Periódico Eletrônico Fórum Ambiental da Alta Paulista
Electronic Journal Environmental Forum of Alta Paulista

ISSN 2966-2931 - v. 21, n. 3, 2025

The Current Scenario of the Sustainable-Use Protected Areas in the Brazilian State of Pernambuco

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Submissão: 05/08/2025
Aceite: 12/10/2025
RÊGO, Ananda do Nascimento; ARAÚJO, Bianca Gonzaga de; LIMA, Renata Bezerra de Moura; TELINO JÚNIOR, Wallace Rodrigues; LYRA-NEVES, Rachel Maria de. O Retrato atual das Unidades de Conservação de Uso Sustentável no Estado de Pernambuco. **Periódico Eletrônico Fórum Ambiental da Alta Paulista**, *[S. l.]*, v. 21, n. 3, p. e2503, 2025. DOI: 10.17271/1980082721320256203. Disponível em: https://publicacoes.amigosdanatureza.org.br/index.php/forum_ambiental/article/view/6203.

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Electronic Journal Environmental Forum of Alta Paulista

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O Retrato atual das Unidades de Conservação de Uso Sustentável no Estado de Pernambuco

RESUMO

Objetivo - O presente estudo buscou analisar as Unidades de Conservação (UCs) de Uso Sustentável no estado de Pernambuco, elencando por suas categorias, biomas protegidos e instrumentos de gestão, como planos de manejo e conselhos gestores.

Metodologia - A pesquisa possui caráter descritivo e exploratório e foi realizada em três etapas principais: (1) levantamento bibliográfico em artigos científicos, legislações e documentos governamentais relevantes; (2) coleta de dados junto à Agência Estadual de Meio Ambiente (CPRH), com filtros específicos para identificar as UCs estaduais e municipais, seus biomas associados, e a existência de planos de manejo e conselhos gestores; e (3) organização e análise dos dados em tabelas e gráficos para uma visualização clara e acessível. Essa abordagem proporciona uma visão detalhada e fundamentada da gestão das UCs no estado.

Originalidade/relevância - O estudo aborda lacunas na gestão e distribuição territorial das UCs em Pernambuco, tornando clara a necessidade de maior representatividade de biomas, especialmente a Caatinga, no contexto das políticas públicas ambientais.

Resultados Foi possível identificar que Pernambuco possui 48 UCs estaduais e 28 municipais de uso sustentável, com baixa representatividade da Caatinga e desafios na implementação de instrumentos de gestão, como planos de manejo e conselhos gestores.

Contribuições teóricas/metodológicas - O estudo destaca a importância de fortalecer a gestão participativa nas UCs por meio da implantação de conselhos gestores e planos de manejo, além de ampliar a proteção de biomas negligenciados.

Contribuições sociais e ambientais - As UCs desempenham papel crucial na preservação da biodiversidade, no equilíbrio ambiental e no cumprimento dos Objetivos de Desenvolvimento Sustentável, promovendo benefícios sociais, econômicos e ecológicos.

PALAVRAS-CHAVE: Políticas públicas ambientais. Gestão Ambiental. Biodiversidade.

The Current Portrait of Sustainable Use Conservation Units in the State of Pernambuco

ABSTRACT

Objective – This study analyzed the Sustainable Use Conservation Units (CUs) in the state of Pernambuco, categorizing them by types, protected biomes, and management tools, such as management plans and advisory councils.

Methodology – The research, descriptive and exploratory in nature, was conducted in three main stages: (1) a bibliographic review of scientific articles, legislation, and governmental documents; (2) data collection from the State Environmental Agency (CPRH), applying filters to identify state and municipal CUs, associated biomes, and the existence of management tools; and (3) organization and analysis of the data in tables and charts for clear and accessible visualization.

Originality/Relevance – The study addresses gaps in the management and territorial distribution of CUs in Pernambuco, emphasizing the need for greater protection of the Caatinga biome within public environmental policies.

Results – Pernambuco has 48 state and 28 municipal sustainable use CUs. However, the Caatinga biome is underrepresented, and there are significant challenges in implementing management tools, such as management plans and advisory councils.

Theoretical/Methodological Contributions – The study highlights the importance of strengthening participatory management in CUs through the implementation of advisory councils and management plans, as well as expanding protection for underrepresented biomes.

Social and Environmental Contributions – CUs play a crucial role in biodiversity conservation, environmental balance, and achieving the Sustainable Development Goals, generating social, economic, and ecological benefits.

KEYWORDS: Environmental public policies. Environmental Management. Biodiversity.

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El retrato actual de las Unidades de Conservación de Uso Sostenible en el Estado de Pernambuco

RESUMEN

Objetivo – Este estudio analizó las Unidades de Conservación (UC) de Uso Sostenible en el estado de Pernambuco, categorizándolas por tipos, biomas protegidos e instrumentos de gestión, como planes de manejo y consejos gestores.

Metodología – La investigación, de carácter descriptivo y exploratorio, se llevó a cabo en tres etapas principales: (1) revisión bibliográfica en artículos científicos, legislaciones y documentos gubernamentales; (2) recopilación de datos en la Agencia Estatal de Medio Ambiente (CPRH), aplicando filtros para identificar las UC estatales y municipales, biomas asociados y la existencia de instrumentos de gestión; y (3) organización y análisis de los datos en tablas y gráficos para una visualización accesible.

Originalidad/Relevancia – El trabajo aborda vacíos sobre la gestión y distribución territorial de las UC en Pernambuco, destacando la necesidad de una mayor protección del bioma Caatinga dentro de las políticas públicas ambientales.

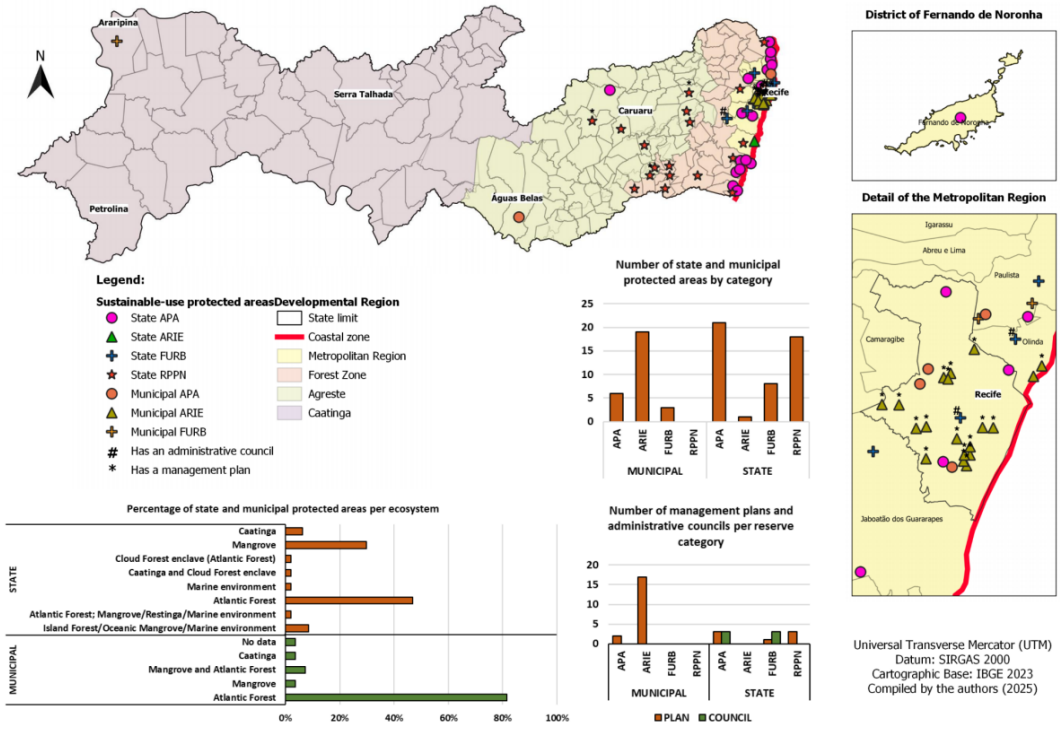
Resultados – Pernambuco cuenta con 48 UC estatales y 28 municipales de uso sostenible. Sin embargo, la representatividad del bioma Caatinga es baja, y existen desafíos significativos en la implementación de instrumentos de gestión, como planes de manejo y consejos gestores.

