


# Jalapão Mosaic: Perspectives and Challenges for Implementing the Sustainable Development Goals (SDGs)

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## Keywords

Jalapão,  
Sustainability  
Public Policies  
Correlation Matrix  
Hierarchical Clusters

## Abstract

The objective of this article was to evaluate the stage of implementation of the SDGs in the municipalities that belong to the Jalapão Mosaic (JM), exploring the opportunities and obstacles to achieving the SDGs in this territory. The methodological basis involves a quantitative approach of hierarchical clusters and a correlation matrix based on secondary data, identifying the most relevant SDGs for the region and the challenges for their implementation. The study reveals 15 SDGs with high relevance for the JM, with emphasis on SDGs 1 (End Poverty), 2 (Zero Hunger), 3 (Quality Health), 4 (Quality Education), 8 (Decent Work and Growth Economic), 10 (Reducing Inequalities), 13 (Climate Action), 15 (Life on Earth) and 16 (Peace, Justice and Strong Institutions). However, several challenges prevent the full implementation of these objectives, such as the scarcity of financial and human resources, marked social inequalities, environmental degradation, weaknesses in governance and low social participation. The results showed that municipalities in the region are far from meeting the goals of the 2030 Agenda, despite having high performance in SDGs of the Economic Axis. Despite the obstacles, the study also presents positive perspectives for the future of the TCJ. The region has rich potential for sustainable development, driven by its rich biodiversity and natural resources. Furthermore, the growing interest in ecological tourism in the region can generate opportunities for local development. To overcome the challenges and achieve the SDGs in the JM, the study presents some recommendations, such as increasing investments in social and environmental public policies, strengthening local governance and social participation, promoting environmental education and valuing local culture, supporting the development of sustainable economic activities. As final considerations, it is proposed that local managers and stakeholders be trained to understand these goals, in order to guide public policies, so that municipalities observe the best practices inside and outside Tocantins for Socioeconomic Development. Furthermore, the study's conclusions and recommendations can be useful for formulating more effective public policies and promoting the well-being of local populations, contributing to the construction of a more prosperous and sustainable future for the region.

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## INTRODUCTION

The 2030 Agenda for Sustainable Development establishes a global plan to achieve a sustainable and inclusive future through 17 Sustainable Development Goals (SDGs). These goals cover a wide range of social, economic and environmental issues, challenging nations and local communities to implement meaningful change.

The UN (2023) reported that of the 169 goals linked to the 17 Sustainable Development Goals (SDGs), half showed moderate or severe deviations from the goals of the 2030 Agenda at a global level. In Brazil, implementing the SDGs in municipalities represents a complex challenge, given local diversity and specificities.

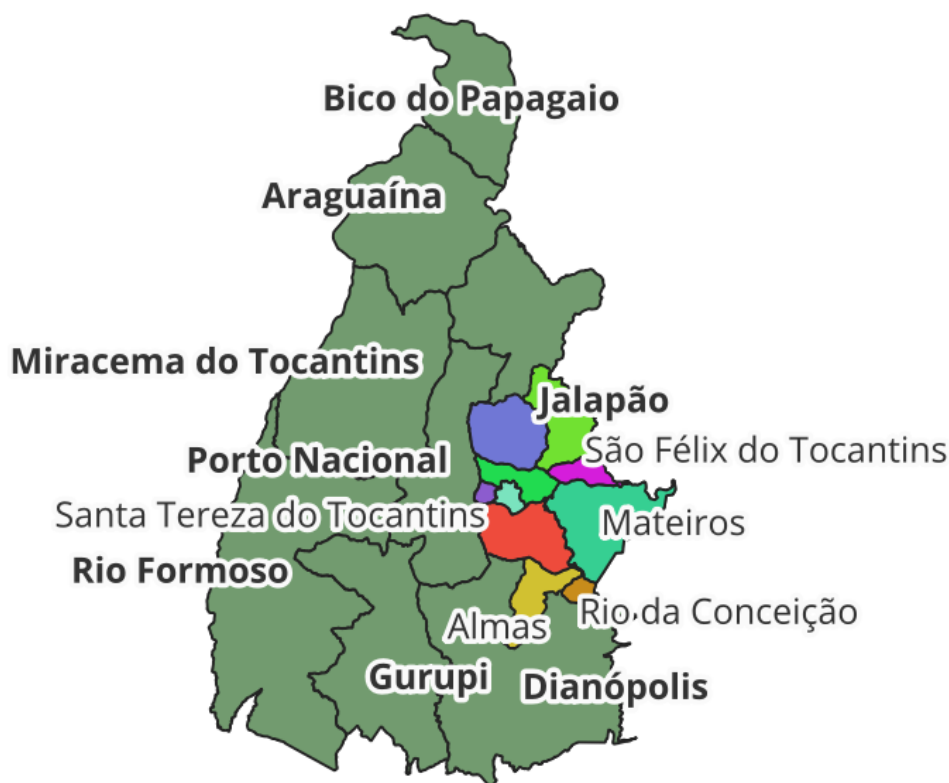
At Tocantins, Seall (2023), considered that compliance with the SDGs achieved 44%, placing the state in 16th position among the 27 federative entities. This study focuses on the

municipalities that make up the Jalapão Mosaic (JM) (Brasil, 2016), which comprises an area of 43,881.14 km<sup>2</sup>, constituting 15.81% of the area of the state of Tocantins (ICMBIO, 2020).

In this region, there are deficiencies in terms of the SDGs, (*Instituto Cidades Sustentáveis* [Sustainable Cities Institute] - ICS, 2023a). As an aggravating factor, there is difficulty in access due to unpaved roads, a situation expected to improve in 2024, with the provision of infrastructure services (Tocantins, 2023).

The JM is constituted as a Political-Geographic Microregion, comprising several Conservation Units (CUs). According to Lima and Martins (2021), the region inside Tocantins includes the municipalities of: Almas, Lagoa do Tocantins, Lizarda, Mateiros, Novo Concorde, Ponte Alta do Tocantins, Rio da Conceição, Rio Sono, Santa Tereza do Tocantins and São Félix of Tocantins, as shown in Figure 1 below.

Figure 1 - Map of the Jalapão Mosaic



Source: The authors (2024).

Figure 1 presents the Microregions of Tocantins with bold labels, painted green. The JM Municipalities are presented with labels in regular font in different colors. Given this context, it was sought to answer the following research problem: what are the levels of implementation of the SDGs in the municipalities of JM? Based on this issue, this

study contributes to a deeper understanding of Sustainable Development efforts at the municipal level, highlighting the importance of adapting global strategies to local realities.

This article is organized into five sections, including this introduction. In the following section, the theoretical framework and the scholarly literature on the SDGs are addressed.

