INFRASTRUCTURE AND SOCIO-PRODUCTIVE SYSTEMS: CHALLENGES FOR INTEGRATED MANAGEMENT IN PROTECTED AREAS OF THE LOWER RIO NEGRO MOSAIC

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ABSTRACT

Mosaics of Protected Areas emerge as an approach to strengthen the management of protected areas in Brazil, aiming for more effective governance through the integration of territories. We present the case of the Mosaic of the Lower Rio Negro (MBRN), in Amazonas, to reflect on the challenges of integrated management in Conservation Units with resident populations. Through structured questionnaires applied in 115 traditional communities of eight MBRN protected areas in 2022, we characterized productive practices and access to community infrastructure items. Later, we tested the hypothesis that larger traditional communities with more community infrastructure items present more productive practices. We identified that practices such as agriculture, fishing, crafts, and extractivism were homogeneous throughout the territory, while tourism activities, natural resource management, and livestock were developed in specific territories. No protected area can be characterized as excellent in relation to access to infrastructure, highlighting the precariousness of services in the region. We found that access to community infrastructure items enables the development of more productive practices, regardless of the size of the community. The territory of the MBRN revealed great heterogeneity in access to community infrastructure and socio-productive systems, which hinders the implementation of integrated management strategies. We highlight the significant challenge of jointly managing the territory to guarantee the quality of life and preserve the Amazon socio-biodiversity.

Keywords: Central Amazon, socio-economics, rural development, Conservation Units

INFRAESTRUTURA E SISTEMAS SOCIOPRODUTIVOS: DESAFIOS PARA A GESTÃO INTEGRADA EM ÁREAS PROTEGIDAS DO MOSAICO DO BAIXO RIO NEGRO

RESUMO

Os Mosaicos de Áreas Protegidas surgem como uma abordagem para fortalecer a gestão das áreas protegidas no Brasil, visando uma governança mais eficaz por meio da integração territorial. Trazemos o caso do Mosaico do Baixo Rio Negro (MBRN), no Amazonas, para

a reflexão sobre os desafios da gestão integrada em Unidades de Conservação com populações residentes. Através de questionários estruturados aplicados em 115 comunidades tradicionais de oito Unidades de Conservação do MBRN em 2022, caracterizamos as práticas produtivas e o acesso à itens de infraestrutura comunitária. Posteriormente, testamos a hipótese de que comunidades maiores e com mais itens de infraestrutura comunitária apresentam mais práticas produtivas. Detectamos que práticas como a agricultura, pesca, artesanato e extrativismo foram homogêneas ao longo do território, enquanto atividades turísticas, manejo de recursos naturais e pecuária foram desenvolvidos em territórios específicos. Nenhuma Unidade de Conservação pode ser caracterizada como excelente em relação ao acesso à infraestrutura, evidenciando a precariedade dos serviços na região. Constatamos que o acesso à itens de infraestrutura comunitária possibilita o desenvolvimento de mais práticas produtivas, independentemente do tamanho da comunidade. O território do MBRN revelou grande heterogeneidade no acesso à infraestrutura comunitária e nos sistemas socioprodutivos, o que dificulta a implementação de estratégias de gestão integrada. Ressaltamos o desafio significativo na gestão conjunta do território para garantir a qualidade de vida e conservar a sociobiodiversidade amazônica.

Palavras-chave: Amazônia Central, socioeconomia, desenvolvimento rural, Unidades de Conservação

1. INTRODUCTION

Sustainable productive practices that integrate biodiversity conservation with the needs of contemporary societies have been increasingly debated in the political and scientific spheres (Levis et al., 2020; Santos; Santos; Veríssimo, 2022). This challenge is particularly complex in tropical countries, which are characterized by socio-spatial heterogeneity, ethnocultural diversity, and rich endemic biodiversity (Da-Gloria; Piperata, 2019; Silva, 2019). In these regions, low income and limited social development directly affect local livelihoods, often conflicting with global biodiversity conservation principles (Hanusch, 2023; Sunderlin et al., 2005). Thus, developing conservation strategies in these territories

requires understanding the multiple, often contrasting, social, political, cultural, economic, and environmental consequences (Campos-Silva et al., 2021; Gurdak et al., 2019).

Protected areas represent the principal instrument for implementing environmental policies on a global scale (Barreto Filho et al., 2021). Since the 1980s, Brazil has discussed the effectiveness of several public policies aimed at guaranteeing the collective use rights of traditional populations over their territories to promote the maintenance of the ecosystems in which they reproduce (Bittencourt; Potiguar; Fernandes, 2024). The creation of Conservation Units (CUs), a category of protected area, represented one of the most effective policy instruments for ensuring the conservation and sustainable use of natural resources, as well as the rights of traditional peoples and populations residing in protected territories (Campos-Silva et al., 2021; Miranda et al., 2020; Watson et al., 2014). These areas have proven to be important instruments for environmental conservation combined with generating socioeconomic opportunities (Young; Medeiros, 2018).

Currently, approximately 23% of the Legal Amazon is comprised of Indigenous Lands, 20% of private properties, 19% of Conservation Units, 13% of family holdings, and 12% of undesignated public land (IBGE, 2024). Within this intricate territorial network, acknowledging heterogeneity constitutes a fundamental premise for the formulation of socio-environmental conservation strategies. Such recognition is essential for identifying cultural attributes, social relations, and territorial dynamics across both micro- and macro-scales, thereby elucidating the interactions between traditional populations and natural resources (Da-Gloria; Piperata, 2019; Silva, 2019).

