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Components and Environmental factors for the Diagnosis of Brazilian Ecological-Economic Zoning, Scale 1:250,000

Componentes e Fatores Ambientais utilizados no Diagnóstico dos Zoneamentos Ecológico-Econômicos Brasileiros, Escala 1:250.000

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Abstract

The Ecological-Economic Zoning (ZEE) analyzes the landscape potentialities and vulnerabilities using different environmental information. This study identifies and prioritizes the components and environmental factors used for the diagnosis of Brazilian ZEEs at 1:250,000 scale. The methodological guidelines of the Ministry of Environment and Climate Change (MMA) and the consolidated zoning plans for the States Acre, Mato Grosso do Sul, and Tocantins were analyzed as references, according to the following methodology: literature review; survey and comparative analysis; development, application, and analysis of a questionnaire using percentages assigned to degrees of importance (0 to 10), and qualitative analysis based on the number of respondents. A total of 27 factors grouped into five environmental components were identified. The most important environmental components (degree 10) were the physical environment and integrated studies, highlighted by 57% of respondents. The environmental factors with the highest degree of importance were: water resources (74%) and geomorphology (69%) from the physical environment; vegetation (63%) and ecosystem services (56%) from the biota; land use (74%) and traditional populations (50%) from the socio-economic; legal aspects (54%) and institutional areas (37%) from the legal-institutional; and environmental vulnerability (65%) and environmental fragility (65%) from integrated studies. Qualitatively, all components and environmental factors were classified as class 4 (extremely important), with varying percentages. The preparation of maps and reports was identified as high and extremely important information in 13 factors. It is concluded that all analyzed components and environmental factors should be considered in studies, although with varying degrees of importance.

Keywords:
Environmental management, Territorial organization, Environmental planning, Integrated landscape, Sustainability.

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Resumo

O zoneamento ecológico-econômico (ZEE) analisa as potencialidades e as fragilidades da paisagem, utilizando diversas informações ambientais. Este estudo busca identificar e hierarquizar as componentes e fatores ambientais utilizadas na etapa de diagnóstico dos ZEEs brasileiros, na escala 1:250.000. Foram estudados como referência as diretrizes metodológicas do Ministério do Meio Ambiente e Mudança do Clima (MMA) e os Zoneamentos consolidados dos estados do Acre, Mato Grosso do Sul e Tocantins com a seguinte metodologia: revisão de literatura; levantamento e análise comparativa; desenvolvimento, aplicação e análise do questionário, utilizando o percentual atribuído aos graus de importância (0 a 10) e análise qualitativa, baseados no número de respondentes. Foram identificados 27 fatores agrupados em cinco componentes ambientais. As componentes ambientais com maior importância (grau 10) foram meio físico e os estudos integrados, apontados por 57% dos respondentes. Os fatores ambientais, recursos hídricos (74%) e geomorfologia (69%), do meio físico; vegetação (63%) e serviços ambientais (56%) do biótico; uso da terra (74%) e populações tradicionais (50%) do socioeconômico; aspectos legais (54%) e áreas institucionais (37%), do jurídico-institucional e; vulnerabilidade ambiental (65%) e fragilidade ambiental (65%) do meio, estudos integrados foram os que mais receberam grau de importância 10. Qualitativamente, todas as componentes e fatores ambientais foram classificados como classe 4 (extrema importância), com diferentes percentuais. A elaboração de mapas e relatórios é apontada como informação de alta e extrema importância em 13 fatores. Conclui-se que todas as componentes e fatores ambientais analisadas devem ser consideradas nos estudos, porém com diferentes graus de importância.

Palavras-chave:
Gestão ambiental, Organização territorial, Planejamento ambiental, Paisagem integrada, Sustentabilidade.

I. INTRODUCTION

The Brazilian government created the National Environmental Policy (PNMA) through Federal Law No. 6,938/1981 and, among its various instruments, instituted the Environmental Zoning, aiming to plan and organize the Brazilian territory. Known until the end of the 1980s as Environmental Zoning, it came to be called Ecological-Economic Zoning (ZEE) when Federal Decree No. 4,297/2002 was issued (Brazil, 1981; Brazil, 2002).

According to Brazil (2002), ZEE is defined as an instrument to organize the territory that must be followed in the implementation of public and private plans, works, and activities, establishing measures and standards for environmental protection aimed at ensuring environmental quality, water resources, soil, and biodiversity conservation, guaranteeing sustainable development and improving the living conditions of the population. Its general objective is to organize, in a coherent manner, the decisions of public and private agents regarding

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plans, programs, projects, and activities that directly or indirectly use natural resources, ensuring the full maintenance of the capital and environmental services of ecosystems.

The Ministry of Environment and Climate Change (2006), through the methodological guidelines for ZEE, establishes that the States plan their action strategies to be used on in its elaboration, based on the following stages: planning, diagnosis, prognosis and implementation, allowing adaptations as needed. The diagnostic stage of a ZEE should be based on the constraints and aptitudes of the landscape, obtained by the integrated analysis of different information from the environmental components: physical, biotic, socioeconomic environment, legal and institutional aspects, and integrated studies.

The elaboration and adoption of the ZEE by the States is essential for a strategic vision of the Brazilian territory, which allows the reconciliation of goals for economic growth and the fight against social inequalities with the conservation of natural resources.

In Brazil, the central element of this strategic vision refers to valuing the territory as an object of integration from diverse plans, programs, policies, and projects, overcoming the sectoral vision and making it easier to understand the problems and prioritize the actions to be implemented. The Complementary Law No. 140, of December 8, 2011, provides in Article 23 of the Federal Constitution, that the elaboration and implementation of the ZEE (Ecological-Economic Zoning) is the responsibility of the States. However, one observe that after more than 40 years since the promulgation of the Law, this is still not a reality (Brazil, 2011; Brazil, 1981).

