RELISE

ENVIRONMENTAL DIMENSION OF SUSTAINABILITY: AN ANALYSIS OF THE INDICES OF A MUNICIPALITY IN THE STATE OF RIO GRANDE DO NORTE[1]

DIMENSÃO AMBIENTAL DA SUSTENTABILIDADE: UMA ANÁLISE SOBRE OS ÍNDICES DE UM MUNICÍPIO POTIGUAR

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ABSTRACT

This article aims to compare the indices of the UN Sustainable Development Goals (SDG) related to the environmental dimension in the city of Mossoró/RN, available on the platform in the Sustainable Development Index of Cities – Brazil (IDSC-BR), with the actions released by the municipality. To achieve it, the methodological procedures of bibliographic review were carried out to support the concepts of documentary research for local data collection, using the qualitative approach. The results showed that two of the four SDGs in the environmental dimension that presented satisfactory indices on the IDSC-BR platform were corroborated with actions developed by the municipality. While the two that showed indices below the reference in the IDSC-BR were not measured or were not released by the municipality.

Keywords: sustainable development, environmental dimension,iIndicators, IDSC-BR.

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RESUMO

Este artigo tem por objetivo comparar os índices dos Objetivos do Desenvolvimento Sustentável da ONU (ODS) relacionados à dimensão ambiental na cidade Mossoró-RN, disponíveis na plataforma no Índice de Desenvolvimento Sustentável das Cidades – Brasil (IDSC-BR), com as ações divulgadas pelo município. Para alcançá-lo, foram realizados os procedimentos metodológicos de revisão bibliográfica para fundamentação dos conceitos de pesquisa documental para coleta de dados locais, utilizando a abordagem qualitativa. Os resultados mostraram que dois dos quatro ODS da dimensão ambiental que apresentaram índices satisfatórios na plataforma IDSC- BR foram corroborados com ações desenvolvidas pelo município, enquanto os dois que mostraram índices abaixo da referência no IDSC-BR não foram constatadas medidas ou estas não foram divulgadas pelo município.

Palavras-chave: desenvolvimento sustentável, dimensão ambiental, indicadores, IDSC-BR.

INTRODUCTION

The last decades have been marked by growing global awareness of the need to align socioeconomic growth, environmental preservation, and social justice in order to improve the quality of life for present and future generations, without compromising the planet's natural resources (DIAS, 2015). In this regard, according to the United Nations (UN), sustainable development (SD) is defined as: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Barbieri (2020) highlights that the pursuit of Sustainable Development demands a balanced approach between economic, social, and environmental aspects, recognizing the interconnections and interdependencies among these dimensions. In the quest for a more just, inclusive, and environmentally sustainable future, the UN, together with representatives of its Member States, created the 2030 Agenda in 2015, which establishes 17 Sustainable Development Goals (SDGs) and 169 targets, representing an action plan to transform social reality by 2030.

It is in this context that so-called sustainability indicators play a primary role, as they are considered tools that enable such monitoring and provide data on risks and development trends, constituting a navigation chart for the future (GUIMARÃES; FEICHO, 2009).

Among the various available tools, the Sustainable Development Index of Cities – Brazil (IDSC-BR) can be mentioned, which will be used as a data collection instrument for the present research. This index is an initiative of the Institute for Sustainable Cities (ICS), within the scope of the Sustainable Cities Program (PCS), in partnership with the Sustainable Development Solutions Network (SDSN), and presents an overview of the performance of Brazilian cities concerning the 17 SDGs.

The information is of a public nature; thus, the study aims to compare the indices of the SDGs (SDGs 13, 14, 15, and 16) that make up the environmental dimension in the city of Mossoró-RN, available in the IDSC-BR, with the actions disclosed by the municipality.

THEORETICAL FRAMEWORK

Sustainable development and sustainability

The interference of human action on the environment can be identified since the genesis of history; however, it became more intense throughout the process of the evolution of civilizations. A highly significant milestone in this process was the so-called Industrial Revolution, which reconfigured the production system through its technological innovations and promoted transformations in various spheres of society, whether economic, social, or environmental. Among its main implications are the increase in production, consumption, the structuring of new labor relations, as well as the disorderly growth of urban centers (DIAS, 2015).