In the third section, the methodological procedures of this study are presented. In section four, the presentation and discussion of the results are addressed. In section five, the final considerations are made.

### *The Sustainable Development Goals*

The SDGs were developed in Brazil, in Rio de Janeiro, based on the results of the United Nations Conference on Sustainable Development (Rio+20), in 2012. This conference brought together world leaders with the private sector and other stakeholders with the objective of reflecting on poverty reduction, promoting social equity and ensuring environmental protection (UN, 2016). The discussion on the SDGs was adopted in August 2015 (UN, 2015). In terms of achieving the SDGs, the UNDP (United Nations Development Programme) is the lead agency of the UN global development network.

In the contemporary context, Brazil took measures to implement the SDGs by creating, through Decree 8,892 (Brasil, 2016), the National Commission for the SDGs. However, it

was revoked through Decree 10,179 (Brasil, 2019), being resumed through Decree 11,704 (Brasil, 2023).

Still in Brazil, the Sustainable Cities Development Index (SCDI) was developed by the Sustainable Cities Institute (ICS, 2023a), being used since 2013. It evaluates the SDGs for all 17 goals in annual studies, collecting data on all 5,570 Brazilian municipalities. The SDGs are measured through a set of 100 indicators from Brazilian official statistical bases such as DataSUS, IBGE and INEP and thematic observatories, such as the Climate Observatory and MapBiomass (ICS, 2023a).

These indicators for each SDG are described in detail in ICS (2023c). Chart 1 below lists the SDGs with the thematic axes linked to them (Boar *et al.*, 2022). Quantitative data for the 100 indicators available in Brazil and the targets for each SDG can be found in ICS (2023d). These indicators, however, do not constitute the totality of the 230 indicators recommended in the 2030 Agenda on a global scale (Pakkan *et al.*, 2023).

**Chart 1 - Thematic axes vs. SDGs**

| <b>Axle</b> | <b>SDG</b>                                                                                                                                                                                                                                                                                                      |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Society     | 1. Eradication of poverty, 2. Zero hunger and sustainable agriculture, 3. Health and well-being, 4. Quality education, 5. Gender Equality, 7. Clean and Sustainable Energy, 11. Sustainable Cities and Communities, 16. Peace, Justice and Effective Institutions, 17. Partnerships and Means of Implementation |
| Environment | 6. Drinking Water and Sanitation, 13. Action against Global Climate Change, 14. Life in Water, 15. Life on Land                                                                                                                                                                                                 |
| Economic    | 8. Decent Work and Economic Growth, 9. Industry, Innovation and Infrastructure, 10. Reducing Inequalities, 12. Responsible Consumption and Production                                                                                                                                                           |

Source: based on Boar *et al.* (2022).

As can be seen in the previous chart, the indicators of one SDG may have a negative correlation with those of another SDG. This configures a trade-off, in which the fulfillment of SDGs related to one axis may harm the fulfillment of another SDG in another axis (Boar *et al.*, 2022). Some examples are the SDGs linked to the Economic Axis, which can harm the fulfillment of SDGs related to the Environment Axis. More specifically, responsible consumption and production are, in general, negatively correlated with practices to lower the economic costs. Another case is that of small-scale sustainable agriculture practices vs. combating hunger, as those small-scale practices have less potential on a global scale, due to the production deficit between food supply and demand.

Another form of interaction between SDGs is

synergy (*ibid.*), that is, when the fulfillment of one SDG helps in achieving the goals of another, for example, as occurs between the SDGs within the Environment axis. That study involved 285 articles from the Scopus and Web of Science databases, presenting interactions between SDGs. The greatest synergies occurred based on the SDGs related to quality in education and renewable energy, as these two issues foster the development of all other SDGs. They also warn that the trend in countries is for trade-offs between the SDGs to grow, with more research needed to develop innovations that provide more synergies between them.

In the view of Silva *et al.* (2021), the biggest difficulty in terms of fulfilling the SDGs in Brazil was the trade-off of the economic and social dimensions with the environmental

dimension. For example, Bento Gonçalves and Lajeado, with good economic indicators, had a drop in their performance due to their environmental indicators, moving to the last positions in the general SDG.

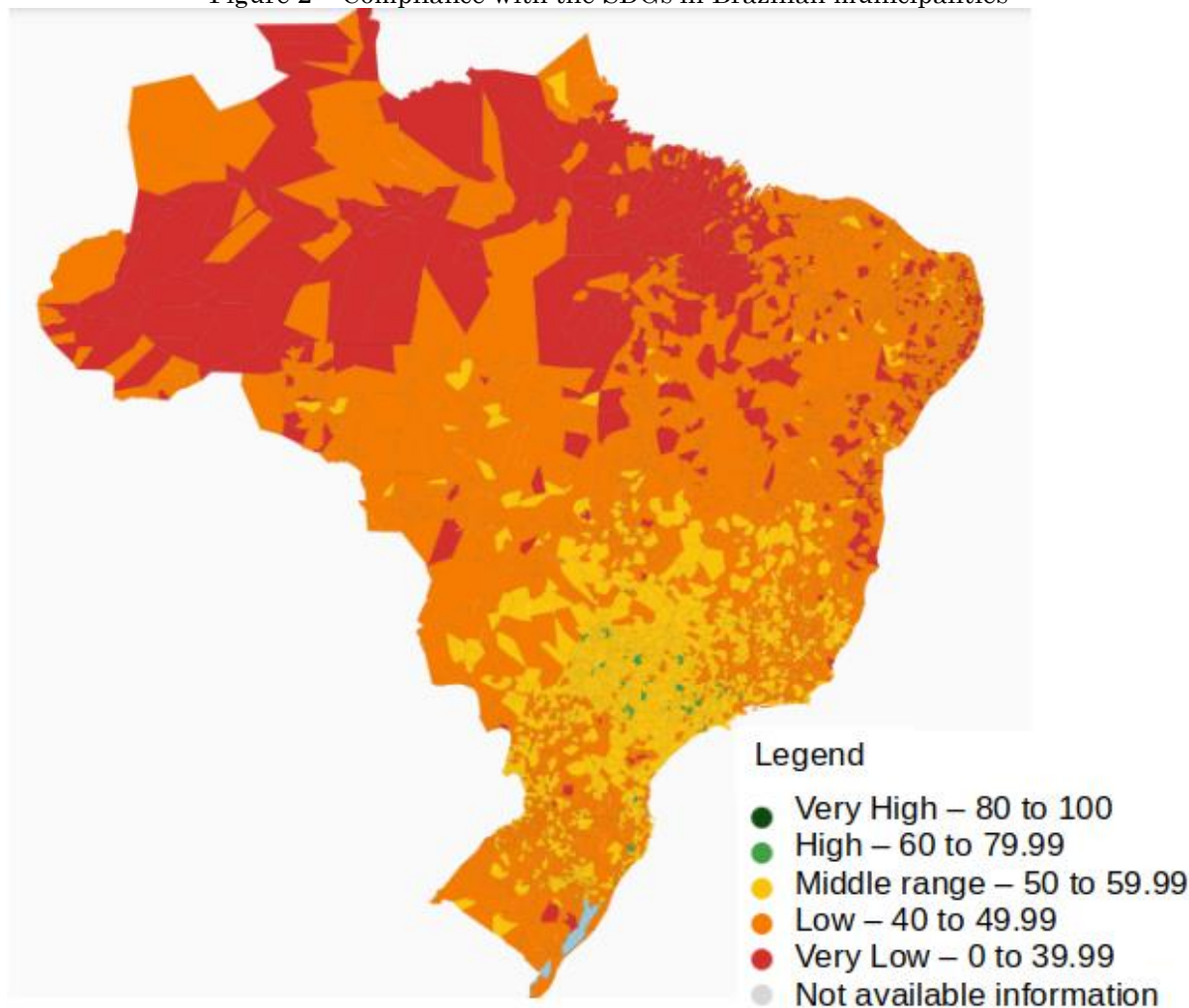
In the context of the 5,570 Brazilian municipalities, according to the ICS (2023a), the one that most fulfilled the SDGs was São Caetano do Sul-SP, with 63.4%. The one that had the most difficulty in achieving these goals was Buriticupu (MA), with 29.8%. On average, Brazilian municipalities achieved 46.8% of compliance with the SDGs.