The literature points to several obstacles that can compromise the development, implementation, and effectiveness of this instrument, such as: political will; the large amount of data from different nature (physical, environmental, socioeconomic, cultural) and time required for data collection and analysis; the need for varied participation of specialists from different areas of knowledge, team planning, and fieldwork; lack of financial resources to carry out complex studies and implement the measures proposed in the ZEEs; difficulty in involving civil society in the construction of the ZEEs; and the existence of different interests among the various social actors, which can generate conflicts and hinder consensus. The lack of coordination between the different levels of government (federal, state, and municipal) can generate inconsistencies and overlaps in land use policies; the existence of divergent legislation at different levels of government can hinder the implementation of Ecological-Economic Zoning (EEZ); rapid socioeconomic and environmental changes require constant updating of EEZs, which demands resources and technical capacity. Furthermore, the pressure for economic development can generate conflicts with environmental conservation objectives (Ab'Saber, 1989; Santos, 2004; Benatti, 2004;

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TCU, 2008; Câmara, 2008; Fritzsons; Corrêa, 2009; Santos; Ranieri, 2013; MMA, 2016; Nicolodi et al., 2018; Lopes et al., 2019; Fontes; Fontes; Silva, 2021; Vagula; Uliana; Arana, 2021; Ross et al., 2022, etc).

Given the issues raised, this study seeks to identify which environmental components and factors are most important for the development of an environmental diagnosis, to obtain an optimal result in less time and at a lower cost, ensuring greater speed in the diagnosis.

In this context, our objective is to identify and prioritize a set of environmental components and factors defined in the diagnostic stage contained in the methodological guidelines for ZEE in Brazil, proposed by the MMA and those used in the zoning of Acre, Mato Grosso do Sul and Tocantins States, at 1:250,000.

The selection of the States Acre, Mato Grosso do Sul and Tocantins was motivated by the need to understand the evolution and differences in the formats adopted by each State during the development phase of the ZEE and due to available structured datasets.

II. MATERIAIS E MÉTODOS

Study area

The study area corresponds to the States Acre and Tocantins, both in Northern Brazil, and Mato Grosso do Sul, in the Central-West region (Figure 1). The ZEE-Acre is the most complete and oldest one, while the ZEE-TO is the most recent. Acre developed Phase 1 (scale 1:1,000.000) in the early 2000s and subsequently Phase 2 (scale 1:250,000), which was approved by the State Legislative Assembly under Law No. 1,904/2007, amended by Laws 2,006/2008 and 2,693/2013 (Brazil, 2007; Brazil, 2008; Brazil, 2013).

The ZEE-TO was completed in 2018, at 1:250,000; It was approved by the State ZEE commission, but has not yet been ratified by the State Legislative Assembly (Brazil, 2018).

Mato Grosso do Sul developed Phase 1 at scale 1:1,000,000, it was approved by the Assembly in 2009. Afterwards Phase 2 was developed at 1:250,000, finalizing it in 2015, but it was not yet approved by the State Legislative Assembly (Brazil, 2015).

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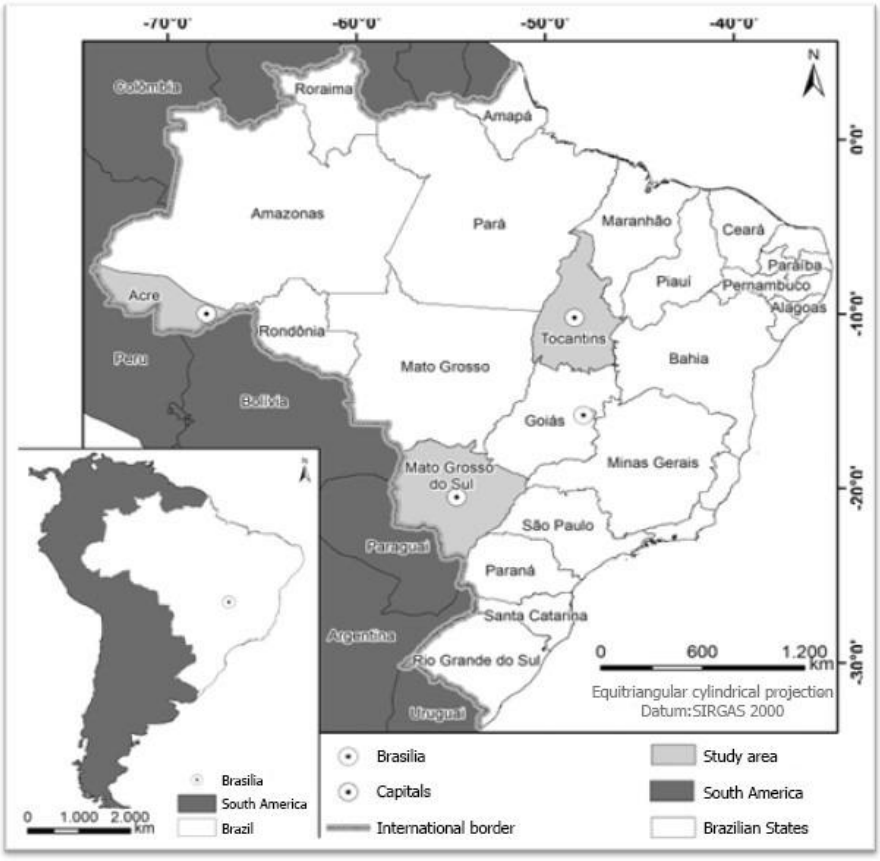

Figure 1 – Location map of the study areas (Source: the authors).

The Acre State, located in the northern Region, borders Peru, Bolivia, Amazonas, and Rondônia States. It has an area of 164,173.429 km² and 22 municipalities. The population recorded in 2022 was 830,018 people, with a population density of 5.06 inhabitants/km² (IBGE, 2022).

