

## THE SCIENTIFIC WORK ON LANDSCAPE ANALYSIS IN BRAZIL: PERSPECTIVES FOR AN INTEGRATING DEBATE

*A PRODUÇÃO CIENTÍFICA ACERCA DA ANÁLISE DA PAISAGEM NO BRASIL: PERSPECTIVAS PARA UM DEBATE INTEGRADOR*

*LA PRODUCCIÓN CIENTÍFICA ACERCA DEL ANÁLISIS DEL PAISAJE EN BRASIL: PERSPECTIVAS PARA UN DEBATE INTEGRADOR*






### ABSTRACT

**Introduction:** The academic discussion on landscape expresses one of the most significant theoretical-methodological entry point of geography towards an integrating debate between society and nature. Besides, this approach has been used as an alternative to sectorial planning, which has displaced nature from cultures, deflating the current understanding of problems related to environmental degradation, and fragmentation and transformation of landscape. **Objective:** In this context, the present study aims to: (1) understand the geographic academic work in Brazil by examining scientific publications about the concept of landscape, between 2006 and 2016; and (2) briefly analyze the structure and dynamics of the national landscape complex. **Methods:** To that end, bibliometric research was carried out using scientific journals on Brazilian Geography by spotting different variables and seeking to understand the current state of research and the perspectives and tendencies in those scientific publications. Later on, based on Ross's, 2006, proposal about natural systems of (little and strongly transformed) landscapes, a discussion was held about the state of such Brazilian landscape mosaics. **Results:** At first, the study revealed a tendency towards the use of an integrative approach that relates landscape, local scale, river basins and environmental themes. Subsequently, the study identified four little-transformed natural landscapes and nine strongly transformed ones, which points to the heritage of old and recent processes of liaison between society and nature. **Conclusion:** It is hoped that the present discussion will serve as a basis for future research on the topic, not only from a theoretical perspective but also, and especially, from an applied perspective geared to territorial planning.

**Keywords:** Integrated Physical Geography, Landscape, Environment, Bibliometrics, Brazil.

### RESUMO

**Introdução:** O debate sobre a paisagem expressa-se como uma das entradas teórico-metodológicas mais significativas da ciência geográfica para o debate integrador entre sociedade e natureza. Esse conceito tem sido utilizado como alternativa a um planejamento setorial, o qual tem afastado a natureza das culturas, deflacionando o entendimento atual dos problemas de degradação ambiental e de fragmentação e transformação da paisagem. **Objetivo:** Nesse contexto, busca-se com este trabalho: (1) compreender a produção geográfica ocorrida no Brasil acerca do conceito de paisagem, entre 2006 e 2016; e (2) realizar uma breve análise da estrutura e dinâmica do complexo paisagístico nacional. **Métodos:** Para isso, realiza-se uma pesquisa bibliométrica a partir de periódicos científicos da Geografia brasileira por meio do entendimento de distintas variáveis, buscando o entendimento do estado atual e das perspectivas e tendências dessa produção científica. Posteriormente, a partir da proposta de Ross, 2006, acerca de sistemas naturais de paisagens pouco e fortemente transformadas, desenvolve-se uma discussão sobre o estado desses mosaicos paisagísticos brasileiros. **Resultados:** Apresenta-se, em um primeiro momento, uma tendência do uso da abordagem integradora que relaciona paisagem, escala local, bacia hidrográfica e temática ambiental. Posteriormente, identificam-se no território nacional quatro paisagens naturais pouco transformadas e nove fortemente transformadas, as quais indicam a herança de processos antigos e recentes de articulação entre a sociedade e a natureza. **Conclusão:** Espera-se que o debate firmado sirva de base

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para futuras pesquisas sobre o tema, tanto numa perspectiva teórica, como, especialmente, em uma perspectiva aplicada, voltada ao ordenamento territorial.

**Palabras-chave:** Geografia Física Integrada, Paisagem, Ambiente, Bibliometria, Brasil.

## RESUMEN

**Introducción:** La discusión sobre el paisaje como concepto, se nos presenta como uno de los aportes teórico-metodológicos más importantes de la ciencia geográfica en el marco del debate integrador entre la sociedad y la naturaleza. Este concepto ha sido utilizado como alternativa a la planificación sectorial, que separa a la naturaleza de las culturas, modificando la comprensión actual de los problemas de degradación ambiental y fragmentación y transformación del paisaje. **Objetivos:** En este contexto, este artículo busca: (1) estudiar la producción geográfica generada en Brasil sobre el paisaje, entre los años 2006 y 2016; y (2) realizar un breve análisis de la estructura y dinámica de los paisajes a nivel nacional. **Métodos:** Para ello, se lleva a cabo una investigación bibliométrica en las revistas brasileñas de Geografía, mediante el análisis de diversas variables, que busca entender el estado actual, las perspectivas y tendencias de esta producción científica, en cuanto al uso del enfoque integrador del paisaje, a escala local, en cuencas hidrográficas y en la temática ambiental. Posteriormente, sobre la base de la propuesta de Ross (2006), se desarrolla la discusión acerca de los paisajes naturales poco y fuertemente transformados y el estado de estos mosaicos paisajísticos brasileños. **Resultados:** En un primer momento, se presenta la tendencia hacia el uso de un enfoque integrador que relaciona el paisaje, la escala local, las cuencas hidrográficas y los problemas ambientales. Posteriormente, se identifican en el territorio brasileiro cuatro paisajes naturales poco transformados y nueve fuertemente transformados, lo que muestra el legado de los procesos antiguos y recientes de articulación entre la sociedad y la naturaleza. **Conclusión:** Se espera que el debate establecido sirva de base para futuras investigaciones sobre el tema, tanto desde una perspectiva teórica como, especialmente, desde una perspectiva aplicada, centrada en la planificación territorial.

**Palabras-clave:** Geografia Física Integrada, Paisaje, Medio Ambiente, Bibliometría, Brasil.

## INTRODUCTION

How has the research conducted within the scope of the Brazilian geographic science been important to understanding the national landscape complex concerning its similarities and particularities? What is the current state of landscape in terms of conservation and degradation? What is the importance of understanding the history and the current state of Brazilian landscapes? Those are the research questions that transversally guide the analysis developed in the present article.

Such questions allow grasping the concept of landscape that has been increasingly addressed in various scientific fields, including Geography – which presents a prolific theoretical and methodological instrument for the analysis of landscape structure, functioning, dynamics and evolution.

It should be pointed out that due to the amount of theoretical research at the national level and at the international level that discuss different forms of interpreting the concept of landscape and its historical evolution in different schools, the present article departs to another field of investigation. In this regard, it takes on a differentiated epistemological and practical purpose and positions itself towards the potential of Geography to analyze the integrative landscape of/in Brazil.

This study therefore agrees with traditional research on the topic, especially the proposals by Ab'Saber (1969a, 1970, 2003), Christofletti (1979, 1999), Monteiro (1982, 1987, 1996, 2000, [1978] 2001) and Troppmair (1983, 2004) discussing the importance of geomorphology / environmental analysis, geomorphology, landscape climatology / physiology, and biogeography, respectively. The authors mentioned above, in addition to Martinelli (1994), Nucci (1998), Passos (2003) and Ross (1994, 2006), for example, sought an integrated landscape-environment analysis based on a systemic approach that allowed considering theory and practice of integrated (physical) geography studies in Brazil, especially grounded on authors such as Bertrand (1968), Sochava (1977, 1978), Tricart (1977, 1982) and Troll (1971).

In this context, this study intends to analyze the geographic academic work published in Brazil about the concept of landscape, between the years of 2006 and 2016, given that such a concept has been effective to tackle the environmental theme within this disciplinary field, although frequently approached in a polysemic, albeit integrative, manner. Additionally, it aims to briefly investigate the structure and dynamics of the national landscape complex, as this shall allow apprehending the theme from an integrating historical perspective between society and nature.

In order to analyze this complex scenario of multiple theoretical and practical positioning, the study considers the integrative approach between society and nature as the structuring axis to base the ideas for landscape studies in Brazil. Besides, this approach has been used as an alternative to sectorial planning, which has displaced nature from cultures, deflating the current understanding of problems related to environmental degradation, and fragmentation and transformation of landscape. That discussion assesses the understanding of landscape as an inheritance of historically territorialized natural and/or social/cultural processes, both at the level of material and identity representation.