Contribuciones Teóricas/Metodológicas – El estudio resalta la importancia de una gestión participativa en las UC, promoviendo la implementación de consejos gestores y planes de manejo, además de sugerir la ampliación de la protección de biomas subrepresentados.

Contribuciones Sociales y Ambientales – Las UC son esenciales para la preservación de la biodiversidad, el equilibrio ambiental y el cumplimiento de los Objetivos de Desarrollo Sostenible, generando beneficios sociales, económicos y ecológicos.

PALABRAS CLAVE: Políticas públicas ambientales. Gestión Ambiental. Biodiversidad.

GRAPHIC ABSTRACT



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1 INTRODUCTION

The Brazilian Environment Ministry (MMA, 2024) defines a conservation unit as a legally-protected area, including territorial waters, that has relevant natural characteristics and plays a fundamental role in the preservation of local biodiversity and supporting the quality of life. The principal objective of these areas, which are organized in two principal categories based on their management criteria, is the conservation and preservation of nature. Each category reflects the scope of the protected environments and the measures necessary to guarantee the sustainable use and conservation of these areas.

In Brazil, the concept of protected areas was established formally through the implementation of the National System of Conservation Units (*Sistema Nacional de Unidades de Conservação da Natureza* – SNUC), which was regulated by federal law number 9,985 of July 2000. The SNUC establishes the guidelines, objectives, and criteria for the creation and management of protected areas in the federal, state, and municipal spheres. This legislation establishes two principal groups of protected areas, based on their management principles – (i) fully protected areas, which permit only indirect use and prioritize the preservation of natural resources, and (ii) sustainable-use protected areas, which aim to balance conservation with the rational exploitation of the natural resources available within the area (Brasil, 2000).

The SNUC establishes five categories of fully protected areas – Ecological Station, Biological Reserve, National Park, Natural Monument, and Wildlife Refuge – and seven categories of sustainable-use protected areas (Brasil, 2000). These categories are Area of Environmental Protection, Area of Relevant Ecological Interest, National Forest, Extractivist Reserve, Wildlife Reserve, Sustainable Development Reserve, and Private Natural Heritage Reserve.

There are now 2945 protected areas in Brazil, which cover approximately 18% of the country, and 26% of its territorial waters. The Amazon biome has the largest total area of protected environments, with 120.4 million hectares, representing 28.50% of the country's protected areas. The state with the largest extension of protected areas is Pará, while Piauí is the state with the smallest number of protected areas (Brasil, 2024).

In the Brazilian state of Pernambuco, state and municipal protected areas are included in the State Conservation Unit System (*Sistema Estadual de Unidades de Conservação* – SEUC), which was established by state law 13,787 of June 8th, 2009. The SEUC covers all the diversity of natural ecosystems found in the state of Pernambuco and its territorial waters, and is this aligned with the principles and aims established by the national system (SNUC). The goals of the system include the maintenance of biodiversity, and the preservation and recuperation of natural ecosystems, as well as the conservation of the state's natural resources (Pernambuco, 2009).

In this context, the present study surveyed the state and municipal level sustainable-use protected areas located in Pernambuco, examining the categories of the reserves, the proportion of each biome being protected by these areas, and their relative importance for the state's biodiversity. The management status of each area was also, based on the the confirmation (or otherwise) of the existence of an administrative council and/or a management plan for the reserve. These administrative tools are essential for the effective management of a protected area, through the development of integrated actions, and the regulation of the

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occupation and use of the area, as well as establishing its specific objectives, in terms of the conservation of natural resources.

2 OBJECTIVES

The present study analyzed the sustainable-use protected areas of the Brazilian state of Pernambuco, and verified their categories, the biomes they protect, and the implementation of management tools, such as management plans and administrative councils.

3 METHODS

The present study was based on a descriptive and exploratory approach. Gil (1996) considered this approach to allow for a greater proximity with the problem under investigation, permitting a thorough and detailed analysis of the research question.

The study was divided into three stages – (i) a literature search of the scientific papers available on the study topic, together with the state legislation and other government documents, (ii) the collection of specific data on each area from the state or municipal environmental agency, and (iii) the organization and presentation of the data obtained during the previous two stages.

Once the literature search was complete, the database of the Pernambuco State Environment Agency (CPRH) was consulted to identify the protected areas found in the state and apply the necessary filters for the processing of the data. The CPRH is responsible for the administration and environmental management of the protected areas in Pernambuco state. The filters applied were: protected areas; state sustainable-use protected areas, and sustainable-use protected areas at both state and municipal levels. This filter also permitted the identification of the biome associated with each protected area, as well as the verification of the existence (or otherwise) of a management plan and/or administrative council.

To provide a comparative perspective, the data collected in the present study were analyzed together with those available on sustainable-use protected areas located within similar biomes in other Brazilian states, based on the sources available from the environmental agencies of each state. These sources provided adequate, up-to-data for only six states – Alagoas, Bahia, Ceará, Paraíba, Pernambuco, and Minas Gerais.

The data collected in the present study were organized in tables, for the compilation of graphs using the Office package of the Sheets software. These plots facilitated the visualization of the patterns inherent to the data, and the distribution and relative proportions of the data collected during the study.

4 RESULTS AND DISCUSSION

4.1 State protected areas in Pernambuco

According to the data from the State Environment Agency (CPRH, 2024), the Brazilian state of Pernambuco administers a total of 48 sustainable-use protected areas (Graph 1), of

