ISSN: 2447-3359

REVISTA DE GEOCIÊNCIAS DO NORDESTE

Northeast Geosciences Journal

v. 12, nº 1 (2026)

https://doi.org/10.21680/2447-3359.2026v12n1ID42087

Effectiveness of Environmental Management practices in the Stoessel de Brito Private Natural Heritage Reserve (RPPN), NE-Brazil

Eficácia das práticas de Gestão Ambiental na Reserva Particular do Patrimônio Natural (RPPN) Stoessel de Brito, NE-Brasil

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Abstract: In recent years, there has been a significant increase in the interest of landowners in converting portions of their properties into protected areas, such as Private Natural Heritage Reserves (RPPNs), aligning economic, social, and environmental development policies with conservation principles. Within this context, various methodologies have been developed to assess the management effectiveness of protected areas, among which the *Rapid Assessment and Prioritization of Protected Area Management* (RAPPAM) stands out. This study aimed to apply the RAPPAM method to evaluate the environmental management of the Stoessel de Brito RPPN. Data collection was carried out through a structured interview and an in loco technical visit, enabling the identification of the main strengths and weaknesses of the reserve. The results indicated a medium level of management effectiveness, suggesting satisfactory conditions for conservation, although limitations persist that reduce management efficiency. The study area presented favorable characteristics for maintaining and balancing the Caatinga ecosystem, with a tendency toward improved management effectiveness in the coming years. It is concluded that strengthening planning and management actions is essential to enhance the effectiveness of RPPNs as key instruments for biodiversity conservation.

Keywords: Caatinga; Semi-arid; Conservation Unit.

Resumo: Nos últimos anos, tem-se registrado um aumento significativo no interesse de proprietários em converter parte de suas propriedades em áreas protegidas, como as Reservas Particulares do Patrimônio Natural (RPPNs), integrando políticas de desenvolvimento econômico, social e ambiental às diretrizes de conservação. Nesse contexto, diferentes metodologias foram desenvolvidas para avaliar a efetividade dessas unidades, entre as quais se destaca o Rapid Assessment and Prioritization of Protected Area Management (RAPPAM). Este estudo teve como objetivo aplicar o método RAPPAM na avaliação da gestão ambiental da RPPN Stoessel de Brito. A obtenção dos dados foi realizada por meio de entrevista estruturada e de visita técnica in loco, permitindo identificar as principais potencialidades e fragilidades da unidade. Os resultados apontaram nível médio de efetividade de gestão, indicando condições satisfatórias para a conservação, mas ainda com limitações que reduzem a eficiência do manejo. Verificou-se que a área apresenta características favoráveis à manutenção e ao equilíbrio do ecossistema de Caatinga, com tendência de aprimoramento da gestão nos próximos anos. Conclui-se que o fortalecimento das ações de planejamento e gestão é essencial para elevar a eficácia das RPPNs enquanto instrumentos de conservação da biodiversidade.

Palavras-chave: Caatinga; Semiárido; Unidade de Conservação.

Received: 14/11/2025; Accepted: 06/01/2026; Published: 09/01/2026.

1. Introduction

The process of economic, technological, and social transformations resulting primarily from the Industrial Revolution triggered profound changes in global environmental dynamics. These impacts fostered the formulation of conservation policies and supported the creation of protected areas as essential instruments for mitigating environmental degradation and preserving natural resources. In this context, Conservation Units (Unidades de Conservação – UCs) constitute fundamental mechanisms for maintaining ecological processes, biological diversity, and habitats that compose ecosystems and sustain life on the planet (Salvio, 2017; Peres, 2020).

In recent decades, there has been a growing interest in converting private lands into protected areas, notably Private Natural Heritage Reserves (RPPNs), as a means of integrating economic, social, and ecological development policies with environmental guidelines (Ferrari & Melo, 2023; Oliveira & Vazquez, 2024). According to Morsello (2001), this movement is related to factors such as the intensification of land tenure conflicts, which has driven the search for land tenure regularization, in addition to benefits arising from the official recognition of reserves, such as access to credit lines and tax incentives. The creation of these reserves contributes directly to the conservation of threatened ecosystems and to the promotion of sustainable development. Moreover, UCs play a relevant role in protecting not only biological diversity but also the sociocultural values of the territories in which they are located (Araripe et al., 2021).

Contemporary environmental policies have been consolidated as rational strategies for territorial management, promoting new forms of regulating the use of and access to natural resources in a sustainable manner (Silva, 2017). Such strategies are fundamental for strengthening the effectiveness of protected areas, contributing to the reduction of vegetation cover loss and to the mitigation of ecosystem degradation processes (Guzmán & Sibaja, 2015; Leberger et al., 2020).