In the context of this article, the term objectives refers to the Sustainable Development Goals as a whole, while targets refer to the specific target values that must be achieved in order to fulfill an SDG, as recommended by Macfeely (2019). The same author reported that only 93 of the 232

indicators are regularly collected by at least half of the countries around the world, which makes it impossible to comprehensively measure progress against the 169 targets for the 17 SDGs on a global scale. This scarcity of data, according to the author, reflects the lack of access of 52% of the global population to the internet, which makes it impossible to collect data for the indicators, in an agile and large-scale manner.

As seen in figure 2 below, the municipalities with the highest percentages of compliance with the SDGs are concentrated in the South, Southeast and Central-West regions, in the range of 50 to 60% (in yellow). Practically no Brazilian municipality is in the 60% and above ranges (light green and dark green). The municipalities that face the greatest difficulties in meeting the SDGs are in the North and Northeast regions (in red), in the range of 0 to 40%.

Figure 2 – Compliance with the SDGs in Brazilian municipalities



Source: ICS (2023b).

Based on what was seen in this section, there are several opportunities for improvement, respecting cultural differences, in order to

promote Human Development in the different Brazilian regions. The need for contextualized approaches to implementing the SDGs is

highlighted, emphasizing the importance of strategies adapted to local realities.

Specifically in Tocantins, municipalities with 40 to 50% of the SDGs predominate. Secondly, in terms of relative frequency in the state, municipalities score between 0 and 40% of compliance with the SDGs, which justifies the need for the statistical analysis that will be presented in the following section.

## METHODOLOGICAL PROCEDURES

This descriptive and quantitative study was carried out using the RStudio statistical software to evaluate the implementation of the SDGs in the JM. These analyzes included cluster analysis and Correlation Matrix techniques. Data for the 100 indicators related to the 17 SDGs were obtained from ICS (2023d).

As a way of implementing the analysis, initially, the municipalities were grouped according to the level of compliance with the SDGs by means of an Hierarchical Cluster Analysis. Next, a correlation matrix was created in order to identify significant differences between municipalities considering the different SDGs, in a similar way to Kostetckaia and Hametner (2022) and Pakkan *et al.* (2023).

In case of absence of data in ICS (2023d), they were collected from official and public

sources, such as the Atlas de Saneamento Básico Brasileiro, Brazilian Basic Sanitation Atlas in English (ANA, 2023) and the information base on Basic Sanitation in Brazilian Municipalities (INFOSANBAS, 2024). Through these means, a detailed and contextualized analysis of the implementation of the SDGs in the municipalities of JM was possible, evaluating the progress achieved and the challenges to be overcome. In the following section, the results and discussion are presented.

## RESULTS AND DISCUSSION

In terms of descriptive statistics, the JM municipalities fulfilled, on average, 42.26% of the SDGs. This score generated a JM's average rating of 4,243.7 regarding the ranking of Brazilian municipalities, with a performance considered low (40 to 49.99% compliance with the SDGs).

In the following section, the analysis begins based on the hierarchical clusters technique.

### *Analysis of Hierarchical Clusters*

Considering that the municipalities were named according to chart 2 below, the similarity between them is analyzed using the dendrogram, using the variables available in ICS (2023a).

**Chart 2 - Municipalities vs. codes used in the dendrogram.**

| Number | Municipality              |
|--------|---------------------------|
| 1      | Almas                     |
| 2      | Lizarda                   |
| 3      | Mateiros                  |
| 4      | Novo Acordo               |
| 5      | Ponte Alta do Tocantins   |
| 6      | Rio da Conceição          |
| 7      | Rio do Sono               |
| 8      | Santa Tereza do Tocantins |
| 9      | São Félix do Tocantins    |
| 10     | Lagoa do Tocantins        |

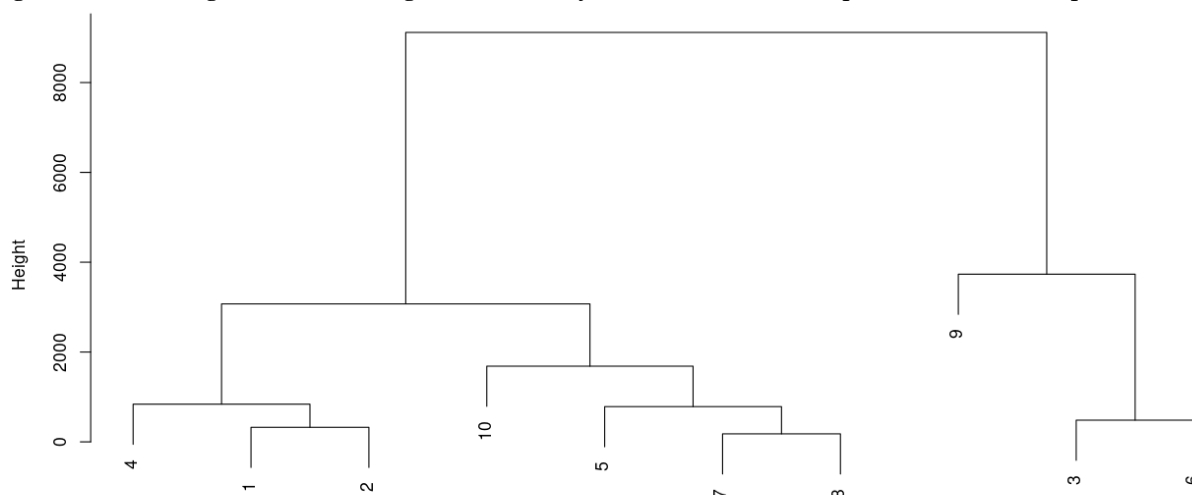
Source: The authors (2024).