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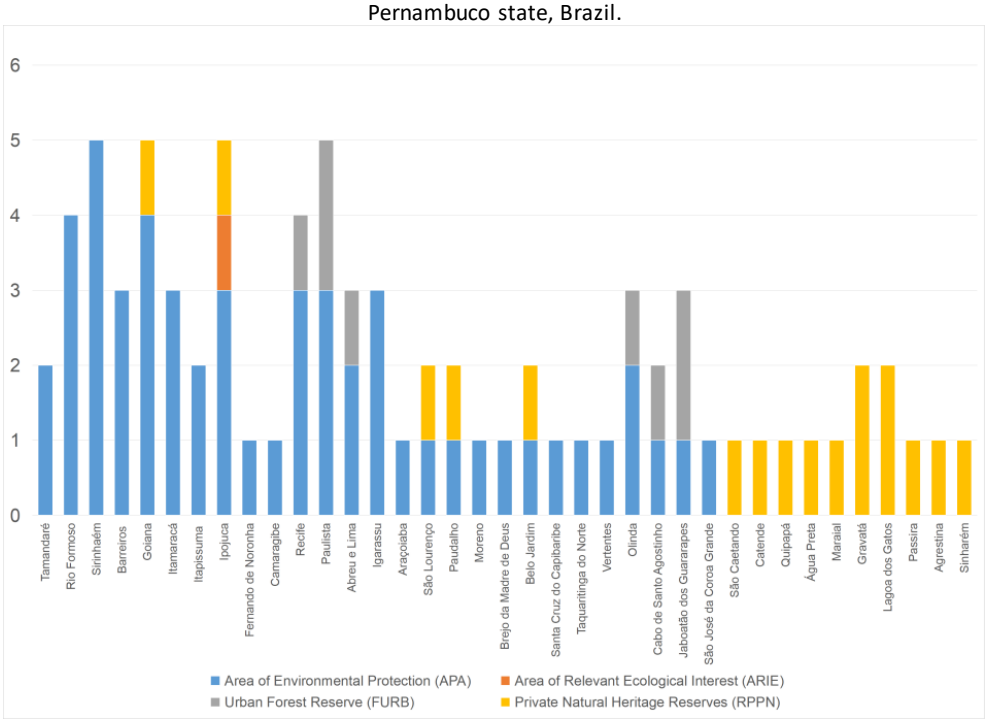
which, 18 are Private Natural Heritage Reserves (*Reserva Particular de Patrimônio Natural* – RPPN), eight are Urban Forest Reserves (*Reserva de Floresta Urbana* – FURB), 21 are Areas of Environmental Protection (*Área de Proteção Ambiental* – APA), and one is an Area of Relevant Ecological Interest (*Área de Relevante Interesse Ecológico* – ARIE). Only four of these 48 reserves currently have both an administrative council and a management plan (Graph 2), while two have an administrative council, but no management plan, and three have a management plan, but no council.

The APA de Guadalupe, an area of environmental protection on the southern coast of Pernambuco, is located within the municipalities of Tamandaré, Sirinhaém, Rio Formoso, and Barreiros (Graph 3A), and is one of the state protected areas that has both a management plan and an administrative council. In the case of the private reserves (Graph 3B), the RPPN Bituri, located in the municipality of Belo Jardim, RPPN Pedra D'Antas in Lagoa dos Gatos municipality, and RPPN Santo Antônio in Passira are the only protected areas in this category that have a management plan, although they do not yet have administrative councils. Only one of the urban forest reserves, FURB Mata do Passarinho, which is located in the municipality of Olinda, has both a management plan and an administrative council (Graph 3C). By contrast, the state's only area of relevant ecological interest, ARIE Ipojuca-Merepe, in the municipality of Ipojuca, has neither a management plan nor an administrative council.

Graph 1 – The distribution of the state-level sustainable-use protected areas in the different municipalities of Pernambuco state, Brazil.



Source: Compiled by the authors; Data: CPRH, 2024.

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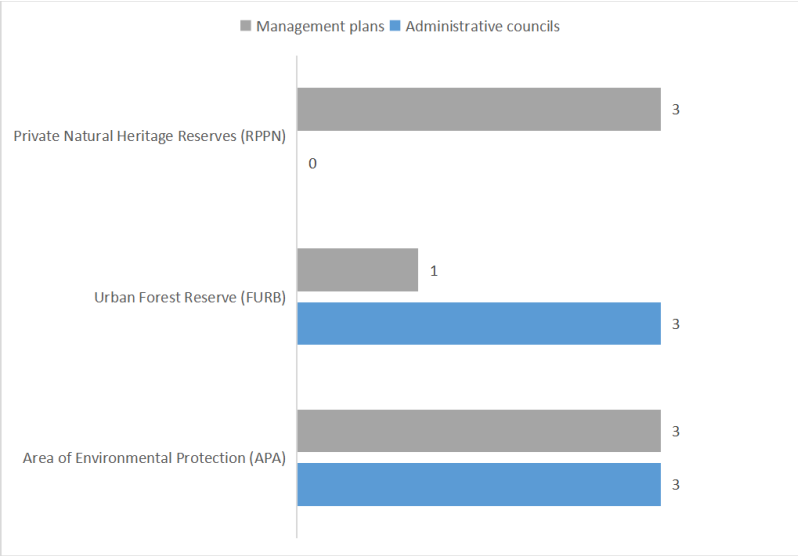
Graph 2 – Number of state-level sustainable-use protected areas of each category in Pernambuco state, Brazil that have current management plans and/or administrative councils.



Source: Compiled by the authors; Data: CPRH, 2024.

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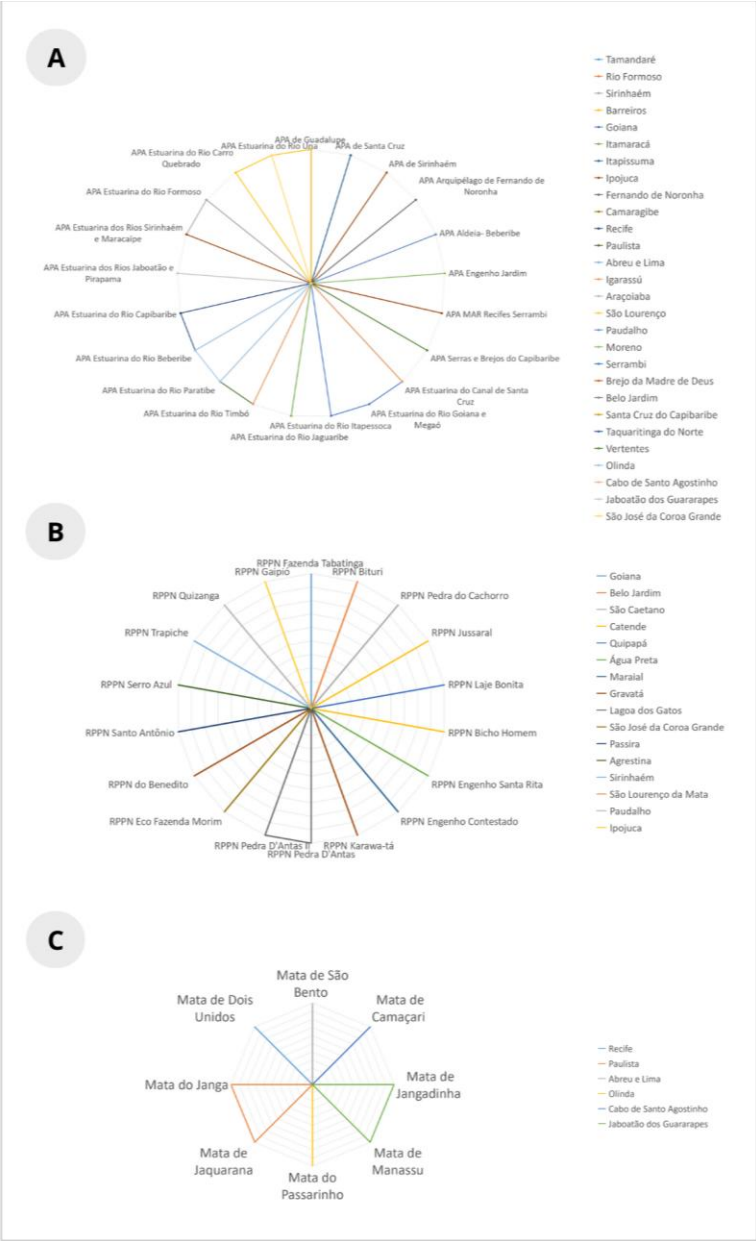
Graph 3 – The distribution of the state-level sustainable-use protected areas among the different municipalities of Pernambuco state, Brazil: (A) Areas of Environmental Protection (APAs); (B) Private Natural Heritage Reserves (RPPNs); (C) Urban Forest Reserves (FURBs).