Global socio-environmental discussions began at the Stockholm Conference in 1972. However, the expression “sustainable development” gained prominence in the 1980s with the publication of the report “Our Common Future” by the World Commission on Environment and Development (WCED), as Barsano and Barbosa (2017) affirm. This document, also known as the Brundtland Report, defines Sustainable Development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1991, p.46), based on premises around the need to fight poverty and raise awareness about the exploitation of the environment.

Among these landmark moments stands out the United Nations Conference on Sustainable Development (UNCSD), also called Rio+20, held in 2012 in Rio de Janeiro, which resulted in the report “The Future We Want,” reinforcing the three dimensions of SD and the political commitment to achieve it. Thus, the foundations were outlined for building a new global plan with goals and targets: The 2030 Agenda for SD (UNITED NATIONS - UN, 2023).

The aforementioned Agenda is a universal action plan aimed at Sustainable Development, to which 193 UN member states, including Brazil, committed. This proposal, adopted in 2015, established 17 goals (1-Eradication of Poverty; 2-Zero Hunger and Sustainable Agriculture; 3-Health and Well-being; 4-Quality Education; 5-Gender Equality; 6-Clean Water and Sanitation; 7-Affordable and Clean Energy; 8-Decent Work and Economic Growth; 9-Industry, Innovation, and Infrastructure; 10-Reduced Inequalities; 11-Sustainable Cities and Communities; 12-Responsible Consumption and Production; 13-Climate Action; 14-Life Below Water; 15-Life on Land; 16-Peace, Justice, and Strong Institutions; and 17-Partnerships for the Goals) and 169 targets to be met, considering the economic, environmental, and social dimensions.

Thus, the need to maintain a balance between these three spheres of

sustainability became evident so that one does not outweigh the other (UN, 2023).

A notable element in the elaboration of this agenda was the broad global openness for discussion lasting two years, allowing the SDGs to be considered from different perspectives, moving from a macro (international) to a micro (local) vision, with greater contributions from governments, civil society, the private sector, research institutions, among other actors (BARBIERI, 2020).

Sustainability indicators (IDS)

Indicators can be considered a fundamental tool in the management process, being used primarily to better guide decision-making. Thus, with the growing discussion around Sustainable Development (SD), the need to develop indicators related to the theme soon became evident. This process had the contribution of important institutions such as the United Nations (UN) and the World Bank (MALHEIROS; COUTINHO; PHILIPPI JR., 2012, P.31).

As the 2030 Agenda itself already mentions in one of its structural parts, it is necessary not only to establish and implement actions for sustainability but also to monitor and evaluate the efforts being made to execute them. Therefore, there is a need to use indicators to measure the degree of effectiveness of these actions concerning the proposed objectives (IDHL – Lippi Human Development Institute, 2024).

This discussion is also supported by Guimarães and Feicho (2009), who argue about some necessary characteristics for such indicators to effectively contribute to the process of change in the pursuit of SD. In this sense, they point out that indicators must be able to measure the different dimensions; enable society's participation in the process of defining development; communicate trends, supporting decision-making processes; and relate variables, as reality is neither linear nor unidimensional. It is within this context of increasing demand

for tools to monitor and measure actions for SD that the IDSC emerges.

Sustainability index for sustainable cities (IDSC-BR)

The IDSC-BR is a tool designed to encourage the fulfillment of the goals and objectives defined by the 2030 Agenda, through the measurement and evaluation of indicators that cover the three dimensions of Sustainable Development (SD) in the context of Brazilian cities, encompassing areas such as health, education, housing, and gender equality. Its development is the result of an initiative by the Institute for Sustainable Cities (ICS), within the Sustainable Cities Program (PCS), carried out in partnership with the Sustainable Development Solutions Network (SDSN) – an instrument created by the United Nations to mobilize technical and scientific knowledge among various social actors – aiming to achieve the 2030 Agenda.

The IDSC-BR, supported by the Ministry of Science, Technology, and Innovation (MCTI), the United Nations Environment Programme (UNEP), and the Global Environment Facility, assigns an overall score to each city based on the average of the 17 SDGs, as well as an individual score for each specific SDG. Both scores range from 0 to 100 and are distributed into five rating levels: very high (80 to 100 points); high (60 to 79.99 points); medium (50 to 59.99 points); low (40 to 49.99 points); and very low (0 to 39.99 points).