As highlighted by Leverington et al. (2010), the expansion of public policies aimed at the creation of new Conservation Units has driven the development of specific methodologies to assess management effectiveness, taking into account their ecological and institutional particularities (Ervin, 2003; WWF-Brasil, 2017). These methodologies constitute management support tools by providing an integrated view of pressures, threats, severity, and intensity of anthropogenic actions (Stoll-Kleemann, 2010; Masullo, Gurgel & Laques, 2019). According to Araújo (2012), more than 70 effectiveness assessment methodologies have been applied in approximately 100 countries, totaling over 90,000 applications, which demonstrates their global relevance.

Among the existing methodologies, the Rapid Assessment and Prioritization of Protected Area Management (RAPPAM) stands out, having been applied in more than 53 countries and 1,600 conservation units (Soares, 2019). The method allows the measurement of management effectiveness by identifying whether the objectives of Conservation Units are being achieved, as well as evaluating trends and the criticality of pressures and threats affecting protected areas (Hockings, Stolton & Dudley, 2000; Ervin, 2003). Developed by the World Wide Fund for Nature (WWF) between 1999 and 2002, RAPPAM aims to improve the management of conservation systems, enabling comparative analyses among different types of units through integrated and standardized procedures (Soares, Spinola & Reis, 2022).

Considering the relevance of studies focused on evaluating management effectiveness in conservation units, especially in semi-arid environments, this study aims to apply the RAPPAM method to analyze the environmental management of the Stoessel de Brito RPPN. Research of this nature provides technical support for improving management and planning practices in Conservation Units, in addition to guiding efforts toward areas that are more vulnerable to environmental degradation.

2. Materials and methods

2.1 Study area

The research was conducted in the Private Natural Heritage Reserve (RPPN) Salobro Farm, known as Stoessel de Brito, with a total area of 818.5 hectares. The reserve is located in the municipality of Jucurutu, state of Rio Grande do Norte, at the coordinates 6°13′04″ S and 37°02′25″ W (Figure 1). It was officially recognized as a protected area by Federal Ordinance No. 52, of May 20, 1994, issued by the Brazilian Institute of the Environment and Renewable Natural Resources (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis – IBAMA/RN).

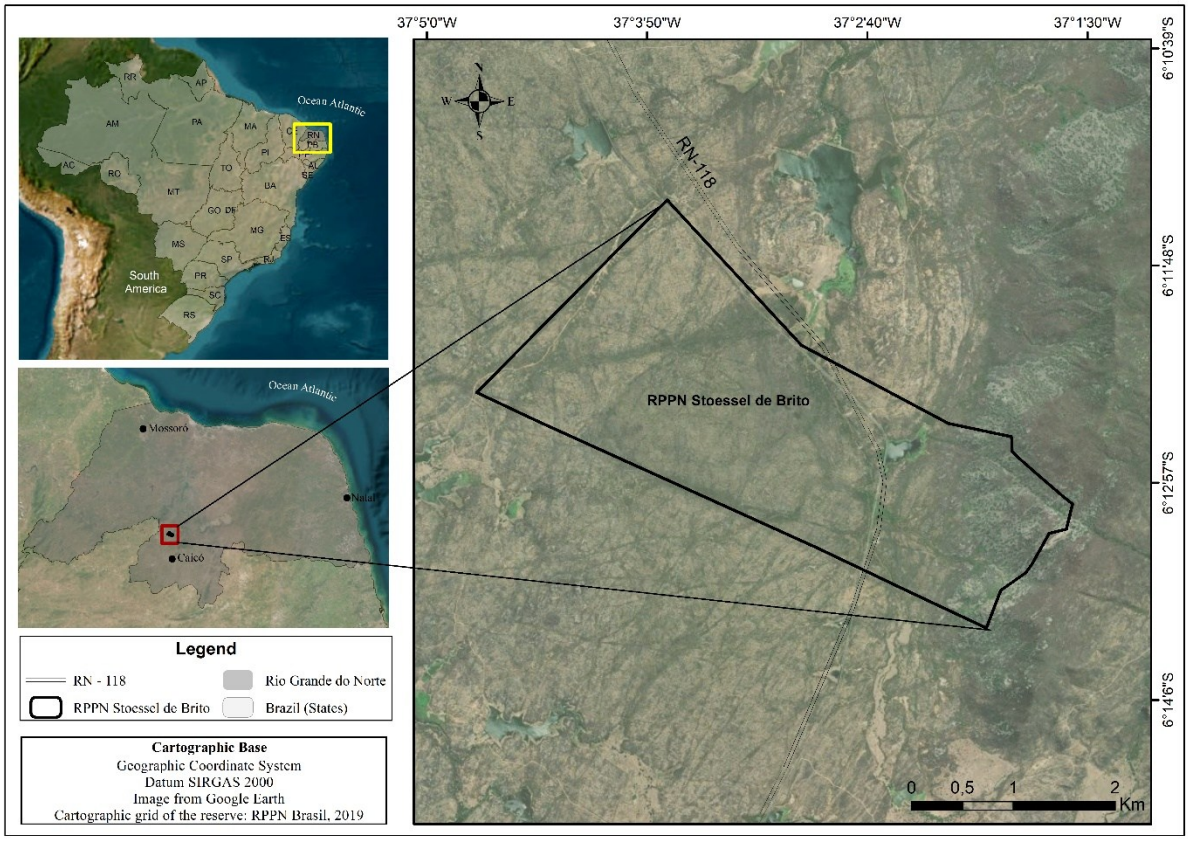

Figure 1 – Location map of the Stoessel de Brito RPPN.
Source: Authors (2025).