This study presents four points of justification, as it:

(1) promotes a broad debate on questions of epistemological character by discussing the concept of landscape within a particular scientific context – i.e. Geography –, given that the concept has been through a consolidation process due to a series of initiatives towards its application, in a practical and theoretical way, since the last decade, both by science and by public policy;

(2) indicates the possibility of understanding the trajectories and tendencies of landscape studies in a broad temporal period while discusses a historical profile of the use of the concept, favoring the analysis of contradictions regarding the uses of such a nationally important field, given its biodiversity and geodiversity;

(3) demonstrates that landscape in Geography has a versatile and aggregating character of interdisciplinary contents for the fact that it is used together with other scientific fields, being supplied by them. Such fields also intend to discuss ideas that are extraneous to the linear and factorial scientific debate of Cartesian-Newtonian nature due to the constant use of the “renewed” systemic approach, which feeds on diverse contents of complex thinking, important for a dialogical debate of the theme;

(4) also notes that landscape is increasingly present in debates on environmental planning and land-use planning. These are still influenced by the application of new techniques and methods, especially those related to Geographic Information Systems, and Geoprocessing, since such instruments provide real support for landscape spatial analysis (LANG; BLASCHKE, 2009).

Regarding the development of the present study, three pathways of analysis are presented, divided into four topics. First, a discussion on the Brazilian geographic work is carried out with the aid of bibliometric data and thematic mappings, generated from the analysis of national scientific publications in journals, between 2006 and 2016. From such an elucidative approach, with the aid of



cartographic representation, the Brazilian environmental transformations and their reflections on the national landscape mosaics are systematically discussed.

As far as landscape transformations are concerned, in addition to thematic mappings with the variables of the scientific work about the concept, this study presents a synthesis product named “Landscapes of Brazil”, seeking to apprehend natural landscapes that are little and strongly transformed. Finally, some perspectives and tendencies about the topic are discussed and then final remarks are presented.

### **PUBLICATIONS ON LANDSCAPE IN THE BRAZILIAN GEOGRAPHY: ANALYTICAL VARIABLES AND THE SOCIETY-NATURE DEBATE**

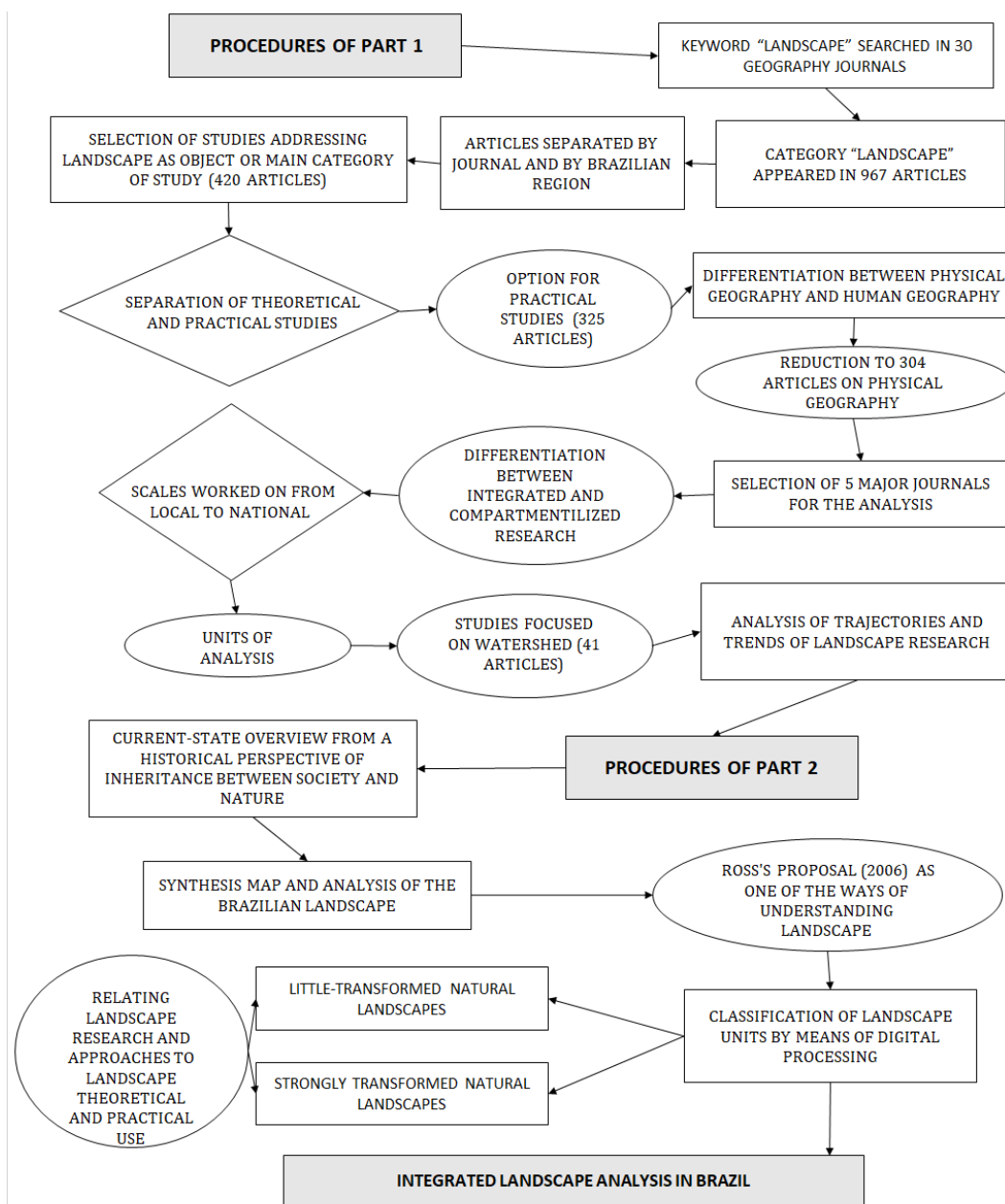
The scientific geographic work on the concept of landscape published in Brazil between 2006 and 2016 is broad and shows a quantitative growth, mainly regarding studies related to the environmental theme. In this respect, Neves and Salinas (2017) took a deeper look at the effectiveness of the use of such a concept as an important tool for integrative analyses. They argue that the systemic approach, based on geosystems, has stood out among integrative studies for jointly considering the structure, functioning, dynamics and evolution of landscape, and has as well addressed the relationship between society and nature. Such studies allow rethinking the problems of hierarchical models (structure), landscape identification approaches, classification methods, and the lexical system about landscape cartography (BRAZ et al., 2020; CAVALCANTI; CORREA, 2016; SALINAS; RAMÓN, 2013).

Research has called readers’ attention to an important tradition in geographic studies, that is, the study of the state of the art associated with an epistemological debate of themes and concepts (SUERTEGARAY, 2001, 2005; SUERTEGARAY; NUNES, 2011; SILVA; AQUINO, 2016). The above studies were important for the choice of analytical variables retrieved from 30 scientific journals (Figure 1), graded A1, A2 and B1 according to the Qualis classification by CAPES Foundation - Brazil<sup>1</sup>.

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<sup>1</sup> Website of the Qualis journal ranking on the Sucupira Platform of the Coordination for the Improvement of Higher Level Personnel (CAPES Foundation).