METHODOLOGY

Research universe

The city of Mossoró is located in the western region of the state of Rio Grande do Norte. According to IBGE (2022), it has a population of 264,577 inhabitants and a territorial area of 2,099.334 km². Regarding the IDSC (Sustainable Development Index of Cities), Mossoró has a score of 47.26%,

ranking 2,514th overall among all cities in the country for the year 2023, thus characterizing it as a city with a low level of Sustainable Development.

Procedures and techniques

Regarding the procedures, bibliographic and documentary research were used, the latter being considered “the one in which the data collection source is restricted to documents, written or not, constituting what is called primary sources” (Lakatos, 2021, p. 66). For this stage, data provided by the ICS digital platform were used; this system is open and freely accessible, providing, in addition to guidelines, information and news about urban sustainability and public policies (ICS, 2023).

Furthermore, data provided by the official page of the municipality’s government in focus were also accessed in order to make a correlation between the results presented by the two databases. In this regard, the relationship between the level of Sustainable Development presented in each of the indicators and the actions developed by the municipality that contributed to achieving it was verified.

It is important to mention that the IDSC-BR includes 100 indicators, generating a general index for each city (considering the average of the 17 SDGs) and an individual score between 0 and 100 for each goal, with performance closer to 100 classified as excellent. Thus, it can facilitate the definition and monitoring of actions established by the UN in a local context. The present study addresses the SDGs that make up the environmental dimension of sustainability which, according to Barbieri (2020), involve the elements detailed in Chart 1.

Chart 1: Environmental dimension and its indicators

ODS	INDICATOS
SDG 12 - Sustainable Production and Consumption	Household solid waste collected per capita; Recovery of urban solid waste collected selectively; Population served by selective collection.
SDG 13 - Climate Action	CO2 emissions per capita; Concentrations of heat focus; Proportion of strategies for risk management and prevention of natural disasters; Percentage of the municipality deforested.
SDG 14 - Protect Life Below Water	Sewage treated before reaching the sea, rivers, and streams.
SDG 15 - Protect Life on Land	Rate of forested and natural areas; Conservation units of full protection and sustainable use; Maturity level of environmental protection financing instruments.

Fonte: Dados da pesquisa (2023).

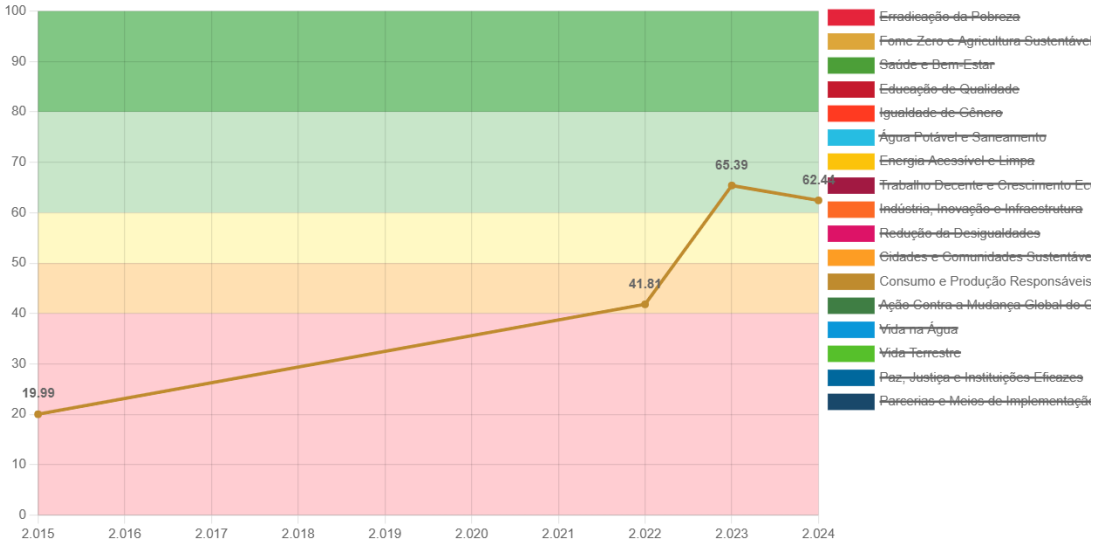
RESULTS AND DISCUSSION

Next, an analysis was conducted of the SDGs that make up the environmental dimension and their respective indicators in the city of Mossoró-RN.