In the geoenvironmental context, the study area is characterized by ridge relief associated with igneous, granitic, and metamorphic rocks, predominantly gneisses, belonging to the morphostructural unit known as the Eastern Interplateau Sertaneja Depression of the Borborema Massif. These landforms are predominantly oriented in the NE–SW direction (Maia & Bezerra, 2014; Diniz, Oliveira & Maia, 2017). According to these authors, the massifs constitute important remnants of erosional processes acting since the Cenozoic, with altitudes ranging between 200 m and 700 m.

The climate of the area is hot and dry semi-arid (Bswh), with mean temperatures ranging from 25 °C to 35 °C (Silva et al., 2022). The main atmospheric system acting in the region is the Intertropical Convergence Zone (ITCZ), which is responsible for most of the rainfall occurring during the summer, especially between January and April, resulting in a pronounced water deficit from September to November (Varela-Freire, 2002).

Chromic Luvisols, Litholic Neosols, Fluvic Neosols, and Regolithic Neosols occur in the area (IBGE, 2024; Diniz Filho et al., 2009). From a phytogeographical perspective, the area is located within the Northern Sertaneja Depression Ecoregion (Velloso, Sampaio & Pareyn, 2002; Silva & Barbosa, 2017), with Caatinga physiognomies characterized by arboreal–shrub vegetation, which may be either dense or open. This vegetation is associated with the floristic regions of the Sertaneja and São Francisco depressions (Costa et al., 2002; Silva & Souza, 2018).

2.2 Methodological Procedures

Data collection on management effectiveness was conducted based on the RAPPAM method, using the questionnaire proposed by Ervin (2003), which was applied to the reserve management and staff in 2024 (Table 1). These elements were adjusted and organized into 16 thematic modules, developed from the management cycle adapted from Hockings, Stolton, and Dudley (2000). Each module comprises a variable number of questions and a specific maximum score, allowing an integrated assessment of aspects such as context, planning, inputs, processes, outputs, and outcomes of protected area management, taking into account the specific context of the RPPN category of Conservation Unit.

Table 1 – Composition of RAPPAM elements and thematic modules.

ELEMENTS	THEMATIC MODULES	NUMBER OF QUESTIONS	MAXIMUM SCORE
CONTEXT	Profile (descriptive)	7	–
	Pressures and Threats	–	–
	Biological Importance	10	50
	Socioeconomic Importance	10	50
	Vulnerability	9	45
PLANNING	Objectives	5	25
	Legal Support	5	25
	Area Design and Planning	6	30
INPUTS	Human Resources	4	20
	Communication and Information	6	30
	Infrastructure	5	25
	Financial Resources	6	30
PROCESSES	Management Planning	5	25
	Decision Making	6	30
	Research, Evaluation and Monitoring	6	30
RESULTS	Results	11	55
TOTAL	16	95	470

Source: Adapted from Ervin, 2003; WWF-Brasil, 2017.

For each question within the modules, four response alternatives are provided, with corresponding scores: Yes (Y) = 5; Predominantly Yes (Pred. Yes) = 3; Predominantly No (Pred. No) = 1; and No (N) = 0. In this study, the Context element is composed of five thematic modules, totaling 36 questions that can reach up to 145 points. The Profile module gathers identification information about the unit, including dates and legal instruments related to its establishment (Table 2).

Table 2 – Composition of the Profile element of the RAPPAM.

Official Name of the Protected Area	Popular Name	Area (ha)	Biome	Managing Institution	Legal Instrument of Creation	Year of Creation
Salobro Farm Private Natural Heritage Reserve	Stoessel de Brito	818.5	Caatinga	INSPIRA	Decree No. 52, May 23, 1994	1994

Source: Adapted from Ervin, 2003; WWF-Brasil, 2017.

Pressure aspects analyze the negative impacts observed in the Conservation Unit (CU) over the last five years, considering the presence, absence, and intensity of these pressures. For each identified pressure, a weighting is performed based on trend, extent, impact, and permanence (Table 3).

Table 3 – Composition of the Pressure element of the RAPPAM.