Figure 1. Procedures of the present analysis

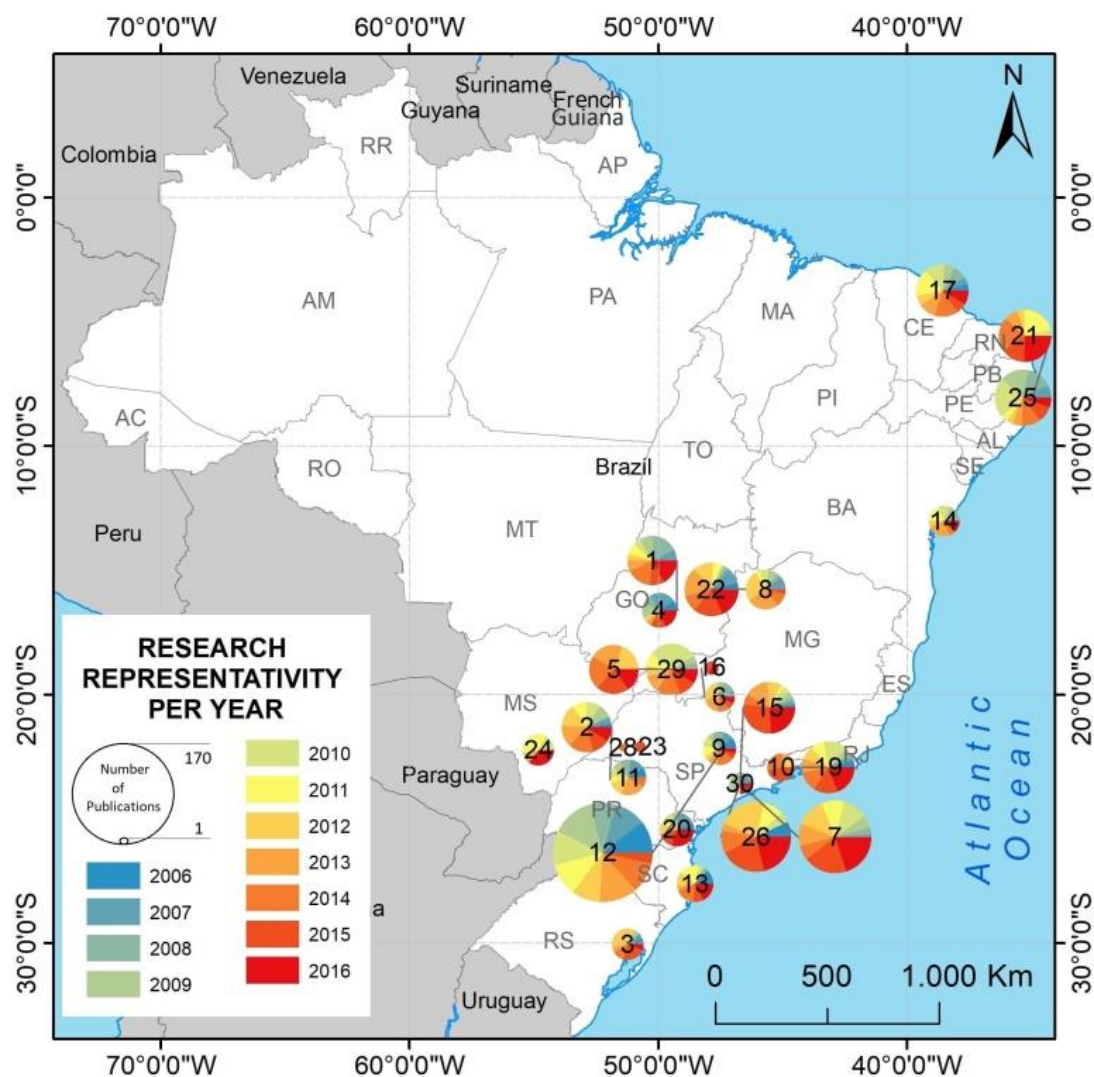


In this way, the study aimed to identify: (1) articles grounded on the concept in question; (2) how the use of the concept relates to Physical Geography and Human Geography; (3) the use of landscape studies in a secondary or central manner; (4) the quantitative difference between theoretical and practical research; (5) the relation between compartmentalized and integrative research; (6) finally, which spatial scales and units of analysis substantiated those studies, given that the variables explained in items 5 and 6 above retrieved from the five most expressive journals in the national scope about the use of the concept in question.

As can be seen in Figure 2, landscape research, according to the journals analyzed, concentrates in the Central-South region of Brazil.



Figure 2. Publications on landscape between 2006 and 2016 in the journals analyzed



### Scientific Journals analyzed

- |                               |   |
|-------------------------------|---|
| 1 Ateliê Geográfico (UFG)     | 16 Hygeia (Uberlândia)                        |
| 2 Boletim de Geografia (UEM)  | 17 Mercator (Fortaleza)                       |
| 3 Boletim Gaúcho de Geografia | 18 Ra'e Ga                                    |
| 4 Boletim Goiano de Geografia | 19 Revista Brasileira de Cartografia          |
| 5 Caminhos de Geografia (UFU) | 20 Revista Brasileira de Climatologia         |
| 6 Campo – Território          | 21 Revista Brasileira de Geografia Física     |
| 7 Confins (Paris)             | 22 Revista Brasileira de Geomorfologia        |
| 8 Espaço e Geografia (UNB)    | 23 Revista Cidades                            |
| 9 Estudos Geográficos (UNESP) | 24 Revista da ANPEGE                          |
| 10 Geo UERJ                   | 25 Revista de Geografia (Recife)              |
| 11 Geografia (Londrina)       | 26 Revista do Departamento de Geografia (USP) |
| 12 Geografia (Rio Claro)      | 27 Revista Nera (UNESP)                       |
| 13 Geosul (UFSC)              | 28 Revista Pegada Eletrônica                  |
| 14 Geotextos                  | 29 Sociedade & Natureza (UFU)                 |
| 15 Geosp (USP)                | 30 Terra Livre                                |

This result points to the relationship of such journals with graduate departments and programs in Geography, consolidated in the national scenario, which has provided these instruments with greater competitiveness and adaptation to the parameters of classification and international scientific production standards. It can be seen as well that journals allocated in more recent programs, for being in the peripheries and not in the nodes of the national research network, receive less investment and are still consolidating their technical and theoretical expertise.

However, new scenarios are emerging. Several journals linked to relatively young graduate departments and programs have assumed regional importance in the latest Qualis journal rankings. Such journals have presented important material, such as specialized studies in their home region, a fact evinced by Correa (2017). It is worth stressing that the author of the present study understands that an ideal analysis should include all journals in the area, which would favor the greatest number of network connections, since territorial rooting is also detrimental to the interpretation of the different ways of approaching the subject, also favoring scientific endogeneity. However, the material produced by such journals is truly relevant, as it favors a diffusing view of the geographical knowledge on landscape in Brazil.

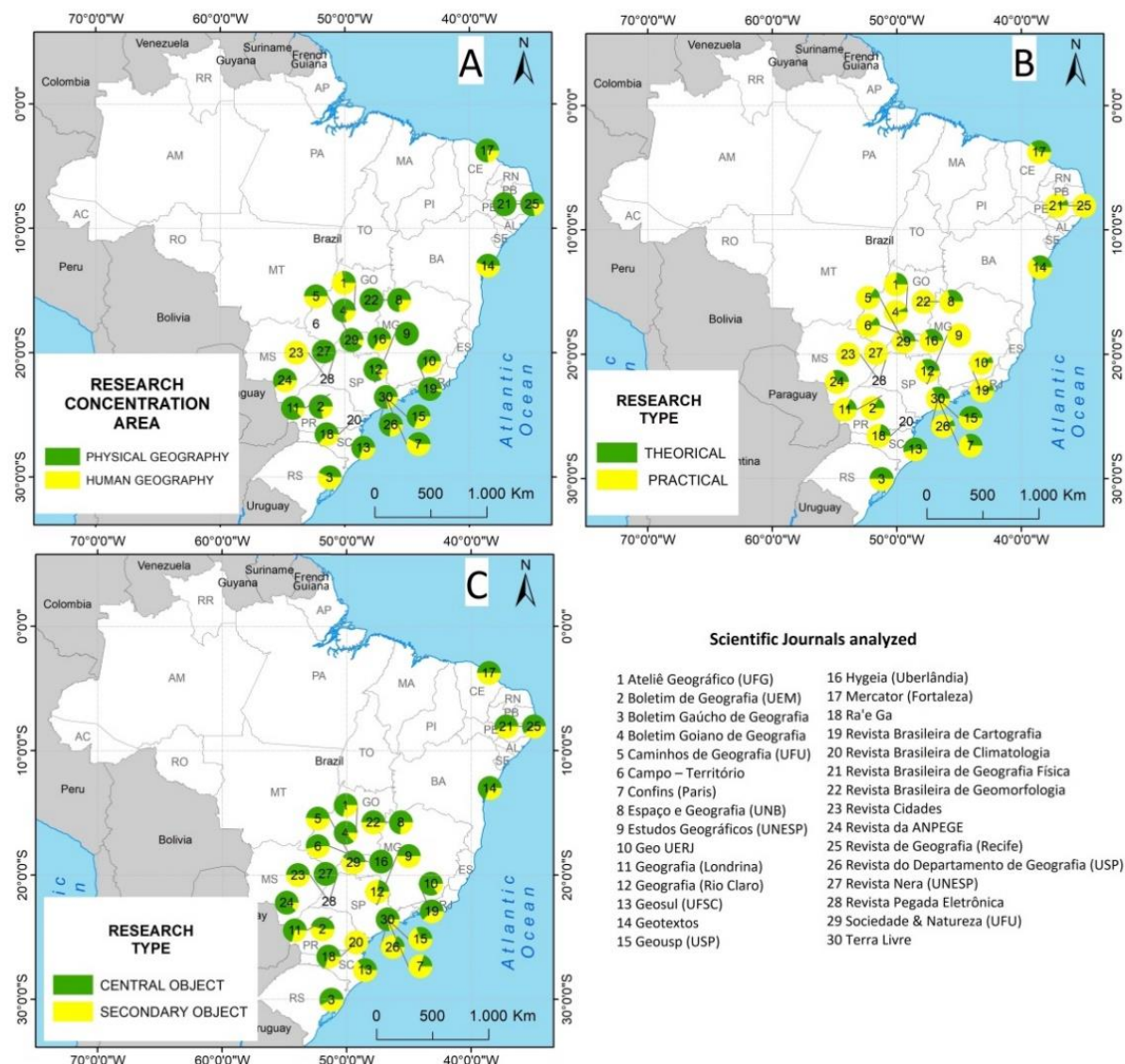
Thus, in order to elucidate the variables previously indicated, and based on the mapping of the data extracted from the journals, Figure 3 was created. It shows that the concept has been debated mostly in Physical Geography (3a), from a practical perspective (3b) as a secondary object (3c), in an integrative manner (4a), at local scales (4b), being river basin the basic unit of analysis (4c).