Responsible Consumption and Production – SDG 12

The implementation of this SDG is related to the strengthening of the circular economy through, for example, sustainable production actions, efficient resource management, and waste reduction. The data observed for the year 2023 showed a local performance of 65.39%, as shown in figure 1, allowing the city to be classified with a high level of sustainable development, given that it fits within the parameter established for this range, which varies from 60 to 79.99%.

Figure 1: Evolution of SDG 12 in the city of Mossoró



Source: IDSC (2023).

Regarding the scores of this goal by each indicator that composes it, it can be noted that:

- Indicator 1 - Household solid waste collected per capita

The household solid waste collected in the municipality mainly includes organic waste (food scraps, fruit and vegetable peels, etc.); recyclable waste (paper, plastics, glass, metals); and non-recyclable waste (dirty packaging, disposable diapers, etc.), with collection carried out by the city's urban cleaning service. For calculation purposes, the National Sanitation Information System (SNIS) considers the mass of household and public waste collected per capita in relation to the total population served by the collection service.

The parameter to consider this indicator as achieved is 1.5. It is likely that this reduction is due to the selective collection programs carried out in the city (which will be presented later). In 2021, the municipality reached a level of 1.05, thus receiving a classification of "High performance," with results being better the closer they are to zero.

- Indicator 2 - Recovery of urban solid waste collected selectively

This stage refers to the process of separation and recycling of materials discarded by the population. These materials are collected separately by the city or responsible company to be sent for recycling processes. According to the analyzed data, this indicator represents major challenges for the municipality, as the rate of recovery of recyclable materials was 0.34 in 2021, being the second-lowest rate since 2015.

This value is far below the reference calculated by SNIS, where, to consider the goal achieved, the index should be 25.48. This means the city either does not treat solid waste properly or that the information is left to a private company. No information was found on the official city hall website, not even regarding activities related to the 0.34 result.

- Indicator 3 - Population served by selective collection

The number of people served by selective collection can vary according to the location and system implemented in each city. In some places, it may be carried out only in specific areas, such as urban centers or selected neighborhoods.

In these cases, only part of the population is served by this service. According to IDSC-BR, the minimum parameter for this indicator is 70 points. Mossoró, meanwhile, achieved an index of 97.89 points in 2021, surpassing the IDSC-BR reference.

According to PMM (Municipal Government of Mossoró), the program currently called “Mossoró Limpa” features actions that, among other goals, seek to involve the community through conscious waste disposal. Some events (figure 2) have been promoted since 2021 to raise awareness about recyclable materials, such as clean-up campaigns, collectors in public departments, and drive-thru collection points organized to gather recyclable materials. The mentioned activity collected more than 3 tons of waste.

Figure 2: Mossoró Limpa actions

Source: PMM (2021).

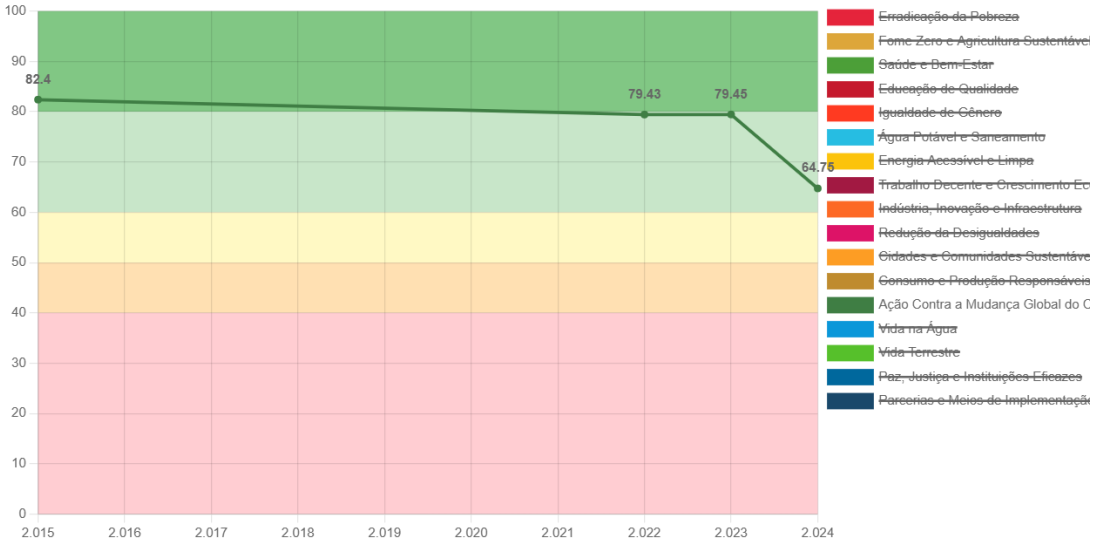
Action against global climate change – SDG 13