Trend over the last 5 years	The level of pressure over the last 5 years has been:		
	SCOPE	IMPACT	STAY
- Yes **- There has been no pressure in the last 5 years.**			
It increased drastically/Very high = 2	Total (>50%) = 4	Severe = 4	Permanent (>100 years) = 4
Increased slightly/High = 1	Generalized (15-50%) =	High = 3	Long term (20-100 years) =

	3		3
Remained constant/Average = 0	Scattered (5-15%) = 2	Moderate = 2	Medium term (5-20 years) = 2
It decreased slightly/Low = -1	Located (<5%) = 1	Smooth = 1	Short term (<5 years) = 1
Decreased drastically/Very low = -2	0	0	0

Source: Adapted from Ervin, 2003; WWF-Brasil, 2017.

The Threat element assesses the likelihood of pressures occurring over the next five years, classified from "very low" to "very high." Each threat is analyzed in terms of its severity, extent (size of the affected area), impact on the CU, and permanence of damage (Table 4).

Table 4 – Composition of the Threat element of the RAPPAM.

The probability of this threat materializing in the next 5 years is:	**The severity of this threat over the next 5 years will likely be:**		
- Yes **- It will not be a threat in the next 5 years.**			
Very high = 2	**Scope:**	**Impact**	**Permanence of damage**
High = 1	Total (>50%) = 4	Severe = 4	Permanent (>100 years) = 4
Average = 0	Generalized (15-50%) = 3	High = 3	Long term (20-100 years) = 3
Low = -1	Scattered (5-15%) = 2	Moderate = 2	Medium term (5-20 years) = 2
Very Low = -2	Located (<5%) = 1	Smooth = 1	Short term (<5 years) = 1

Source: Adapted from Ervin, 2003; WWF-Brasil, 2017.

Pressures and threats were evaluated based on their criticality, obtained by summing the criteria of trend, probability, extent, impact, and permanence, expressed as a percentage. The Planning element comprises three modules and 16 questions, totaling 80 points, and is focused on administrative management and the guidelines of the National System of Conservation Units (Sistema Nacional de Unidades de Conservação – SNUC).

The Inputs element consists of four modules, with 24 questions and up to 110 points, assessing human and financial resources, infrastructure, communication, and social benefits. The Processes element includes three modules, with 29 questions and 145 points, while the Results element comprises 12 questions (60 points), related to management effectiveness and conservation outcomes (IBAMA, 2007). The final calculation considered the mean of the values assigned in the questionnaires, converted into a percentage. Management effectiveness followed the classification proposed by Ervin (2003): >60% high, 40–60% medium, and <40% low.

3. Results e discussion

Despite the legal flexibilities associated with sustainable-use Conservation Units, the RPPN presents a management model oriented toward the maintenance of local biodiversity. This orientation is evidenced by the good conservation status of the vegetation cover, in contrast to surrounding areas, as demonstrated by Oliveira et al. (2019). Regarding the scores obtained by the evaluation modules, the RPPN achieved a total of 244 points, corresponding to 52% of the maximum possible value (Table 5), thus falling within the medium effectiveness class (40%–60%), according to the classification proposed by Ervin (2003).

Table 5 – Composition of RAPPAM elements and thematic modules. Where: ■ – High effectiveness; ■ – Medium effectiveness; ■ – Low effectiveness.

MODULES	**Score obtained**	**(%)**
BIOLOGICAL IMPORTANCE	39	78
SOCIOECONOMIC IMPORTANCE	28	56
VULNERABILITY	21	46,6
OBJECTIVES	23	92

LEGAL SUPPORT	15	60
PROTECTED AREA DESIGN AND PLANNING	15	50
HUMAN RESOURCES	13	65
COMMUNICATION AND INFORMATION MANAGEMENT	8	26,6
INFRASTRUCTURE	6	24
FINANCIAL RESOURCES	3	10
MANAGEMENT PLANNING PROCESSES	15	60
DECISION-MAKING	18	60
RESEARCH, EVALUATION, AND MONITORING	18	60
RESULTS	22	40
TOTAL	244	-

Source: Authors (2025).

Among the evaluated modules, Objectives presented the highest percentage score (92%), reflecting clarity regarding the unit's purposes, alignment with SNUC principles, and commitment to biodiversity conservation. Similar results were reported by Soares et al. (2019) and Padovan (2003), who demonstrated that RPPNs with well-defined management objectives tend to exhibit greater institutional coherence and continuity in conservation actions.

The Biological Importance module (78%) also stood out positively, indicating that the RPPN plays an essential role in maintaining the ecological integrity of the Caatinga. The biological relevance of the area reinforces the need for continuous protection mechanisms and ecological connectivity strategies with other conservation units, as highlighted by Velloso, Sampaio, and Pareyn (2002) and Leberger et al. (2020).