Thus, the dendrogram is presented in figure 4, below, using the codes in chart 2 for the municipalities of the JM. The dendrogram was created using the `hclust` function (`stats`

package). The municipalities were clustered using the secondary data about SDGs in ICS (2023a).



Figure 4 - Dendrogram illustrating the similarity between the municipalities of the Jalapão Mosaic



Source: The authors (2024).

As seen in Figure 4, the dendrogram helps to understand which municipalities are most similar to each other in terms of the 17 SDGs. In general, it can then be observed that the clusters in the graph correspond to the different performance groups in table 1 below: (1) São

Félix do Tocantins, Rio da Conceição and Mateiros; (2) Novo Acordo, Almas and Lizarda and (3) Rio Sono, Santa Tereza do Tocantins, Ponte Alta do Tocantins and Lagoa do Tocantins.

**Table 1 - Municipalities vs. SDGs and classification in the national ranking**

| County                    | Cluster | General SDG | General Classification |
|---------------------------|---------|-------------|------------------------|
| São Félix do Tocantins    | 1       | 47.52       | 2428th                 |
| Rio da Conceição          | 1       | 44.9        | 3431st                 |
| Mateiros                  | 1       | 44.45       | 3580th                 |
| Novo Acordo               | 2       | 42.34       | 4293rd                 |
| Almas                     | 2       | 41.83       | 4452nd                 |
| Lizarda                   | 2       | 41.59       | 4552nd                 |
| Rio Sono                  | 3       | 40.94       | 4721st                 |
| Santa Tereza do Tocantins | 3       | 40.72       | 4776th                 |
| Ponte Alta do Tocantins   | 3       | 39.92       | 4963rd                 |
| Lagoa do Tocantins        | 3       | 38.36       | 5241st                 |

Source: The authors (2024).

As seen in table 1, based on data in ICS (2023a), similar municipalities are grouped together, facilitating the creation of agreements and institutional relationships between them. Synthesizing the SDG scores in the JM municipalities, the best scores were in the SDGs: 3 (Health and Wellbeing), 10 (Reducing Inequalities), 11 (Sustainable Cities and Communities), 12 (Responsible Consumption and Production) and 16 (Peace, Justice and Effective Institutions). The worst performances were in the SDGs: 4 (Quality Education), 5 (Gender Equality), 6 (Clean Water and Sanitation), 9 (Industry, Innovation and Infrastructure), 13 (Action Against Global

Climate Change), 14 (Life in Water) and 17 (Partnerships and Means of Implementation).

In terms of the thematic axes, the averages were between 2 (low) and 3 (medium) for the social and economic axes. The average was between 1 (very low) and 2 (low) only on the environmental axis. It can then be seen that the SDGs linked to the sphere of human activity have better evaluation than those linked to the Environment.

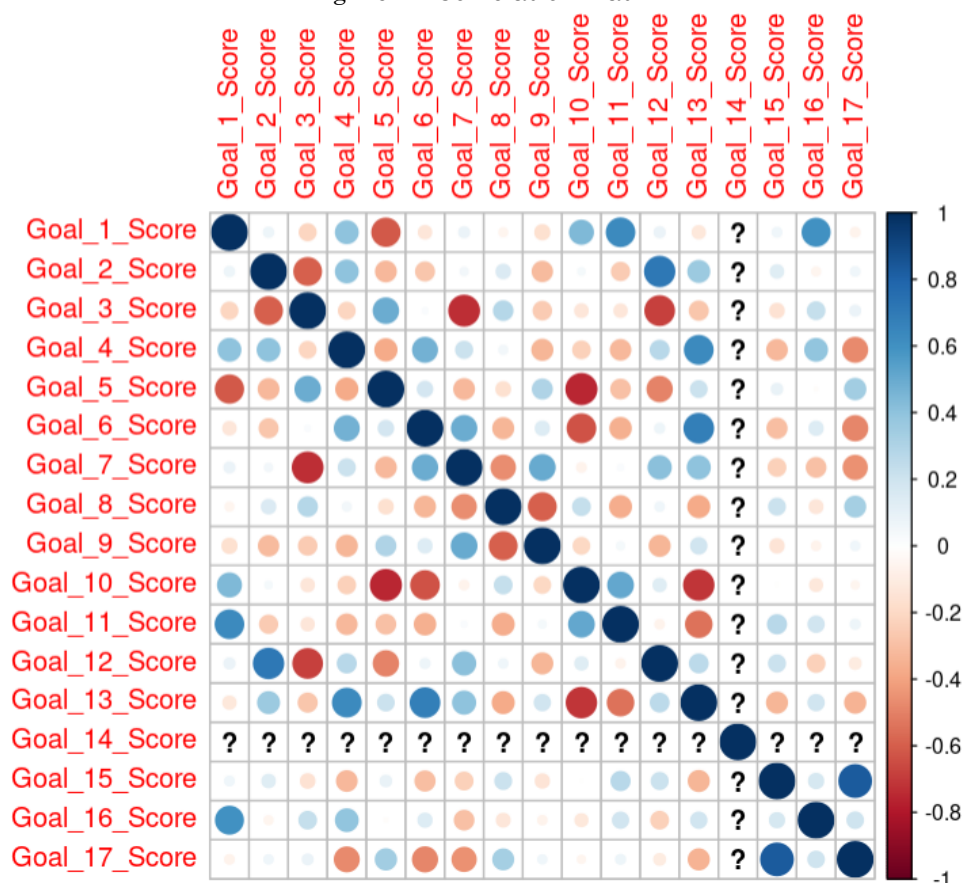
In the following section, the correlation matrix was analyzed in order to identify which variables influence each other in the case of the JM municipalities.

### Correlation Matrix

To prepare the correlation matrix, as seen in figure 5 below, the general scores were used, referring to the 17 SDGs in the JM municipalities (ICS, 2023d). Therefore, it was considered more viable to carry out correlations between the 17 SDGs than between the 100 indicators available in ICS (2023d). In line with

the vision of Kostetckaia and Hametner (2022), correlation coefficients greater than 0.5 were considered as synergies and those below -0.5 as trade-offs between SDGs. The analysis of synergies and trade-offs followed the model adopted by Kostetckaia and Hametner (2022) and Pakkan *et al.* (2023).

