

Proposal for Analysis of Geoenvironmental Sustainability Indicators for the Municipality of Barcarena in the State of Pará

Rosivan Alves Nilander¹, Marcelo dos Santos Targa², Celso de Souza Catelani³, Angelo Ricardo Balduino⁴

^{1,2}Department of Environmental Sciences, University of Taubate, Brazil

³Department of Environmental Sciences, Institute for Environmental Research in Hydrographic Basins, Brazil

⁴Department of Environmental Sciences, Tocantins Federal Institute of Education, Science and Technology, Brazil

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Abstract— *This research proposes an analysis of the municipality of Barcarena, in the State of Pará, from the use of geoenvironmental and sustainability indicators, with the intention of verifying possible changes in the local landscape due to plant extractivism in the past and current mineral extraction. Specifically, it is intended to understand how geoenvironmental and social sustainability indicators can be used to monitor local changes; evaluate the quality of life in the municipality of the Barcarena, from the use of physical and socio-environmental indicators; propose a system of indicators capable of gathering physical and socio-environmental indicators of sustainability from the discussion on the quality of urban and environmental life observed in the research. For this, research was carried out that presents a qualitative and quantitative character and can be identified as a study that involves a mixed method because it used diversified techniques in an attempt to achieve its objectives, including bibliographic, documentary survey, as well as field research. The results obtained prove that the geoenvironmental indices of the Municipality of Barcarena place it in an intermediate position, a fact that can be proven through the Sustainability Barometer published by the Amazon Foundation for Research in Pará – FAPESPA. This occurrence is because the interests of large mining companies predominate in the region to the detriment of the costs and expenses that could incur initiatives aimed at maintaining and preserving the environment, as well as the absence of effective public policies that ensure the maintenance of socio-environmental well-being in the region.*

I. INTRODUCTION

Human needs are the main elements that drive the constant urban transformations and consequent degradation of natural environments, resulting in direct impacts on the quality of life of individuals. In the midst of these processes, the geoenvironmental indicators emerge as fundamental instruments to enable the development of

evaluations and analyses related to public policies, besides allowing the monitoring of urban development according to the correct use of natural resources.

Although it is possible to verify the attempt to use a sustainability concept in several historical periods, it was only after 1970 that scientific movements related to the subject started to have more relevance. During this period,

scholars in the area realized that it was a subject capable of covering the various sectors that make up and influence society. After the United Nations Conference on Human Environment and Development, held in Stockholm in 1972, the intentional interest in producing statistics on environmental issues became evident, contributing to the development of specific environmental concepts and classifications.

From 1980 on, the terminology "sustainability" started to be used more frequently, stimulating the strengthening of its social attributions, encouraging the development of methodologies capable of measuring the sustainability level under its several dimensions. As to the Conference of European Statisticians that occurred in 1990, the first formulations of environmental indicators and their respective conceptual references appeared, but were not limited to the provision of statistical data.

In this scenario, the first studies on the influence of social development on urban evolution began to be developed. In 1990, the United Nations Organization (UNO) released the First International Report on Human Development (UNDP), which described for the first time the Human Development Index (HDI), responsible for the calculation capable of ranking the countries according to their respective health conditions, education, income, and other basic information about the population. With the help of this instrument, it has become possible to verify the gradual precariousness of living conditions in urban centers, making it possible to increase debates on social issues.

It is relevant to mention the United Nations Conference on Environment and Development, which is also known as Eco-92, Earth Summit, Summer Summit, Rio de Janeiro Conference, or Rio 92, which is configured as a confluence of debates related to socio-environmental and urban issues. From Eco-92 on, several statistical environmental research emerged, aimed at the planning and formulation of public policies for developing urban centers, contributing to the strengthening of urban data systems and the consequent creation of sustainable development indicators.

The relevance of such indicators was confirmed at the 2nd World Conference on Human Settlements (Habitat II), held in Istanbul in 1996, where it was suggested the implementation of the Urban Indicators Program for Monitoring the Urban Life Conditions in several cities around the world, including Brazil.

In view of the above, this research develops an analysis of the Municipality of Barcarena in the State of Pará, through the use of geo-environmental and sustainability indicators. Specifically, the occurrence of environmental

changes caused by urban growth in the region will be verified, as well as to discuss the relevance of using geo-environmental indicators for monitoring local changes and evaluating the quality of life of the surrounding population.