Source: Compiled by the authors; Data: CPRH, 2024.

The creation of a protected area should be based on environmental surveys, which compile data on the location of the area, and its general features and specific attributes that require conservation, as well as the dimensions and necessary limits for the area (Brasil, 2000). The implementation of the area depends, in particular, on the establishment of specific norms by the entity responsible for its administration, which regulate the occupation of the reserve and the use of its resources. In this context, the Brazilian national system (SNUC) defines the general and more specific objectives that should be targeted by all protected areas (Brasil, 2000, article 4), in order to guarantee the conservation of both biological diversity and environmental quality, as follows:

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I - Contribute to the maintenance of the biological diversity and genetic resources of the nation and its territorial waters;
II - Protect the species threatened with extinction at regional and national levels;
III - Contribute to the preservation and restoration of the diversity of natural ecosystems;
IV - Promote the sustainable development of natural resources;
V - Promote the application of the principles and practises of the conservation of nature in the development process;
VI - Protect natural and well-preserved landscapes of exceptional scenic beauty;
VII - Protect relevant geological, geomorphological, speleological, archeological, paleontological, and cultural features of the natural environment;
VIII - Protect and recuperate water and soil resources;
IX - Recuperate or restore degraded ecosystems;
X - Provide incentives and the means for scientific research, study, and environmental monitoring;
XI - Assign economic and social values to biological diversity;
XII - Favor conditions and promote environmental education and interpretation, recreational activities in contact with nature, and ecological tourism;
XIII - Protect the natural resources necessary for the subsistence of traditional populations, respeitando and valorizando seu conhecimento and sua culture and promovendo-as socially and economically.

Based on these fundamental principles, it is clear that the principal focus of the management of any protected area is environmental conservation and the preservation of its biodiversity. Even so, the management aims should also include the improvement of the quality of human life, given the importance of a balanced environment for the wellbeing of a society. This integrated management perspective emphasizes the collective obligation to protect the environment, through initiatives such as environmental education, and the valuation of local communities and traditional knowledge. The SNUC also highlights the fundamental need for both a management plan and an administrative council to guarantee the implementation of these objectives in practise, through the establishment of effective regulatory measures tailored to the specific characteristics of each protected area.

The Brazilian Environment Ministry (MMA, 2020) considers a management plan to be an essential document for the effective administration of a protected area, given that it determines the zoning of the occupation of the environment and the norms for the use of the reserve's natural resources. To achieve this, the management plan is developed through a participative process, which also involves traditional local communities, considering the needs of this population and supporting the valuation of its traditional knowledge for the development of sustainable actions. This process considers the ecosystems present in the local environment and their varying interactions, with the principal aim of balancing sustainable use with conservation needs.

Furthermore, the Brazilian Environment Ministry (MMA, 2020) emphasizes the role of the administrative council as the principal instrument for the integration of a protected area with the local society. This council is designed to promote shared management with ample social participation, and is presided by the administrative organ of the protected area, the Chico Mendes Institute for the Conservation of Biodiversity (*Instituto Chico Mendes de Conservação da Biodiversidade* – ICMBio). The formation of the administrative council should include the following steps: (i) the identification of the government agents and the components of the civil society that are most closely aligned with the objectives of the protected area, (ii) the

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mobilization of these actors for the formation of the council, with specific guidelines for the formulation of the internal regulations of the reserve and the action plan, and (iii) the supervision, implementation, and review of the management plan of the protected area, and the development of integrated actions together with neighboring protected areas.

In this context, it is clear that the successful implementation of the objectives and principles of a protected area requires the effective articulation between the administrative council and the management plan, which is necessary to ensure constructive management based on constant monitoring to guarantee the improvement of the conditions of the protected area. The state protected area system (SEUC) follows the guidelines of the national legislation to oversee the state and municipal level protected areas of Pernambuco. As a consultative and deliberative entity, the SEUC oversees the State Environment Council (*Conselho Estadual do Meio Ambiente* – CONSEMA) in its attributions as the supervisor of the implementation of protected areas, as well as the assessment of proposals for the creation of new protected areas in the state (Pernambuco, 2009).

In addition to these functions, the SEUC coordinates the actions of the Pernambuco State Agency for the Environment and Hydrological Resources (*Agência Estadual de Meio Ambiente e Recursos Hídricos* – CPRH), which is responsible for the implementation and administration of the state-run public protected areas, in partnership with the civil society. The CPRH is responsible for the technical support necessary for the implementation of proposal for the creation of new protected areas and the elaboration of themanagement plans of these reserves, to ensure the efficient and sustainable management of these areas. The ICMBio, in turn, has a complementary role, together with the Independent Environment Policing Corps (*Companhia Independente de Policiamento do Meio Ambiente* – CIPOMA), the Brazilian Institute for the Environment and Renewable Natural Resources (Instituto Brasileiro do Meio *Ambiente e dos Recursos Naturais Renováveis* – IBAMA), the Prosecutor's Office (*Public Ministry*), and the environmental agencies of the municipal governments (Pernambuco, 2009).

The national system (SNUC) defines a Private Natural Heritage Reserve (*Reserva Particular do Patrimônio Natural* – RPPN) as a privately-owned property, which is reserved in perpetuity for the conservation of the local biological diversity. In some cases, the management plan of the reserve contemplates scientific research and/or visitation for tourism, recreational activities, and educational purposes, as long as prior approval is obtained from the administration, and all the regulations are followed correctly (Brasil, 2000).

Areas of Environmental Protection (APAs), in turn, tend to cover much larger areas, and allow for human occupation, being constituted of the biotic and abiotic factors that are essential for the maintenance of the local biodiversity and quality of life. The principal objective of an APA is thus to reconcile sustainable use with the conservation of the natural resources available the area of the reserve (Brasil, 2000).

Areas of Relevant Ecological Interest (*Área de Relevante Interesse Ecológico* – ARIE) are made up of a set of public and private lands, which cover an area smaller than an APA, and have little or no human occupation. These reserves contain exceptional natural characteristics or protect rare specimens of the regional biota, and thus aim to protect natural ecosystems that are important in a regional or local context, and to regulate the use of these areas with their conservation aims (Brasil, 2000).

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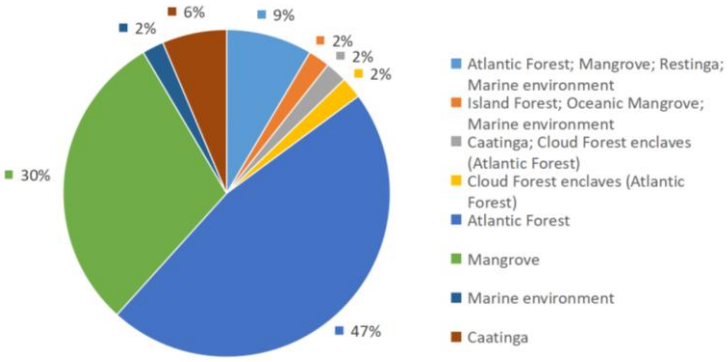
Overall, then, while the different categories of protected area have varying characteristics and management criteria, they all uphold the fundamental, common objective of conserving local natural resources. This contributes to the preservation of biodiversity, covering the different biomes that encompass factors that are essential for a balanced and sustainable environment. Based on data from the CPRH (2024), the state-level protected areas in Pernambuco cover a range of different ecosystems, in particular in biomes that contain a rich diversity of fauna and flora (Graph 6).