Global Climate Change is an urgency that affects the entire world, requiring immediate action to protect the planet and future generations. Reducing greenhouse gas emissions is crucial, involving, among other measures, a transition to renewable energy sources and sustainable practices. Governments and companies must implement incentive policies and regulations, in addition to investing in mitigation technologies such as carbon capture, sustainable agricultural practices, and water conservation.

In this regard, SDG 13 specifically focuses on Climate Action. This goal aims to take urgent measures to combat climate change and its impacts. The most recent data indicate that Mossoró achieved a performance score of 79.43 (Figure 3).

Thus, being within the classification range of 60 to 79.99%, considered a high reference, the city presents a high level of sustainable development in the SDG in focus.

Figure 3: Evolution of SDG 13 in the city of Mossoró-RN



Source: IDSC-BR (2023).

Regarding the scores of this goal by each indicator that composes it, it can be noted that:

- Indicator 1 - CO2 emissions per capita

This indicator is used to assess the individual environmental impact of each person, considering daily activities such as transportation, energy consumption, and food. The reference for meeting this indicator is that the gross CO2 emission level and (t) GWP-AR5 per capita should achieve a result below 2 (t). According to the data, the municipality presents a value of 2.11 (t), thus considered an average classification with challenges to overcome. However, no actions that reflect this result were found in the official data released by PMM.

- Indicator 2 - Concentration of heat spots

This indicator refers to the municipality's contribution to the total number of fires in Brazil. According to the National Institute for Space Research (INPE), the term "fire pixel" is used to identify locations with vegetation burning, captured through digital images from satellite sensors. This term is translated as "heat spot" or "fire spot." The reference value to achieve the goal is 0.18 (unitless). Mossoró's data, according to IDSC-BR, reached 0.05 in 2017, characterizing it

as an indicator better than the reference. Regarding this, no data corroborating the above value or protective measures or alerts to deter intentional practices were found on the official website of the Municipal Government of Mossoró.

- Indicator 3 - Proportion of strategies for risk management and prevention of natural disasters

This indicator corresponds to the number of responses to strategies marked "Yes" (adopted) divided by a total of 25 recommended strategies. The recommended strategies are divided into 4 groups:

1st Group: The municipality has various planning instruments, including the Master Plan, the Land Use and Occupation Law, a specific law for disaster prevention, the Municipal Risk Reduction Plan, a geotechnical map for urbanization suitability, and an implementation plan for works and services to reduce disaster risks.

2nd Group: For managing disaster risks related to floods and inundations, the municipality has risk area maps, a housing program for relocating low-income populations, control and inspection mechanisms to prevent occupation in risk areas, a contingency plan, engineering projects, and an early warning system.

3rd Group: For managing disaster risks related to landslides and slope slips, the municipality has risk area maps, a housing program for relocating low-income populations, control and inspection mechanisms to prevent occupation in risk areas, a contingency plan, an early warning system, and a risk register.

4th Group: Regarding risk and disaster management, the municipality has a Fire Department unit and the Municipal Coordination of Protection and Civil Defense (COMPDEC) or a similar body.

The municipality scored 52 on this sustainable development indicator, considered a medium level, indicating major challenges to be overcome.

The prevention of flooding and disasters caused by rain involves a combination of infrastructure measures, management, and public awareness. In

this context, corrective measures by the management to solve problems caused by natural disasters such as flooding were found on the Municipal Government of Mossoró's website. Evidence can be seen in figures 4 and 5.

Figure 4: Preventive and corrective actions of PMM

Source**:** PMM (2023).

Figure 4 illustrates the corrective actions implemented by the public administration aimed at mitigating the impacts of natural disasters, especially flooding. These actions include improvements in urban infrastructure, such as the expansion and maintenance of the drainage system, as well as preventive measures for cleaning and unclogging channels.

Figure 5: Flooding in the streets of Mossoró

Source: PMM (2023).