The Mosaics of protected areas, provided for in Article 26 of the National System of Conservation Units (SNUC), are territorial management and planning tools created to promote the participation and involvement of managers and inhabitants in the conservation of territories and increase the connectivity between protected areas of different types and categories to meet the various interests of social groups residing in the territories, minimize land conflicts, protect the rights of traditional populations, and strengthen the autonomy of territorial management (Pinheiro, 2010). Although Mosaics are established as important participatory models of sustainable management of territories and conservation of socio-

biodiversity, part of the studies related to these territories still consider only environmental indicators focused on fauna and flora to assess the conservation of socio-biodiversity (Campos-Silva et al., 2021; Pinheiro, 2010).

According to Soares, Miranda, and Mourao (2020), the success of Conservation Units depends on the type of governance and the management instruments applied, which should be participatory and shared. However, this strategy has been proving challenging for environmental agencies due to the difficulties in integrating the different players and institutions into a network. In this context, analysis mechanisms that integrate environmental, social, and economic aspects need to be improved to ensure the objectives of protected areas of guaranteeing and safeguarding the representativeness of different populations, recognizing and integrating traditional populations in promoting the conservation of fauna, flora, and ecosystems (SNUC, 2000), are effective in the long-term, especially in the Legal Amazon's region.

Socioeconomic studies have proven to be essential for CU analysis, providing tools for understanding the relationship of traditional populations with natural resources, productive practices, and the management of territories (Garret et al., 2021; Moura et al., 2016; Nascimento et al., 2019; Santos; Santos; Veríssimo, 2022). It is urgent that conservation models consider the valuing of natural resources and the need to establish adequate conditions for the permanence of traditional populations. Which includes the guarantee of infrastructure, provision of essential services (D'Antona, 2023; Pereira et al, 2022) and fair economic benefits (Abramovey et al., 2021), with strategies and public policies that encompass socio-cultural diversity (Santos; Santos; Veríssimo, 2022), traditional knowledge (Lima; Pozzobon, 2005) and multiple types of social organization for management and governance (Bandura; Mckeown, 2020).

The present study aimed to assess whether the size of communities, as well as access to a greater number of community infrastructure items, contributed to the development of more productive practices in traditional communities in the Lower Rio Negro Mosaic (MBRN). As a hypothesis, we argue that access to infrastructure and services enables improvements in the quality of life and development of productive practices carried out

throughout protected territories (Hanusch, 2023). Ensuring the permanence of residents in these environments and alternative sources of income that provide food and economic security, as well as better quality of life indexes (Turley; Uzsoki, 2018).