The contact with the proposed theme awakened the interest in understanding the dynamics and complexity of the processes, to improve knowledge regarding the applicability of geo-environmental indicators as tools for monitoring and control, through which regional public managers can develop specific environmental control actions. Nevertheless, the development of this approach was based on the interest in discussing the possibility of developing systems capable of measuring the quality of life in its socio-environmental dimension.

From a regional perspective, the approach focuses on the need for permanent evaluations, aimed at the maintenance and control of human action and its influences on the environment.

II. THE CONCEPTUALIZATION OF SUSTAINABILITY INDICATORS

Human beings constantly receive grids of information flows, which originate from data from various types of indicators. This statement highlights the idea of the need to measure, sort and process data and measures, to transform them into indexes capable of assisting in the determination of relevant social aspects (SOLIGO, 2012).

The phenomena observed by the Social Sciences are too complex and variable to be analyzed under a unidimensional aspect, revealing the need to perceive them under a diversified and comprehensive perspective, referring to the importance of using indicators. Mitchell (2004), cited by Campos and Melo (2008, p.542) states that an indicator is a "[...] tool that allows obtaining information about a given reality, having as its main characteristic that of being able to synthesize several pieces of information, retaining only the essential meaning of the analyzed aspects."

According to the semantic perception of Rodrigues (2010), the word indicator presents synonymy with other existing terminologies in the Portuguese language, such as, "[...] sign, symptom, omen, warning, hint, clue, clue, situation, category, data, pointer, dial, instrument, measure." Nevertheless, the aforementioned author states that indicators can assist in the development of analysis about social phenomena, in the sense of providing data that can be converted into information.

The concept of sustainable development has been widely used since 1990, when it was used to define a

specific development model for the first time Van Bellen (2006). However, to achieve the previously set goals, there was no prior discussion. This information shows the lack of a scientific consensus on the concept of environmental development, considering the divergences related to the assessments of development sustainability.

Generally, is sustainability being something variable, resulting in the determination of a flexible concept, avoiding the consequent attribution of imprecise adjectives, driving the establishment of a proper conceptualization. In the perception of Lustosa (2010), sustainability is composed of interdependent dimensions, which are described by environmental, social, economic, cultural and political factors, evidencing the mutual influence or impact of these elements, regardless of periods or levels in which they coexist.

Souza and Armada (2017) report that contemporary literature establishes a differentiation between the terms sustainability and sustainable development, where the first refers to the results obtained through the efforts employed for the effectiveness of the second, describing the utopia that underlies the concept of sustainability, where it is considered responsible for maintaining the future itself.

Van Bellen (2004) explains that environmental indicators integrate the composition of systems capable of assisting in the correction of objectives or directing them through the emergence of needs. However, the measurement of sustainability should not be based on static periods or situations, but "[...] as an integrated measurement over time to document processes, and able to show trends, due to the inherent temporal dimension inserted in the concept of sustainable development. (GALLOPÍN, 1997, cited by HANAI and ESPÍNDOLA, 2011).

In isolation, the indicators have the function of warning about the occurrence of certain problems before they occur, enabling the development of early solutions (VAN BELLEN, 2006).

According to Silva et al. (2012), the socioeconomic indicators can assist in political decision making, however, for effective evaluations and analysis, there is the need to establish comparisons with other indicators, describing the complementarity between them regarding the provision of information.

In this perspective, sustainability indicators enable the realization of quantitative analyses, which foster the survey of socio-political, environmental, economic issues, among other specificities about each region.

Seabra (2019) clarified that indicators can compare two or more scenarios in different periods, facilitating the creation of initiatives capable of meeting public needs.

Still addressing the subject, the aforementioned author states that in addition to enabling the development of prognostics, sustainability indicators enable the complementarity of the components that make up sustainability.

A relevant fact amid the environmental contextualization in Brazil, is described by the release of the book "Indicators of sustainable development - Brazil" by the Brazilian Institute of Geography and Statistics (IBGE, 2015), which presents the set of 63 indicators adapted to the reality of the country, formulated from the model proposed by the Commission for Sustainable Development of the United Nations, first released in the year 1996. (SEABRA, 2019).

In general, it is understood that indicators have their own specificities and meanings, but their main characteristic is the importance they assume amidst decision-making processes by providing information about events that make up the daily life of a society.