Figure 4 - Correlation matrix



Source: The authors (2024).

In the Matrix Correlation (Figure 4), the positive correlations are in blue and the negative ones are in red. The larger the circle and the stronger the color, the higher the absolute value of the correlation coefficient. As seen in the previous graph, it was not possible to calculate the correlation for SDG 14, as none of the municipalities informed the databases used

by ICS (2023d) about local sewage treatment conditions, which led to the absence of values to compute the correlations in this variable. However, based on the Atlas on sanitary sewage in Brazil (ANA, 2023), it is possible to measure these conditions in the region, as shown in table 4 below.

**Table 4** - Sanitary sewage conditions in the Jalapão Mosaic (JM)

| County                    | Individual solution (%) | Collected and untreated (%) | Collected and treated (%) | Not collected and not treated (%) |
|---------------------------|-------------------------|-----------------------------|---------------------------|-----------------------------------|
| Santa Tereza do Tocantins | 1.79                    | 0.25                        | 0                         | 97.96                             |
| Rio Sono                  | 5.82                    | 0                           | 0                         | 94.18                             |
| Ponte Alta do Tocantins   | 1.06                    | 5.1                         | 0                         | 93.84                             |
| Mateiros                  | 9.95                    | 4.59                        | 0                         | 85.46                             |
| Lagoa do Tocantins        | 38.22                   | 0.08                        | 0                         | 61.7                              |
| Novo Acordo               | 36.26                   | 3.57                        | 0                         | 60.17                             |
| Almas                     | 38.86                   | 0                           | 2.4                       | 58.74                             |
| Rio da Conceição          | 43.77                   | 0.51                        | 0                         | 55.72                             |
| Lizarda                   | 75.65                   | 1.2                         | 0                         | 23.15                             |
| São Félix do Tocantins    | 89.04                   | 0                           | 0                         | 10.96                             |
| Average                   | 34.04                   | 1.53                        | 0.24                      | 64.19                             |

Source: The authors (2024).

As seen in the previous table, it can be inferred that SDG 14 is classified as “very low” (0 to 39.99% of target compliance) for all municipalities, due to the virtual absence of sewage treatment in the region.

In the following paragraphs, the synergies (significant and positive correlations) that were found between the SDGs in the JM will be discussed: (a) 1, 10, 11, 16; (b) 2, 12; (c) 4, 6, 13; (d) 7, 9 and (e) 15, 17. The classification for performance in meeting the SDGs can be seen in Figure 2 (p. 6) of this article.

In the case of SDGs 1 (Eradication of Poverty), 10 (Reducing Inequalities), 11 (Sustainable Cities) and 16 (Peace, Justice and Effective Institutions), it is clear that all efforts to improve inequality indices (represented in the SDGs 1 and 10) improve the indices related to violence, represented in SDG 16. Furthermore, community efforts towards SDGs 1 and 11 promote the implementation of sustainability in the municipalities, as Almeida (2022) reported to have occurred in Portugal. In the case of JM, this type of initiative was reported by Lindoso and Parente (2015).

Regarding the relationship between SDGs 2 (Zero Hunger and Sustainable Agriculture) and 12 (Sustainable Consumption and Production), all municipalities had scores in the range of high to very high performance for this indicator. In the case of SDG 2, most municipalities performed between the low and medium range. In the case of SDG 2, the indicator “Family Farming Producers with support from PRONAF” is still under development, with emphasis on the municipalities of Mateiros, São Félix and Santa Tereza do Tocantins with either high or very high performance. However, the indicator “Establishments that practice organic agriculture” of SDG 2 had a score of 0 for all municipalities in the JM.

On the other hand, in the case of SDG 12 (Sustainable Consumption and Production) indicators, only Santa Tereza do Tocantins and Rio da Conceição are in the optimal range for solid waste collection (between 0.5 and 0.8 kg per day/inhabitant). In contrast, as seen in table 4 (p. 11), 7 of the 10 municipalities have this service, with no implementation of selective waste collection in any of the 10 municipalities.

In the case of synergy between SDGs 4 (Quality Education), 6 (Drinking Water and Sanitation) and 13 (Action Against Global Climate Change), all municipalities had very low or low performance in SDGs 4 and 6. In terms of SDG 4 indicators, all municipalities had high or very high performance in school internet access. However, only in Santa Tereza do Tocantins there are facilities suitable for people with disabilities, resources for specialized educational services and 100% of teachers with a College degree working in Kindergarten. Mateiros, on the other hand, stands out with 97% of teachers with a College degree in Elementary and Middle Schools. In terms of the presence of cultural spaces, São Félix, Rio da Conceição, Santa Tereza, Lagoa do Tocantins, Novo Acordo and Mateiros scored with high performance in this regard.

As a negative point of SDG 4 (education), in terms of the population up to 19 years of age that have High School education, all municipalities are between 6.38% and 13.64% of the population. In terms of the *Prova Brasil*, an exam measuring the proficiency level of the elementary students in all school subjects, all indicators were considered low according to the ICS (2023d) parameters. Furthermore, illiteracy rates vary between 14.57% and 26.37% in the municipalities of JM.

Still in the study of this synergy, in the case of SDG6 (Drinking Water and Sanitation), São



Félix, Novo Acordo, Lagoa do Tocantins, Santa Tereza, Rio da Conceição and Almas had a high performance in the indicator “Population served with water service”. However, all municipalities had very low performance in terms of sanitary sewage collection and treatment (ICS, 2023d; ANA, 2023).

On the other hand, only São Félix and Rio da Conceição performed highly in SDG 13 (Action Against Global Climate Change). All municipalities have excess CO<sup>2</sup> emissions per capita and half of the municipalities have an excess concentration of fire spots, due to the high number of wildfires in the region. To make matters worse, in all municipalities there is a lack of natural disaster prevention strategies. As positive points, in Ponte Alta, Rio da Conceição, Lizarda and São Félix, the percentage deforested is below 5%, which is considered a good performance inside the Brazilian context (ICS, 2023d). Considering the synergy between SDGs 4, 6 and 13, it is demonstrated that educational and sanitation indicators, even if gradually, go hand in hand with reductions in climate change, for example, using sustainable strategies in agriculture (Campbell *et al.*, 2018).

Continuing this analysis, SDGs 7 (Clean and Sustainable Energy) and 9 (Industry, Innovation and Infrastructure) also showed synergy. In the case of SDG 7 indicators, all municipalities had between low (64.46%) and medium (96.25%) access to electricity. For SDG 9 (Infrastructure) proxies, in all municipalities, there is low public investment in infrastructure and low participation of jobs in knowledge-intensive activities. In this way, it can be seen that the JM prefectures are not yet concerned with infrastructure, but there are already signs of progress towards energy justice. In this sense, Lippert and Sareen (2023) recommend that these advances should be measured in terms of inclusion, equity and contextual heterogeneity in terms of access to electrical energy by the population.