Acre is predominantly covered by the Amazon rainforest, one of the planet largest biomes; it has an extensive hydrographic network, notably the Acre River and tributaries, which are used for transportation, fishing, and water supply. The terrain is flat, with some areas of low hills; the climate is tropical hot and humid, with a high annual rainfall.

The Tocantins State, located in central Brazil, borders Goiás, Mato Grosso, Pará, Maranhão, Piauí, and Bahia. It has an area of 277,423.627 km² and 139 municipalities. The population recorded in the 2022 census was 1,511,460 people, with a population density of 5.45 inhabitants/km² (IBGE, 2022).

Tocantins presents three main types of relief: plateaus, plains, and depressions; the predominant climate is tropical, with two seasons: a dry and a rainy season. The vegetation cover is mostly composed of Cerrado (Brazilian savanna). At its northern portion, there is a transition to the Amazon Rainforest. The State is rich in

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water resources, with important rivers such as the Araguaia, Tocantins, Sono, and Balsas. Bananal Island, the largest river island in the world, is located on the Araguaia River.

The Mato Grosso do Sul State, located in the Central-West region, borders Mato Grosso, Goiás, Minas Gerais, São Paulo, and Paraná State, as well as Paraguay and Bolivia. It has an area of 357,142.082 km² and 79 municipalities. The population recorded in the 2022 census was 2,757,013 people, with a population density of 7.72 inhabitants/km² (IBGE, 2022).

The landscape of Mato Grosso do Sul State is characterized by plains, plateaus with escarpments, and depressions. The predominant climate is tropical, with two well-defined seasons: a rainy in the summer and a dry season in the winter. The vegetation cover consists of Cerrado (Brazilian savanna), Atlantic Forest, and the Pantanal, which is the largest wetland in the world. The State has much water resources, with important rivers such as the Paraguay, Paraná, Taquari, and Miranda.

Methodologic procedures

The method adopted for this study is qualitative-quantitative, according to Lüdke and André (1986, p. 11). Initially, a bibliographic survey was carried out, according to the methodology proposed by Marconi and Lakatos (2017). Subsequently, a documentary research was conducted to gather and identify environmental information related to detail the methodological guidelines for the ZEE in Brazil (MMA, 2006). Information published by the State Secretary for the Environment and Indigenous Policies (Semapi) regarding the Acre Ecological-Economic Zoning (Acre, 2010a-e), the State Secretary for the Environment, Economic Development, Production and Family Agriculture (Semagro) regarding the Mato Grosso do Sul Ecological-Economic Zoning (Mato Grosso do Sul, 2015), and the Secretary for Planning and Budget (Seplan) of Tocantins (Tocantins, 2016; Tocantins, 2017a-g; Tocantins, 2018a-b) were also retrieved, referring to the three completed Ecological-Economic Zoning projects at 1:250,000 scale.

Subsequently, a comparative method was carried out on the information used in the three studied ZEEs and the methodological guidelines for the ZEE, with the aim to "verify similarities and explain divergences" (Marconi; Lakatos, 2017). The tables with the environmental components and factors were used for this comparison.

After the identification and comparative analysis, information on environmental services (or ecosystem services) suggested in the MMA (2016) study on the ZEE of the Legal Amazon was included, as well as some data indicated in the consulted bibliography, synthesized in Appendix A (Synthesis of the environmental information

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used in ecological-economic zoning, scale 1:250,000). This synthesis allowed to structure the questionnaire, sent to the experts.

For each zoning area studied, a set of environmental components and factors was established. This grouping of information was based on the systematization of the thematic structure of the diagnoses established in the methodological guidelines by the MMA (Ministry of the Environment) and in the ZEEs (Ecological-Economic Zoning) of the Acre, Mato Grosso do Sul, and Tocantins States.

The questionnaire was structured in two sections, consisting of multiple-choice questions. Thus, the experts could choose a certain importance value from a set of options. The two sections comprise environmental information in: Group 1 - Environmental components used in ZEEs; and Group 2 - Environmental factors that make up the environmental components. The questionnaire was implemented on the Google Forms platform.

Each class represents a different level of information that, when combined, provides a holistic and integrated view of the territory. This allows an improved understanding of the interactions and impacts, facilitating the development of more efficient and effective management scenarios and maps.

The application of the questionnaire developed from the previous steps seeks to highlight which components and factors have the highest degree of importance in the environmental diagnosis stage. The experts assigned a degree of importance ranging from 0 (no importance at all) to 10 (maximum importance) for each environmental component and for each environmental factor identified and listed. For the qualitative analysis and discussion, the degrees of importance (0 to 10) were empirically grouped into four classes, associating quality with them, with two classes close to the extremes and two intermediate classes. The logic of this stratification technique is to separate the information into relatively homogeneous groups in order to facilitate analysis and interpretation.

Class 1 (0 to 2) – no importance

Class 2 (3 to 5) - low importance

Class 3 (6 to 8) - high importance

Class 4 (9 to 10) - extreme importance

In order to ensure the participation of different knowledge areas, the selection of experts to whom the questionnaire was addressed was as follows: professors, researchers, independent specialists, technicians from the Federal and State governments, obtained from the websites of postgraduate courses, the Ministry of the

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Environment, State Secretariats, research institutes and companies (Sema, IBGE, Universities, etc.) and, in the authorship of published articles related to Zoning.

To expand the list of respondents, a methodological technique called Snowball (Goodman, 1961) was used for data collection, which allows initial participants to indicate other professionals, thus successively creating a chain of referrals, until the proposed objectives are achieved. Initially, 117 questionnaires were sent, with 8 more added through referrals, totaling 125.

The questionnaires were sent by email on November 1, 2022, and the experts contacted again on November 18, 2022, to check if there were any problems receiving the questionnaires. By January 2023, 62 complete questionnaires had been received, 8 of which were discarded for not meeting the research requirements. It should be noted that, for legal reasons, respondents were identified in the results by numbers (1; 2; 3...) etc. As the data are presented in aggregate form, there was no need for approval from the ethics committee.

