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Article

Territorial Management in the Amazon from the Perspective of Ecological Economics: Proposition of a Conceptual Model

Francisco Bezerra de Lima Júnior[1], Carlos Alberto Franco da Costa[2], Raimundo Cláudio Gomes Maciel[3], Rodrigo Duarte Soliani[4]

[1] Doutorando em Biodiversidade e Biotecnologia. Docente no Instituto Federal do Acre. ORCID: 0000-0003-3170-5145. Email: francisco.junior@ifac.edu.br

[2] Doutor em Meio Ambiente Natural e Humano nas Ciências Sociais. Docente na Universidade Federal do Acre. ORCID: 0000-0002-4966-4348. Email: carlos.costa@ufac.br

[3] Doutor em Economia Aplicada. Docente na Universidade Federal do Acre. ORCID: 0000-0001-8979-4895. Email: raimundo.maciel@ufac.br

[4] Doutor em Tecnologia Ambiental. Docente no Instituto Federal do Acre. ORCID: 0000-0003-3354-6838. Email: rodrigo.soliani@ifac.edu.br

RESUMO

A Amazônia enfrenta intensas pressões ecológicas e sociopolíticas, decorrentes de um modelo de ocupação baseado na exploração intensiva dos recursos naturais e em métricas econômicas unidimensionais. Nesse cenário, torna-se necessário desenvolver instrumentos analíticos compatíveis com a complexidade dos sistemas socioecológicos da região. Este artigo propõe um modelo conceitual de gestão territorial ecológica para a Amazônia, fundamentado nos princípios da Economia Ecológica e operacionalizado por meio do Índice Multicritério de Sustentabilidade (IMS). A metodologia consistiu em uma revisão sistemática da literatura, abrangendo estudos publicados entre 2020 e 2025 sobre gestão territorial, métodos multicritério e sustentabilidade em contextos amazônicos. A análise de 51 artigos permitiu identificar três categorias analíticas centrais: valores normativos, dimensões da sustentabilidade e critérios substantivos. Como principal resultado, apresenta-se um modelo estruturado em cinco dimensões — ambiental, social, econômica, governança e práticas produtivas sustentáveis — articuladas a critérios substantivos e valores normativos, como justiça ambiental, equidade e metabolismo ecológico. O IMS foi selecionado como eixo operacional por sua flexibilidade metodológica, capacidade de adaptação territorial e processos de validação participativa. Os resultados indicam que o modelo constitui uma alternativa analítica aplicável ao planejamento territorial em regiões complexas como a Amazônia. Sua implementação, contudo, requer capacidades institucionais, disponibilidade de dados locais e processos participativos qualificados. Pesquisas futuras devem explorar sua aplicação empírica e compará-lo a outras abordagens multicritério, de modo a avaliar sua efetividade na formulação de políticas públicas territorialmente sensíveis.

Palavras-chave: sistemas socioecológicos; justiça ambiental; governança territorial; avaliação da sustentabilidade; métodos multicritério.

ABSTRACT

The Amazon region faces intense ecological and sociopolitical pressures resulting from a development model based on the intensive exploitation of natural resources and unidimensional economic metrics. In this context, it is necessary to develop analytical instruments compatible with the complexity of the region's socioecological systems. This article proposes a conceptual model of ecological territorial management for the Amazon, grounded in the principles of Ecological Economics and operationalized through the Multicriteria Sustainability Index (MSI). The methodology consisted of a systematic literature review covering studies published between 2020 and 2025 on territorial management, multicriteria methods, and sustainability in Amazonian contexts. The analysis of 51 articles allowed the identification of three core analytical categories: normative values, sustainability dimensions, and substantive criteria. As the main result, the paper presents a model structured into five dimensions—environmental, social, economic, governance,

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and sustainable productive practices—articulated with substantive criteria and normative values such as environmental justice, equity, and ecological metabolism. The MSI was selected as the operational axis due to its methodological flexibility, territorial adaptability, and participatory validation processes. The results indicate that the model constitutes an analytical alternative applicable to territorial planning in complex regions such as the Amazon. Its implementation, however, requires institutional capacity, availability of local data, and qualified participatory processes. Future research should explore its empirical application and compare it with other multicriteria approaches to assess its effectiveness in formulating territorially sensitive public policies.
Keywords: socioecological systems; environmental justice; territorial governance; sustainability assessment; multicriteria methods.

Introduction

The Amazon constitutes a strategic territory in multiple dimensions, ecological, climatic, geopolitical, and sociocultural, whose centrality has been widely recognized in national and international debates (Flores et al., 2024). From an ecological standpoint, it harbors one of the greatest biodiversities on the planet and plays an essential role in regulating water and carbon cycles on a continental scale (Fassoni-Andrade et al., 2021). Its climatic integrity, in turn, directly influences the stability of the Earth system, affecting precipitation and temperature patterns in various regions (Bottino et al., 2024). On the geopolitical level, the Amazon represents a frontier of disputes over natural resources, infrastructure, and sovereignty, attracting diverse and often contradictory interests (Merino, 2025). It is also, in its sociocultural dimension, the living space of hundreds of Indigenous peoples and traditional communities whose ways of life maintain deep ties with the forest and hydrological systems (De Francesco, 2025).