In the case of SDGs 15 (Life on Earth) and 17 (Partnerships and Means of Implementation), there was also synergy between environmental and social indicators, leading municipalities with higher indicators in SDG 17 to better indicators in SDG 15. In terms of forested areas (ha/inhab.), 8 of the 10 municipalities had high performance. In the case of the existence of Conservation Units, only Mateiros, Novo Concorde and Ponte Alta had high performance. In terms of maturity for raising funds for environmental preservation, only Almas had a high performance.

Regarding SDG 17 (partnerships), the municipalities of Mateiros, São Félix and Lizarda had a high performance in terms of total revenue collected. In this way, it is confirmed that there was the implementation of public-private partnerships between municipalities with the objective of strengthening ecological tourism in the region, which led to an increase in SDG 15, as reported in Tocantins (2019).

Next, the trade-offs (significant negative correlations) are analyzed relevant in the JM: (a) 1, 5, 6, 10, 11, 13; (b) 2, 3; (c) 3, 7, 12 and (d) 8, 9.

In the trade-off between the environmental SDGs (6 - Potable Water and Sanitation and 13 - Action against Climate Change) and social (1 - Eradication of Poverty; 5 - Gender Equality; 10 - Reduction of Inequalities and 11 - Sustainable Cities), it was observed that the environmental agenda has more priority than social indicators in municipalities with the best scores in the total SDG. According to Adhikari *et al.* (2023), this phenomenon occurs due to the unbalanced exploitation of ecotourism. In this type of situation, environmental conservation measures are not designed together with native peoples, leading them to be unable to carry out their traditional activities to generate income. As a solution, planning for the conservation of the PAs (Protected Areas) must occur collectively, so that workers who are involved in activities that cause environmental degradation are trained to generate income, through environmentally sustainable economic activities with a focus on gender equality.

Now follows the analysis of the trade-off between SDGs 2 (Zero Hunger and Sustainable Agriculture) and 3 (Health and Well-being) with SDGs 7 (Affordable and Clean Energy) and 12 (Responsible Consumption and Production). In the case of the JM municipalities, all municipalities have scores between low and high for SDG 3 (Health) and high or very high for SDG 12 (Responsible Consumption and Production). On the other hand, SDG 2 (Zero Hunger) has a score between very low and medium. SDG 7 (Affordable Energy), in turn, has all indicators classified as very low. In this way, it is clear that Health and Consumption indicators were prioritized to the detriment of Food Security and access to Electricity. This phenomenon occurs mainly in low-income contexts, where trade-offs are maximized and synergies are hampered, as reported by Wei *et al.* (2023).

In the case of the trade-off between SDG 8 (Decent Work and Economic Growth) with SDG 9 (Industry, Innovation and Infrastructure), it is clear that there was investment by

municipalities in Ecotourism, to the detriment of investment in industrialization. This is corroborated by the highest indicators in the SDG in municipalities that are gateways to Jalapão, such as São Félix, Mateiros and Santa Tereza.

As seen throughout this section, the municipalities were divided into conglomerates grouped by performance in the SDGs, but scored between 38.36% and 44.45% in general compliance with the SDGs, which places them in the low performance range, in their majority (9 out of 10 municipalities). The SDGs to improve are mainly those that had very low-performance for all municipalities: 9 (Industry, Innovation and Infrastructure - Economic Axis); 14 (Life in water - Environment Axis) and 17 (partnerships and means of implementation - Society Axis). The SDGs that performed best were on the economic axis: 10 (Reduced Inequalities) and 12 (Responsible Consumption and Production). Therefore, care must be taken to ensure that there is no trade-off between the Economic Axis and the others, which is the case in Bento Gonçalves and Lajeado (both in Rio Grande do Sul), as seen in the theoretical framework. In the following section, final considerations are made.

## FINAL CONSIDERATIONS

This study explored the implementation of the Sustainable Development Goals (SDGs) in the municipalities that make up the JM, reflecting on the global challenges of sustainable development in the region. By means of our analysis, it was identified that, although there is significant progress in some areas, substantial challenges remain, particularly in relation to environmental and social goals.

Comparing the findings with the existing literature, a convergence with similar studies was observed, indicating the complexity of implementing the SDGs at municipal levels, given the diversity of contexts and limited resources. This work, however, is not without limitations. The main restriction encountered was data availability, a common challenge in evaluating SDGs at the municipal level.

Given these reflections, a more in-depth analysis of SDG indicators that had low data completion in small Brazilian municipalities is suggested as a path for future research, using official databases, as it was carried out in this article. Furthermore, future studies can explore comparisons between different regions of Brazil or even in an international context, expanding

the understanding of SDG implementation strategies.

Finally, it is essential to highlight the importance of an integrated approach in implementing the SDGs, considering the synergies and trade-offs between the different SDGs. It is recommended that policymakers and municipal managers consider these interactions when planning and implementing local initiatives. Cooperation between different sectors and levels of government, as well as the participation of civil society, are crucial for success in the search for truly sustainable development.

This study reinforces the need for a continuous and innovative commitment to the SDGs, adapting to local realities and learning from the experiences of different communities on the path to achieving a sustainable future for all. As suggestions for managers and stakeholders, it is suggested that local agents be trained to understand these indicators, in order to guide public policies, so that municipalities have access to the best practices oriented to their development.

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## REFERENCES

- ALMEIDA, F. The Contribution of Local Agents and Citizens to Sustainable Development: The Portuguese Experience. *Sustainability*, v. 14, n. 19, p. 12696, 2022. <https://doi.org/10.3390/su141912696>
- AGÊNCIA NACIONAL DE ÁGUAS - ANA. *Atlas Esgotos: Despoluição das Bacias Hidrográficas*. Brasília: ANA, 2023. Available: <https://arquivos.ana.gov.br/imprensa/publicacoes/ATLASeESGOTOSDespoluicaoodeBaciasHidrografica>