Figure 3a shows a superior application of the concept in studies that emphasize the dynamics of nature (Physical Geography), to the detriment of Human Geography. This can indicate a historical trait that may be related with the very genesis of Physical Geography, which relates to the concept of landscape (VITTE; SPRINGER, 2011).

This discussion tends to gather momentum due to the increased number of articles published per year (Figure 2). The data obtained show a concentration of journals in the Central-South region of Brazil and some highlights in the Northeast region. Despite the increased number of publications, the North region of the country still has no journals ranked according to the grades established for this study. However, the recent creation of graduate programs in Geography in the North region of Brazil allows envisaging a possible increase in the geographic academic production over the coming years.



**Figure 3.** Variables of the publications on landscape in Brazil between 2006 and 2016



Caption: A - Research in Physical and Human Geography; B - Theoretical and practical research; C - Representativity per year; D - Research using the concept of landscape.

Figure 3b shows a superior number of practical studies in relation to theoretical ones, although theory is frequent and appears in most applied studies. Such practical studies seek to create knowledge at the local, municipal and regional levels. This is why the recurrence of studies relating land cover and land use, interconnected with the potentialities and fragilities of the areas has made it possible, besides recognizing the structure and functioning of degraded landscapes, to understand the degree and intensity of anthropogenic actions from a historical perspective.

Within this analytical framework, landscape units – understood as land areas with physical-geographic characteristics and similar historical social changes (METZGER, 2001) – should be mapped, as this would

represent an important product for generating valuable diagnoses geared to land planning. This was discussed by Amorim and Oliveira (2008), studying the municipality of São Vicente in the state of São Paulo, who considered landscape units a category of geographic analysis. Thus, a collaborative discursive agenda is inserted into the study and the maintenance of biodiversity and geodiversity in Brazil, moving towards an analysis that goes from the spirit of synthesis to the spirit of system (BERTRAND; BERTRAND, 2002).

In terms of the differentiation between the publications in question considering landscape either as a central or a secondary (supporting) object, it was found that, despite its relevance to Geography, there have been more research addressing landscape in a secondary manner (561 articles) rather than in a centralized manner (422 articles) (Figure 3c). The concept of landscape as a supporting object appears in all Qualis journal rankings, where 62% of the articles were graded A1, 51% graded A2, and 57% graded B1.

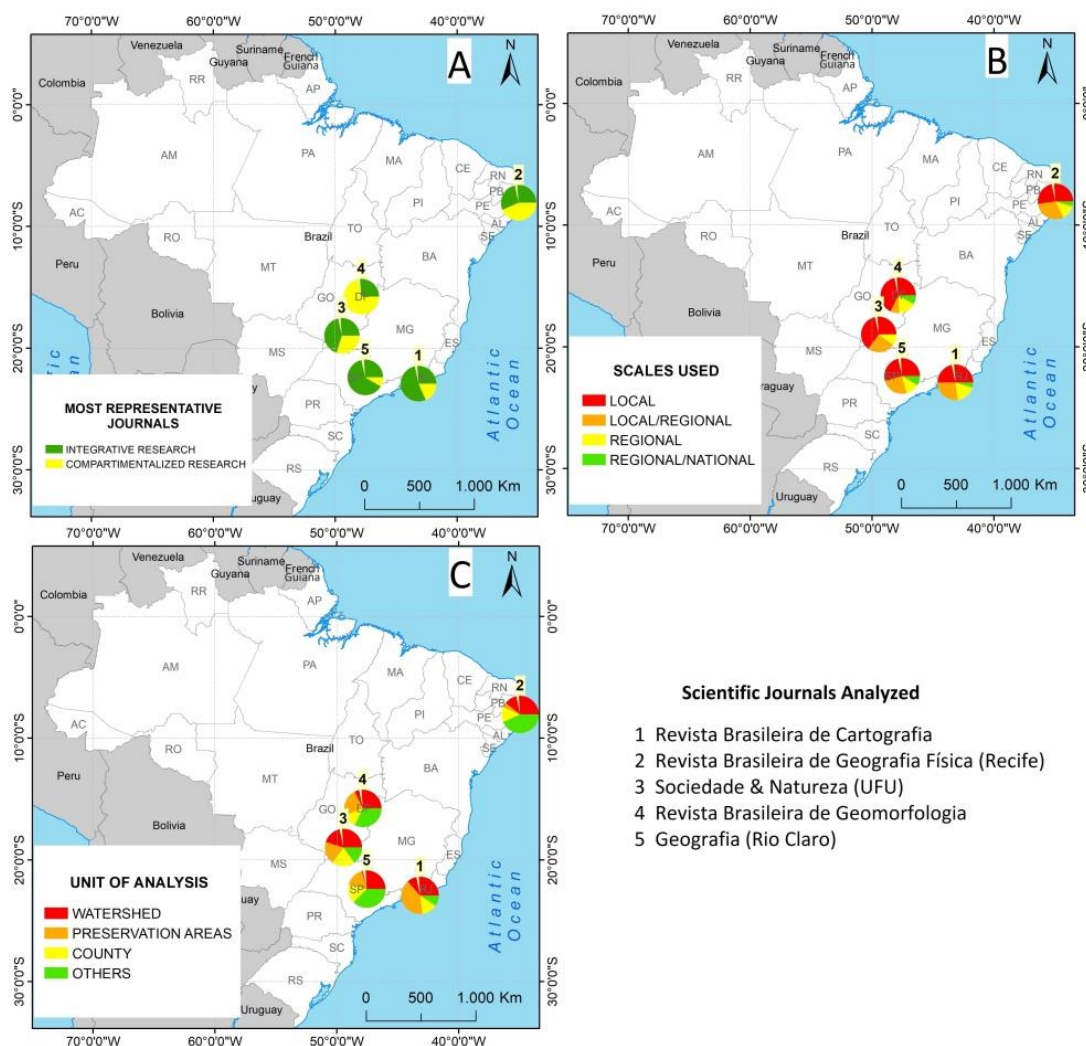
However, three journals contributed more expressively to that result, which are well-established journals that had or have had a great influence on the national geographic scientist production. The journals are: *Geografia* (from the city of Rio Claro, SP, Brazil), *Revista Confins* (São Paulo, SP, Brazil), *Revista do Departamento de Geografia* (São Paulo, SP, Brazil), containing respectively 70%, 75% and 77% articles using landscape as a support for other concepts and themes, such as space, territory, region, place, among others. This perspective of support allows inferring that such a 'support-concept' must turn into a 'tool-concept', evincing an epistemological, conceptual and methodological character, essential for the study of heterogeneous mosaics formed by interactive units (i.e. landscape).

Thus, the debate displayed in Figure 3 and extended in Figure 4 is in line with Neves and Machado's (2017) discussion on the use of geosystems to promote a shift from compartmentalized research to integrative research in this science.

In this scenario, integrating environmental debates have been more expressive than compartmentalized analyses, although it is clear that specialized research is more often published in specific journals (Figure 4a). This leads to a thematic diversification, but also to a scalar one (Figure 4b), in addition to associated units of analysis (Figure 4c) taking into account the multiplicity of related problems and their consequent impacts on landscape, which favors a dialectical and dialogic view of the relationship between society and nature in the studies analyzed.