Despite this territorial complexity, the Amazon remains shaped by a logic of occupation guided by extractive and short-term economic interests (Domingues & Sauer, 2021; Freitas et al., 2024; Schwartzman & Rezende, 2025). This rationale, anchored in the principles of the market economy, focuses on maximizing productivity and commodity flows, often to the detriment of ecological integrity and social justice (Garrett et al., 2024).

According to Marengo et al. (2022), the expansion of the agricultural frontier, the advance of logistics chains, and the liberalization of environmental assets illustrate how Amazonian living systems have been converted into economic resources. In this process, indicators such as Gross Domestic Product (GDP), trade balance, or productivity per hectare are used as central parameters to define regional "development". However, these metrics disregard the biophysical limits of the forest, conceal the social costs of environmental degradation, and reflect a conception of efficiency detached from ecological resilience (Norris et al., 2022).

This model of occupation and management has produced cumulative and interdependent effects, including deforestation, loss of biodiversity, land conflicts, the weakening of local communities, and the disruption of essential ecosystem services (Leal Filho et al., 2025). The growing ecological crisis should not be understood merely as a regulatory failure but as an expression of the structural inability of market mechanisms to address the complexity of socioecological systems. In light of this tension between economic growth and environmental conservation, it becomes evident that alternative development paradigms are needed, capable of integrating ecological, social, and cultural dimensions into decision-making processes (Chakrabarti & Sharma, 2024). Within this context, Ecological Economics (EE) gains prominence by proposing a rationality grounded in strong sustainability, the recognition of ecological limits, and the incorporation of multiple ecological, social, and cultural values into decision-making (Rezende et al., 2024).

Adopting EE as a framework implies not only redefining the objectives of public policies but also reformulating the instruments that guide territorial planning and management (Haddad & Solomon, 2024). As Spash (2020) notes, while the dominant rationale relies on aggregated and unidimensional metrics such as GDP, an approach committed to strong sustainability requires tools capable of capturing multiple dimensions of well-being, incorporating non-monetary values, and making visible the ethical and ecological conflicts embedded in

public decisions. Given this need, the development of analytical models capable of integrating diverse criteria and constructing diagnostics sensitive to the complexity of Amazonian territories gains relevance.

Among the available methodological alternatives, multicriteria methods play a key role by offering evaluative structures that integrate environmental, social, economic, cultural, and institutional dimensions through deliberative and transparent processes (Etxano & Villalba-Eguiluz, 2021). Among these methodologies, the Multicriteria Sustainability Index (MSI) stands out for its analytical flexibility and participatory character, allowing decisions to be guided in a way that is more consistent with ecological limits and the needs of local populations, particularly in regions of high sociocultural diversity and intense environmental pressure, such as the Amazon (Lima et al., 2023).

Based on this framework, this article proposes the formulation of a conceptual model of ecological territorial management, grounded in the principles of Ecological Economics and operationalized through the MSI. The study is based on a systematic literature review and seeks to contribute to the improvement of planning instruments capable of integrating environmental conservation, social justice, and economic viability within a long-term perspective.

Fundamentals of EE for territorial management

EE has become an interdisciplinary field that seeks to address the socio-environmental dilemmas generated by the dominant economic rationality (Spash, 2020). Its origin is linked to the critique of authors who, beginning in the 1970s and 1980s, questioned the assumptions of neoclassical economics in light of growing social inequalities and environmental degradation. While the conventional approach operates on premises such as unlimited economic growth, maximized individual rationality, and substitutability between natural and manufactured capital, EE introduces a theoretical inflection that subordinates economic processes to the planet's physical and ecological limits (Godin et al., 2022). In doing so, it shifts the focus from allocative efficiency to systemic sustainability, incorporating ethical, ecological, and social values into economic analysis.

One of its key pillars is the notion of strong sustainability, which rejects the idea that natural capital can be fully replaced by human or technological capital (Reijnders, 2021). It recognizes that insurmountable biophysical limits exist and that economic systems are subsystems dependent on the biosphere. Within this context, the concept of a sustainable scale reinforces that economic growth must respect the carrying capacity of ecosystems and the ecological boundaries of the planetary system (Haddad & Solomon, 2024). Thus, the economy is conceived not as an autonomous system of production and consumption but as a metabolic process that transforms energy and matter, generating waste and impacts that must be considered in any feasibility analysis (Singh et al., 2021).

This perspective also incorporates the concept of entropy, originally derived from the second law of thermodynamics, which describes the natural tendency of physical systems toward the degradation of usable energy (Kümmel, 2024). In EE, this principle is reinterpreted to demonstrate that economic processes depend on continuous flows of energy and matter from nature, which are inevitably degraded over time. This understanding implies that economic expansion faces insurmountable physical limits and that maintaining productive activity requires respecting ecosystems' regenerative capacity (Martinez-Alier, 2022). Consequently, the maximization of productivity and efficiency, often celebrated in market-based economic discourse, becomes insufficient, or even contradictory, when confronted with the need to preserve the integrity of ecological systems (Rudolf & Schmidt, 2025).