- [s-ResumoExecutivo\\_livro.pdf](#) . Accessed on: apr. 15, 2024.
- ADHIKARI, B.; URBACH, D.; CHETTRI, N.; SHARMA, E.; BREU, T.; GESCHKE, J.; FISCHER, M.; PRESCOTT, G.W. A multi-methods approach for assessing how conserving biodiversity interacts with other sustainable development goals in Nepal. **Sustainable development**. v. 1, n. 1, p. 1-15, 2023. <https://doi.org/10.1002/sd.2582>
- BARDIN, L. **Análise de conteúdo**. Lisboa: Edições 70, 2011.
- BOAR, A.; PINYANA, E. P.; PALAU, E.; OLIVERAS-VILLANUEVA, M. Alternatives to solve SDG trade-offs and to enforce SDG synergies: A systematic literature review. **Management of Environmental Quality: An International Journal**, v. 33, n. 2, p. 478-493, 2022. <https://doi.org/10.1108/MEQ-07-2021-0181>
- BRASIL. **Decreto nº 8.892, de 27 de outubro de 2016**. Revogado pelo Decreto nº 11.704, de 2023. Cria a Comissão Nacional para os Objetivos de Desenvolvimento Sustentável. Brasília: Presidência da República, Secretaria-Geral, Subchefia para Assuntos Jurídicos, 2016. Available: [https://www.planalto.gov.br/ccivil\\_03/\\_ato2015-2018/2016/Decreto/D8892.htm#:~:text=DECRETA%3A,pela%20Rep%C3%BAblica%20Federativa%20do%20Brasil](https://www.planalto.gov.br/ccivil_03/_ato2015-2018/2016/Decreto/D8892.htm#:~:text=DECRETA%3A,pela%20Rep%C3%BAblica%20Federativa%20do%20Brasil). Accessed on: 26 de abr. de 2024
- BRASIL. **Decreto nº 10.179, de 18 de dezembro de 2019**. Declara a revogação, para os fins do disposto no art. 16 da Lei Complementar nº 95, de 26 de fevereiro de 1998, de decretos normativos. Brasília: Presidência da República, Secretaria-Geral, Subchefia para Assuntos Jurídicos, 2019. Available: [https://www.planalto.gov.br/ccivil\\_03/\\_Ato2019-2022/2019/Decreto/D10179.htm#art2](https://www.planalto.gov.br/ccivil_03/_Ato2019-2022/2019/Decreto/D10179.htm#art2). Accessed on: 26 de abr. de 2024.
- BRASIL. **Decreto nº 11.704, de 14 de setembro de 2023**. Institui a Comissão Nacional para os Objetivos de Desenvolvimento Sustentável. Brasília: Presidência da República, Casa Civil, Secretaria Especial para Assuntos Jurídicos, 2023. Available: [https://www.planalto.gov.br/ccivil\\_03/\\_Ato2023-2026/2023/Decreto/D11704.htm#art11](https://www.planalto.gov.br/ccivil_03/_Ato2023-2026/2023/Decreto/D11704.htm#art11) . Accessed on: 26 de abr. de 2024
- BRASIL. Ministério do Meio Ambiente. **Portaria nº 434, de 29 de setembro de 2016**. Reconhecer o Mosaico do Jalapão, abrangendo as seguintes áreas localizadas nos estados do Tocantins e da Bahia. Brasília: Ministério do Meio Ambiente, Gabinete do Ministro, 2016. Available [https://antigo.mma.gov.br/images/arquivo/80238/Mosaicos/PORTARIA\\_N\\_434\\_DE\\_29\\_DE\\_SETEMBRO\\_DE\\_2016\\_-\\_Diario\\_Oficial\\_da\\_Uniao\\_-\\_Imprensa\\_Nacional\\_JALAPAO\\_002.pdf](https://antigo.mma.gov.br/images/arquivo/80238/Mosaicos/PORTARIA_N_434_DE_29_DE_SETEMBRO_DE_2016_-_Diario_Oficial_da_Uniao_-_Imprensa_Nacional_JALAPAO_002.pdf). Accessed on: 26 de abr. de 2024
- CAMPBELL, B. M.; CAMPBELL, B. M.; HANSEN, J.; RIOUX, J.; STIRLING, C. M.; TWOMLOW, S.; WOLLENBERG, E. L. Urgent action to combat climate change and its impacts (SDG 13): transforming agriculture and food systems. **Current opinion in environmental sustainability**, v. 34, p. 13-20, 2018. <https://doi.org/10.1016/j.cosust.2018.06.005>
- GT AGENDA 2030. **VI Relatório Luz da Sociedade Civil da Agenda 2030 de Desenvolvimento Sustentável no Brasil**. 2022. Recife: Gestos, 2022. Available: [https://brasilnaagenda2030.files.wordpress.com/2022/07/pt\\_rl\\_2022\\_final\\_web-1.pdf](https://brasilnaagenda2030.files.wordpress.com/2022/07/pt_rl_2022_final_web-1.pdf) . Accessed on: 26 de abr. de 2024
- HAIR, J. F.; BLACK, W. C.; BABIN, B. J.; ANDERSON, R. E.; TATHAM, R. L. **Análise multivariada de dados**. São Paulo: Bookman, 2009.
- HOFSTEDE, G. **Masculinity and femininity: The taboo dimension of national cultures**. New York: Sage, 1998.
- INFOSANBAS - INFORMAÇÕES SOBRE SANEAMENTO BÁSICO [Informations about Basic Sanitation in the Brazilian Municipalities]. **Informações sobre Saneamento Básico**. Belo Horizonte: UFMG, 2024. Available: <https://infosanbas.org.br>. Accessed on: 26 de abr. de 2024
- ICMBIO. Projeto Jalapão. 2020. Available: <https://www.gov.br/icmbio/pt-br/assuntos/mosaicos-e-corredores-ecologicos/projeto-jalapao> . Accessed on: 26 de abr. de 2024
- INSTITUTO CIDADES SUSTENTÁVEIS – ICS [Sustainable Cities Institute]. **Índice de Desenvolvimento Sustentável das Cidades [IDSC]**. 2023a. Available: <https://idsc.cidadessustentaveis.org.br/> . Accessed on: 26 de abr. de 2024
- INSTITUTO CIDADES SUSTENTÁVEIS – ICS [Sustainable Cities Institute]. **Brasil 2023: Pontuação Geral**. 2023b. Available: <https://idsc.cidadessustentaveis.org.br/map/> . Accessed on: apr. 15, 2024.
- INSTITUTO CIDADES SUSTENTÁVEIS – ICS [Sustainable Cities Institute]. **Metodologia: Índice de Desenvolvimento Sustentável das Cidades – Brasil**. 2023c. Available <https://idsc.cidadessustentaveis.org.br/methodology/> . Accessed on: apr. 15, 2024.
- INSTITUTO CIDADES SUSTENTÁVEIS – ICS [Sustainable Cities Institute]. **IDSC - BR: A evolução das 5.570 cidades brasileiras em direção à Agenda 2030 da ONU**. 2023d. Available [https://www.cidadessustentaveis.org.br/paginas/ids-c-br/Base\\_de\\_Dados\\_IDSC-BR\\_2023.xlsx](https://www.cidadessustentaveis.org.br/paginas/ids-c-br/Base_de_Dados_IDSC-BR_2023.xlsx) . Accessed on: 15 de abr. de 2024
- KOSTETCKAIA, M.; HAMETNER, M. How Sustainable Development Goals interlinkages influence European Union countries' progress towards the 2030 Agenda. **Sustainable Development**, v. 30, n. 5, p. 916-926, 2022. <https://doi.org/10.1002/sd.2290>
- LIMA, J. R.; MARTINS, C. C. Análise preliminar de estudos relacionados à região do Jalapão: TO/PI/BA/MA. **Brazilian Journal of Development**, v. 7, n. 3, p. 30197-30210, 2021. <https://doi.org/10.34117/bjdv7n3-646>
- LINDOSO, L. C.; PARENTE, T. G. Ação Coletiva para o Termo de Compromisso na Região do Jalapão-TO: fortalecendo os sistemas de uso comum. **Anais... VII ENANPPAS**, 17 a 20 de maio de 2015. Brasília: UnB, 2015.