This correlative/integrative theoretical-methodological potential (Figure 4a) is applied in several studies, mainly involving the use of remote sensing and geoprocessing to relate landscape changes by means of land use and land cover analyses.

**Figure 4.** Analysis of type of research (A), scales (B) and units of analysis of the scientific work on landscape in Brazil between 2006 and 2016



Caption: Journal 1: 22 publications; Journal 2: 23 publications; Journal 3: 20 publications; Journal 4: 25 publications; Journal 5: 24 publications.

Thus, working with themes related to land use and land cover have allowed understanding the temporal and spatial changes of landscape, especially in articles addressing it as a central object (ALVES et al., 2007; DE NARDIN; ROBAINA, 2010; PAULA; SOUZA, 2010; ZANATTA; LUPINACCI; BOIN, 2016). Examples of that are the studies carried out by Amorim and Oliveira (2008), Marques Neto (2016) and Soares (2006), who developed landscape mapping towards a geoenvironmental analysis and brought important contributions to spatial planning.

In this assessment context, Silva and Aquino (2017), in their analysis of Brazilian scientific events related to Physical Geography, corroborate the results of the present study. They reported that environmental analyses on river basins have been the topics most addressed in geographic studies, in addition to analyses of impacts and land use and occupation, among other subjects, which are in line with geographers' interest in

contributing to territory management and planning. Those studies therefore focus mainly on the overlap between geosystems and “anthropic systems”, aiming at the understanding of spatial organization, as expressed by Dias and Perez Filho (2017).

In the face of its versatility, the debate on landscape has also been involved more clearly in the analysis of culture and the symbolic, since it has contributed to the analysis of territory landscapes (SILVA; PASSOS, 2018). This observation allows considering a research pathway beyond those demonstrated by Barreiros (2017), who singles out a systemic and cultural landscape research path. Instead, the present analysis of national journals demonstrates the combination of these two approaches – a new systemic-cultural path linked by dialectics.

In this scope, Bertrand (2010) pointed out in 2010 that landscape research had changed its status, purpose and content, back then based on 20 years before, now almost 30 years back. It has become one of the 21st century's dimensions of the ecological-economic-social paradigm and one of the entry points and components of (environmental and patrimonial) territory planning, also reported in Ross's (2006) ecogeographic analysis. Faced with this versatile character, landscape is used along with other concepts, such as space, environment, territory, region and place, showing its multifaceted, polysemic and integrating character (CONSEIL DE L'EUROPE, 2006).

In this context, Figure 4b shows the predominance of local and local/regional scales focusing on the transformation and fragmentation of landscape due to inadequate land use. This tendency to use the local scale favors fieldwork and stems from the epistemological assumptions of this science, highlighting the reinvention of the concept of place (SUERTEGARAY, 2005), but also the need to choose a better scale of study for territory planning (NEVES; MACHADO, 2017).

As shown in Suertegaray (2005), the use of a local scale has been observed in geographic studies of urban spaces, river basins, parks and forest reserves, urban sectors and municipalities. However, the present study reiterates that, among all these units of analysis, river basin has been the highlighted one. By focusing on integrating the elements of that unit, environmental geographic research then focuses on the relationship between society and nature, as it allows evincing the relation between ecological potential, biological exploration and anthropic action in its fullness. Perhaps this is one of the greatest conveniences found in considering river basins.

Additionally, river basins have often been regarded as the stage for discussions of several public policies towards environmental planning and management. The reviewed journals also show that a focus on river basins alone is not more representative than “other studies” that include several analytical units, among them census tracts, marginal areas of highways, neighborhoods, schools, urban areas, (local) squares, and others,

such as states, morphoclimatic domains, and biomes. Furthermore, if “river basins”, “preservation units” and “municipalities” are grouped together as local and local/regional scale units, they represent 80.7% of the five journals sampled. In this case, “river basins” alone represent 36% of the sample (Figure 4c).

In this way, river basins are presented as a complex system that integrates the particularity/diversity contained in landscape, once it presents itself as an organizing unit, a stronghold of nonlinear interactions of dynamic subsystems of different scales (MATTOS; PEREZ FILHO, 2004). However, it should be noted that river basins assume several scales, not only the most comprehensive ones, of national and international importance such as the basins of the Amazonas, Paraná, and São Francisco rivers or of regional importance such as the basins of the Paranapanema, Jacuí and Parnaíba do Sul rivers, or even of state interest such as the basin of the Tietê river, but also at a local scale such as the lands and streams of the different institutions that are linked to the present study.

From the relationship between the concept of geosystems and the emphasis on Bertrand's (1968) dialectical and dynamic landscape concept, an even more practical approach has been put forward, as well as subsidies for environmental and territorial diagnosis and prognosis, as seen in Oscar Júnior (2013). Such authors, in a practical and integrated way, analyzed the coastal region of Rio de Janeiro in order to perform its planning based on a geoecological perspective.

Despite this approachment, it is clear that geosystems does not account for landscape in its entirety, since there is a greater comprehension in the second (real and abstract) concept, especially because such concepts were created for particular purposes. Nevertheless, it can be said that landscape and geosystems go hand in hand and both are concepts under construction, besides being important conceptual filters for the debate of Integrated Physical Geography. Thus, looking at the (near and far) past, based on the proposed analysis, allows understanding the structures of the integrated geographical, dialectical and systemic analysis, with which one can understand current and future contexts (FROLOVA, 2018; NEVES et al., 2014).

In this way, the proposed topic allows considering the relationship between subjects of high importance for integrative studies, questions that are necessary for a complex view upon the understanding of landscape in Brazil. Through the discussion set up, this concept has allowed achieving continual learning and adaptive management in historically unjust areas; valuing common concerns of stakeholders towards landscape transformations and clarifying their rights and responsibilities in such transformations; understanding the characteristics and particularities of landscapes; enabling the analysis of multiple scales; expressing their multifunctionality; understanding the interests of multiple stakeholders involved; enabling a negotiated and transparent change logic of areas under a wide process of fragmentation of the ecological potential; diagnosing strengthened stakeholder capacity and promoting social and ecological diversity; and



understanding and highlighting the resilience processes of the environment and the local population (SAYER et al., 2013).

Therefore, looking at the national landscape mosaic, given its multiple interpretations, there is a particular standpoint regarding the understanding of national landscapes, one that aligns with the Brazilian researchers previously analyzed. For this purpose, a descriptive-reflective profile was built up of the distinctions and transformations of national landscapes.

### **LITTLE AND STRONGLY TRANSFORMED BRAZILIAN LANDSCAPE MOSAICS**

According to Vitte (2011), Ross's (2006) article "Ecogeografia do Brasil: subsídios para planejamento ambiental" (Ecogeography of Brazil: subsidies for environmental planning), stands out as one of the greatest innovations in the Brazilian Geography in the last 30 years, hence a landmark in environmental and landscape studies of the national territory due to its integrative approach.

Vitte (2011) also points out that Ross (2006), with emphasis on Aziz Ab'Saber's (1970) morphoclimatic classification besides the geographic-geomorphological studies based on topographic, superficial and physiological analyses of landscape, reveals the concepts of potentiality, fragility, relief and geosystems under a geoeological and interdisciplinary approach majorly necessary for the conservation of biodiversity and geodiversity in Brazil.

Therefore, the above proposal was used as a guideline for the present analysis and mapping of the national landscape mosaic and for the mapping shown in Figure 5.