III. MATERIAL AND METHODS

Because it presents quantitative and qualitative characteristics, this research can be qualified as a mixed study, where the qualitative is described aspect Grounding in the specific and inseparable phenomena of the regional contextualization analyzed, does not exist the possibility of generalization of the results obtained.

In turn, it is considered quantitative because it resorts to the use of numbers for measuring the established geoenvironmental indicators (MARAFON, et al. 2013). Nevertheless, the research also presents interpretative characteristics, considering the analysis of bibliographies and in loco research carried out.

The methodology adopted opposes the positivist current described by Vergara (2015), which perceives the existence of a world independent of the analyses and interpretations of individuals.

From this perspective, the phenomenology employed is understood as a strategy and as a scientific method, since it is a qualitative study focused on phenomenological perspectives, in which techniques and methods are used in an attempt to discover the causes and facts involved in the problematic addressed.

Regarding the research, the study developed is characterized as applied research, taking into account the

concern in "[...] generating knowledge for practical application, directed to the solution of specific problems (SILVEIRA and CÓRDOVA, 2009).

Additionally, it is informed that the indexes used are based on generic truths and interests, regardless of addressing specific problems of the locality studied.

Regarding the procedures adopted, the development of the research required a bibliographic and documental survey, field research, and ex-post-facto research.

To explain the need for the complementarity of these procedures, we resort to the information of Silveira and Córdova (2009), who present the bibliographical research as the "[...] survey of theoretical references already analyzed and published by written and electronic means, such as books, scientific articles, web pages." (FONSECA, 2002, cited by. SILVEIRA and CÓRDOVA, 2009).

Despite presenting similarities to the bibliographic research, the documentary research is differentiated by means of the sources researched, which may not receive any type of analytical treatment, correspond to the research objectives, besides being able to be interpreted in different ways, regardless of having already been processed (SILVEIRA and CÓRDOVA, 2009). Nevertheless, these authors inform that the field study is described through the development of bibliographic, documentary and local investigations (SILVEIRA and CÓRDOVA, 2009).

The field research, in turn, deepens the perception of a specific reality, through direct observations of the reality studied. In relation to ex post facto research, Silveira and Córdova (2009) that it is an investigative procedure focused on the cause-and-effect relationship between phenomena and facts, presenting as its main characteristic the data collection that occurs after the occurrence of the events.

Technical interpretations and scientific concepts from the literature considered were used in the data analysis. Additionally, MS Word was used for the dissertation construction, MS Excel for the grouping and categorization of the stipulated indexes, and the Qgis 2.18 software for the elaboration of the maps presented.

The bibliographic research was conducted according to the criteria established by Lakatos and Marconi (2017), where it was first listed the steps that were carefully obeyed: delimitation of the theme, preparation of the study plan and formulation of the respective research objectives.

Subsequently, the databases where the bibliographic survey was conducted were established, which considered the scientific impact and credibility of the publications, as well as the availability and level of depth on the theme in question.

After the aforementioned selection, summaries were prepared with the intention of listing the contents of the bibliographies, and selecting them according to the years of publication, exposed objectives, results, and the position of the authors about their respective approaches.

However, information was retrieved about a study developed during the graduation in Geography in 2004, entitled "SISBAR - System of physical and socio-environmental indicators of sustainability and quality of life for the Municipality of Barcarena - Pará" (NILANDER, 2004).

In the midst of the described processes, it was also requested to the Center for Higher Amazonian Studies the possibility of preparing the maps presented in this study, considering the need to use updated data and specialized software to perform such a task, which enabled the preparation of comparisons between the years 2000 and 2010.

The interpretative analysis, as well as the dissertative construction was concerned with the elaboration of a descriptive-textual text, which presents textual fragments that serve as scientific argumentative subsidy to substantiate the information exposed throughout the study.

To this end, we opted for bibliographic research in personal collections, libraries, and Internet portals responsible for indexing scientific content, such as Scientific Electronic Library Online (SciELO), Educational Resources Information Center (ERIC), Google Scholar, Portal Periódicos CAPES/MEC, Brazilian Institute of Information in Science and Technology (IBICT), platforms Science.gov and ScienceResearch.com.

Regarding the internet indexers, the following keywords were used as search criteria: local development; sustainable development; definition of indicators; sustainability dimensions; sustainability indicators; geoenvironmental indicators; environment; sustainability.