In contrast, the Financial Resources (10%), Infrastructure (24%), and Communication and Information (26.6%) modules presented the lowest effectiveness indices, evidencing the operational fragility of the unit. These limitations are closely associated with the management model of RPPNs, which, as private sustainable-use units, depend heavily on landowner initiative and external partnerships for maintenance and investment (Ferrari & Melo, 2023). Furthermore, the absence of specific public policies aimed at providing financial and technical support for RPPNs in the Caatinga constitutes a significant restrictive factor (Oliveira & Vazquez, 2024).

Paz et al. (2020) state that limitations in structural resources represent one of the main obstacles to the effectiveness of private protected areas in semi-arid regions. The weakness observed in communication and information also reveals a lack of environmental education actions and community integration, which are fundamental for strengthening social and institutional support for conservation (Stoll-Kleemann, 2010; WWF-Brasil, 2017).

The remaining modules showed intermediate levels of effectiveness, indicating that although consistent management efforts exist, there is a need to improve the articulation between planning, implementation, and monitoring of management actions. The overall pattern of responses—42 "Yes," 38 "No," 15 "Predominantly Yes," and 3 "Predominantly No"—reveals heterogeneity in the application of management guidelines, suggesting that certain processes are well implemented, while others remain at incipient or discontinued stages (Table 6).

Table 6 – Effectiveness questionnaire applied in the Stoessel de Brito RPPN.

Element	Modules	Question	Response	Score
CONTEXT	BIOLOGICAL IMPORTANCE	03a) The CU harbors species listed as nationally or state-level threatened with extinction.	Pred. Yes	3
		03b) The CU harbors species with populations under pressure from exploitation or other factors.	Pred. Yes	3
		03c) The CU has significant levels of biodiversity.	Yes	5
		03d) The CU has significant levels of endemism.	No	0
		03e) The CU performs a critical function in the landscape.	Yes	5
		03f) The CU contributes significantly to the representativeness of the CU system.	Yes	5
		03g) The CU supports minimum viable populations of key species.	Yes	5
		03h) The landscape maintains its conservation status over time.	Yes	5

		03i) The CU protects ecosystems whose extent has been significantly reduced.	Pred. Yes	3
		03j) The CU conserves a significant diversity of natural processes and natural disturbance regimes.	Yes	5
	SOCIOECONOMIC IMPORTANCE	04a) The CU is an important source of employment for local communities.	No	0
		04b) Local communities depend on the use of CU resources for subsistence.	No	0
		04c) The CU promotes community development through the sustainable use of resources.	Yes	5
		04d) The CU has religious or spiritual importance.	Pred. Yes	3
		04e) The CU has attributes of relevant aesthetic, historical, and/or cultural importance.	Pred. Yes	3
		04f) The CU contains plant species of high social, cultural, or economic importance.	No	0
		04g) The CU contains animal species of high social, cultural, or economic importance.	No	0
		04h) The CU has high recreational value.	Yes	5
		04i) The CU contributes significantly to environmental services and benefits.	Yes	5
		04j) The CU has high educational and/or scientific value.	Yes	5
	VULNERABILITY	05a) Illegal activities in the CU are difficult to monitor.	Yes	5
		05b) Enforcement of legal instruments is weak in the region.	Pred. Yes	3
		05c) The CU is experiencing civil unrest and/or political instability.	No	0
		05d) Cultural practices, beliefs, and traditional uses conflict with the CU category and objectives.	No	0
		05e) The market value of CU resources (e.g., land value) is high.	Pred. No	1
		05f) The CU is easily accessible for illegal activities.	Yes	5
		05g) There is high demand for natural resources from the CU.	No	0
		05h) CU management is pressured to undertake actions inconsistent with CU objectives.	No	0
		05i) Hiring and retaining staff is difficult.	Yes	5
PLANNING	OBJECTIVES	06a) The objectives stated in the CU creation decree include biodiversity protection and conservation.	Yes	5
		06b) Biodiversity objectives are clearly defined in the management plan.	Yes	5
		06c) Plans and projects are consistent with CU objectives.	Yes	5
		06d) CU staff and managers understand CU objectives and policies.	Yes	5
		06e) Local communities support CU objectives.	Pred. No	1
	LEGAL SUPPORT	07a) The CU and its natural resources have legal protection.	Yes	5
		07b) Land tenure status is regularized.	Yes	5
		07c) Boundary demarcation and signage of the CU are adequate.	No	0
		07d) Human and financial resources are adequate to carry out critical protection actions.	No	0
		07e) There is legal support for conflict management.	Yes	5
	AREA DESIGN AND PLANNING	08a) The CU location is consistent with its objectives.	Pred. No	1
		08b) CU design favors biodiversity conservation and/or sociocultural and economic aspects.	Yes	5
		08c) CU zoning is adequate to achieve its objectives.	Yes	5
		08d) Surrounding land uses facilitate effective CU management.	No	0
		08e) The CU is connected to another conservation unit or protected area.	No	0