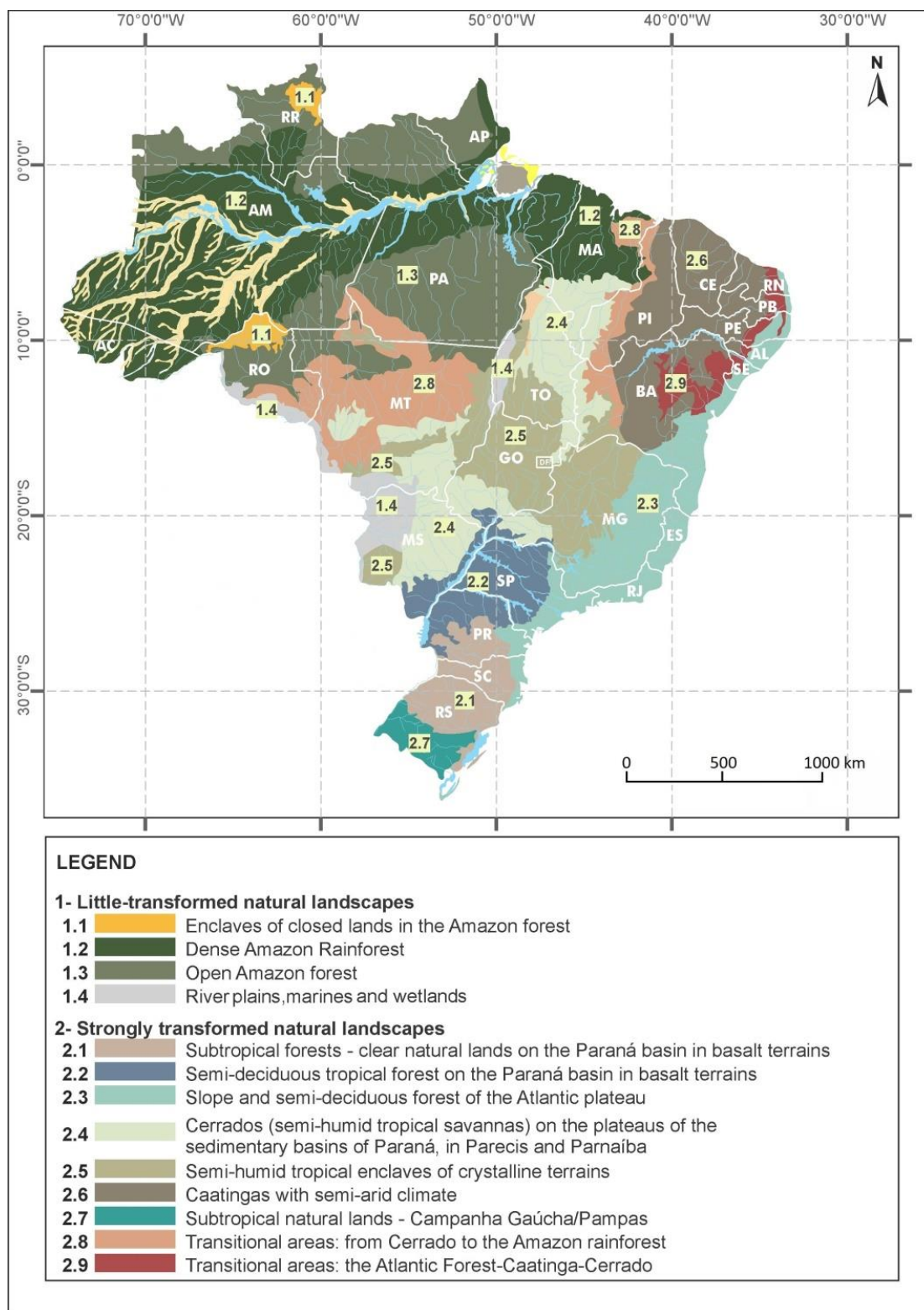
With such emphasis, the Natural Environmental Systems of Brazil, identified and mapped by Ross (2006), based on a conceptual and terminological modification, were produced from thematic maps and numerous technical-scientific reports. Such reports were published by public institutions such as Embrapa (Brazilian Agricultural Research Corporation), IBGE (Brazilian Institute of Geography and Statistics) and DNPM (National Department of Mineral Production) using information on relief, geology, soil, climate and vegetation, combined from Geographic Information System.

Such a synthesis product for the Brazilian territory differs from Ab'Saber's (1970) mapping "Domínios Morfoclimáticos Brasileiros (áreas nucleares – 1965)" [Brazilian Morphoclimatic Domains (core areas – 1965)] with six domains (Amazon, Cerrado, Mares de Morros, Araucaria, Prairies, and Transition Strips) because it aimed to relate more vehemently the articulation between society and nature in the formation of such landscape mosaics. Therefore, the given cartographic product sought to identify the natural domains



associated with social use, and were sorted into two broad categories: the little-transformed and the strongly transformed natural landscapes.

**Figure 5.** Brazilian landscapes from an integrated perspective



Adapted from Ross (2006).

Therefore, based on Ab'Saber's (2003) domains of nature, and several other theoretical and practical studies, this article reflects upon the Brazilian landscape debate in order to assist in the diagnosis and prognosis of areas in a wide fragmentation and degradation process, considering the high resistance level of such landscapes, many of which are at another homeostasis level.

It is worth mentioning that studies that aimed to understand the Quaternary climatic oscillations via Geomorphology in the 1960s and 1970s were important to understand the development of Brazilian natural landscapes (AB'SABER, 1968). Such landscapes are understood as resulting from genetic processes of tectonic origin, from lithologic and structural arrangements, from the paleoclimatic and climatic dynamics of a recent natural time scale (DIAS; PEREZ FILHO, 2015).

However, one can only understand the structure, functioning, dynamics and evolution of natural landscapes by considering the Holocene<sup>2</sup>, which corresponds to the most recent Cenozoic era, with a reasonable understanding of the various geological moments and climatic changes through which the planet Earth has passed for billions and millions of years, as numerous landscapes were created back then (ROSS, 1987). In this respect, Ab'Saber (1969a) has a point by stating that it is in climatic conditions with little stability that several areas of the globe evolve more markedly. Thus, morphogenetic and pedogenetic processes coexist (QUEIROZ NETO, 2002).

However, despite the relevance of the geomorphological and phyto-climatic characteristics of the Brazilian territory in his analysis, Ab'Saber, with the works mentioned in the footnote below<sup>3</sup>, presented a great proposal of integrated domains of nature. So he sets out his analysis of the domains of nature in Brazil and its landscape potential, then becoming one of the bases for the understanding of national landscapes and the integrating debate, object of study here.

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<sup>2</sup> The Holocene is the chronostratigraphic equivalent of modern postglacial conditions, which although it does not yet contain an accurate dating, is often cited as having begun in the last 10 to 12 thousand years before the present. On the geological time scale, the Holocene is the present time of the Quaternary period of the Cenozoic era of the Ferozozoic Eon that began some 11,65,000 years before the present, after the last glacial period, which concluded with the Holocene glacial retreat.

<sup>3</sup> In this context, throughout the 1960s, Ab'Saber published a series of reference works on the subject, seeking to highlight the intrinsic relationships between relief, geological base, current climates, and vegetation cover. In this respect, the article "Domínios Morfoclimáticos e Províncias Fitogeográficas do Brasil" [Morphoclimatic Domains and Phytogeographic Provinces of Brazil] (AB'SABER, 1970) – differing from Domingues (1963) who also carried out mappings of national territory domains – is more comprehensive than the phytogeographic analysis prioritized by Domingues (1963), since it more emphatically includes the climatic discussion developed by Cailleux and Tricart (1957). Ab'Saber (1970) denominated these areas of Domínio Amazônico, Cerrado, Mares de Morros, Caatingas, Araucárias, Pradarias e extensiva faixa de transição [Amazonian Domain, Cerrado (Savannah), Mares de Morros, Caatingas, Araucarias, Prairies and extensive transition strip] around the core of the Cerrado of central Brazil. This product was the basis for a South American analysis (AB'SABER, 1977a) with the publication of "Domínios Morfoclimáticos e Fitogeográficos Sul americanos" [South American Morphoclimatic and Phytogeographical Domains], which added to his studies of geomorphology at the service of the Quaternary (AB'SABER, 1969b), the review of the Paulista Quaternary under a time perspective (AB'SABER, 1971) and the study and mapping of the "Domínios Naturais da América do Sul" [Natural Domains of South America] (AB'SABER, 1977b), presented a fertile ground to think about Brazilian natural environmental systems.



Thus, little transformed natural landscapes account for 30-35% of the national territory and are represented by the following systems: enclaves of closed lands in the Amazon forest; dense Amazon rainforest; open Amazon forest; river plains, marines and wetlands. However, since society is understood as a part of the environmental system, acting and interacting with the other components of the system, the recognition of the implications and consequences of such social interventions must be studied in order to recognize the current state and the relationship between society and nature.

Therefore, it is crucial to understand the strongly transformed natural landscapes in Brazil, which represent 65-70% of the national territory and involve most of the aforementioned “natural landscapes”. These are represented by: Subtropical forests – clear natural lands in the Paraná basin; Semi-deciduous tropical forest in the Paraná basin; Slope and semi-deciduous forest of the Atlantic plateau; Cerrados (semi-humid tropical savannas) on the plateaus of the sedimentary basins of Paraná, in Parecis and Parnaíba; Semi-humid tropical enclaves of crystalline terrains; Caatingas with semi-arid climate; Subtropical natural lands – Campanha Gaúcha/Pampas; Transitional areas: from Cerrado to the Amazon rainforest; Transitional areas: the Atlantic Forest-Caatinga-Cerrado.