After receiving and analyzing the conformity of the questionnaires, tabulations were made in the form of a frequency table and the results presented using graphs and charts. To hierarchize the information, using the percentage assigned to the degrees of importance (0 to 10), the number of respondents for each component or factor was used, converted into a percentage.

In this context, the more experts who assigned, for example, a score of 10 to a question, the higher the percentage of respondents and, consequently, the greater its importance.

III. RESULTADOS E DISCUSSÃO

Components and environmental factors used for ecologic-economic zoning, at 1:250.000 scale

There are 5 components and 20 environmental factors considered fundamental for the development of Brazilian ZEEs (Table 1, first column), according to the methodological guidelines from the Ministry of the Environment (MMA, 2006).

Thus, it can be observed that similar characterization and environmental diagnosis studies were carried out in the three ZEEs studied, in accordance with the guidelines established by the MMA. Acre and Tocantins, belonging to the Legal Amazon (AML), and Mato Grosso do Sul, part of the Central-West region, present a set of environmental information, which were grouped into 5 components, encompassing 30 environmental factors (Table 1, second column).

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Table 1 – Components and environmental factors suggested in the methodologic guidelines from the MMA and those identified at the State ZEE's.

Components and environmental issues				
MMA	**States**	**AC**	**MS**	**TO**
Physical environment				
1.Climatology	1.Climatology	x	x	x
2.Hydrology	2. Water resources (hydrography)	x	x	x
	3.Hydrogeology (related to geology))		x	x
3.Geomorphlogy	4.Geomorphology	x	x	x
4.Pedology	5. Pedology	x	x	x
5.Geology	6.Geology	x	x	x
	7. Mineral resources		x	x
Biotic environment				
6. Biodiversity	8.Vegetation	x	x	x
	9. Fauna	x	x	x
	10. Flora	x	x	x
Social economic environment				
7. Land use	11. Land use and occupation	x	x	x
	12. Land tenure structure and land subdivision	x	x	x
8. Urban-Regional network	13. Public and productive infrastructure (transport and basic sanitation, energy and means of communication)	x	x	X
9. Economics and Space Management	14. Economic aspects and forestry potential (GDP and economic activities/land use)	x	x	x
	15. Dynamic areas (population concentration; economic plurality; opportunity; physical and virtual connectivity).	x	x	x
10. Population Studies	16.Evolution and population distribution and demographic dynamics (Social, economic, political and cultural situation)	x	x	x
	17.Archeology	x		
11.Living conditions of the population	18.Social indicators (Work, Earnings, Education, Health, Sports, Leisure, Culture, Security, Housing/Dwellings, Basic sanitation (Urban cleaning, Urban Rainwater drainage, Water supply, Solid waste collection, Sewage disposal), demographic aspects and HDI).	x	x	x
12.Traditional Populations	19. Special areas (Tourism, Conservation Units and Traditional Communities - indigenous, quilombolas, babaçu coconut breakers - etc).	x	x	x
Legal and institutional aspects				
13. Institutional areas	20. Legal protected areas (conservation units and traditional communities: indigenous lands, areas of permanent preservation, legal reserve, quilombolas, among others).	x	x	x
14. Legal aspects	21.Land tenure, State resource plan, State forestry plan, Water resources plan, State biodiversity program, Municipal master plans, Forestry code, City statute, etc.	x	x	x
15. Civil organizations	22. Professional organizations, NGOs, Private and governmental institutions	x	x	x
Integrated studies				
16.Basic territorial units	23.Basic territorial unit		x	
	24.Landscape units/biophysical landscape units	x		x
	25.Territorial management	x	x	x
17.Environmental vulnerabilty	26.Vulnerability of landscape units/ Environmental or geo-environmental vulnerability / Vulnerability anthropogenic action	x	x	

Continues...

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18.Landscape fragility	27. Environmental fragility / Erosive potential	x	x	x
19. Soil suitability	28. Suitability for agriculture (relationship withy pedology)	x	x	x
20.Socioeconomic potential	29.Socioeconomic potential	x	x	
	30.Spatial socioeconomic dynamics			x

Source: Adapted from the Ministery of the Environment (MMA, 2006).

It was found that the three zoning plans analyzed are in line with the recommendations presented by the methodological guideline for the Brazil ZEE. However, they are at different stages of execution and the environmental information was prepared in different ways, sometimes making it difficult to unify the legends and guidelines, which would allow a single view of the country.

Starting from the identification of the study elements in the environmental diagnosis phase, it was found that all followed the MMA methodology, but the distribution of the elements presents differences since they have unique characteristics, considering the methodology used, the team and the biophysical characteristics of each State studied.

Prioritization of environmental components and factors used in ecological-economic zoning, at 1:250,000

The responses obtained from the online questionnaire allowed us to identify the degree of importance and prioritize the environmental components and issues, based on the responses obtained from consultations with experts. It should be noted that in the preparation of the questionnaire, questions were asked about 25 environmental issues, since hydrology, hydrogeology, and limnology were grouped into Water resources.

The components refer to the fundamental elements that make up the natural and socioeconomic environment, and are essential to understand the physical and biological basis of the region. Among the environmental components (Figure 2), the relevance of the physical environment and integrated studies stands out, as both received a degree of importance 10 (maximum) from 57% of the experts, while the biotic environment, socioeconomic environment, and legal-institutional aspects had a degree of importance 10 assigned by experts, of 48%, 37%, and 28%, respectively.

Thus, there seems to be an understanding among experts on the importance of the physical environment as the main basis for the information needed to ZEEs, since in the physical environment the activities and changes occur. Furthermore, this is the "home" of the biotic system, including studies of vegetation, flora, fauna, and environmental systems. The physical-biotic components are articulated and integrated in such a way that they define complex mechanisms of function and interdependence, which must be understood and considered by the planners (Ross, 2000; Moreira, 2008).