In this step, the analysis of the titles, abstracts and references of the bibliographies was carried out, with the intention of verifying the possibility of collaboration of the materials with the study.

IV. RESULTS AND DISCUSSION

Figure 1 shows that the Municipality of Barcarena is part of the metropolitan mesoregion of Belém, capital of the State of Pará, which is located 30 km away. Data from the last demographic census of the IBGE (2010) show that the Barcarena has a total area of 1,316.2 km², bordered by the municipalities of Acará, Moju, Abaetetuba, and Belém, and the bays of Marajó and Guajará.

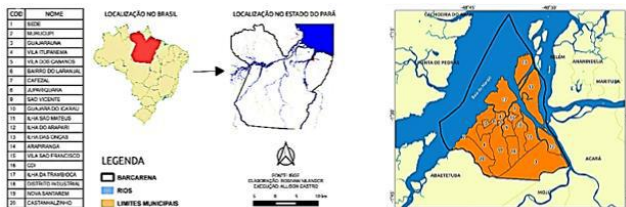


Fig. 1: Geographic position of the City of Barcarena – Pará

Analytical and graphic crossing of basic sanitation regarding accessibility to water supply, sanitary sewage and sewage treatment, and domestic garbage collection (IBGE, 2015), allowed estimating an arithmetic mean of sustainability indicators for the region. However, the respective socio-environmental factors were adopted as criteria:

- Existence of urban planning policies appropriate to the local environment;
- Participatory urban planning;
- Integration of environmental and urban policies among municipal agencies;
- Existence of a strategy for treating solid and liquid wastes;
- Sanitation networks are available to serve the population;
- Evolution of the contamination of the waters of beaches, rivers and streams;
- Recovery of ecosystems, especially conservation units;
- Number of conservation units demarcated, signposted and monitored;
- Existence of conservation units created and/or implemented;
- Evolution of the diversity fauna and flora;
- Number of actions focused on information and local environmental education.

The association of cartographic data and information obtained through the demographic census (IBGE, 2010) enabled the preparation of descriptive maps, through which the vectoring of the Municipality of Barcarena was

carried out, according to the correspondence of the previously established indexes. The sum of the data corresponding to the census sectors allowed the formulation of comparative tables for the years 2000 and 2010, considering the respective total values obtained for each variable, which were taken as spatial clippings for the determination of geoenvironmental indicators.

Subsequently to the elaboration of these tables, the spatial association of the districts that integrate the Barcarena area to their spatial correspondents of the cartographic base was carried out, which was elaborated in shapefile (shp) format, enabling the analysis through the Qgis 2.18 software. To determine the geoenvironmental indices, a formula was developed by calculating the individual indexes of each component (water, sewage, garbage) for each district:

Formula 1 - Calculation of the geo-environmental indexes referring to water

$$IAG = \frac{((AGERAL / TP) * 3) + ((APOCO / TP) * 2) + (((1 - (AOUTRA / TP)) * 1)) / 8}{8} * 100$$

Source: IBGE (2015), adapted by NILANDER (2022).

Where:

- IAG = Indice of distribution and access to water;
- AGERAL = General municipal network supply;
- TP = Total of properties;
- APOCO = Artesian well supply;
- AOUTRA = Other forms of water supply.

Formula 1 describes the main geo-environmental influences regarding water supply and consumption (general supply network and artesian wells). Regarding the other sources of supply, they were considered with negative effect for the sewage geo-environmental index (Formula 2):

Formula 2 - Calculation of the geo-environmental indexes referring to sanitation (sewage)

$$\frac{(((ESG_GERAL / TP) * 3) + ((ESG_FOSS/TP) * 2) + ((1 - (ESG_RUD / TP)) * 1) + (1 - (ESG_OUT/TP)) * 2)/8}{8} * 100$$

Source: IBGE (2015), adapted by NILANDER (2022).

Where:

- ESG_GENERAL = Sewage through the municipality's general network;
- ESG_FOSS = Sewage through septic tank;
- ESG_RUD = Sewage through rudimentary septic tanks;
- ESG_OUT = Sewage through other ways;
- TP = Total of properties.

The determination of the sanitation geoenvironmental index (formula 2) considered the general sewage network and the septic tanks, which are characterized as positive elements for the specification of the referred index, where the weights 3 for the general sewage network and 2 for the septic tank were adopted. The sewers described as rudimentary cesspits or other forms of waste disposal, should be interpreted on their negative geoenvironmental impacts, where rudimentary cesspits correspond to weight 1 and other forms of waste disposal weight 2.

