveal that the discussion about the SDGs still raises several challenging aspects, whether for society in general or for public managers. In this sense, it was possible to propose some actions that are coupled to these municipalities, regardless of their territorial size or their economic, social, environmental and/or institutional complexities.

Initially, it is believed that the formation of partnerships with higher education institutions to implement Quality Programs focusing on the Efficiency of Public Spending is an action that can combat irregularities (such as corruption) and offer a better understanding of the management of public resources. At the same time, promoting mobilization through feasibility studies through inter-municipal consortia is another relevant action, as it allows forces to be combined and to jointly combat adjacent problems in the region, for example, focusing on problems as an initial target. economic and/or social in the most vulnerable neighbourhoods.

Another focus lies in the emphasis on qualification programs and municipal policies to promote the formalization of business and the inclusion of people in microcredit. This could generate a multiplier effect of social emancipation, regardless of the size of the municipality, attacking the problems of informality, as well as the effects generated by the COVID-19 pandemic.

On the other hand, faced with numerous challenges to which the environmental variable is exposed, it is understood that the need to carry out a georeferenced mapping of degraded areas and the consequent confrontation with the requirement of 20% Permanent Preservation Area, combined with the urban discussion of the Master Plan, are essential conditions for the defence of a territorial order in line with sustainability.

Still, regarding the expansion of the debate, it is urgent to organize and restructure the Municipal Development Councils (Comudes) in favour of preventive actions in the four dimensions studied, considering their effectiveness through qualified discussions with an emphasis on combating



local weaknesses, which, common in these regions, they also become regional problems.

At the same time, to expand knowledge about the 2030 Agenda, the intensification and insertion of actions must be reinforced, either through the *web pages* of each city hall or through the presence of municipal representatives in public spaces, to expand the debate on the SDGs with the local population. in

Therefore, the main contribution of this work lies in identifying and proposing concrete actions to face the challenges related to the implementation of the Sustainable Development Goals (SDGs). These actions may include partnerships with educational institutions to improve the management of public resources, mobilization through feasibility studies in inter-municipal consortia, programs to promote the formalization of business and insertion in microcredit, mapping of degraded areas, restructuring of Municipal Councils of Development and intensification of the dissemination of the SDGs.

The study also highlights the importance of these actions to face social, economic, environmental and institutional challenges and contribute to sustainable development. Furthermore, it could serve as a reference and stimulus for similar or comparative studies, which could be carried out in other Brazilian states, as there are currently no studies similar to this one known in the country.

The synergies of the economic and environmental dimensions, and their absence among the others, indicate paths and challenges for the actions suggested for the general improvement of the dimensions. In effect, such a mission requires a set of information and knowledge, as complete as possible, regarding the territorial behaviour of the different dimensions of sustainable development. That said, it is understood that this study represents a relevant contribution to the selected region and, methodologically, to research based on this proposal in other places in Brazil.

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