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From a qualitative point of view, the physical environment remains the most relevant set of information, as it was classified as class 4 (extreme importance) by 85% of the experts, followed by the biotic environment with 81%, integrated studies with 77%, the socioeconomic environment with 76%, and the legal-institutional aspect with 56%. It should be noted that only slightly more than half of the respondents considered legal information, relevant for the preparation of the ZEE.

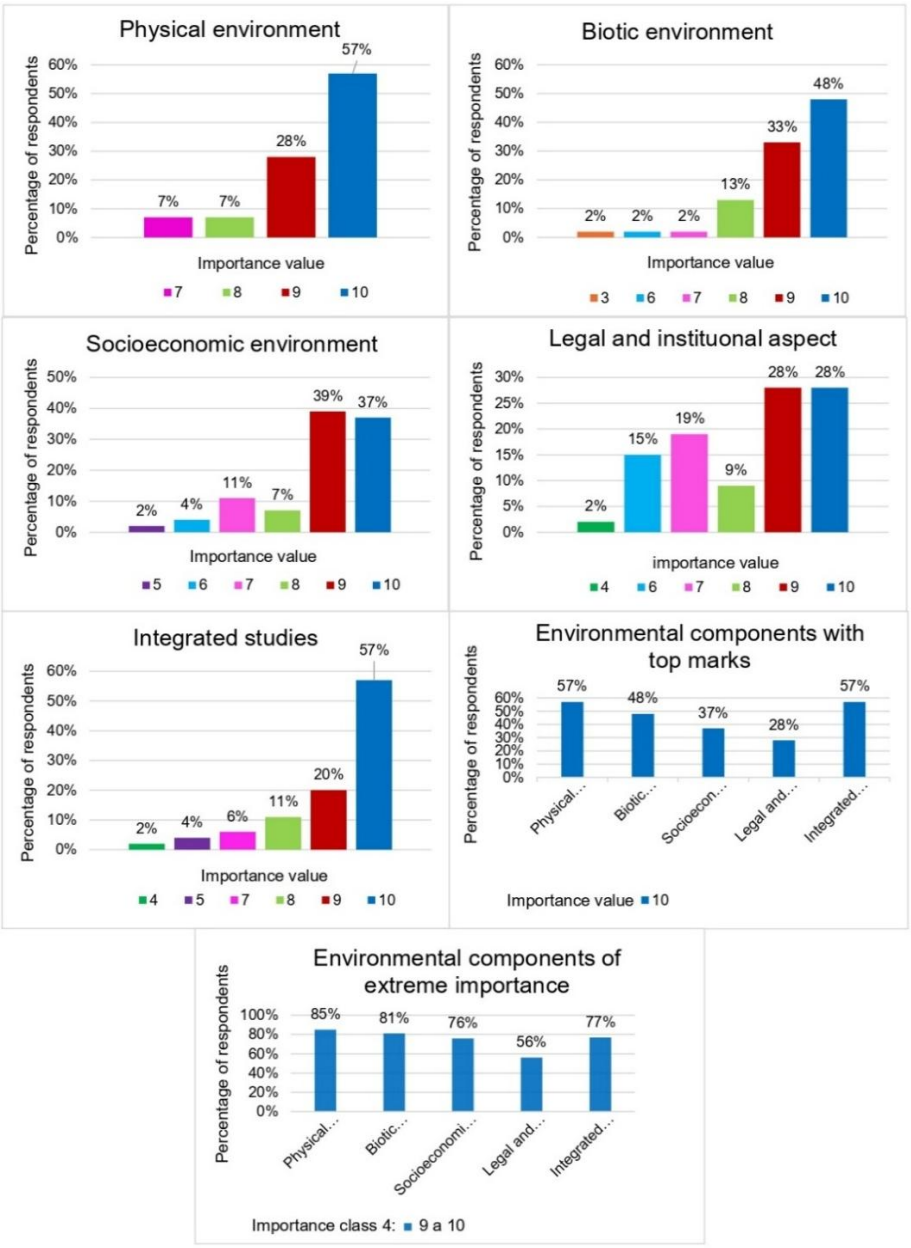

Figure 2 – Level of importance from environmental components obtained by interviews with experts (Source: the authors).

Among the five environmental components, it is noted that the institutional legal aspects and socioeconomic environment components received the lowest percentages of importance rating from the

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experts, being 28% and 37%, respectively. Studies referring to institutional legal aspects relate to legal issues, to formally guide and influence the actions of people among themselves and on the territory, through legislation that delimits, interferes with, and defines the contents of the territories (MMA, 2006, p. 62).

It is necessary to understand that both the natural and the anthropic environments are fundamental parts to understand the process, and the analysis of socioeconomic relations between humans and nature is essential. Therefore, human societies should not be treated as elements foreign to nature; on the contrary, they are active agents in this process that make the system function as a whole (Ross, 2000).

It is understood that all these environmental components support animal and human life. Factors are the variables that influence or are influenced by the components. The identification and analysis of environmental factors helps to understand the dynamics and interactions between the different components of the environment. To improve its understanding, environmental factors will be presented in association with their respective environmental components, highlighting the presentation of graphs only for factors associated with the physical and biotic environments.

From a quantitative point of view, the six environmental factors of the physical environment (Figure 3) were ranked considering the highest percentages of importance level 10 assigned by experts as follows: water resources (74%), geomorphology (69%), climatology (56%), pedology (54%), geology (48%) and mineral resources (30%). Qualitatively, the ranking was as follows: water resources, geomorphology, and soil science were classified as class 4 (extreme importance) by 78% of the experts, followed by climatology with 76%, geology with 61%, and mineral resources with 50%.