#### **LAND USE, LAND COVER, AND LANDSCAPE TRANSFORMATIONS**

In spite of the many peculiarities and similarities between the aforementioned landscape mosaics, already demonstrated in Ross (2006), this article did not focus on the descriptive analysis of each of those landscapes, since the debate held here aims to emphasize the use of such landscape units in an inter-related way and under a historical aegis. Thus, with a view to achieving a link between land use and land cover, and the loss of biodiversity and geodiversity due to associated environmental impacts, a fruitful debate was encouraged to reflect upon the landscapes mapped for the purpose of the present study.

Thus, as previously addressed, the Brazilian territory consists of a complex physical-geographic framework whose physiognomies are directly related to the geological history and the morpho-cultural, climatic and paleoclimatic processes acting with land use and land cover to evidence the current analytical framework. However, looking at strongly transformed natural landscapes, one realizes that analyzing the history of landscape appropriation and transformation throughout the various economic phases of the national territory formation is essential for the debate.

In this mote of analysis, the South American landscape mosaic, especially the Brazilian one, according to a historiographical analysis, may have undergone vigorous transformations throughout more than 500 years of appropriation. This is clearly portrayed by Dean (1996) in his celebrated book “A Ferro e Fogo: a história e a devastação da Mata Atlântica brasileira” [With fire and sword: history and devastation of the Brazilian

Atlantic Forest]. The discussion developed by Dean (1996) allows thinking of a nature, as well as a landscape, which, prior to the arrival of the Europeans, functioned and organized itself by including humans as another organism, with no ruptures in their dynamic and homeostasis equilibrium.

Chronologically, Dean (1996) then discusses the importance of this natural environment at the heart of socioeconomic processes, later leading to the thought of how human beings in society imprint, on nature, relations that affect the conservation and continuity of their biodiversity. Consequently, these interventions are manifested by converting landscapes of native vegetation, whose potential is still unknown, into fields of agriculture, forestry, livestock, mining and urban areas, which sometimes do not favor the local/regional population.

The aforementioned devastation began with the extraction of *Paubrasilia* in the Atlantic Rainforest, which soon gained greater economic significance on the coast of the former Captaincy of Pernambuco due to the introduction of sugarcane crops, started by the then Captaincy of São Vicente on the coast of the State of São Paulo. This is the first phase of conversion of forests into planted areas of exotic plant species. It is noted that the phase of exclusive sugar export activity lost economic importance in the eighteenth century for the mining activity of gold, diamond and other precious stones found and exploited in the territory of the Brazilian States of Minas Gerais, Goiás, and Mato Grosso, thus generating major transformations in the local landscapes. Parallel to the sugarcane activity, agricultural and livestock activities were also developed. These, together with the mining areas, expanded the deforested areas in Brazil.

The landscape of sierras and mountains of Planalto Atlântico, covered by the Atlantic Rainforest, for example, was again strongly affected by a vigorous process of occupation and settlement throughout the nineteenth and first half of the twentieth centuries with the introduction of coffee-growing agriculture on the coast of the State of Rio de Janeiro (in 1808). This agriculture rapidly expanded to the south of Minas Gerais and east-northeast of the state of São Paulo and north of Paraná. Since the 1970s, federal public policies have given a new impetus towards effective occupation of the Brazilian territory. Now the great target of the territorial occupation has become the Cerrado (savannah) landscapes of central Brazil and the Amazon rainforest, following a strategic military policy under the slogan “integrar para não entregar” [integrate to not give up] within a vast and powerful National Integration program.

This overwhelming process was largely supported by public agricultural and livestock incentive policies through subsidized medium- and long-term financing, attracting rural investors. In this domain, in twenty years, practically all the Cerrado areas with outstanding conditions and soil favorable to mechanized agriculture became productive land. The non-agricultural areas gave way to beef cattle raising, and pastures grown with exotic grasses such as *Brachiaria decumbens*. Residual occurrences of Cerrado vegetation are currently found in very steep reliefs or in extremely sandy or rocky soils that make the mechanized agriculture

or the cultivation of exotic grasses impossible. Technological and research incentives for recognition and better use of those areas have been implemented for some decades, with the support of Embrapa (Brazilian Agricultural Research Corporation), which is a public company linked to the Ministry of Agriculture, Livestock and Supply of Brazil. With this instrument, it is hoped to increase productivity and profitability in the long term.

Such discussion draws on Sayer et al.'s (2013) idea, as they state that the main driver of landscape change will occur in rural areas, with the intensity and spatial extent of agriculture. Agricultural intensification offers opportunities to staunch the substantial yield gap that afflicts many production systems, and this is unlikely to be sufficient to meet the demands of a growing global population. It is also noted that “demands for nonfood land-based commodities, including wood products, vegetable oils, and biofuels (as well as mined resources), will also compete for space with agriculture” in the coming years (SAYER et al., 2013, p. 4).

Thus, high-productivity agricultural activities (soybean, maize, wheat, cotton, beef cattle) are grouped in the central area of the Brazilian territory, more precisely in the Cerrado region, which extends from North to South, tending to experiencing intensification and to improving production. This has already been observed in the central areas of the country, since there are transformations of low-productivity pastures into areas of sugarcane agriculture, silviculture, with a simultaneous improvement in agricultural and livestock management processes.

Cropland and livestock farming, through conservation initiatives, no longer remain with soils exposed and awaiting the next planting, while crop rotations and no-till on straw mulch are more frequently observed, generating benefits in tropical regions, especially among small producers because of the high rainfall index and erosive susceptibility of soils. According to Embrapa, such techniques have generated productive stability and improved the use of land, water, soil and nutrients, in addition to increased efficiency in weed control and soil erosion reduction. Furthermore, it improves farmers' working conditions, and make other sources of food and income available to small and medium producers (SOUZA; FIALHO, 2003).

In the South region of the country, the practice of having three annual crops is in rapid expansion – soybean followed by maize, and in winter because it is humid the third one may be wheat, barley or oat for the production of grains and fodder for animal feed. In the west-central region, two summer crops are practiced – soybean followed by maize. This management of two or three crops for the production of grains or fodder for animal nutrition is a widespread practice that increases agricultural productivity, reducing pressure on forested areas, and supporting the fight against deforestation.

In this regard, Ribeiro et al. (2009), when quantifying how much of the Neotropical Atlantic Forest still existed and taking into account its spatial distribution, proposed conservation guidelines, as follows: (1) large mature forest fragments should be a conservation priority; (2) smaller fragments can be managed in order to

maintain functionally linked mosaics; (3) the matrix surrounding the fragments should be managed in order to minimize edge effects and improve connectivity; (4) restoration actions should be taken, particularly in certain key areas. Thus, for the above authors, differences between regions should be considered in environmental and landscape planning, aiming at the conservation of biodiversity.

As could be seen, there is a trend of vigorous expansion of silviculture, especially of eucalyptus, pine and rubber tree. There is also an expansion of low-productivity pastures in the Planalto Atlântico belt in the east of the State of São Paulo, east and south-central Minas Gerais, northeast of Mato Grosso do Sul, north-central Espírito Santo, south coast of Bahia, east-central regions of the States of Paraná and Santa Catarina, south-central Rio Grande do Sul. In those areas, with inadequate conditions, usually for mechanized agricultural activities, and with low-productivity pastures, the lands are leased or traded to the paper and pulp industry. Therefore, the economic importance of this resource should be noted, although there are serious criticisms against it, even in the face of the increasing use of disposable paper, reuse of water, the increasing use of biomass, and treatment of effluents.

In the semi-arid landscapes, place of dry forest vegetation (Caatinga), there is a clear demographic depletion area, mainly where soil and relief conditions, combined with climatic constraints, greatly hamper extensive husbandry and breeding, as well as traditional family farming. In these areas, rural and regional exodus tend to prevail, mostly among young people who are looking for a job opportunity in the coastal cities of northeastern Brazil and other regions of the country. However, the Caatinga has areas that are true “green islands”, where polygons of irrigated agriculture are developed, mainly of fruits for national supply and export. Yet, as previously presented, despite the economic gains, it is necessary to discuss who, in fact, has been benefited by such irrigated perimeters.