2. METHODOLOGY

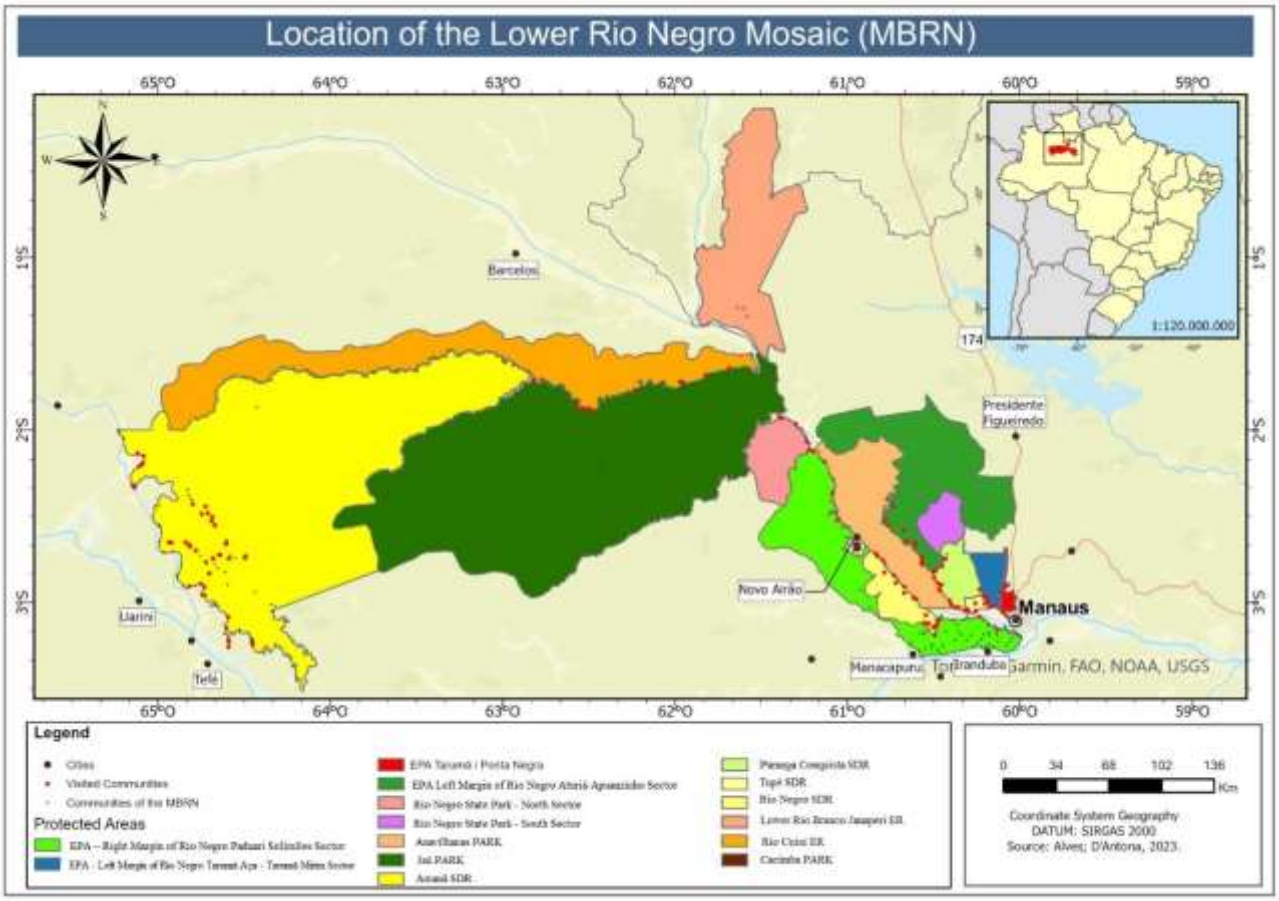
2.1 Area of Study

The Lower Rio Negro Mosaic (MBRN) consists of a set of 15 Conservation Units, covering an area of approximately eight million hectares, located in the states of Amazonas and Roraima, North of Brazil. Strategically positioned inside the Amazon, it is a territory relevant for the conservation of Amazonian socio-biodiversity due to its promotion of connectivity between extensive preserved areas and the presence of complex population arrangements in an urban-rural context, over and juxtaposed to other territories (Plano De Ação da Reserva da Biosfera da Amazônia Central, 2021; Alves; Pereira, 2023). Located between two important urban centers of the North region, Manaus at the far east and Tefé at the extreme west, it also houses a population distributed over more than 250 communities located on the banks of the main rivers of the region such as Negro, Solimões, Branco, Jaú, Unini, and Cuieiras (Alves; Pereira, 2023).

In this paper, we will employ the term "Conservation Units (CUs)" to categorize the different types of protected areas in Brazil, with reference to the definitions set forth in the SNUC (2020). These definitions distinguish between two categories of Conservation Units: full protection units and sustainable use units. Created in 2010 by the Ministry of the Environment, the MBRN is an initiative of integrated territorial management of an area composed of UCs of 5 distinct categories of integral protection and sustainable use, establishing itself as a management model that features the participation of traditional populations in its Advisory Council (Ministério Do Meio Ambiente, 2010). It is an interesting study model for the debate on the challenges and strategies of regional inequalities in the Brazilian Amazon and the role of different territorialities and spheres of

governance in protected areas with multiple socioeconomic particularities (Didier et. al., 2018).

Figure 1. Location of the Lower Rio Negro Mosaic (MBRN) and all its Conservation Units (CUs). The red dots indicate the communities interviewed during this work.



Source: prepared by the authors based on IBGE data, 2024.

2.2 Data collection and analysis

Field work for data collection was carried out between February and October 2022, in 115 traditional communities distributed over eight UCS in the Lower Rio Negro Mosaic, as shown in Table 1. The communities assessed represented approximately 46% of the existing localities in the territory.

Table 1. Name of Conservation Units (CUs), their respective management categories as defined by the SNUC, the municipalities in which they are located, and the number of communities that were interviewed.

CU name	CU Categories	Municipality	No. of Communities
Environmental Protection Area, Right Margin of Rio Negro, Paduari Solimões Sector (EPA – RM Paduari Solimões)	Sustainable Use	Novo Airão e Iranduba	6
Environmental Protection Area, Left Margin of Rio Negro - Aturiá/Apuauzinho Sector (EPA – LM Aturiá/Apuauzinho)	Sustainable Use	Novo Airão e Manaus	12
Rio Negro State Park - North Sector (Rio Negro SP)	Full Protection	Novo Airão	4
Amanã Sustainable Development Reserve (Amanã SDR)	Sustainable Use	Maraã	45
Puranga Conquista Sustainable Development Reserve (Puranga Conquista SDR)	Sustainable Use	Manaus	15
Rio Negro Sustainable Development Reserve (Rio Negro SDR)	Sustainable Use	Iranduba, Manacapuru, Novo Airão	17
Tupé Sustainable Development Reserve (Tupé SDR)	Sustainable Use	Manaus	6
Rio Unini Extractive Reserve (Rio Unini ER)	Sustainable Use	Barcelos	10

Source: The authors, 2024

Were used 2 questionnaire models. One of them had as a sample unit the households, with questions aimed at the heads of the household to obtain recall information about the productive activities developed throughout the year 2021. Another questionnaire was aimed at community leaders, with the communities as the sample unit, to identify the infrastructure

conditions at the community level through the identification of the presence or absence of items of collective use (Moura et al, 2016).

Household questionnaires were applied in 300 households, representing 30% of the households in 115 selected communities. The activities were designed to identify and measure aspects of the productive practices developed by the residents with a particular focus on commercialization. We also used Federal and State legislations, which regulate and guarantee practices of sustainable participatory management of natural resources in protected territories, particularly those related to fishing and logging activities (Governo Do Estado Do Amazonas, 2002; Ministério Do Meio Ambiente, 2011; Peralta; Lima, 2013; Guinato et al., 2023). The categories used were as follows: agriculture, alternative commercial fishing, livestock, non-logging plant extractivism, handicraft production, community-based tourism, and sustainable management of natural resources, focusing on logging and fishing, according to the criteria described in Table 2.

Table 2. The characterization of productive activities for commercialization, as developed by the inhabitants of the communities that comprise the Lower Rio Negro Mosaic (n=45 communities).