EE also emphasizes environmental justice, intergenerational equity, and the plurality of values that structure socio-ecological systems. This perspective acknowledges that the values involved in public decision-making are multiple, incommensurable, and often conflicting, requiring deliberative and participatory

approaches that make the diversity of cultural and ethical perspectives visible (Lenzi et al., 2023; Rivera-González et al., 2023). Recognizing that economic decisions unequally affect social groups and ecosystems, EE demands that decision-making processes incorporate ethical, cultural, and territorial dimensions often ignored by conventional models. This concern with distributive impacts and the legitimacy of values mobilized in public decisions shifts the focus from efficiency to justice and systemic resilience (Langemeyer et al., 2024).

Another central point lies in EE's critique of the dominance of traditional economic indicators, such as Gross Domestic Product (GDP) or labor productivity, which measure economic growth without accounting for ecological costs, natural resource depletion, or social exclusion (Zheng & Chen, 2024). In the Amazon, for instance, regional GDP expansion can occur alongside forest degradation, impoverishment of local populations, and escalating territorial conflicts. This scenario underscores the inadequacy of such indicators for guiding decisions that involve multiple values and competing interests (Hänggli et al., 2023).

Thus, EE provides an analytical framework consistent with the challenges of territorial management in the Amazon. Its emphasis on subordinating the economy to ecology, valuing multiple dimensions of well-being, and recognizing the material limits of growth makes it particularly relevant for designing management instruments that break with utilitarian rationality and incorporate the principles of strong sustainability.

The MSI in Amazonian territorial management

The management of complex socio-ecological systems, such as those that compose the Amazon territory, requires analytical tools capable of addressing multiple and often conflicting dimensions of value (Morales-Giner et al., 2021). One-dimensional indicators, based solely on isolated economic or environmental metrics, are insufficient to capture the diversity of factors involved in decisions that affect ecosystems, local populations, and institutional structures (Xavier et al., 2025). In this context, multicriteria methods emerge as methodological alternatives that incorporate this complexity by allowing the simultaneous consideration of multiple values and objectives in integrated decision-making processes.

Multicriteria analysis arises as a response to the limitations of traditional evaluation models, enabling ecological, social, economic, and political objectives to be considered simultaneously in public decisions (Kpadé et al., 2024). This approach is particularly relevant in contexts such as the Amazon, where decisions on land use and conservation involve incommensurable values, distributive conflicts, and long-term impacts. Multicriteria methods make it possible to build assessment models that incorporate these aspects and make explicit the value choices involved in setting priorities (Morales-Giner et al., 2021).

Among the multicriteria methodologies applied to territorial sustainability, the one adopting a constructivist and participatory approach stands out, guided by the integration of different social perspectives and the adaptation of evaluation criteria to local specificities (Framesche et al., 2025). In this regard, the MSI was developed as a tool for the integrated analysis of the sustainability of territorial units, organizing evaluation criteria into five main axes: Governance, Environmental, Economic, Social, and Agronomic (Lima et al., 2023). These axes correspond to the fundamental dimensions of strong sustainability, directly aligned with the principles of Ecological Economics and enabling analyses that reconcile ecological, social, and economic factors (Mangabeira et al., 2021).

The MSI concept is based on a participatory construction logic, in which local actors and experts contribute to defining criteria, indicators, and relative weights for each dimension (Lima et al., 2023). This approach aligns with the perspective of participatory multicriteria analysis, which seeks to integrate different viewpoints and social values into the decision-making structure, strengthening the legitimacy and transparency of the evaluation process (Dean, 2022). Similarly, Jiménez-Ortega et al. (2022) demonstrate that applying multicriteria methods with the participation of producers and cooperatives allows the index to be adapted to the specific conditions

of each territory, making it more representative and sensitive to local dynamics. The hierarchical model used in multicriteria methods such as the MSI also facilitates the organization of information at different levels of aggregation, allowing both individual components and overall sustainability performance to be analyzed in an integrated and comparable manner (Ziemba, 2022).

In the Amazon, the MSI has already been applied in experiences such as that of the Chico Mendes Extractive Reserve, where it was used to assess the degree of sustainability of the conservation unit based on criteria built from primary and secondary data (Lima et al., 2023). The results made it possible to identify critical points and potentialities across different dimensions, guiding integrated territorial action proposals. This application demonstrates the technical feasibility and political relevance of the IMS as an instrument to support territorial management in regions with high ecological and sociocultural diversity.

Thus, the MSI is characterized as a method consistent with the principles of Ecological Economics and suitable for the challenges of territorial governance in the Amazon. Its ability to integrate multiple dimensions of value, combined with its participatory character and hierarchical analytical structure, makes it a promising tool for guiding public decisions that articulate environmental conservation, social justice, and economic viability in highly complex contexts.

Methodology

This article adopts a qualitative, exploratory, and theoretical–propositional approach, structured in two interdependent methodological stages: (i) a systematic literature review (SLR) on ecological territorial management and multicriteria methods; and (ii) the formulation of a conceptual model grounded in the principles of EE and operationalized through the MSI.

The objective is to develop an analytical model capable of integrating multiple dimensions of sustainability, applicable to the Amazonian context, which is characterized by high socio-ecological complexity and persistent territorial conflicts. Figure 1 summarizes the main methodological steps adopted in this study.