According to Ross (1995), climatological studies contribute to knowledge about soils, relief dynamics, the evaluation of erosive processes, flooding, landslides, chemical erosion processes, as well as favoring the understanding of the vegetation cover distribution or the behavior of the hydrological regime of rivers. Water has always been essential for the survival of cultural and economic development from civilizations (Tundisi, 2003), and the adequate assessment of the potential quantity and quality of water are objectives pursued in planning. Without giving due consideration to the importance of water for human society, any planning will be doomed to failure in the medium or long term. Júnior (2007) emphasizes the need for water management, its importance being reinforced in public policies, which allow and demand greater involvement and participation of society, a fact that has led to a sum of efforts for social awareness and the opening of the main decentralized and participatory management systems.

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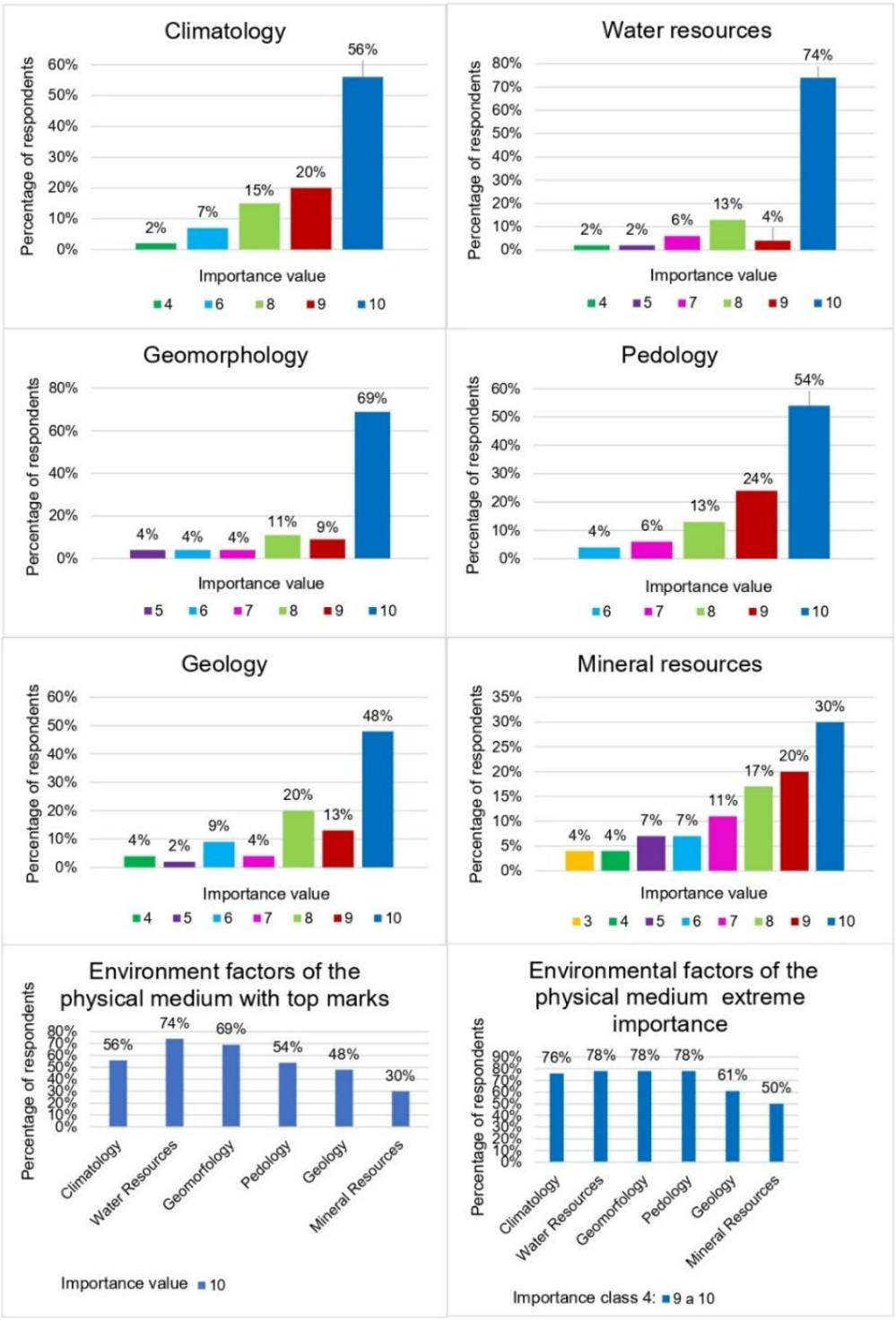

Figure 3 – Degree of importance of environmental factors within the physical environment obtained by interviews with experts. (Source: the authors).

Geomorphological analyses require information on geology, soils, climate, water, vegetation cover, and land use types. On the other hand, geomorphological studies, based on understanding dissection patterns and slope typology identified with the analysis of aerial photographs, radar and satellite images, offer fundamental

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support for the identification and analysis of rock and soil typology (Christofoletti, 1980, p. 01). Pedology, in turn, should be concerned with the morphological, physical, chemical, and mineralogical characterization of soils while simultaneously mapping and classifying soil types. These studies evaluate the agricultural suitability of lands and provide information on textural, structural, and chemical characteristics for the analysis of relief dynamics, fragility, and functionality of the environmental systems where each dominant soil type occurs.

The exploitation of mineral resources causes negative impacts on the environment, resulting in the depletion of vegetation, altered topography, soil, and pollution of water resources as a consequence of mining activities (Ross, 1995). However, everything depends on the correct management, through the method, technology, and avoided impacts, among other factors. Therefore, it is important to monitor and supervise mining activities to prevent environmental damage.

From a quantitative point of view, the four environmental factors of the biotic environment (Figure 4) were ranked considering the highest percentages of importance value 10 assigned by the experts as follows: vegetation (63%), flora (50%), environmental services (56%), and fauna (46%). Qualitatively, the ranking was as follows: vegetation, flora, environmental services, and fauna, which were classified by experts as class 4 (extreme importance) as 87%, 76%, 75%, and 65%, respectively.