Productive Activity	Characterization
Agriculture	Cultivation of plant-based products, including planting, harvesting, and land-clearing steps. Cultivation was defined as when the plant was produced by anthropic factors, in which the producer selects the species of interest and produces based on these crops.
Alternative commercial fishing	A type of fishing carried out for commercial purposes by a fisherman authorized by the competent state body, which has fishing as their profession or main means of subsistence. In this work, we considered commercialization outside of participatory fishing management initiatives.
Livestock	Animal farming for commercial purposes.
Non-logging plant extractivism	Extraction of non-logging plant resources such as fruits, seeds, oils, medicinal plants, waxes, and fibers. It differs from agriculture because resources are collected from the natural environment, without plantations and crops.
Handicraft production	Products made of clay, ceramics, carpentry, and bio-jewelry (using stones, vines, fibers, seeds, and natural dyes)
Community-based tourism	Tourism organized and managed by the local community. In this work, it was related to the provision of services such as tour guides, and activities in inns, or community restaurants.
Management of natural resources with a focus on logging and fishing	Licensed practices related to fishing and logging forest management activities, with rules agreed upon between local communities, with the support of partner institutions and regulated by environmental agencies

Source: The authors, 2024

The questionnaires presented to the community leaders were based on the works by Moura et al. (2016) and Nascimento et al. (2019) and sought to obtain information related to access to community infrastructure items regarding the main public services provided. We interviewed 115 leaders and communities categorized in relation to the presence or absence of different public communication services (public telephone, radio, Internet, cell phone signal, collective rural antenna); power (electric power, solar panels); transportation (ambulance boat, boat with center motor, sterndrive engine); tools for community use tools for productive practices (flour oven, chainsaw, fishing equipment); sanitation, (water well);

health (health center); education (school); leisure (soccer field) and establishments (church, commerce, community center, and cemetery).

Statistical Analyses

We used descriptive and multivariate statistical techniques to assess the relationship between community size, the presence of infrastructure and production activities. The analyses allowed us to identify how production practices developed throughout the MBRN territory, based on the different categories of CUs.

We characterized the productive profile of the CUs and then applied a Principal Coordinates Analysis (PCoA) to the matrix of productive activities (columns) by communities (rows) in order to reduce the dimensionality of the matrix and find the productive activities that explained most of the variance in the data between the different PAs.

To analyze the items of community infrastructure, we added up the items per community and categorized them into quartiles: communities with "little access to infrastructure" (presence of 0 to 25% of the items); "medium access" (between 26% and 50%); "great access" (between 51% and 75%) and "excellent access" (between 76% and 100%).

Finally, to test whether the size of communities and access to more infrastructure items enabled more productive practices developed and marketed by residents, a multiple linear regression analysis (GLM) was applied to the sum of the productive activities developed in the communities and the sum of the items of community infrastructure and number of households.

All analyses were carried out using version 4.2.2 of the R software (R Development Core Team, 2024) with functions present in the vegan and stats package. For the PCoA, we used the *cmdscale* function and for multiple linear regression, the *glm* function. All analyses were considered significant when $p < 0.05$.