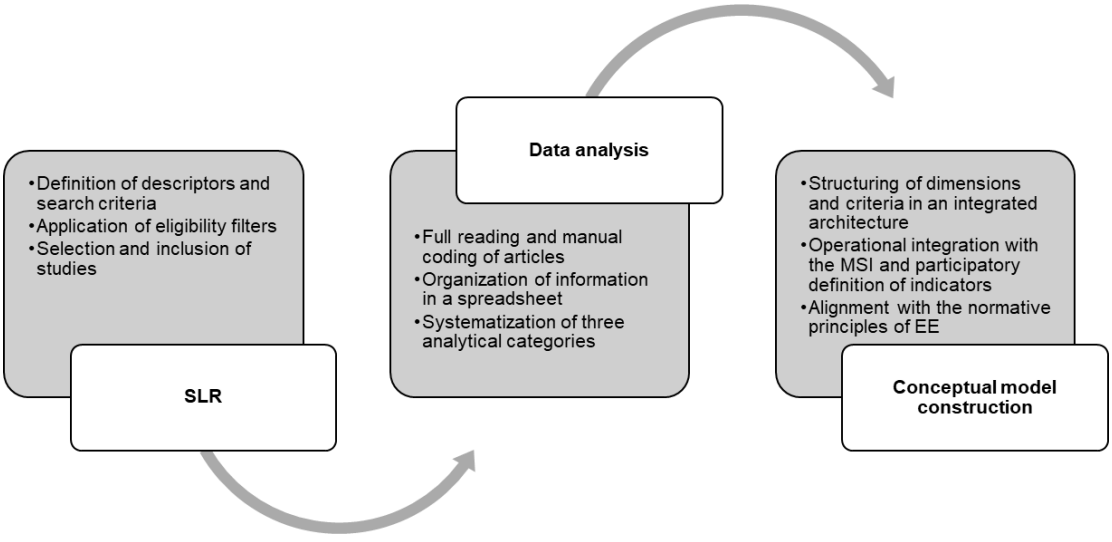

Figure 1. Methodological steps for model construction. Source: prepared by the authors (2025).

The first stage consisted of conducting the SLR, aiming to identify the main conceptual and methodological approaches related to ecological territorial management, the application of multicriteria methods, and the use of the MSI or similar tools in socio-environmental contexts. The search strategy followed the methodological guidelines proposed by Sauer and Seuring (2023) and was carried out in comprehensive academic databases, including Scopus, Web of Science, and SciELO.

The following descriptors were used, combined with Boolean operators: ("Ecological Economics" AND "territorial management") OR ("multicriteria methods" AND "sustainability assessment") OR ("Multicriteria Sustainability Index" AND "Amazon") OR ("sustainable development" AND "territories"). The search period covered 2020–2025 to capture the most recent contributions aligned with contemporary debates on sustainability and territorial management.

In the identification stage, all records retrieved using the descriptors were considered. The selection process applied the following inclusion criteria: (i) articles published in peer-reviewed journals in Portuguese or English; (ii) publications available in full text; (iii) studies with theoretical or applied scope related to ecological management of territories; (iv) approaches using or discussing multicriteria methods applied to sustainability; and (v) publications addressing directly or indirectly the Amazonian context.

Studies were excluded if they: (i) duplicated previously identified works; (ii) were not available in full text; (iii) relied exclusively on economic or financial methods without articulating ecological or social values; (iv) lacked explicit sustainability criteria; or (v) replicated content already included in other publications by the same authors.

The inclusion stage consisted of a full reading of all potentially eligible papers, resulting in the final sample that supported the formulation of the conceptual model. The entire process rigorously followed the methodological stages defined in the SLR protocol.

Data analysis

After applying the filters and reading the selected texts in full, data were analyzed using inductive thematic synthesis, a qualitative approach that seeks to identify recurring patterns in studies without relying on predefined categories (Naeem et al., 2023). This process involved a detailed reading of the materials, allowing themes to emerge directly from the data rather than being derived from prior theoretical schemes.

The initial coding was carried out manually, with the extraction of relevant excerpts organized into a spreadsheet in Microsoft Excel. This tool was used to systematically record information, enabling comparison across studies and the identification of common themes. The information units were progressively grouped into broader categories based on conceptual similarities and thematic recurrence.

As a result, three main analytical categories were defined: (i) normative values guiding sustainability approaches, such as environmental justice, ecological limits, and intergenerational equity, which express the ethical and epistemological foundations mobilized in the studies; (ii) recurring dimensions of territorial sustainability, environmental, social, economic, governance, and sustainable productive practices, representing the main areas of impact and decision-making; and (iii) substantive criteria used in evaluation, represented by concrete attributes associated with each dimension (e.g., biodiversity, inclusion, income, or social participation), which operate as comparative elements across different experiences.

The systematization of these categories provided the empirical foundation for the formulation of the conceptual model, articulating the findings from the literature with the normative objectives of EE.

Conceptual model construction

Based on the findings of the SLR, we developed a conceptual model of ecological territorial management grounded in the principles of Ecological Economics. The model's construction began with the identification and systematization of the most recurrent dimensions, criteria, and normative values in the analyzed studies, focusing on those aligned with the principles of strong sustainability. These elements were organized into an integrated analytical structure, having the MSI as its operational axis, selected for its ability to incorporate multiple dimensions of sustainability within complex contexts.