		08f) CU design and category definition resulted from a participatory process.	No	0
INPUTS	HUMAN RESOURCES	09a) There are sufficient human resources for effective CU management.	No	0
		09b) Staff have adequate technical capacity to perform management actions.	Pred. Yes	3
		09c) There are training and professional development opportunities appropriate to CU needs.	Pred. Yes	3
		09e) Working conditions are sufficient to maintain staff aligned with CU objectives.	Yes	5
	COMMUNICATION AND INFORMATION	10a) There is adequate communication infrastructure between the CU and other administrative bodies.	Yes	0
		10b) Existing ecological and socioeconomic information is adequate for management planning.	Yes	5
		10c) There are adequate means for data collection.	No	0
		10d) There are adequate systems for data storage, processing, and analysis.	No	0
		10e) There is effective communication between the CU and local communities.	Pred. Yes	3
		10f) There is effective communication among local communities.	No	0
	INFRASTRUCTURE	11a) Transport infrastructure is adequate to meet CU objectives.	Pred. Yes	3
		11b) Work equipment is adequate to meet CU objectives.	No	0
		11c) CU facilities are adequate to meet its objectives.	Pred. Yes	3
		11d) User infrastructure is appropriate for the level of use.	Pred. Yes	3
		11e) Infrastructure maintenance ensures long-term functionality.	No	0
	FINANCIAL RESOURCES	12a) Financial resources over the last 5 years were adequate to meet CU objectives.	No	0
		12b) Financial resources are projected for the next 5 years to meet CU objectives.	No	0
		12c) Financial management practices enable efficient CU management.	No	0
		12d) Resource allocation is consistent with CU priorities and objectives.	No	0
		12e) Long-term financial planning for the CU is stable.	No	0
		12f) The CU has the capacity to raise external funding.	Pred. Yes	3
PROCESSES	MANAGEMENT PLANNING	13a) There is a management plan adequate for CU management.	Yes	0
		13b) There is an inventory of natural and cultural resources adequate for CU management.	Yes	5
		13c) There is an analysis and strategy to address threats and pressures on the CU.	Yes	5
		13d) There is an operational plan to achieve CU management goals.	No	0
		13e) Research results, monitoring, and traditional knowledge are routinely incorporated into planning.	Yes	5
	DECISION-MAKING	14a) There is a clear internal organization within the CU.	Yes	5
		14b) Decision-making in management is transparent.	Yes	5
		14c) The CU regularly collaborates with partners, local communities, and other organizations.	Yes	5
		14d) Local communities effectively participate in CU management and decision-making.	No	0
		14e) There is effective communication between CU staff and administration.	No	0
		14f) There is an implemented and effective management council.	No	0
	RESEARCH, EVA	15a) The impact of legal activities in the CU is accurately monitored and recorded.	No	0

		15b) The impact of illegal activities in the CU is accurately monitored and recorded.	No	0
		15c) Research on ecological issues is consistent with CU needs.	No	0
		15d) Research on socioeconomic issues is consistent with CU needs.	Yes	5
		15e) Staff and communities have regular access to research results.	Yes	5
		15f) Critical research and monitoring needs are identified and prioritized.	Pred. Yes	3
RESULTS	**RESULTS**	16a) The CU conducted management planning in the last two years.	Pred. Yes	3
		16b) The CU carried out area restoration and mitigation actions appropriate to its needs in the last two years.	No	0
		16c) The CU conducted wildlife or habitat management in the last two years.	No	0
		16d) The CU carried out outreach and information actions for society in the last two years.	Yes	5
		16e) The CU carried out visitor control appropriate to its needs in the last two years.	No	0
		16f) The CU carried out infrastructure implementation and maintenance in the last two years.	Yes	5
		16g) The CU carried out prevention, threat detection, and law enforcement in the last two years.	Yes	5
		16h) The CU carried out staff supervision and performance evaluation in the last two years.	No	0
		16j) The unit promoted training for communities and the council in the last two years.	No	0
		16k) Research aligned with CU objectives was developed in the CU in the last two years.	No	0
		16l) Management results were monitored in the last two years.	No	0

Source: Adapted from Ervin, 2003; WWF-Brasil, 2017.

With regard to the pressures and threats affecting the conservation unit, twelve anthropogenic activities were identified as exerting a direct influence on the area (Table 7). Among these, hunting presented the highest impact index, reaching 82.1% of the maximum possible value, and was also the only factor whose extent was considered total, affecting more than 50% of the reserve area. This activity represents a critical threat to local wildlife, potentially compromising trophic structure and the functional integrity of ecosystems, as highlighted by Peres et al. (2020).

Table 7 – Pressures and threats in the Stoessel de Brito RPPN.