3. RESULTS

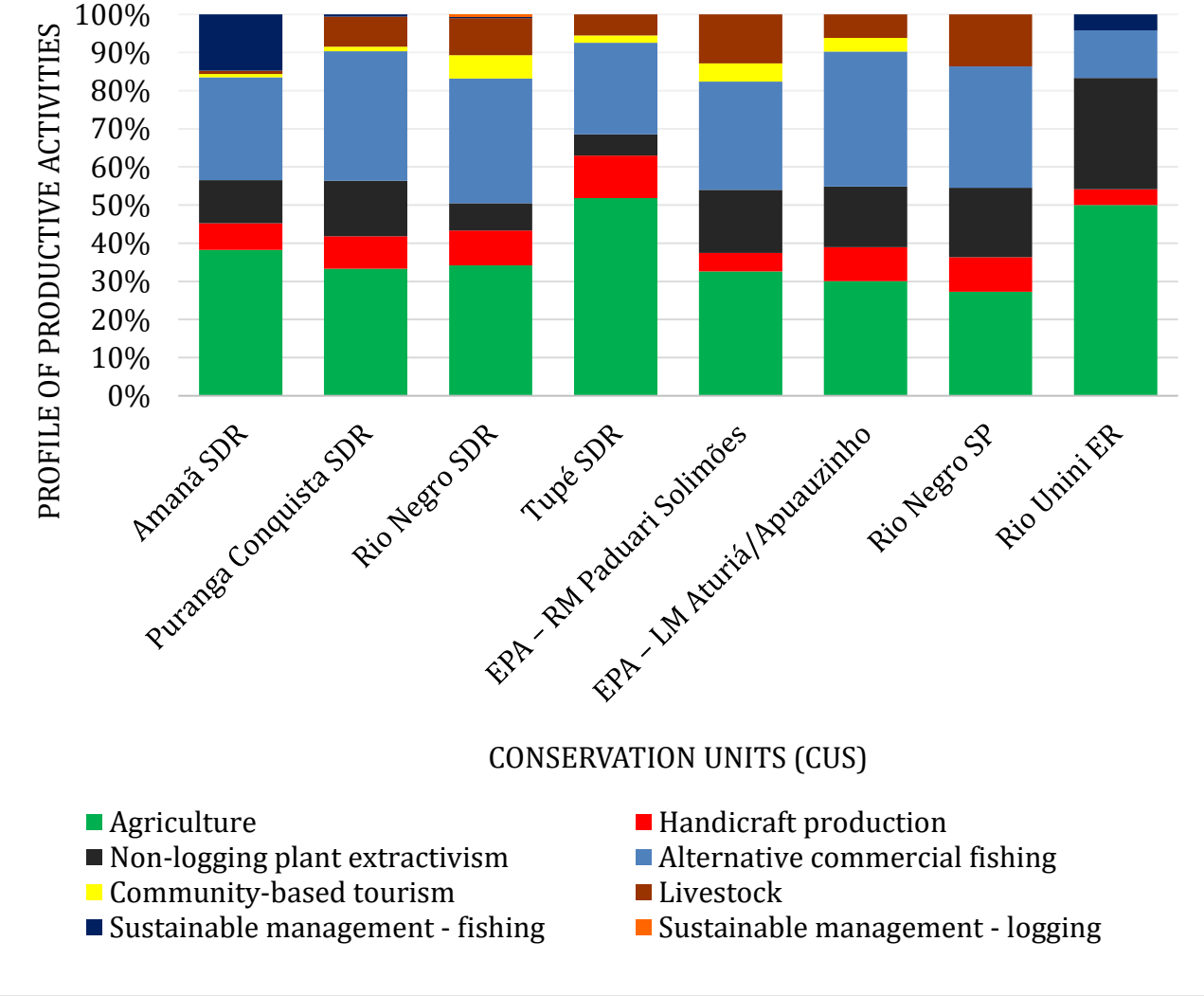
Productive Activities

Regarding the productive practices developed in the traditional communities of the UCs of the MBRN, we observed the predominance of agricultural practices, developed in 81% of the communities assessed. Fishing was the second most practiced activity, carried out by 48% of the communities; 35% of the localities worked with extractivism; 28% with the production of handicrafts; 18% with natural resources management (fishing and logging forest); 17% with livestock; and 17% with tourism.

We detected socio-spatial homogeneity in agricultural activities, handicraft production, extraction, and fishing in communities of all the CUs assessed (Figure 2). Other productive activities, however, were identified in specific territories, such as fishing and logging forest management activities, livestock, and tourism practices, presenting as exclusive practices of certain communities (Figure 2).

The contribution of fisheries management in the Amanã Sustainable Development Reserve (SDR) and the Rio Unini Extractive Reserve (ER) is particularly significant, with special attention to the management of pirarucu (*Arapaima gigas*) and tambaqui (*Colossoma macropomum*), species of considerable cultural and economic importance for the middle Solimões region. In the Negro River channel, small-scale livestock production, forest management, and tourism activities have been most prominent, particularly in territories located near major urban centers such as Manaus and Iranduba, thereby evidencing the interdependence of urban and rural contexts in the region (Figure 2).

Figure 2. Profile of the productive activities carried out by inhabitants of traditional communities located in the MBRN Conservation Units (n = 300 households).

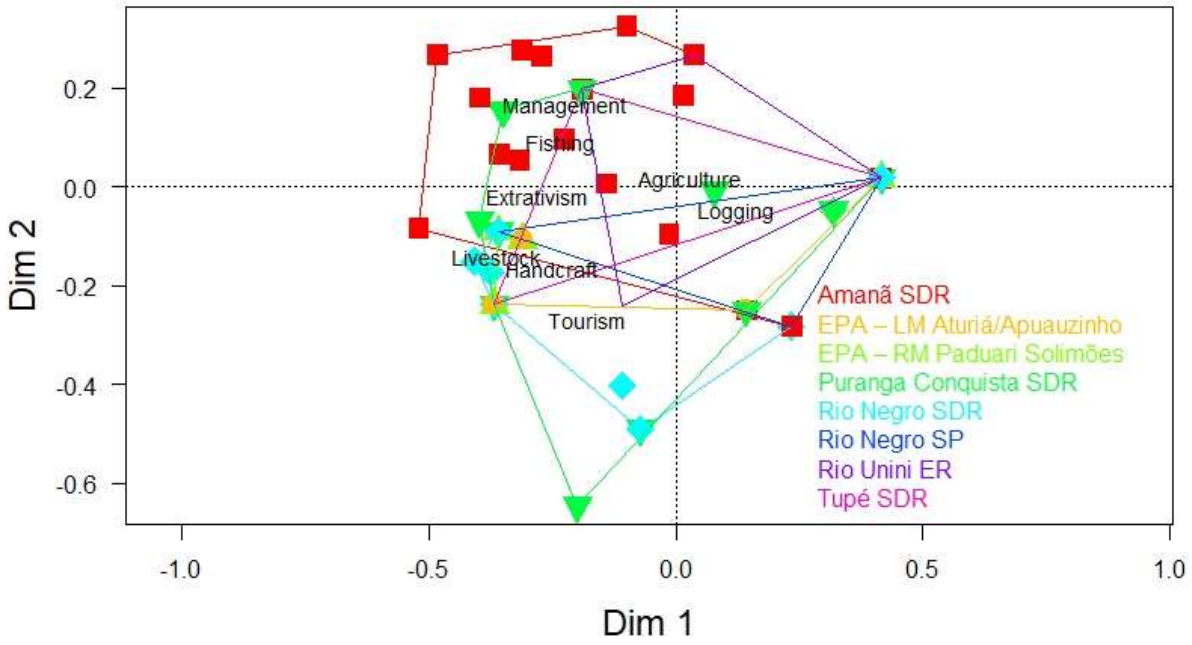


Source: The authors, 2024.

The PCoA showed a variation of 16% on axis 1 and 6% on axis 2, representing an accumulated explanation of 22%. The attributes that contributed the most to the variance in the first axis were livestock, extractivism, handicrafts, and logging. The second axis had as the main contributions to its variance management and tourism, with the most significant values (Figure 3 and Table 3). The greatest disparity observed by the PCoA was between the Amanã SDR, which focuses on practices of alternative fishing and fishing management, and

the SDRs Puranga Conquista and Rio Negro, which focus on practices of tourism, handicrafts, and livestock.