The model is structured around five central dimensions (Governance, Environmental, Economic, Social, and Sustainable Productive Practices) which reflect the main areas of impact and decision-making identified in the literature, as well as their relevance to the Amazonian context. The construction also considered the possibility of participatory adaptation of indicators and weights, enabling the tool's customization for different territorial units and decision-making contexts.

The proposal therefore seeks to coherently articulate the normative framework of Ecological Economics with the multicriteria logic of the MSI, resulting in an analytical tool applicable to territorial management in socio-ecologically complex regions. The MSI is interpreted here not merely as an evaluative instrument but as an operational component of a model guided by non-utilitarian values, committed to environmental justice, resilience, and the integrity of ecological systems.

Results and Discussion

The results presented in this section correspond to the methodological process described previously, focusing on the identification, screening, categorization, and synthesis of the evidence obtained through the systematic literature review. The objective was to identify conceptual and methodological approaches concerning territorial management in socioecological systems, the application of multicriteria methods to sustainability assessment, and the normative foundations of EE.

Initially, 184 publications were identified across the databases Web of Science (n = 61), SciELO (n = 36), and CAPES Journals (n = 87). Subsequently, filters were applied to remove duplicates (–29), exclude works outside the temporal scope (–12), non-Portuguese or non-English publications (–7), and unavailable full-text articles (–6), resulting in 130 eligible publications for screening.

During the qualitative analysis of titles and abstracts, 64 studies were excluded for not fitting the thematic scope of the research. Consequently, 66 articles were selected for full reading. In the final stage, after in-depth examination, 15 studies were disregarded for not fully meeting the inclusion criteria, such as the absence of a clear connection between sustainability and territorial management or exclusive reliance on economic approaches.

At the end of the process, 51 articles comprised the final sample used to formulate the conceptual model of ecological territorial management. Figure 2 presents the flow of identification, selection, and inclusion of the articles that formed the final sample of the systematic review.

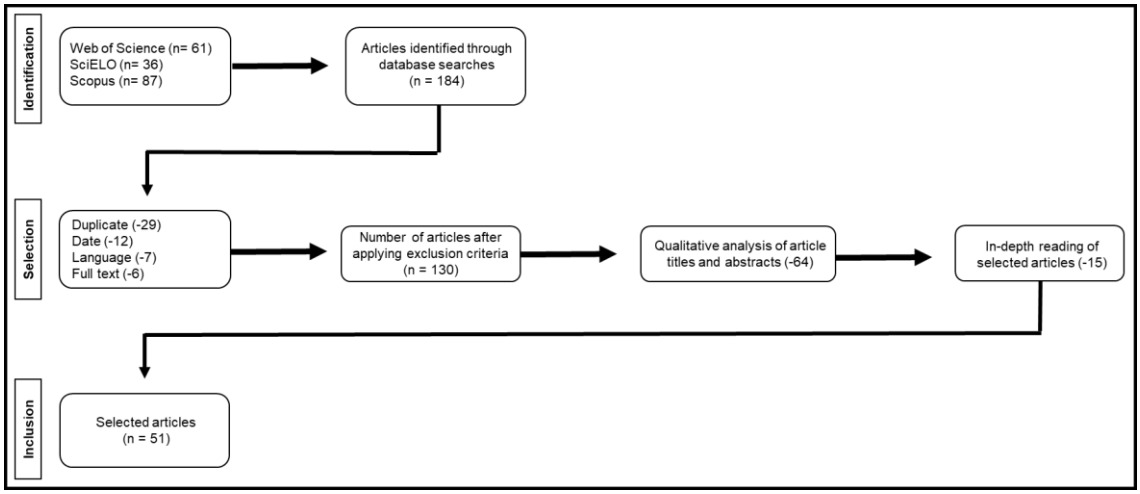

Figure 2. Stages of identification, selection, and inclusion of articles in the SLR. Source: prepared by the authors (2025).

After defining the final sample, the articles underwent an inductive thematic analysis, as described in the methodological section. This stage involved full-text reading and the systematic extraction of the most relevant excerpts from each study, organized in an analytical spreadsheet and compared according to their recurrence and conceptual convergence. From this systematization, it was possible to identify recurring interpretative patterns, revealing how the literature has structured the relationship between sustainability and territorial management across different contexts and approaches.

The analysis enabled the synthesis of findings into three central elements. The first corresponds to the most recurrent dimensions of sustainability identified in the studies; the second to the substantive criteria associated with each dimension; and the third to the normative values that guide these approaches. These elements constitute the conceptual foundation sustaining the formulation of the ecological territorial management model proposed in this article.

Table 1. Dimensions of sustainability, substantive criteria, and associated normative values

Dimension	Substantive criteria	Associated normative value
Environmental	Biodiversity, Ecosystem services	Ecological limits, Entropy
Social	Inclusion, Food security, Equity	Environmental justice, Plural values
Economic	Income, Diversification, Local Sustainability	Strong sustainability, Social metabolism
Governance	Participation, Transparency, Deliberation	Co-production, Democratic legitimacy
Productive practices	Sustainable agriculture, Local extractivism	Ecosocial integration, Resilience

Source: prepared by the authors (2025).