To the determination the geoenvironmental index referring to garbage collection, the respective formula 3 was elaborated:

Formula 3 - Calculation of the geo-environmental indexes referring to garbage collection

$$\frac{(((LIXO\ COL / TP) * 3) + ((1 - (LIXO\ TERR / TP)) * 3) + ((1 - (LIXO\ OUT / TP)) * 2)) / 8 * 100}{}$$

Source: IBGE (2015), adapted by NILANDER (2022).

Where:

GARBAGE_COL = Garbage collected;

LIXO_TERR = Garbage discarded on land;

LIXO_OUT = Other garbage disposed;

TP = Total properties.

To establish the general geoenvironmental sustainability index (GESI) of the Municipality of Barcarena for the years 2000 and 2010, formula 4 was used:

Formula 4 - Calculation of the index of general geoenvironmental sustainability (ISGG)

$$ISGG = (ESG * 3 + LIXO * 2 + \acute{A}GUA * 1) / 5$$

Source: IBGE (2015), adapted by NILANDER (2022).

From the respective formula, maps were drawn with the classifications of sustainability levels for each district of Barcarena in the years 2000 and 2010.

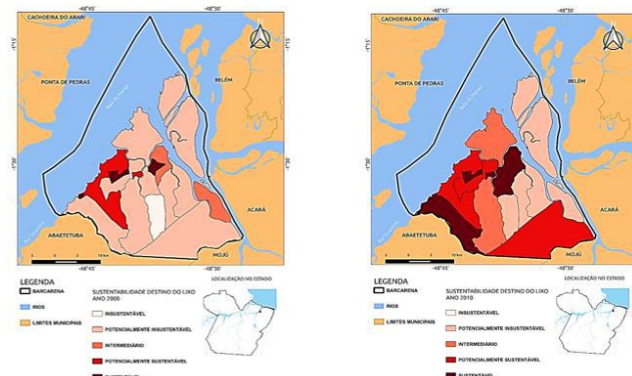


Fig. 2: Level of sustainability of the municipality of Barcarena in relation to waste treatment

In view of the above, the municipal management of Barcarena could implement some actions aimed at the maintenance of the environment, as well as direct greater attention to the treatment of waste, such as selective collection, composting, recycling, incineration, and landfill.

As of the 90's the collection system of Barcarena underwent expansion works to serve the nearby communities. It is estimated that until 1996 there 18 sewage outlets flowed into the rivers and mangroves. In this same period the first stage of the sanitary sewage system was inaugurated, which was destined to serve 25 thousand inhabitants of the towns of Vila do Conde, São Francisco and Vila dos Cabanos.

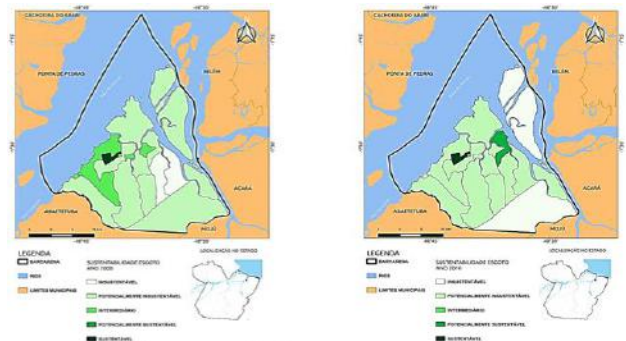


Fig. 3: Level of sustainability of the municipality of Barcarena regarding sewage treatment

Regarding water supply, the main source of supply are the wells, which are mostly the Amazon type, less than 25 meters deep and seek to supply the deficiency of the general supply network of the city. These wells are drilled manually, without any technical concern or hygienic care, and are therefore considered potential sources of pollutants, because they can contaminate the groundwater.

Although a large part of the population of Barcarena uses some kind of treatment with water for daily consumption, 12.3% of the residents of this municipality do not take any special care, that is, the way the water is taken from the source that supplies the homes, it is consumed without first going through any kind of treatment, which makes this percentage of the population susceptible to water-borne diseases.

Water is wasted in most homes in Barcarena, especially when performing domestic activities that consume the most water, such as washing clothes, which is consumed daily by approximately 44.2% of the city's inhabitants.