Figure 3: Projection of the scores for dimensions 1 and 2 of the Principal Coordinate Analysis (PCoA) within the MBRN Conservation Units (n = 115 communities)



Source: The authors, 2024.

Table 3: Results of the Principal Coordinate Analysis (PCoA) (n = 115 communities).

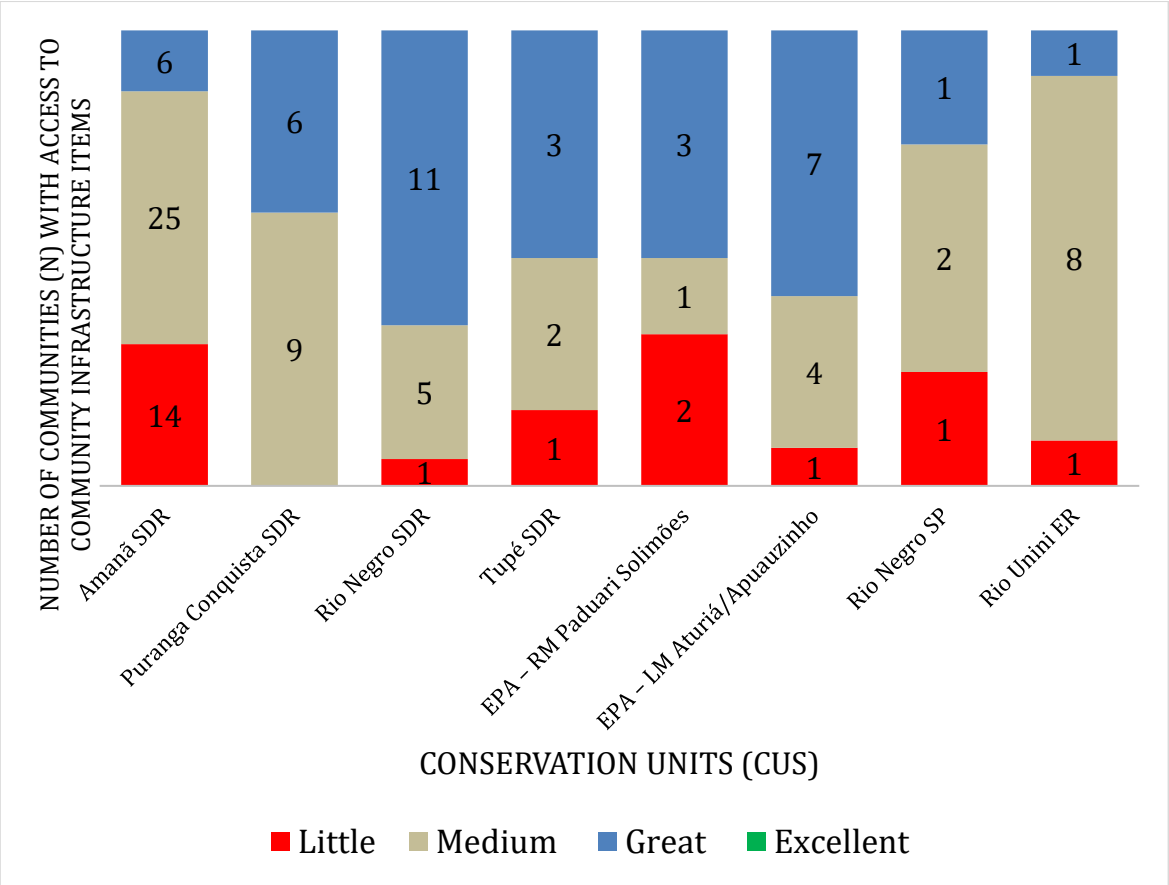
	Dimension 1	**Dimension 2**
Explanation %	16	6
accumulated %	16	22
Variable		
Agriculture	0.02	0.01
Fishing	-0.23	0.08
Extractivism	-0.27	-0.01
Management	-0.22	0.16
Handicrafts	-0.24	-0.16
Logging	0.12	-0.04
Tourism	-0.17	-0.26
Livestock	-0.36	-0.13

Source: The authors, 2024

Community infrastructure

Regarding the infrastructure items present in the communities, no CU presented communities that were categorized as excellent, with all the items evaluated (Figure 4). Most communities, regardless of CU, were categorized as having between average (49% of communities) and high accessibility (33%). Among the communities, 18% presented little access, with only the Puranga Conquista SDR not presenting communities with little accessibility.

Figure 4: The presence of community infrastructure items in traditional communities located within MBRN Conservation Units (n = 115 communities).



Source: The authors, 2024.

Among the CUs, we observed that the EPA of the Right Margin of Rio Negro and the Rio Negro State Park had the communities with the least access to infrastructure items, while the Rio Negro, Amanã, and Puranga Conquista SDRs had communities with access to the highest number of items (Table 3). Among the items assessed, communication infrastructures, work equipment, transportation, and health were non-existent in most of the UCs assessed, with a great scarcity of items such as collective rural antenna, radio signal, collective fishing gear, ambulance boats, solar panels, chainsaws and boats with a center and sterndrive engine. The presence of football fields, churches, schools, and access to electricity stood out as the items present in most UCs (Table 3), evidencing the disparity of the items and services available in the region, as well as the lack of services directly related to productive practices.

Table 4. Percentage (%) of communities with access to infrastructure items in the MBRN CUs (n = 115 communities). The colors represent the different categories of access to infrastructure items: Red = Little access; Black = Medium; Blue = Great; Green: Excellent.