Graph 6 – Distribution of the state-level sustainable-use protected areas of Pernambuco state, Brazil, among the different ecosystems found in the state.



Source: Compiled by the authors; Data: CPRH, 2024.

Biomes are formed by a characteristic fauna and flora which are associated with extensive areas that have broadly similar climatic and edaphic features (Albuquerque et al., 2022). The plant species and vegetation types that predominate in these domains are characteristics that contribute to the identification of the biomes, together with their biotic constitution. In tis context, biomes are considered to be important refuges for the development of species, in particular those that depend on specific abiotic factors available in these environments for their survival, together with the local ecosystems themselves, which also contribute to the equilibrium of the environment.

The Brazilian Atlantic Forest is considered to be a national heritage in article 225 of the federal constitution, and has enormous economic, social, and biological importance, which is recognized not only in Brazil, but internationally. This biome is highly endangered, with only 7% of its original vegetation cover remaining intact, in highly fragmented remnants. This forest is an important regulator of drainage basins, guarantees the fertility of the soil, controls the climate, and protects escarpments and slopes. In particular, this biome protects the sources of water that supply urban centers in Pernambuco and other Brazilian states (Souza et al., 2023).

The Caatinga dry forest is an exclusively Brazilian biome, composed predominantly of xerophilous (from the Greek *xero*, dry, and *phials*, friend) plants, which are adapted for survival under arid conditions (Cavalcante-Silva et al., 2022). This biome has low annual precipitation rates, of 250–1000 mm, combined with mean temperatures of 24–26°C, factors that have a direct influence on the local ecological patterns, and the adaptations of the local fauna and flora (Barbosa; Gomes-Filho, 2022). Given these characteristics, the biodiversity of the Caatinga is highly endemic, and is particularly vulnerable to environmental impacts. One state-level protected area that deserves attention is the FURB Mata do Passarinho (Graph 5), which is the

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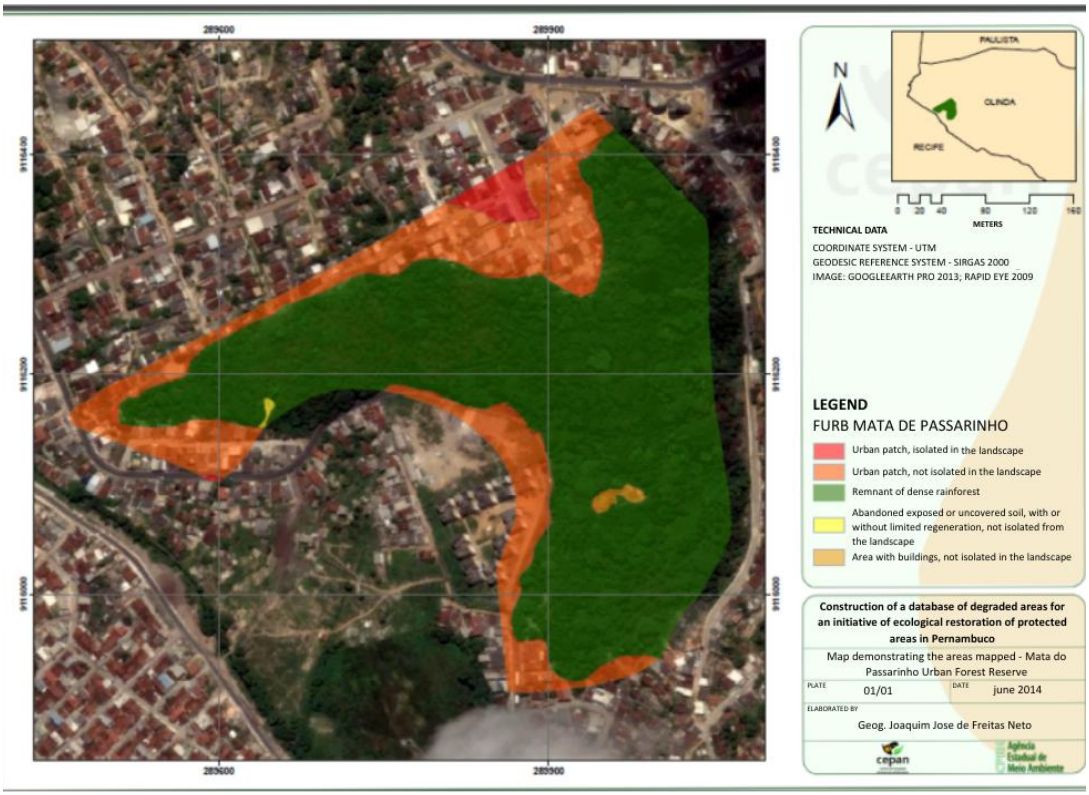
only urban forest reserve that has both a management plan and an administrative council in operation. The FURB Mata do Passarinho covers an area of 13.6 hectares of Atlantic Forest (CPRH, 2024), and is considered to be the largest remnant of this ecosystem in the municipality of Olinda (Figure 1).

The urban forest (FURB) category is, in fact, a modification of the ecological station category in the state level system of Pernambuco, and is defined in state law 13,787 of June 8th, 2009, which established the state system of protected areas (SEUC). Article 20 of the SEUC defines an Urban Forest Reserve (FURB) as an area of remnant ecosystem, dominated by native vegetation, that has important environmental attributes, despite its location within the urban perimeter, where it is exposed to significant environmental impacts (Pernambuco, 2009).

Figure 1 – Map of the different zones of the FURB Mata do Passarinho in the city of Olinda, Pernambuco, Brazil.



Source: CPRH, 2024.

The management plan of the FURB Mata do Passarinho focuses on the tracts of forest located within urban areas, which are essential factors for the quality of city life, and contribute to the conservation of the environment, integrated with social, economic, and cultural factors, and the involvement of the local community through educational actions. This plan also focuses on important features, such as the biological characteristics of the protected area, that are necessary for the understanding of its role as a protected area, such as the predominance of the vegetation of the Atlantic Forest biome, which supports a varied fauna and flora (*Plano de Manejo FURB Mata do Passarinho*, 2013).