Figure 5, in turn, highlights the results of these interventions, showing a reduction in areas affected by flooding and an increase in safety in previously vulnerable regions. This demonstrates that the preventive actions of the city government are directly linked to improvements in the population's quality of life and health.

- Indicator *4 - Percentage of the Municipality Deforested*

This indicator refers to the percentage of converted areas (hectares of forest cover plus hectares of non-forest natural areas converted to livestock farming or transformed into non-vegetated areas) in relation to the total area of the municipality (in hectares).

The parameter for this indicator is a value of 0.05 to consider the goal achieved. The city studied presented, according to the latest data, a value of 0.31, indicating a challenge for which solutions must be sought. An official information search was conducted on the PMM website to learn about actions monitoring deforestation in the region; however, no disclosure of actions related to this indicator was found.

There are several environmental compensation measures that can be adopted to help recover and preserve forests, among which reforestation stands out, consisting of planting trees in deforested or degraded areas. It is important to use native species, adapted to local conditions, to promote biodiversity.

Regarding this, events organized by the environmental department were recorded through the "Mossoró Verde" program, which includes a schedule of actions aimed at urban tree planting, through which plant seedlings are distributed, thus contributing to the recovery of areas affected by deforestation caused by the city's growth, as shown in Figure 6.

Figure 6: Environmental Compensation Measures (Reforestation)

Source: PMM (2023).

Figure 6 shows the "Municipal Forest Nursery," a seedling production site that is part of the "Mossoró Verde" program. This space houses a wide variety of plants, including native, fruit-bearing, ornamental, and medicinal species, standing out for its contribution to the city's tree planting and the recovery of areas degraded by urban deforestation.

Regarding SDGs 14 and 15, Life Below Water and Protect Life on Land, respectively, no significant data were found in the local context, as the information contained in the IDSC-BR is far from the estimated reference value for the indicators or the data are not updated. Therefore, it is not possible to infer that the mentioned SDGs are being effectively addressed to achieve the expected results.

CONSIDERATIONS

The analysis of the environmental dimension of the SDGs in the municipality of Mossoró-RN shows satisfactory results for some indicators and challenging ones for others. Regarding SDG 12, the results indicate a high performance in the overall score in IDSC-BR, where two of its three indicators showed satisfactory indexes (Household solid waste collected per capita and

Household solid waste collected per capita), while urban solid waste recovery remained a challenge to be overcome.

Regarding SDG 13, also classified as high performance in the overall ranking, one of its four indicators showed satisfactory indexes (Concentration of heat spots), two were classified as medium performance (CO2 emissions per capita and Proportion of strategies for risk management and prevention of natural disasters), and one as low (Percentage of the municipality deforested).

As for SDG 14, which includes the indicator “Sewage treated before reaching the sea, rivers, and streams,” it was classified as low performance; and SDG 15, which includes three indicators: “Rate of forested and natural areas,” “Conservation units of full protection and sustainable use,” and “Maturity level of environmental protection financing instruments,” with the first two classified as low and the last as very low. No actions related to these were found on the municipality’s website.

Based on this analysis, some improvement proposals are suggested to strengthen environmental management in the municipality. Solid Waste Management (SDG 12): the expansion of environmental education programs, as well as incentives for recycling and composting. Partnerships with cooperatives and specialized companies to optimize waste management. Climate Policies (SDG 13): the development of carbon offset strategies, including reforestation programs and incentives for renewable energy use. The creation of a municipal climate action plan with clear and measurable goals. Sewage Treatment and Water Quality (SDG 14): awareness campaigns on the sustainable use of water and proper disposal of liquid waste. Conservation of Natural Areas and Biodiversity (SDG 15): expansion of protected areas and strengthening financing mechanisms for environmental protection. Tax incentives for landowners who preserve forested areas, as well as stronger enforcement to prevent degradation of protected areas. Integration with Global and Regional Sustainability Networks:

To align with international best practices, the municipal management can join sustainable city networks, such as ICLEI (Local Governments for Sustainability), which facilitates access to innovative technologies, financing, and exchange of experiences.

Finally, as a suggestion for future work, it is recommended to expand the analysis to include the social and economic dimensions of the SDGs, complementing the assessment of sustainable development in the municipality. Additionally, the creation of a more robust methodology for monitoring environmental indicators is proposed, with more frequent and detailed data collection, enabling a more precise analysis of the impacts of public policies and the formulation of more effective actions to meet the SDG targets.

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