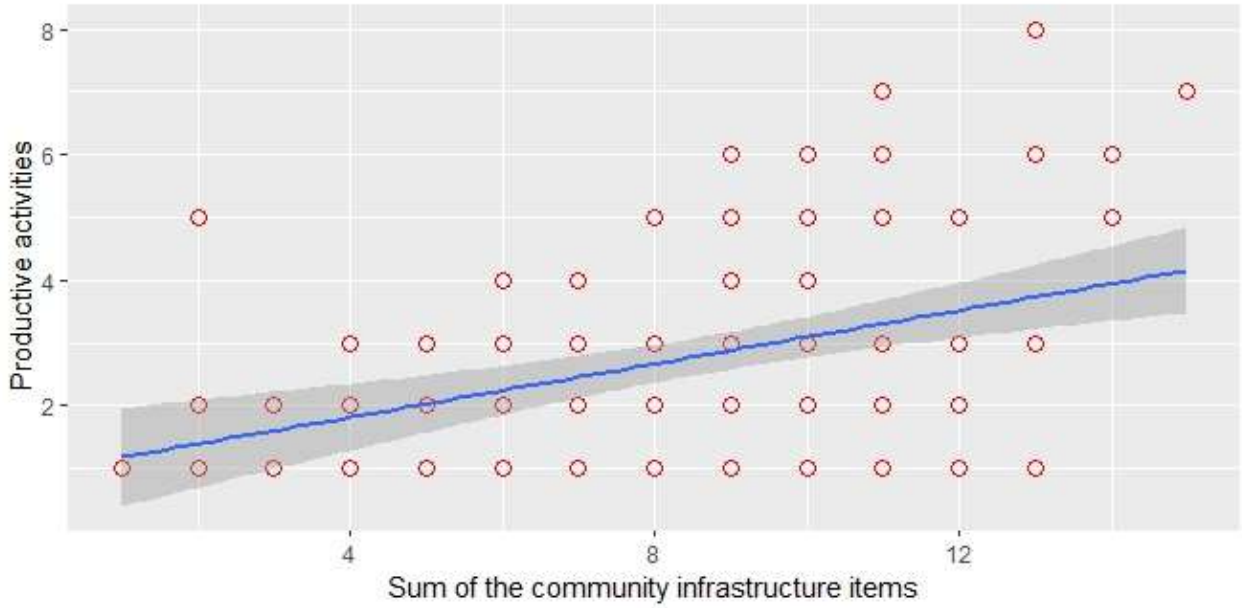
Name of the Conservation Unit	EPA – RM Paduari Solimões	EPA - LM Aturiá/ Apuauzinho	Rio Negro SP	Amanã SDR	Puranga Conquista SDR	Rio Negro SDR	Tupé SDR	Rio Unini ER
Health unit	33	50	0	4	40	29	33	50
Trade	50	100	25	49	73	88	83	30
Community Center	50	83	25	60	87	88	83	90
Football Field	50	100	100	78	93	100	100	90
Church	83	92	75	87	87	94	100	80
Graveyard	67	42	50	29	33	35	33	50
Electrical Power	100	92	75	80	100	88	100	70
School	83	83	75	84	67	71	67	100
Water Well	67	83	25	33	87	100	83	60
Chainsaw	0	0	25	0	13	47	0	0
Boat with Center Engine	0	0	25	7	7	0	0	0
Sterndrive Engine	33	0	50	11	13	41	0	10
Flour Oven	50	33	75	64	33	53	17	10
Solar Panels	50	25	0	18	33	41	17	20
Ambulance Boat	17	25	0	16	13	29	0	10
Collective Fishing Gear	0	25	50	16	7	18	0	0
Public Telephone	0	50	0	7	33	24	33	100
Radio Signal	0	8	0	4	0	6	17	40
Internet	67	83	50	22	87	76	100	40
Cell Phone	0	50	0	20	40	35	83	0
Rural Antenna	0	0	0	4	7	0	0	0

Source: The authors, 2024

The presence of infrastructure alone does not guarantee either service provision or quality standards. In most areas, community access to electricity relies on diesel-powered generators operating for limited hours per day. Likewise, the existence of educational and health facilities without adequate staffing, together with sanitation systems that do not ensure effective treatment, illustrates the structural deficiencies that constrain productive activities in the rural Amazon.

Through multiple linear regression, we found that the size of the communities did not show a relationship with the number of productive practices developed ($p = 0.78$). However, we found that localities with more community infrastructure items developed a greater number of productive practices ($p = 2.5{,}10^{-5}$) (Figure 5).

Figure 5. Relationship between the sum of productive activities and community infrastructure items (n = 115 communities).



Source: The authors, 2024

DISCUSSION

The communities in the Lower Rio Negro Mosaic showed variations in relation to access to community infrastructure, with a shortage of communication services, work equipment, transportation, and health services throughout the different CUs categories. Among the multiple productive practices developed throughout the territory, we observed the predominance of agriculture, extractivism, fishing, and handicrafts, as well as practices carried out exclusively in some territories, such as natural resource management, tourism, and livestock activities.

Socio-productive diversification is essential for guaranteeing monetary income for families at different times of the year, as it respects environmental and socio-cultural aspects (Gualberto; Estupinán, 2017; Guinato; Loureiro; Corrêa, 2025), as well as providing a stable scenario for consolidating food security and subsistence for these populations.