Tricart (1977) states that living beings are one of the three forces that govern the geographical environment. Therefore, the geographical environment is thus the physical environment plus living beings seen in the scope of their interactions, with living beings as its formative subject (Moreira, 2008). In this way, the physical environment supports living beings and is divided into climatic and edaphic data. In this sense, we can understand that living beings, plants and animals, are the link that integrates and gives the character of a whole to the environment. Finally, man is the living being that confers the meaning of environment to the environment (Moreira, 2008). For this understanding, the following is highlighted:

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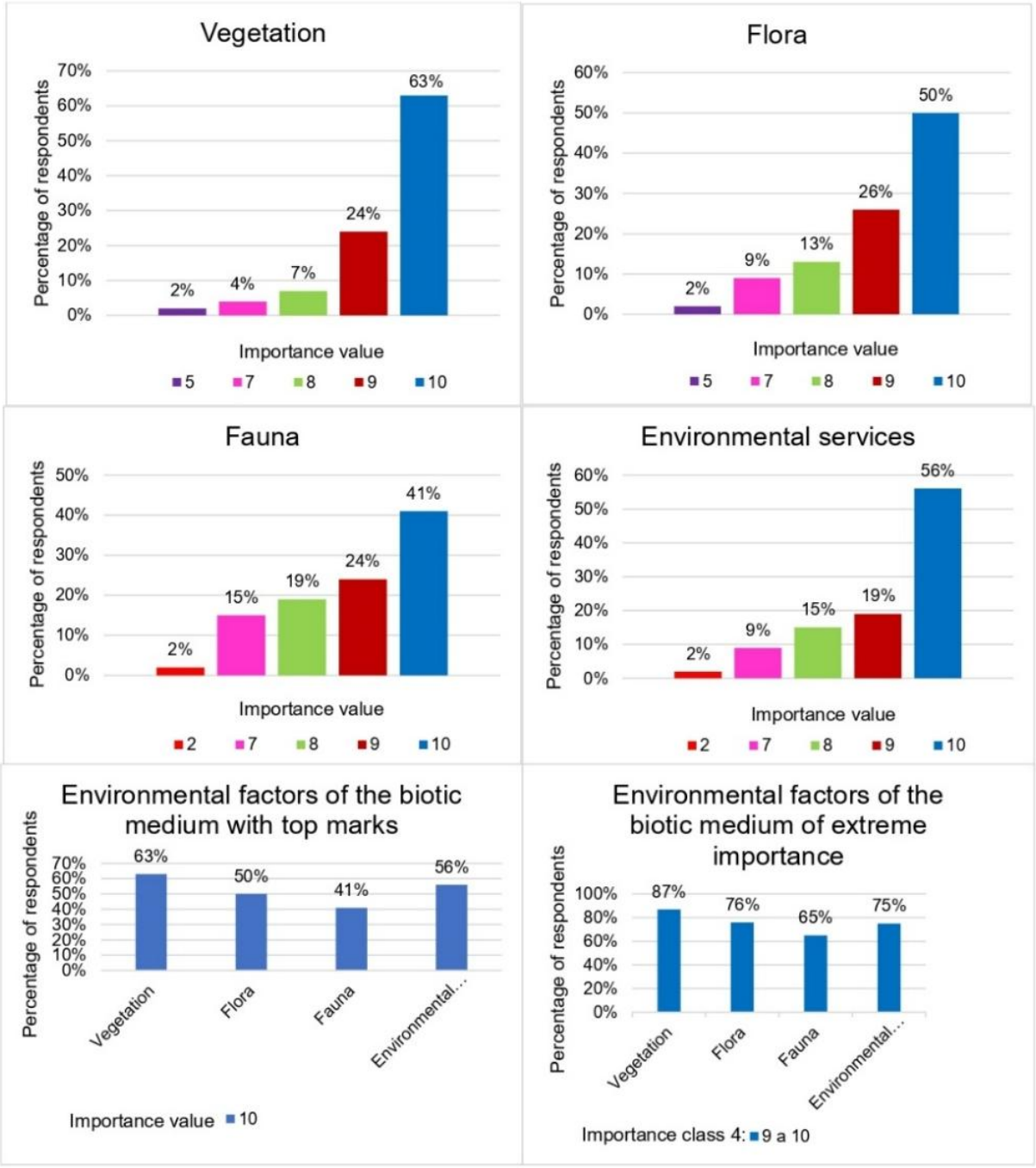

Figure 4 – Degree of importance of environmental factors in the biotic medium obtained through interviews with experts. (Source: the authors).

Vegetation plays an essential role, as it protects and nourishes the soil, contributing in addition to air humidity, which in turn contributes to the high rainfall and rich hydrographic network of this ecosystem. With the destruction of the forest, thousands of plant and animal species are extinct; humidity decreases and, consequently, rainfall levels decrease, causing additionally soil impoverishment, which loses the protection and nutrients provided by dense vegetation. In this way, the destruction of the forest, which occurs at an accelerated

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pace, also contributes to warming the atmosphere and disrupts the balance of the ecosystem. The disruption of this imbalance has global implications; therefore, the preservation of the forest is an environmental necessity for the planet Earth (Florenzano, 2007, p. 69).

According to Araújo (n.d.), vegetation is one of the most important components of the biota; its state of conservation and continuity defines the existence or not of habitats for animal species, the maintenance of environmental services, and the provision of essential goods for the survival of human populations. Perhaps specialists do not attribute as much importance to fauna, as they perceive the essential role that vegetation plays, contributing to the existence of human and animal life. Humans need air, soil, water, plants, and animals; while plants and animals synthesize the energy they extract from the atmosphere, hydrosphere, and lithosphere, which serves as food for humans (Ross, 1995, p. 70).