The analysis reveals a convergence around a conception of sustainability grounded in strong normative values such as environmental justice, ecological integrity, and intergenerational equity, values that challenge the dominant economic rationality. From this perspective, Skene (2022) argues that the economy should be understood as a subsystem of the biosphere, whose viability depends on maintaining ecological cycles and preserving the social and cultural dynamics that sustain territories. This interpretation reinforces the need to rethink territorial management instruments in light of ecological complexity, sociocultural diversity, and the power asymmetries that shape socioecological systems (Langemeyer et al., 2024).

Based on this framework, five central dimensions for assessing territorial sustainability were identified: environmental, social, economic, governance, and sustainable productive practices. These dimensions correspond to the first of the three analytical elements and represent the main fields of impact and decision-making observed in the studies. Each of them responds to concrete challenges found in regions such as the Amazon, providing a structured basis for integrated sustainability analyses.

The first, the environmental dimension, relates to the regenerative capacity of ecosystems, the conservation of biodiversity, and the provision of ecosystem services that sustain regional climatic and hydrological balance (Leal Filho et al., 2025). The values of ecological limits and entropy reinforce the understanding that there are insurmountable biophysical constraints on economic expansion and the intensive use of natural resources.

In the social dimension, the criteria of inclusion, equity, and food security highlight the unequal impacts of environmental degradation on different social groups and indicate the need for policies sensitive to local

vulnerabilities (Maluf et al., 2024). This perspective relies on values such as environmental justice and the recognition of traditional knowledge, cultural rights, and ethnic diversity.

The economic dimension, in turn, is reinterpreted through the notion of a territorialized economy. Rather than relying solely on metrics such as GDP or productivity, it emphasizes local income generation, productive diversification, and the valorization of sustainable practices (Costa et al., 2025). Strong sustainability and social metabolism guide this redefinition, seeking to reconcile economic dynamics with the biophysical flows of ecosystems. The concept of social metabolism underscores that all economic activity involves the transformation of energy and matter, which imposes physical limits on expansion and productive efficiency, reinforcing the need to align regional development with the biosphere's regenerative capacities (Brand et al., 2021).

In the governance dimension, the criteria of participation, transparency, and deliberation stand out. These practices are associated with values such as the co-production of public policies and democratic legitimacy, both essential to addressing power asymmetries and strengthening social control over resources (Pereira & Terrenas, 2022; Malavazi et al., 2025).

Finally, the sustainable productive practices dimension expands the traditional conception of the agronomic dimension (Sá Júnior et al., 2025). By integrating ecological knowledge and sociotechnical innovation, practices such as local extractivism, agroecology, and social technologies are valued for promoting resilience and eco-social integration, essential factors for confronting the effects of environmental change and preserving local ways of life (Borges et al., 2025).

These five dimensions are supported by substantive criteria that reflect both territorial specificities and the normative values of Ecological Economics. The diversity of criteria, such as biodiversity, equity, territorial recognition, food security, and social participation, highlights the limitations of reductionist approaches based exclusively on economic indicators.

From a methodological standpoint, the studies analyzed converge on the adoption of participatory multicriteria methods, such as the MSI, the Analytic Hierarchy Process (AHP), and constructivist approaches adapted to local contexts. These methods are valued for their capacity to integrate multiple dimensions and types of value, enabling the construction of assessment models more sensitive to territorial complexity and the conflicts inherent to decision-making. Among these alternatives, the MSI stands out for combining criteria hierarchy, territorial adaptability, and participatory validation, features that are particularly consistent with the principles of Ecological Economics and the management challenges of the Amazon (Lima et al., 2023).

These findings provide the conceptual and methodological foundation for the formulation of the ecological territorial management model proposed in this article, articulating the normative principles of Ecological Economics with the operational potential of the MSI. The following section presents the model's logical structure and main components.

Proposal of the ecological territorial management model

Based on the findings of the SLR and guided by the principles of EE, we propose a conceptual model of ecological territorial management tailored to the Amazonian context. The model integrates the foundations of strong sustainability with a participatory multicriteria approach, operationalized through the MSI. It is acknowledged that managing socioecological territories requires analytical tools capable of addressing complexity, value conflicts, and biophysical limits. From this premise, the model is structured around five integrated dimensions (environmental, social, economic, governance, and sustainable productive practices), which synthesize the main fields of impact and decision-making identified in the literature. Each of these

dimensions guides distinct processes of planning, assessment, and deliberation, forming a flexible structure applicable to different territorial scales.

These dimensions are broken down into contextualized substantive criteria, associated with normative values such as environmental justice, intergenerational equity, and ecological integrity. Figure 3 below graphically represents the conceptual structure of the model, illustrating its hierarchical organization and the articulation among the normative, analytical, operational, and strategic levels. These levels not only structure the model conceptually but also correspond to different stages of the territorial management cycle — from the definition of guiding principles to the implementation and monitoring of public policies.