All the factors previously described are potential sources of pollution of surface and underground water, since the municipality does not have an effective sanitation

and sewage system that serves the entire city. Physical-chemical analyses performed in water samples from twelve shallow wells located in the municipality verified nitrate levels, in three of the samples (25%), higher than 45 g/L, which is the limit allowed by the legislation in force (Ordinance 518 of the Ministry of Health); these values can be interpreted as anthropic pollution. These statements can be seen in Figure 4.

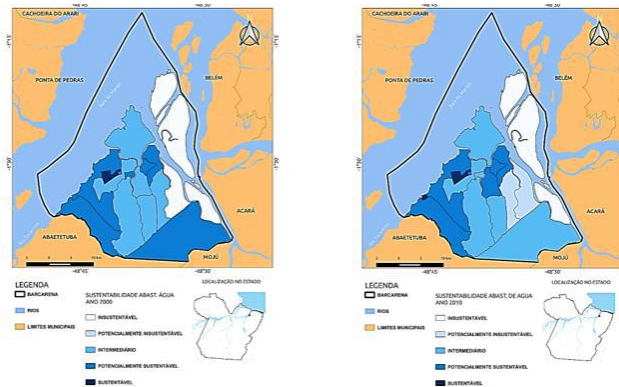


Fig. 4: Level of sustainability of the municipality of Barcarena in relation to water supply

To determine the verification and application of environmental indices in a municipality that was impacted by the installation of mining companies, we considered the methodology of the Sustainability Barometer, which is a tool for assessing sustainability and unsustainability developed by researchers from the World Conservation Union (IUCN) and the International Development Research Center (IDRC).

Kronemberger and Clevelario Junior (2015) explain that the sustainability index is configured as a possibility to mathematically synthesize quantitative and semi-quantitative data related to sustainability. According to these authors, after processing each index there is a numerical value in the form of a mathematical value, which is responsible for assessing sustainability when used to establish comparisons of a standard scale.

Also discussing the subject, Kronemberger and Clevelario Junior (2015) clarify that among the existing indexes, the most used for measuring sustainability are "[...] the Sustainability Barometer (BS), the Sustainability Panel, the Ecological Footprint, the Environmental Sustainability Index - ISA, and the Gross Internal Happiness - GNH." (KRONEMBERGER and CLEVELARIO JÚNIOR, 2015).

The tables with the weights and measures of analysis and application of the sustainability indexes for the municipality of Barcarena are presented below. However, it is explained that for the aggregation of the data that

served as a basis for determining and analyzing sustainability for the Barcarena, the indicators were considered as having the same statistical weight within their respective axes.

The final average value was established based on the logic of proportionality, where higher positive weights present negative weights of equal value and intensity. Subsequently, the different levels of sustainability were established, which are listed in table 1.

Table. 1: Attribution of value to the respective levels of sustainability

LEVEL OF SUSTAINABILITY	BAND
Unsustainable	0,00 a 0,25
Potentially unsustainable	0,25 a 0,50
Intermediate	0,50 a 0,70
Potentially Sustainable	0,70 a 0,85
Sustainable	0,85 a 1,00

Table. 2: Sustainability indexes for the municipality of Barcarena

Physical-Environmental Indicators	Value
Solid Waste Disposal	0,52
Vegetation Cover and Erosion Effects Indicators	0,40
Medium	0,425
Environmental Indicators	Value
Solid Waste Index	0,61
Forest cover and erosion	0,72
Medium	0,665
Sustainability Index Estimated for Barcarena	0,65

Five (5) sustainability fields were then created on a scale of 0 to 1, with zero being the unsustainable situation and 1 being the sustainable situation. The fields created correspond to unsustainable, potentially unsustainable, intermediate, potentially sustainable, and sustainable.

Given the above, the result shows Barcarena in an intermediate situation in relation to the analyzed sustainability indexes and the Barometer of Sustainability, a scenario that can be confirmed through the publication of FAPESPA (2015), in which the municipality of Barcarena maintained an intermediate scenario of sustainability, presenting human well-being and environmental well-being indexes with respective scores of 44 and 54, which can be confirmed through the figure 5.

Thus, it is possible to verify that the local public administration does not have or cannot put into practice an adequate strategic planning. Until the date of the research, most administrators' preoccupation was focused on the elaboration of the budget, while daily the Master Plan receives ad hoc alterations that turn it into a "patchwork quilt" which are made merely to serve speculative interests and completely ignore the fragility of the socio-environmental limits.