Activity	Is there pressure?	Trend (last 5 years)	Extent	Impact	Resilience	Is there a threat?	Probability	Extent	Impact	Resilience	Score
Agriculture and Silviculture	Yes	Remained constant	Localized	Low	Short term	Yes	Low	Localized	Low	Short term	17.9%
Hunting	Yes	Increased drastically	Total	High	Long term	Yes	High	Total	High	Long term	82.1%
Construction and operation of infrastructure	Yes	Remained constant	Localized	Low	Short term	Yes	Very low	Localized	Low	Short term	14.3%
Waste disposal (pollution)	No	Remained constant	Widespread	High	Long term	Yes	High	Widespread	High	Long term	60.7%
Invasive exotic species	Yes	Remained constant	Localized	High	Medium term	Yes	High	Localized	High	Short term	42.9%
Anthropogenic fires	Yes	Remained constant	Localized	High	Long term	Yes	Medium	Localized	High	Medium term	78.6%
External influences	Yes	Remained constant	Localized	High	Long term	No	High	Generalized	High	Long term	71.4%
Human occupation	Yes	Increased slightly	Generalized	High	Permanent	Yes	Medium	Generalized	High	Permanent	75.0%
Fishing	No	Decreased slightly	Localized	Low	Short term	No	High	Localized	Low	Short term	17.9%
Semi-natural processes	Yes	Increased slightly	Localized	High	Medium term	Yes	Medium	Widespread	High	Medium term	50.0%
Tourism and recreation	No	Remained constant	Localized	Low	Short term	No	Very low	Localized	Low	Short term	14.3%
Resource use by resident populations	No	Decreased drastically	Localized	Low	Short term	No	Very low	Localized	Low	Short term	7.1%

Source: Adapted from Ervin (2003); WWF-Brasil (2017).

Anthropogenic fires were also significant, with a score of 78.6%, resulting from direct exposure due to the state highway RN-118, which crosses the reserve. This condition of structural vulnerability also contributes to the external influence index (71.4%), reflecting the continuous risk of fire spread and environmental disturbances in boundary zones, a situation recurrent in conservation units intersected by public roads (Schmidt et al., 2018).

Other relevant pressures include human occupation in the surrounding areas (75%) and inadequate solid waste disposal (60.7%), both related to the proximity of the Laginhas district, in the municipality of Caicó (RN). These activities constitute diffuse sources of pollution and environmental fragmentation, capable of compromising ecological effectiveness and the functional connectivity of the landscape (Kavouras & Meireles, 2025).

Semi-natural processes represent a pressure and threat level of 50% for the Stoessel de Brito RPPN, as prolonged droughts may cause significant losses in local biodiversity, affecting natural vegetation regeneration and the maintenance of trophic chains, as reported by Oliveira et al. (2019). Consequently, the introduction of exotic species emerges as a secondary threat, reaching 43% criticality, due to alterations in ecological conditions and reduced environmental resilience of the reserve (Almeida et al., 2024).

Agricultural and fishing activities presented indices of 17.9%, not constituting significant threats to the conservation unit, as was also the case for tourism and recreation (14.3%) and the use of resources by resident populations (7.1%), which, although present, do not represent effective risks to the integrity of the protected area.

From a comparative perspective, the Stoessel de Brito RPPN shows greater potential for environmental conservation than other strictly protected conservation units in the northeastern semi-arid region, such as the Aiuaba Ecological Station and the Sobral National Forest, both located in the state of Ceará, which presented effectiveness indices below 40% (Bonilla & Nascimento, 2011). On the other hand, when compared to the Seridó Ecological Station (ESEC-Seridó), located approximately 40 km from the study area, the latter achieved around 70% effectiveness, a result associated with its consolidated administrative structure and the presence of a permanent technical team, as reported by Araripe et al. (2021).

According to the overall analysis of the RAPPAM results, the Planning element achieved the highest level of effectiveness (66.5%), followed by Context (60.7%), both classified as high effectiveness (>60%). The Results (40%) and Processes (60%) elements were classified as medium effectiveness, reflecting partial advances in management consolidation. In contrast, the Inputs element (28.6%) showed low effectiveness (<40%), constituting the main critical point of RPPN administration, especially due to the scarcity of human, financial, and structural resources (Figure 2).