Given its location within the urban zone, this protected area is subject to a range of anthropogenic impacts, which affect the characteristics of its biodiversity. The management

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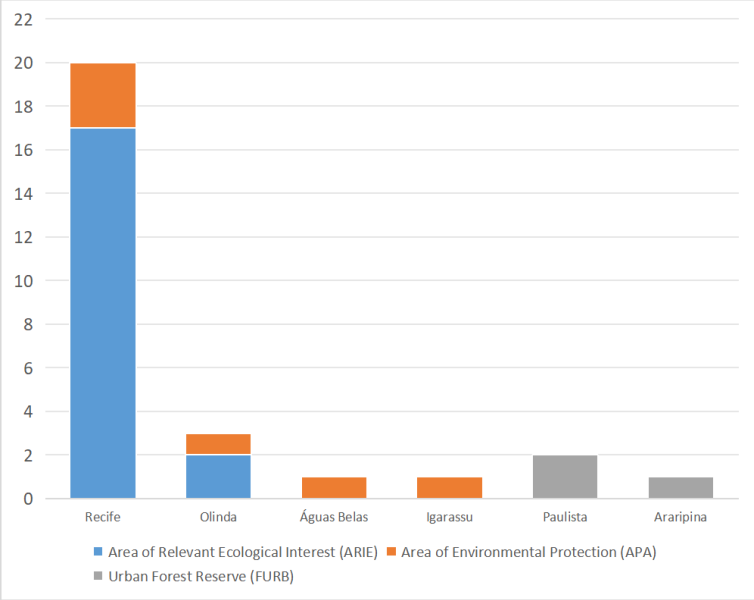
plan refers to a number of vulnerabilities identified by the administrative council in its global analysis of the attributes of the protected area. These vulnerabilities include the illegal occupation of the margins of the forest, which results in impacts such as the dumping of trash, sporadic deforestation, and the presence of both invasive species and domestic animals.

4.2 Municipal protected areas in Pernambuco

The CPRH (2024) reported that Pernambuco has 28 municipal conservation units (Graph 7), a majority of which encompass environments within the Atlantic Forest biome and the mangrove ecosystem (Graph 8). Most (n = 19) of these protected areas are ARIEs (Graph 9 A), while six are APAs (Graph 9 B), and the remaining three are FURBs (Graph 9C). While 19 of these reserves have management plans, none of them currently have an operational administrative council.

Graph 7 – The distribution of the municipal sustainable-use protected areas in Pernambuco state, Brazil.



Source: Compiled by the authors; Data: CPRH, 2024.

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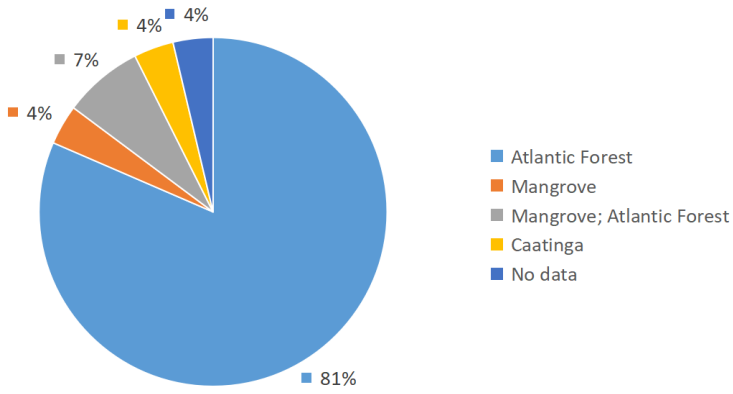
Graph 8 – Distribution of the municipal sustainable-use protected areas of Pernambuco state, Brazil, among the different ecosystems found in the state.



Source: Compiled by the authors; Data: CPRH, 2024.

The ecosystems protected by the municipal reserves include mangrove forests, which have a typical vegetation that is adapted to flooded estuarine environments and tolerant of high levels of salinity in the water and soil. Given the essential conditions necessary for the development of many aquatic species, the mangrove is considered to be an important nursery system, given that so many species depend on this environment for the development of their initial life stages (Oliveira et al., 2022). The mangrove systems also form essential ecological barriers that protect the coastal zone from erosion.

It is important to note here that these municipal protected areas are concentrated primarily in the Atlantic Forest and mangrove domains, with very few reserves located in the Caatinga or other backland ecosystems. This lack of proportionality reflects the absence of priorities on the part of the municipal administrations and the resulting lack of adequate protection for the typical biodiversity of the semi-arid zone of Pernambuco, with municipal-level initiatives being restricted to a single region of the state, despite the importance of the rest of its environments (Florêncio et al., 2022).

In addition to their reduced contribution to conservation at national and state levels, it is important to note that only two municipal protected areas in Pernambuco contemplate the conservation of the Caatinga biome, and neither of thees areas has either a management plan or an administrative council, as required by Brazilian federal law 9,985/2000 (SNUC). A management plan is crucial for the regulation of the sustainable use of a protected area and the adequate conservation of a protected area, while the administrative council is a vital tool that provides incentives for social participation and guarantees the democratic and effective management of the reserve. The lack of an administrative council reduces transparency and connectivity with local actors, which weakens the potential of the protected areas as tools for environmental conservation and sustainable development (Ferreira et al., 2021).

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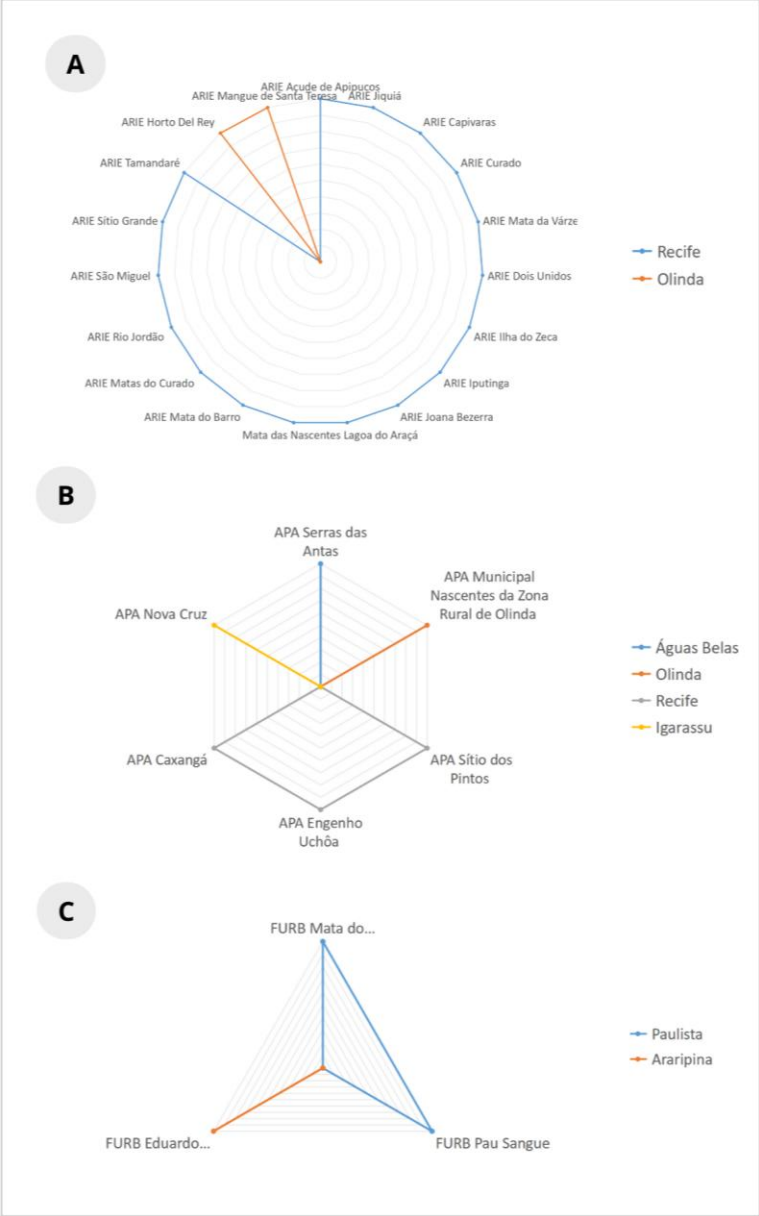
Graph 9 – Distribution of the municipal sustainable-use (A) Areas of Relevant Ecological Interest, (B) Areas of Environmental Protection, and (C) Urban Forest Reserves among the different municipalities of Pernambuco state.