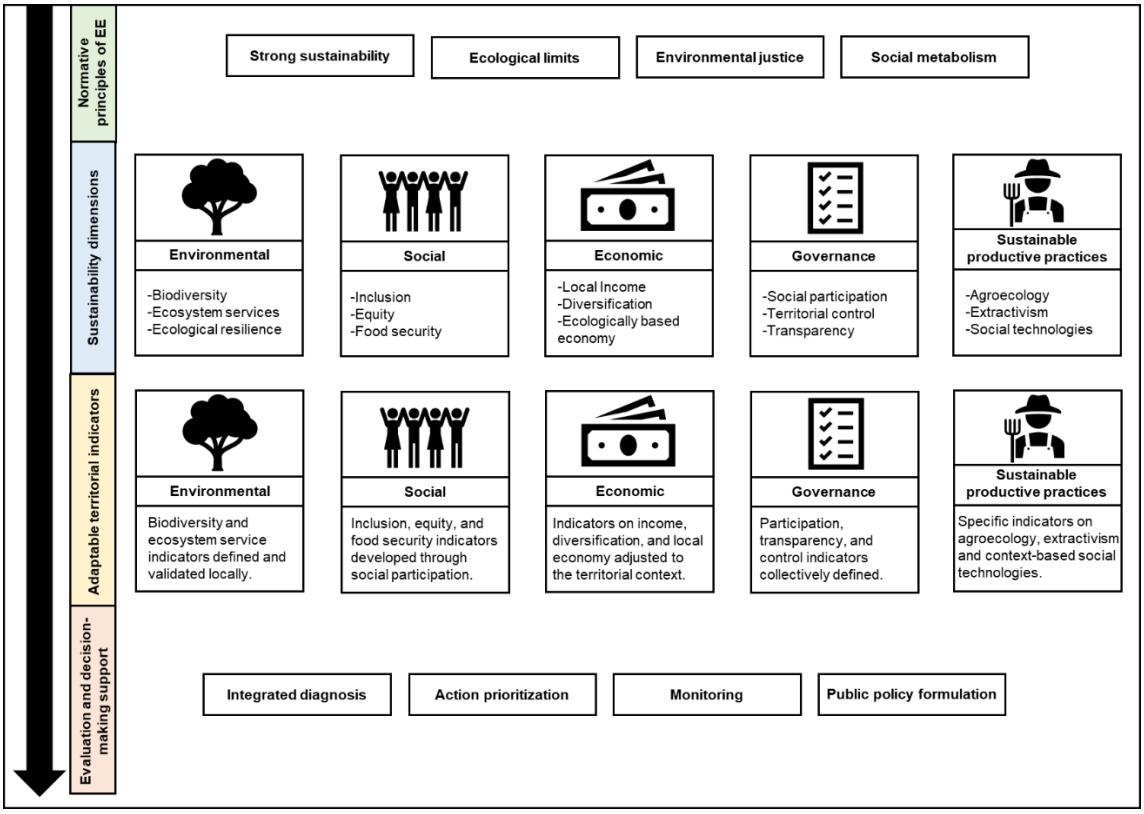

Figure 3. Conceptual model of ecological territorial management guided by EE and MSI. Source: prepared by the authors (2025).

The model is composed of four integrated analytical levels. The first presents the normative foundations of EE: strong sustainability, ecological limits, environmental justice, and social metabolism (Rivera-González et al., 2024). These principles guide the formulation of criteria and define the values that should orient territorial management. The second level organizes the five strategic dimensions of sustainability: environmental, social, economic, governance, and sustainable productive practices. These dimensions encompass key aspects of territorial sustainability. The environmental dimension includes biodiversity, ecosystem services, and ecological resilience, while the social one focuses on inclusion, equity, and food security. The economic dimension emphasizes local income generation, productive diversification, and the valorization of ecologically based economies. Governance relates to social participation, territorial control, and institutional transparency. Finally, sustainable productive practices integrate agroecology, extractivism, and context-appropriate social technologies.

The third level refers to adaptable territorial indicators, built from local data and validated through participatory processes (Calvo-Palomares et al., 2021). Each dimension is operationalized through specific indicators, such as biodiversity and ecosystem service indicators in the environmental dimension, or inclusion and food security indicators in the social dimension, defined collectively according to local contexts and

priorities. The fourth level represents the potential uses of the model for evaluation and decision support. The indicators generated can support integrated diagnoses, guide the prioritization of strategic actions, assist in monitoring socioenvironmental trends, and provide a basis for the formulation of public policies consistent with local specificities (Piquer-Rodríguez et al., 2024). This articulation between technical assessment and social deliberation qualifies the model as an instrument of territorial governance.

To ensure consistent application and adherence to the principles of EE and the participatory logic of the MSI, the model's implementation requires compliance with three operational principles: qualified participation, involving the effective contribution of different social actors in defining criteria and weightings (Angarita-Lozano et al., 2025); methodological transparency, based on the explicit disclosure of aggregation and evaluation procedures (Reid & Rout, 2020); and territorial adaptation, ensuring that the analytical structure can be adjusted to the ecological, cultural, and institutional conditions of each context (OECD, 2020).

By articulating the normative values of EE with a participatory multicriteria approach, the proposed model seeks to overcome the limitations of conventional planning instruments. The proposal combines theoretical coherence with practical applicability, offering a tool to guide integrated public decisions that reconcile environmental conservation, social justice, and economic sustainability in socioecologically complex contexts such as the Amazon. The following section discusses the potentialities, limitations, and innovations of the proposed model, based on the analyzed literature and existing experiences with multicriteria approaches in Amazonian contexts.