The productive activities exclusive of specific territories, such as the management of fishery resources in the region of Amanã SDR and Rio Unini ER, and tourism and livestock in environments near the Manaus region, highlight important environmental and historical-cultural aspects of these regions, as well as the need for specific incentives. The socio-spatial inequality in the MBRN territory stems from the plurality of land use and land coverage defined by the different rules of use of natural resources and permission for human occupation within the different CUs.

Throughout the MBRN region, there are infrastructure limitations, as well as great disparities in basic inputs and the provision of fundamental services that impact on socio-economic development (Abramovay Et Al., 2021; Bandura; Mckeown, 2020). Guinato and collaborators (2023) asked the local leaders of the communities of the CUs in the Rio Negro river channel about "What is missing in the Mosaic region for a better life?" And they found that more than half of the respondents (51%) answered "*the need for work opportunities and new options for income generation*", "*lack of basic infrastructure items, such as access to full-time electricity, basic sanitation, solar panels, communication systems, and access to work tools such as brush cutters, fishing nets, and wheelbarrows."*

Côrtes et al. (2022) identified the relocation of individuals or families to nearby urban centers as a strategy to mitigate the socioeconomic vulnerabilities arising from precarious living conditions in local communities. Such migration is primarily motivated by the need to access goods and public health and education services (Santos, 2020). The shortage of essential infrastructure accentuates socio-spatial inequalities and reveals the multi-scalar complexities that characterize these territories (Santos, 2020; Santos et al., 2022). In this context, territorial connections emerge as a key determinant shaping the productive practices of communities within the Conservation Units (CUs).

The valuation of Amazonian socio-biodiversity products has elicited sustained scholarly debate, particularly regarding its role in advancing quality of life and securing food sovereignty for traditional communities. Within this debate, the imperative extends beyond market considerations to encompass the promotion of alternative frameworks that refine production practices, enhance product valorization, and simultaneously acknowledge producers while safeguarding territorial rights (Uma Concertação Pela Amazônia, 2023; Villar et al., 2023). In this context, the strategic deployment of incentives and targeted investments in appropriate services and infrastructure constitutes a critical prerequisite for fostering inclusive and sustainable socio-economic development at the local level (Barretto Filho et al., 2021; Cook, 2011).

Furthermore, the meaningful incorporation of traditional populations into decision-making arenas is imperative, not only to valorize and legitimize traditional knowledge systems and territorial rights but also to advance governance strategies that ensure their substantive and efficacious participation in the management of territories and associated natural resources. The epistemic recognition of local communities and their integration into the institutional frameworks of protected areas constitute a foundational dimension of socio-environmental governance and an essential condition for robust conservation outcomes. In light of these premises, the urgency of implementing public policies that actively foster cultural resilience while supporting and consolidating the socio-economic practices and plural ontologies of traditional populations becomes unequivocal (Iwamoto, Leal, & Cançado, 2024).

The populations that inhabit the different territories are situated within specific normative, cultural, and socio-demographic contexts, which give rise to disparate perceptions and understandings of the territory. The existence of multiple socio-cultural, economic, geographical, and environmental landscapes indicates that there is no single socio-economic model that applies to the Amazonian context (Santos; Santos; Veríssimo, 2022). Our results illustrate the considerable challenge inherent in the joint management of the MBRN territories. This challenge is defined by the necessity to consider the multiple legal aspects that regulate the PAs, to take into account the social and economic interests of the populations, and to integrate different levels of governance. The diverse categories of natural resource use and management bodies serve to reinforce the existing diversity in this region, thereby underscoring the inherent complexity of promoting integrated management that takes into account not only the distinctive characteristics of the Amazonian biome but also the specific legislation that regulates and supports the various areas that comprise the MBRN. This approach aligns these principles with the diverse interests of the region's residents (Abramovay et al., 2021; Barreto Filho et al., 2021; Campos-Silva et al., 2021; Cook, 2011).

We highlight the importance of developing and adopting specific strategies to enhance productive activities in protected traditional territories, as well as the need to establish territorial management structures that take into account the varied territorialities, environmental, legal, and socio-cultural aspects (Abramovay et al., 2021; Bandura; Mckeown, 2020; Hanusch, 2023). As demonstrated in this analysis, investments in community infrastructure allow communities to diversify their productive practices, thereby enhancing the quality of life in protected areas, facilitating integrated economic and social development, and strengthening governance in the different territories (Guinato; Loureiro; Corrêa, 2025).

4. FINAL CONSIDERATIONS

Our results demonstrate the diverse productive practices developed by resident communities throughout different Conservation Units categories that comprise the MBRN. Additionally, our research reveals deficiencies in access to essential community infrastructure, particularly communication services, work equipment, transportation, and health resources. These limitations directly impact the ability of communities to engage in productive activities.

Recognizing the indispensable role of local communities in the conservation of protected territories is of paramount importance. Accordingly, the formulation and implementation of public policies that align with the cultural specificities of these territories are imperative. Equally essential is the establishment of integrated and participatory management frameworks that not only secure the proposed socio-environmental benefits but also strengthen territorial governance, safeguard and promote productive cultural practices, and ensure both quality of life and food security.

The adoption of context-specific management practices, alongside strategies that foster and enhance traditional socio-productive systems while reinforcing bioregional governance, is likewise critical. Such approaches necessitate the provision of adequate infrastructure and services to sustain traditional practices and to support the well-being of residents across diverse categories of Conservation Units. The coexistence of multiple territorialities underscores the need to conceptualize territories through a plurality of perspectives. This study thus emphasizes the necessity of adopting a multi-scalar and multi-dimensional analytical approach in order to advance territorial development and safeguard the socio-cultural continuity of communities situated within Protected Area Mosaics.

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