Source: Compiled by the authors; Data: CPRH, 2024.

Only two of the municipal protected areas of Pernambuco are located within the Caatinga biome, that is, the APA Serras das Antas, which is located in the municipality of Águas Belas, and the FURB Eduardo Henrique Accioly Campos, in the municipality of Araripina. Neither of these reserves has a either management plan or an administrative council. This scenario is, of course, far from ideal, given that these administrative measures are essential for a meaningful and effective management of the protected areas, in a manner that guarantees the implementation of the objectives of the protected area and the conservation of the Caatinga biome. The lack of an adequate network of protected areas, at all levels of public administration, can compromise local biodiversity profoundly, in particular the endemic and threatened species. Vulnerable environments can be impacted both directly and indirectly by factors that have

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negative impacts on their ecological and climatic dynamics, including the loss of natural habitats and the degradation of soils (Lacerda, 2024).

4.3 The strategic role of protected areas in environmental conservation and the aims of sustainable development

Given the scope of the biotic and abiotic factors found in protected areas, the importance of these areas for the conservation of natural environments is indisputable, although it is also extremely important to understand how human activities impact the dynamics of these environments, and their effects on local biodiversity. By focusing on protected areas that contemplate human occupation, it is possible to verify the impacts of activities that do not adhere to the regulations established by the administration for sustainable use and conservation. These activities can result in serious environmental impacts, such as the introduction of invasive species, which may be exacerbated by processes such as deforestation and impacts on the habitats of the ecosystem. In fact, article 10 of the joint SEMAS/CPRH ordinance number 02/2022, of December 29th, 2022, states that the management plans of the state's protected areas should include provisions for the control, eradication, and monitoring of invasive species (Pernambuco, 2022).

The List of Invasive and Potentially Invasive Exotic Faunal Species in Pernambuco (2022) refers to the enormous potential of exotic invasive species to dominate habitats and disperse across ecosystems, resulting in direct impacts on the native biodiversity. In this context, Figueiredo et al. (2024) concluded that invasive species cause highly negative impacts on both the environment and biodiversity of an area, primarily through competition with native species for essential resources, in particular food, which contributes to a reduction or even the local extinction of these native taxa, threatening the whole of the local biota. Invasive species not only affect the fauna, but also the local flora, by altering vegetation structure and the ecological cycles essential for the adequate functioning of the ecosystem, and the maintenance of its equilibrium.

Other types of environmental impact can be observed in some protected areas, such as the municipal reserves located within the Caatinga biome of Pernambuco (APA Serra das Antas and a FURB Eduardo Henrique Accioly Campos), which face impacts associated with the lack of adequate management and anthropogenic pressures. The principal problems include deforestation, which is driven by the expansion of agricultural frontiers, and leads to the degradation of the native vegetation and the loss of biodiversity. One other critical factor is the inadequate exploitation of natural resources, such as the harvesting of firewood, which intensifies the process of desertification, a constant threat in the Caatinga biome (Leal et al., 2005).

Given these circumstances, the improved monitoring and articulation of the management of these areas will be essential to ensure that these protected areas can play a strategic role in the implementation of the Sustainable Development Goals (SDG) of the United Nations' Agenda 2030, in particular, the objectives related to environmental protection, the sustainable use of natural resources, and human wellbeing. Protected areas contribute directly to SDG 13 (Actions against Global Climate Change) by preserving ecosystems that act as carbon

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sinks and help regulate climate, as well as SDG 14 (Aquatic Life) and 15 (Terrestrial Life), through the protection of biodiversity, combatting environmental degradation, and ensuring the sustainability of natural resources. Protected areas also play a crucial role in the conservation of freshwater springs and aquifers, thus contributing to SDG 6 (Drinking Water and Sanitation), and the promotion of sustainable economic activities, such as ecotourism and forest management, which are aligned with SDG 8, i.e., Decent Work and Economic Growth (Brasil, 2000; ONU, 2015).

By providing essential ecosystem services, such as the purification of the air and water, climate control, and food security, protected areas also have positive impact on SDG 3 (Health and Wellbeing), SDG 1 (Eradication of Poverty), and SDG 2 (Zero Hunger). In sustainable-use areas, traditional populations have the opportunity to develop economic activities that have a reduced impact on the environment, which helps to reduce poverty and contributes to the preservation of local cultural traditions. It is important to note here that urban protected areas also contribute to SDG 11 (Sustainable Cities and Communities), improving the quality of life in urban environments through the conservation of green areas and by providing spaces for leisure activities. Given this, conservation areas not only protect the natural heritage, but also contribute to the equilibrium between economic development, social inclusion, and environmental sustainability (Brasil, 2000; MMA, 2021).

In this context, Cruz, Braida, and Colchete Filho (2020) point out that sustainable-use protected areas have a fundamental role in conservation, given that they permit the protection of nature together with human life, unifying the environmental and social policies that govern land use in an effective manner. Ferrari and Perondi (2023) highlight categories such as extractive reserves, national forests, and sustainable development as examples of protected areas that achieve the goals of sustainable development and ethnodevelopment simultaneously, by combining the protection of the environment with respect for the independence of traditional peoples.

4.4 A Regional Comparison of Sustainable Use Protected Areas in Brazilian States, and the Effectiveness of their Implementation Strategies

The present analysis revealed not only the existence of a relatively large number of state-level protected areas in the Brazilian state of Pernambuco, but also the major administrative challenges faced by these areas, many of which have yet to implement a management plan or administrative council. There is also a pressing need for more effective protection of the natural resources of the Caatinga biome, given the clear deficit of public protected areas in this biome in comparison with the Atlantic Forest and coastal domains. The administrative deficiencies found in Pernambuco are nevertheless consistent with the scenario observed in most other Brazilian states that have areas of Caatinga, for which data are available (Table 1). In some cases, such as Alagoas, the proportion of protected areas with either a management plan or administrative council was much lower than that recorded in Pernambuco, whereas some other states, such as Ceará and Minas Gerais, a large proportion of the protected areas have either a management plan and/or an administrative council, which supports the development of more effective conservation initiatives in these states.

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Table 1: Comparison of the state systems of sustaoinable-use protected areas in the Brazilian states with areas of Caatinga for which data are available. n/a = not applicable (domain not found in the state).

State	Total number of protected areas (PAs)	Number of PAs in[1]:			Number of PAs with a[2]:		Source or reference
		CAA	ATF	COA	MP	AC	
Alagoas	75	6	69	0	4	5	Portal de Dados Abertos do Estado de Alagoas, 2023.
Bahia	70	5	16	15	14	32	Instituto do Meio Ambiente e Recursos Hídricos – INEMA, 2025.
Ceará	31	31	n/a	13	21	17	Painel: Cadastro Estadual de Unidades de Conservaçãoo. Fortaleza: SEMA, 2025.
Minas Gerais	19	3	12	n/a	14	16	Painel de Unidades de Conservação Estaduais de Uso Sustentável.Minas Gerais: SEMAD, 2025.
Paraíba	6	2	3	1	1	5	Superintendência de Administração do Meio Ambiente da Paraiba (Sudema), 2022.
Pernambuco	48	4	29	22	7	6	Agência Estadual de Meio Ambiente (CPRH), 2025).