From a quantitative point of view, the seven environmental factors of the socioeconomic environment were ranked considering the highest percentages of importance level 10 attributed by the experts as follows: land use (74%), traditional populations (50%), population living conditions (46%), economy and spatial management (31%), population studies (26%), urban-regional network (22%), and archaeology (20%). Qualitatively, the ranking was as follows: land use, living conditions, traditional populations, economy and spatial management, population studies, urban-regional network, and archaeology, which were classified as class 4 (extreme importance) by 93%, 77%, 69%, 66%, 56%, 50%, and 37% of the experts, respectively.

Land use and traditional populations imply knowledge of the space and its relations with society, protected by special legislation aimed at its protection. Thus, the results obtained demonstrate that studies of land use and traditional populations are considered the most important environmental factors of the socioeconomic environment for the development of the ZEE.

A proper understanding of the current natural resources use and how a given community utilizes and treats nature, and how it has treated and used it throughout history, allows to perceive the trend and anticipate the "Spontaneous Future Scenario" providing also subsidies to intervene through planning and define the "Projected Future Scenario" (Ross, 1995).

From a quantitative point of view, the three environmental factors of the institutional legal environment were ranked considering the highest percentages of importance level 10 attributed by the experts as follows: legal aspects (54%), institutional areas (37%), and civil organizations (26%). Qualitatively, the ranking was as follows: legal aspects, institutional areas, and civil organizations, which were classified as class 4 (extreme

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importance) by 73%, 70%, and 52% of the experts, respectively. This shows a greater perception among experts regarding legal aspects and institutional areas, but little interest in civil organizations within the scope of zoning.

Therefore, the zoning of a territory should be the spatial translation of the economic, social, cultural, and ecological policies of society. For its functioning, it must take into account the existence of multiple decision-making powers, both individual and institutional, that influence the organization of space (Benatti, 2004). These range from market logic and the particularities of administrative systems to the diversity of socioeconomic and environmental conditions of a region (Benatti, 2004).

From a quantitative point of view, the five environmental factors of the integrated studies were ranked considering the highest percentages of importance level 10 attributed by the experts as follows: environmental vulnerability and environmental fragility, both with 65%; basic territorial units and socioeconomic potential, both with 50%; and agricultural suitability of the land (43%). Qualitatively, the ranking was as follows: environmental fragility, environmental vulnerability, socioeconomic potential, basic territorial units, and agricultural suitability of the land, which were classified as class 4 (extreme importance) by 89%, 84%, 81%, 74%, and 71% of the experts, respectively.

In the debate on sustainable development, the notion of integrated management of natural resources is increasingly relevant. Through it, the possibility to anticipate and prevent environmental problems is indicated; to regulate the relationships between sociocultural systems and the biophysical environment; and to guarantee the renewal or preservation of resources. Above all, the notion of integrated management appears as a way to reconcile preservation and development (Benatti, 2004). Santos (2004) highlights two obstacles; the conflict between specialists in each subject, who work with their own concepts, appropriation of spaces, objectives, spatial scales, temporal evolution, and methods, hinders the successful application of environmental diagnoses. It is important that the team be multidisciplinary and clearly select the integration method for formulating the issues addressed. Often, integration fails due to a lack of coordination among multidisciplinary teams, as everyone must focus on a single proposed method, collaborate, and share relevant information, integrating with other disciplines. It is worth remembering that current integration methods, given that most zoning in Brazil is based on static and qualitative assessments, with rare probabilistic studies, are in practice structured subjectively, requiring the development of methodological strategies (Santos, 2004) to carry out integrated studies.

Reflection on the practice of interdisciplinarity between natural sciences and human sciences highlights some important problems (Dobremez et al., 1990 apud Zanoni; Raynaut, 2015): A – Methodological problems

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(time and levels of approach) and B – The practical organization of work (interdisciplinarity, due to the differences that exist between the representations, methods and languages of the various disciplines involved in the cooperation).

In this sense, the importance of interdisciplinarity to environmental planning at environmental diagnosis becomes clear. According to Teixeira (1995, p.32), interdisciplinarity is the encounter and cooperation between two or more disciplines, each of which brings its own body of concepts, its way of defining problems and its research methods.

IV. CONCLUSÕES

The Ecological-Economic Zoning (EEZ) is a fundamental instrument for the sustainable territorial management in Brazil, but it still faces challenges to its full implementation. One of these is to overcome the diagnostic phase, which involves the collection and analysis of a set from essential information for the construction of an effective and efficient EEZ, representing aspects of the environment state, the natural resources, and related human activities. Consequently, the long period of its elaboration often results in outdated data, among other issues. This data allows a deeper understanding of the territorial reality, facilitating decision-making and monitoring the results of implemented actions. Selecting the appropriate information, it is possible to ensure that the EEZ is a relevant instrument for to promote the sustainable development.

The components and factors evaluated were considered important by the experts. However, it is always questioned whether the more information is available, and the more recent and reliable its sources, the more accurate will be the delimitation of homogeneous natural, socioeconomic, and management zone. This information can better demonstrate their internal homogeneities and heterogeneities, facilitating the identification of the potential and weaknesses of these zones and allowing specific recommendations for each one.

It is difficult to present an ideal set of environmental components and factors. It can even be asserted that there is no ideal set to be adopted. However, this research shows, from the experts' perspective, that there is a preponderance of physical variables, which were prioritized. Thus, it can be said that this attribution refers to the factor of the physical environment, the concreteness of space, so that life can establish itself and make such information dominant.

In this way, this study serves not only as a support of parameters, but also as an important document that refers to relevant points to be considered in ZEEs. With the hierarchical organization of environmental

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components and factors, it becomes easier to exclude some of them, considering time and financial resources. This facilitates the execution of diagnoses for ZEEs and stimulates managers of Brazilian States in the elaboration of this planning instrument.

In conclusion, it is suggested that this discussion be brought to the attention of the various stakeholders involved in the topic of EEZs, aiming to optimize the collection of environmental information.

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