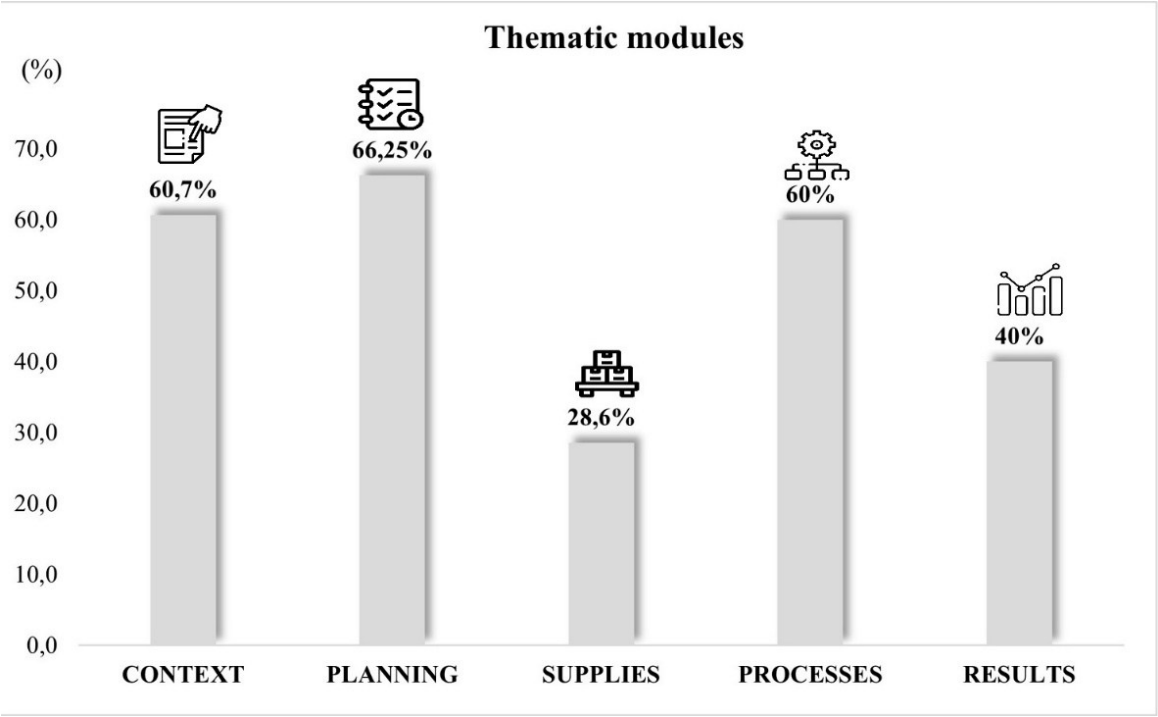

Figure 2 – Effectiveness of each Element for the Stoessel de Brito RPPN.
Source: Authors (2025).

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Research conducted in Conservation Units remains insufficient to reveal the full biological, social, and cultural richness they harbor. This shortfall is even more evident in Seasonally Dry Tropical Forests (SDTFs) (Meira, Nascimento & Silva, 2018). The lack of updated and systematized information compromises planning, monitoring, and enforcement in these areas, reinforcing the need for more integrated and participatory environmental management strategies aimed at preserving natural and cultural heritage (Araripe et al., 2021).

Another recurring challenge is the scarcity of financial resources, which, combined with weaknesses in communication and information sharing, favors environmental infractions and weakens the presence of the State in these areas. The absence of effective dialogue with local communities further aggravates this scenario. Efficient management depends on transparent communication and active social participation, which are capable of guiding more precise management goals and promoting ecological balance among native species (Guzmán & Sibaja, 2015; Azofeifa-Solano et al., 2018).

In this regard, Almeida et al. (2016) argue that bringing reserve management closer to surrounding communities is an essential step toward strengthening conservation. The creation of spaces for dialogue among the management council, committees, and local associations fosters a sense of belonging and environmental co-responsibility, enabling the population to recognize itself as a guardian of the reserve's natural resources.

According to Báez-Vargas et al. (2017), sound management planning is the foundation for implementing actions aimed at maintaining ecological integrity and ensuring effective management. When management is insufficient or poorly directed, direct impacts on landscape structure occur.

4. Conclusions

The results indicate that the Stoessel de Brito RPPN has ecological and structural conditions favorable to maintaining environmental integrity, with a tendency toward improved management effectiveness. The average index obtained through RAPPAM places the unit at a level compatible with consolidated protected areas, although operational limitations still affect full management efficiency.

The Planning and Context modules showed the best performance, reflecting coherence between management instruments and environmental characteristics. In contrast, the Inputs and Results modules revealed resource shortages, logistical weaknesses, and limited community articulation.

Despite these challenges, the RPPN demonstrates the capacity to promote effective conservation and reinforces the role of private reserves within the National System of Conservation Units (SNUC). It is recommended to strengthen governance, expand institutional partnerships, and adopt adaptive management based on environmental and social indicators. The use of methodologies such as RAPPAM proves essential for guiding policies and improving the management of private conservation units in the Caatinga.

Acknowledgments

The authors thank the Coordination for the Improvement of Higher Education Personnel (CAPES) for granting master's and doctoral scholarships. They also thank the Geoprocessing and Applied Studies Laboratory (LABGEO/UECE) and the Geomorphology and Applied Sedimentology Laboratory (LAGESA/CERES/UFRN) for the infrastructure provided. They thank the Seridó Higher Education Center (CERES/UFRN) for financial support and infrastructure. They extend their thanks to the INSPIRA institute for providing information on the study area. Finally, they thank the reviewers and editors for their contributions to improving this work.

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