[1]CAA = Caatinga; ATF = Atlantic Forest; COA = Coastal environments
[2]MP = Management Plan; AC = Administrative Council.
Sources: CEUC (2022 and 2025); Arruda and Fedel (2020); SEMAD-MG (2025).

In Ceará, the state register of protected areas (CEUC, 2025) presents a total of 31 sustainable-use sites under state administration. All of these protected areas are located within the Caatinga biome, and 13 also include coastal areas, which reflects the greater focus on the conservation of the Caatinga in this state, in comparison with Pernambuco. However, only 21 of the 31 reserves currently have a management plan, and only 17 have a working administrative council (CEUC, 2022). This analysis of the administrative status of the sustainable-use protected areas in the state of Ceará further reinforce the importance of the implementation of management plans and administrative councils, which guarantee the effective, long-term protection of the environment. The lack of these administrative tools can compromise seriously the goals of conservation and sustainability (Arruda and Fedel, 2020).

Based on data from the Minas Gerais State Environment Secretariat (SEMAD-MG, 2025), this state has 19 state-run sustainable-level protected areas, of which, 14 have a management plan and 16 have an administrative council, which reflects the advances in the implementation and effectiveness of these essential environmental management tools. Some of these protected areas are located within areas of transition that result in the overlap of these biomes. A total of 22 occurrences of biomes were recorded in the protected areas of Minas Gerais, including the Caatinga in three protected areas, and the Atlantic Forest, which was present in 12 areas.

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These findings reinforce the need to delimit adequately the extent of the predominant biomes found within each protected area, and reinforce the ecological value of the specific biological characteristics of each biome. This is particularly important in the case of the Caatinga, which is relatively poorly protected, despite being considered to be a global conservation hotspot, given its high biological diversity, including relatively large numbers of endemic and endangered species, which is threatened by ongoing anthropogenic impacts, such as deforestation, habitat fragmentation, urbanization, non-sustainable farming practises, and mining. All these problems are further exacerbated by factors related to climate change, and be considered to be priority areas for conservation measures (Teixeira, et al. 2021).

5 CONCLUSIONS

The present study highlighted the relevance of the state-level and municipal protected areas of the Brazilian state of Pernambuco for the protection of the state's biodiversity and the promotion of sustainable development. However, the data indicate that the protected areas of Pernambuco tend to focus on the Atlantic Forest and marine biomes, to the detriment of the areas within the Caatinga domain and the Agreste ecotone, which are still widely neglected. This under-representation of the semi-arid zone reinforces the urgent need for a more all-embracing public policy, which contemplates the full ecological and geographic diversity of the state. In addition, the environmental agencies responsible for the supervision and monitoring of protected areas, such IBAMA, ICMBIO, CPRH, and CIPOMA, are all concentrated in the state capital, Recife, a coastal city in the Atlantic Forest domain, which is reflected in the focus of these organs on the repression of environmental degradation in these local areas. It is thus important to reinforce the pressing need to create effective field offices in the interior of the state, as well as the expansion of the CIPOMA, or even the creation of an Environmental Battalion to operate specifically in the Agreste and Caatinga of Pernambuco.

While many state and municipal protected areas have a management plans and/or administrative council, the lack of a council or any effective administration in many cases compromises participative management and the effectiveness of conservation actions. These tools are essential to ensure the participation of the local society in the planning and administration of the protected areas, while also guaranteeing greater transparency and efficiency in the measures of environmental protection.

One other critical point identified here was the concentration of the municipal protected areas in the metropolitan region of greater Recife, which contrasts markedly with the lack of conservation initiatives in the vast majority of the municipalities located in the semi-arid zone of Pernambuco. This lacuna highlights the need for a more balanced approach, which focuses not only on the biodiversity of the most threatened biomes, such as the Caatinga, but also includes local communities in the development of conservation strategies. The comparison of the data available for other Caatinga states also highlighted the need for the more effective identification and delimitation of the biomes found in each protected area, given their specific biological characteristics.

Ultimately, protected areas play a strategic role in the preservation of biodiversity, the mitigation of climate change, and the maintenance of the ecosystem services that are essential

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to human wellbeing. To maximize the potential of these areas, it is important to strengthen their management through investment in specialist human resources, the amplification of the representativeness of the protected areas, and provide incentives for the creation of new management plans and administrative councils. With an integrated, participative approach, it will be possible to consolidate a more efficient and egalitarian conservation system that is capable of satisfying not only the demands of the preservation of nature, but also the needs of the local populations, guaranteeing a more sustainable future for the Brazilian state of Pernambuco.

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Periódico Eletrônico Fórum Ambiental da Alta Paulista
Electronic Journal Environmental Forum of Alta Paulista

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DECLARATIONS

THE CONTRIBUTION OF EACH AUTHOR

- **Study Conception and Design**: Rachel Maria de Lyra-Neves, and Wallace Rodrigues Telino Júnior;
- **Data curation**: Ananda do Nascimento Rêgo, Rachel Maria de Lyra-Neves, and Wallace Rodrigues Telino Júnior;
- **Formal Analysis**: Ananda do Nascimento Rêgo and Bianca Gonzaga de Araújo**;**
- **Acquisition of financial resources**: Not applicable;
- **Investigation**: Ananda do Nascimento Rêgo; Bianca Gonzaga de Araújo**;** Rachel Maria de Lyra-Neves; Renata Bezerra de Moura Lima, and Wallace Rodrigues Telino Júnior;
- **Methods**: Ananda do Nascimento Rêgo; Bianca Gonzaga de Araújo**;** Rachel Maria de Lyra-Neves; Renata Bezerra de Moura Lima, and Wallace Rodrigues Telino Júnior;
- **Redaction - Initial Draft**: Ananda do Nascimento Rêgo; Bianca Gonzaga de Araújo**;** Rachel Maria de Lyra-Neves; Renata Bezerra de Moura Lima, and Wallace Rodrigues Telino Júnior;
- **Redaction - Critical Review**: Ananda do Nascimento Rêgo and Bianca Gonzaga de Araújo**;**
- **Review and Final Edition**: Ananda do Nascimento Rêgo; Bianca Gonzaga de Araújo**;** Rachel Maria de Lyra-Neves; Renata Bezerra de Moura Lima, and Wallace Rodrigues Telino Júnior;
- **Supervision**: Wallace Rodrigues Telino Júnior and Rachel Maria de Lyra-Neves;

DECLARATION OF CONFLICTS OF INTEREST

We, **Ananda do Nascimento Rêgo, Bianca Gonzaga de Araújo, Renata Bezerra de Moura Lima, Wallace Rodrigues Telino Júnior, Rachel Maria de Lyra-Neves**, declare that the manuscript entitled **"The Current Scenario of the Sustainable-Use Protected Areas in the Brazilian State of Pernambuco":**

1. **Financial Commitments**: Has no financial commitments that might influence the results or interpretation of the study. No financial institution or economic entity was involved in the development of this study.
2. **Professional Relationships**: Does not have any professional relationships that might impact the analysis, interpretation or presentation of the results. No professional relationship relevant to the content of this manuscript was established during the present study.
3. **Personal Conflicts**: Has no personal conflicts of interest related to the content of the manuscript. No personal conflict related to the content of this study was identified in any context.
4.