Normative, operational, and implementation challenges of the model

The proposed model synthesizes the theoretical foundations of EE with the practical requirements of territorial management in socioecologically complex contexts such as the Amazon. Based on the findings of the SLR, a robust normative framework was identified, structured around strong sustainability, environmental justice, and the recognition of ecological limits (Spash, 2020; Martinez-Alier, 2022; Langemeyer et al., 2024). These principles act as ethical and analytical anchors for the model, ensuring coherence between its theoretical assumptions and operational design. By linking the normative dimension of EE with multicriteria decision-making, the model bridges conceptual and empirical domains, reinforcing its potential to guide integrated and participatory governance processes across diverse territorial realities.

The structure is grounded in the premise that the complexity of Amazonian territories demands analytical tools capable of capturing multiple value dimensions while incorporating participatory processes for setting priorities (Freitas et al., 2025). In this regard, the choice of the Multicriteria Sustainability Index (MSI) as the model's operational axis is justified by its methodological flexibility and capacity to hierarchically organize diverse criteria, enabling comparative, context-adapted analyses supported by participatory validation, features already demonstrated in applications within the region (Lima et al., 2023). The MSI stands out from other multicriteria methods by allowing sustainability assessments to be constructed from local realities, thereby respecting ecological and sociocultural diversity and enhancing the legitimacy of diagnoses.

Compared to traditional assessment tools, the proposed model broadens the notion of sustainability by integrating dimensions often marginalized in conventional analyses, such as governance and sustainable productive practices. This expansion responds to critiques by authors such as Haddad and Solomon (2024) and Morales-Giner et al. (2021), who argue that analytical models for sustainability should not be restricted to economic performance metrics or isolated environmental conservation goals. The inclusion of criteria such as co-production, agroecology, equity, and social participation reveals the model's ethical orientation and its compatibility with the principles of EE.

Another significant contribution lies in the operationalization of normative values through territorially adaptable indicators. This constructivist approach, discussed by Calvo-Palomares et al. (2021), enables substantive criteria to be defined through deliberative processes that incorporate local worldviews, priorities, and knowledge. It reinforces coherence between technical evaluation and social legitimacy, a key factor for effective governance instruments in regions marked by power asymmetries and the historical invisibility of traditional populations (Pereira & Terrenas, 2022; Silva et al., 2025).

In practical terms, the model supports multiple stages of the territorial management cycle: diagnosis, action prioritization, monitoring, and policy formulation. Its adaptability across scales and institutional contexts enhances its usability for public managers, civil society organizations, and community collectives alike.

Nonetheless, implementing the model presents several challenges. Effective application of the MSI requires institutional capacity to conduct qualified participatory processes, reliable local-scale data, and technical resources for information systematization and analysis. In Amazonian territories characterized by infrastructure deficits and institutional fragility, such conditions are not always present. As noted by Kpadé et al. (2024), the effectiveness of participatory multicriteria methods depends not only on technical robustness but also on the political and institutional context that sustains them.

While the proposal ensures coherence between normative values and operational criteria, managing value conflicts that emerge during participatory processes remains a challenge. These conflicts cannot be resolved analytically but should instead be made explicit and treated as legitimate components of democratic decision-making, as argued by Etxano and Villalba-Eguiluz (2021).

Rather than being prescriptive or closed, the model is conceived as a flexible and iterative framework, open to refinement through field applications. Its main contribution lies in providing a conceptual foundation that integrates ethical principles, substantive criteria, and participatory processes, thus guiding public policies that are more responsive to the complexity of Amazonian socioecological systems.

Conclusion

This article presented a conceptual model of ecological territorial management for the Amazon, integrating the principles of EE with the participatory and multicriteria logic of the MSI. Based on the systematic literature review, we identified the main normative values, analytical dimensions, and substantive criteria that underpin integrated approaches consistent with the region's socioenvironmental challenges.

The originality of the model lies in its combination of solid theoretical grounding and practical applicability. By integrating dimensions such as governance, sustainable productive practices, social inclusion, and ecological metabolism, the model expands the scope of conventional assessment tools, which tend to privilege isolated economic or environmental metrics. In this way, it provides a methodological pathway for guiding public decisions according to the principles of strong sustainability, while making explicit the ethical values and conflicts inherent in managing complex territories.

The adoption of the MSI as the model's operational axis enhances its adaptability across territorial contexts by allowing participatory validation and analytical hierarchization. These characteristics are particularly relevant in regions with high sociocultural diversity and intense ecological pressures, such as the Amazon. The proposed analytical structure enables both integrated diagnosis and the monitoring of trends, as well as the formulation of territorially sensitive public policies.

It is necessary, however, to recognize the operational limitations of the proposal. Applying the model requires institutional capacity to conduct qualified participatory processes, reliable local-scale data, and adequate technical resources. In contexts marked by institutional fragility, these conditions demand continuous investment and coordination across governance levels. Value conflicts, often present in deliberative processes,

cannot be eliminated through analytical instruments but should be treated as a legitimate part of democratic decision-making.

Thus, the model does not have a prescriptive nature but rather constitutes a flexible and iterative analytical framework, guided by normative values and adaptable to the specificities of each territory. Its main contribution lies in offering an alternative to the dominant development paradigm, grounded in ecological, social, and cultural principles, with the potential to inform fairer, more resilient public policies aligned with planetary boundaries. Future research may explore comparisons between the proposed model and other multicriteria assessment approaches, as well as analyze its effectiveness in supporting the formulation and implementation of public policies across different governance scales.

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