- LIPPERT, I.; SAREEN, S. Alleviation of energy poverty through transitions to low-carbon energy infrastructure. **Energy Research & Social Science**, v. 100, p. 103087, 2023. <https://doi.org/10.1016/j.erss.2023.103087>
- MACFEELY, S. The big (data) bang: Opportunities and challenges for compiling SDG indicators. **Global Policy**, v. 10, p. 121-133, 2019. <https://doi.org/10.1111/1758-5899.12595>
- UNITED NATIONS - UN. **Agenda de Desenvolvimento Sustentável é adotada por unanimidade pelos 193 Estados-membros da ONU**. 2015. Available <https://brasil.un.org/pt-br/70886-agenda-de-desenvolvimento-sustent%C3%A1vel-%C3%A9-adotada-por-unanimidade-pelos-193-estados-membros-da>. Accessed on: 26 de abr. de 2024
- UNITED NATIONS - UN. **Portfólio dos projetos do PNUD Brasil à luz dos Objetivos de Desenvolvimento Sustentável**. 2016. Available: <https://www.br.undp.org/content/brazil/pt/home/library/ods/portifolio-dos-projetos-do-pnudbrasil-a-luz-dos-objetivos-de-des.html>. Accessed on: 26 de abr. de 2024
- UNITED NATIONS - UN. **The Sustainable Development Goals Report**. Special edition. New York: ONU, 2023. Available: <https://unstats.un.org/sdgs/report/2023/The-Sustainable-Development-Goals-Report-2023.pdf>. Accessed on: 26 de abr. de 2024
- PAKKAN, S.; SUDHAKAR, C.; TRIPATHI, S.; RAO, M. A correlation study of sustainable development goal (SDG) interactions. **Quality & Quantity**, v. 57, n. 2, p. 1937-1956, 2023. <https://doi.org/10.1007/s11135-022-01443-4>
- UNITED NATIONS DEVELOPMENT PROGRAMME - UNDP. **Avaliação da Contribuição do PNUD para o Brasil: os resultados de desenvolvimento**. IESP, UERJ, UFBA, 2011. Available: <https://erc.undp.org/evaluation/documents/download/4969>. Accessed on: 26 de abr. de 2024
- SANTOS, N. S.; IWAMOTO, H. M.; CANÇADO, A. C.; BARBOSA, G. F.; RODRIGUES, W. Mulheres e Desenvolvimento: o papel das mulheres no desenvolvimento do Território da Cidadania do Jalapão-TO. **Revista Latino-Americana de Geografia e Gênero**, v. 7, n. 2, pp. 130-147, 2016. <https://doi.org/10.5212/rlagg.v.7.i2.0008>
- SEALL. **Ranking de Sustentabilidade dos Estados**. 2023. Belo Horizonte: Centro de Liderança Pública, 2023. Available: <https://www.clp.org.br/wp-content/uploads/2023/08/Ranking-dos-Estados-2023-ODS-e-ESG-relatorio-2.pdf>. Accessed on: 26 de abr. de 2024
- SILVA, R. F.; MOURA, L. L.; GAVIÃO, L. O.; PONTES, A. T.; LIMA, G. A. B.; BIDONE, E. D. Interdependências e trade-offs entre os objetivos do desenvolvimento sustentável: avaliação de municípios brasileiros pelas três dimensões da sustentabilidade. **Interações**, v. 22, n. 2, pp. 637-652, 2021. <https://doi.org/10.20435/inter.v22i2.2720>
- TOCANTINS. **Mosaico Jalapão é reconhecido pelo Ministério do Meio Ambiente**. 2016. Available: <https://www.to.gov.br/noticias/mosaico-jalapao-e-reconhecido-pelo-ministerio-do-meio-ambiente/r87vusii3jn>. Accessed on: apr. 15, 2024.
- TOCANTINS. **Capim Dourado é a aposta das artesãs de Lagoa do Tocantins para o Economia Solidária**. 2017. Available: <https://www.to.gov.br/noticias/capim-dourado-e-a-aposta-das-artesas-de-lagoa-do-tocantins-para-o-economia-solidaria/3bx5wphjsyog>. Accessed on: apr. 15, 2024.
- TOCANTINS. **Naturatins e Adetuc articulam parceria para ordenamento ambiental e turístico da região do Jalapão**. 2019. Available: <https://www.to.gov.br/naturatins/noticias/nuratinse-adetuc-articulam-parceria-para-ordenamento-ambiental-e-turistico-da-regiao-do-jalapao/2yexg7v999es>. Accessed on: apr. 15, 2024.
- TOCANTINS. **Governo do Tocantins gera desenvolvimento econômico e fortalece o turismo no Jalapão com a pavimentação da TO-247**. 2023. Available: <https://www.to.gov.br/secom/noticias/governo-do-tocantins-gera-desenvolvimento-economico-e-fortalece-o-turismo-no-jalapao-com-a-pavimentacao-da-to-247/2upho11o2hfx>. Accessed on: apr. 15, 2024.
- VINTI, G.; BAUZA, V.; CLASEN, T.; MEDLICOTT, K.; TUDOR, T.; ZURBRÜGG, C.; VACCARI, M. Municipal solid waste management and adverse health outcomes: A systematic review. **International journal of environmental research and public health**, v. 18, n. 8, p. 4331-4357, 2021. <https://doi.org/10.3390/ijerph18084331>
- WEI, Y.; ZHONG, F.; SONG, X.; HUANG, C. Exploring the impact of poverty on the sustainable development goals: Inhibiting synergies and magnifying trade-offs. **Sustainable Cities and Society**, v. 89, p. 104367, 2023. <https://doi.org/10.1016/j.scs.2022.104367>

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Helga Midori Iwamoto: Data curation, Formal analysis, Methodology, Software, Validation, Visualization and Writing – review and editing.

Viviane de Araújo Leal: Writing of the original draft and Investigation.

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