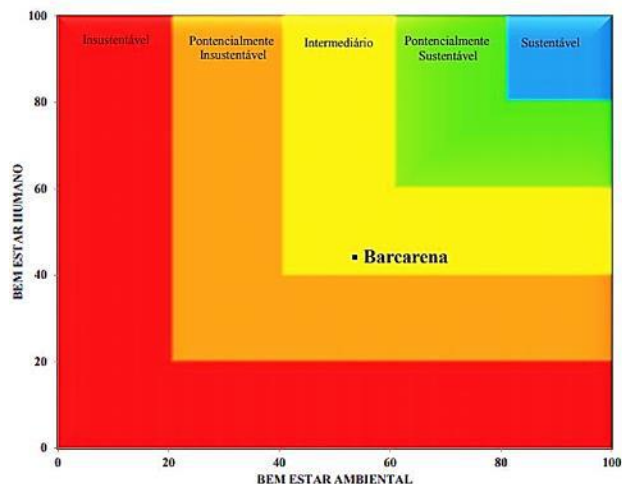


Fig. 5: Level of sustainability of the municipality of Barcarena in relation to water supply - FAPESPA (2015)

In spite of the absence of major initiatives dedicated to the maintenance of the quality of life as well as the preservation of natural environments, there is no doubt that the municipality of Barcarena has unique aspects, which contribute to the fact that one can still live relatively well in the region.

However, if the development model practiced so far still prevails, possibly the region will be led to a delicate, dangerous and irreversible situation, and is the traditional indicators is not being detected by (UN) that guide public policies.

Thus, notably the proposal developed through this research sought to consolidate a perspective capable of articulating the processes of strengthening citizenship simultaneously with the construction of local indicators, from the standpoint of determination and analysis of these indicators configured to conjugate physical-environmental and socioeconomic aspects, configuring itself as an articulated vision between society and the environment, enabling a more sensitive and qualitative follow-up.

V. CONCLUSION

It was possible to verify in this research that the municipality of Barcarena is widely known for its mineral potential, as well as for its strategic location on the shores of Marajó Bay and the flow of people who migrate to the region in search of job opportunities.

The combination of these factors contributes to the consequent disorderly growth, identified by the expansion of housing areas without adequate planning in relation to territorial order, causing relevant impacts to the environment.

During the 1980s, the municipality of Barcarena was made up of specifically rural regions, with only the district of Vila dos Cabanos receiving greater attention, with the aim of assisting the workers of companies installed in the region.

However, the absence of strategic planning, action plans, specialized public policies, as well as inspection and actions for the preservation and maintenance of the region's environmental heritage is observed locally.

The lack of information on local environmental issues directly influences the physical and socioeconomic aspects, especially with regard to mineral exploration, as over the years it shows the lack of interest of the entities involved in developing strategies capable of mitigating the possible environmental impacts caused by mineral exploration.

The region has large multinational companies installed in the region, benefiting from the existence of the port of Vila do Conde with national and international representation, which provides facilities for the flow of goods explored by the waterway network.

Thus, environmental accidents occur, which are frequently reported by the press over the years, which can be listed as red mud leakage, soot rain, kaolin leakage, algae proliferation, heavy metal leakage, among other factors that resulted in extensive oil slicks in the Marajó basin, contamination of rivers, streams, tributaries and streams, allergic reactions and respiratory problems in the local population, fish mortality and impacts on agriculture, tourism and local commerce.

Such perceptions characterize the neglect of both public management and the private sector, due to socio-environmental issues, considering that in 2015 there was the sinking of a ship flying the Lebanese flag, which sank in the port with a load of approximately five thousand live cattle.

Until the conclusion of this research, the ship was still submerged in the port of Vila do Conde with the carcasses of animals that did not manage to escape or had their corpses dragged to nearby beaches, as happened with thousands.

On the other hand, this evidence also demonstrates the inability of municipal public management to broadly exercise its respective administrative functions, given that another relevant point that deserves attention refers to garbage collection, which is configured as a public health problem arising from of irregular occupations, without concern for sewage installations or drinking water supply.

From this perspective, it is believed that technological innovation emerges as an alternative that can be widely

disseminated in the region, with the aim of managing possible environmental crises within the market, not allowing any political interference in relation to the protection of natural resources, giving a true ecological modernization.

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