On the eastern and southern edges of the Amazon Rainforest, in the face of difficulties in developing mechanized grain agriculture, forests are being progressively converted into pastures with exotic grasses, especially brachiaria. At the end of the twentieth century, large land extensions were converted into agricultural areas, where more than 700 thousand square kilometers of pasture occupied areas that were previously forests. In this scenario, the Brazilian territory, which has an area of approximately 8.5 million km<sup>2</sup>, has preserved approximately 2.8 million km<sup>2</sup> of continuous Amazon Forest, and only the State of Amazonas, which accounts for approximately 1/3 of the entire forest, presents less than 3% of deforested areas (FUNCATE, 2006). The Pantanal areas of Mato Grosso and Mato Grosso do Sul, and the Guaporé areas, besides regenerated forest fragments of the Atlantic Forest and coastal mangroves, are also relatively well conserved (ROSS, 2006).

The landscapes of the Amazon forest(s) predominantly cover the lowlands, where the predominant morphologies are hills and residual hills that, depending on the slant of the slopes generally above 10° or 20%,



hinder intensive mechanized agriculture. It is also important to mention the large part of the so-called Brazilian Legal Amazon, which corresponds to about 60% of the national territory and has the largest number of conservation units in the country. It includes Permanent Preservation units (Ecological Parks and Biological Reserves), Sustainable Use units (Extractive Reserves and Environmental Protection Areas – EPAs), as well as the Indigenous Reserves, which are untouchable for conventional economic practices in Brazil. However, there are numerous conflicts between the traditional populations and big capitalist producers due to the illegal or contradictory use of those areas, which has even led to the death of the most fragile peoples, such as indigenous and quilombolas, since the contingent of oversight agents does not suffice (IPEA, 2010).

Thus, the remaining 2.8 million km<sup>2</sup> of the Amazon Forest continue to be deforested along its edges. Although there is a relatively strict environmental legislation, it has not been able to contain the advances of deforestation in the area. In this regard, Bernard, Penna and Araújo (2014) pointed out that, between 1981 and 2012, 93 conservation units lost 5.2 million ha, especially between 2008 and 2012, representing a reduction of 74% of the area in the time scale analyzed by those authors. Their study showed that the main factor of such a decline is the creation of infrastructures for generation and transmission of electric energy in the Amazon Forest; besides, the opening of roads associated to these projects is a possible variable to be included in the aforementioned authors' debate.

However, it should also be noted that the Brazilian Federal Law No. 12651 enacted in 2012, which replaced that of 1965/1989, allows 20% of each rural property in the Legal Amazon to be converted, that is, to be deforested and used for agriculture or livestock practices. This law enactment allows perpetuating even more illegality, as it is practically impossible to control each of the rural properties.

In this scenario, it is believed that the Brazilian Amazon Forest should be treated with ecological-economic objectives well differentiated from those that are occurring in its borders today. By continuing to treat native forests as an untouchable nature, the battle for their conservation is inevitably lost (DIEGUES, 1996).

In addressing the importance of environmental services generated by conservation units, Bernard, Penna and Araújo (2014) pointed out that the fragile Brazilian environmental situation is related to the change in government policy and its chronic deficiencies in financial resources, employees, the need for greater vigilance, and popular participation. Therefore, a link is sought between social use, especially related to valuing the traditional populations' know-how and the continuity of biodiversity, since the idea of an integral protection unit applied in Brazil was, according to the above authors, little innovative as a model of use of tropical environments.

Remote monitoring and control by an aerospace system, for example, with modern technology, is a solved issue already, but the local monitoring logistics and property-to-property measurements are still far from being solved, with the Rural Environmental Registry (CAR) being a substantial initiative. It is also important to highlight the relevance of the Ecological-Economic Zoning (ZEE) (created according to Decree 4.297/2002 of the National Environmental Policy). However, despite its prominence as an instrument for territory planning and management, it is far from occurring effectively in Brazil. It can be said, therefore, that there is an intention to conserve biodiversity in the country. However, further interventions are needed, as well as knowing the benefits of such initiatives to society as a whole, especially regarding investment projects that value the local culture and its relation with the sustainable management of areas that today are in a wide process of landscape fragmentation and environmental degradation.

Thus, in view of the enormous richness that forests represent, both from the perspective of biodiversity and the volume of natural resources, and the very existence of the populations that inhabit them, it must be reaffirmed that public policies should be aimed at promoting sustainable development with rational use of forests rather than keeping the practice of inefficient environmental management. This perspective, similar to the discussion conducted by Townsend, Begon and Harper (2006), indicates the need/existence of an intersection between “explorers” and “environmentalists”, that is, a midfield presenting a basic philosophy that establishes the use of resources in a balanced way.

In this context, regional plans and forest management projects linked to selective extraction of timber, exploitation of non-timber products such as vegetal species of pharmaceutical and food interest, and development of agroforestry systems with native forest species, are paths that should be followed and that could keep forests alive and at the same time profitable for the populations directly involved. In this respect, the present moment or the way of understanding the question of national land use and its relation with landscape continuity and diversity presents itself critically, as it is propelled by the logic of international capital, where there is an exponential impulse for the rupture of the homeostatic level of these environments and complex landscapes. Thus, it can be said that the materialization of capitalism in the national territory, in view of the perverse logic of globalization through large agro-export corporations, has fostered new relations between society and nature in the areas mapped.

Nevertheless, this discussion allows understanding that each area (and its landscape) is analyzed according to its own logic, with its strengths and weaknesses, since the renewed systemic theory and complexity theory demonstrate that each landscape has its own relative, self-organized space and time (NEVES; SODRÉ, 2021). Each landscape mosaic needs a planning and management that recognizes the dynamics and the degree of perturbation of the landscape units, interfering positively on its continuity and diversity. In this regard, Butchart et al. (2010) on global biodiversity argue that, despite the obvious gain with

the creation of numerous conservation units and the improvement of variables related to the state of biodiversity, such as the reduction, even though inexpressively, of risk of extinction of certain species, there has been an increasing pressure on biodiversity due to the significant consumption of natural resources, the invasion of exotic species, and other environmental impacts.

## FINAL REMARKS

The understanding of the trajectories and the current state of national landscape studies has proved significant. Demonstrating a panorama between 2006 and 2016, from the analysis of scientific journals in this area of knowledge, made it possible to understand the growth of integrated research to the detriment of compartmentalized research on the topic in question, as well as latent connections between environmental goals, with emphasis on planning and environmental management. The use of a local/regional-regional scale and the river-basin unit of analysis proved effective, emphasizing the importance of fieldwork.

Thus, the study of landscape, when following new theoretical-methodological paths, has participated more clearly in the analysis of culture and the symbolic and has assumed even greater relevance as one of the components of environmental, patrimonial and sustainable territory policies. This explains the increasing use of such a concept in Human Geography and other disciplinary fields.

Subsequently, in a crosscutting and practical way, the proposed integrating debate of bibliometric character was in fact held, once a mapping of the national landscape complex was presented, according to Ross (2006), encompassing 13 landscape units more or less transformed by social action.

A historical profile of land use in the national territory was developed and aimed to understand its dynamics and its current state, taking into account the broad process of fragmentation and degradation of landscapes in the globalization era. Thus, it should be noted that the Brazilian territory has an enormous diversity in its landscape structure, one that translates differentiated stages of conservation and degradation. The reduction of those landscape mosaics tends to continue, leading to serious environmental costs due to areas of great ecological, economic and cultural interest.

Therefore, in view of the relevance and versatility demonstrated about the concept of landscape in Geography in Brazil, especially in Physical Geography, it is perceived that such a concept must be included in new research. This can be seen especially indicate that, despite current achievements in maintaining biodiversity, substantial changes in land use policies are required at different scales, since such uses are incongruent with the potential of those areas. However, sustained investment in the monitoring and analysis of different indicators is essential for tracking and improving the effectiveness of these proposals. In this

context, the integrative approach between society and nature addressed in the present study contributed to recognizing the use of the concept and the Brazilian landscape mosaic in a given historical and social context, which integrates this discussion with the other studies analyzed here.

In the prism of the analysis undertaken and the questions set forth above, it is possible to think of landscape as a unitary whole, formed by a long temporal and spatial history between society and nature, of long times and short times in coexistence, which provide landscape with a metabolism shaped by relational processes. In this scenario, integrative proposals have been continuously applied and tend not to cease, especially those related to environmental sustainability and in a more specific and directional way towards the ecological, economic, developmental, socio-cultural and environmental dimensions (ARTS et al., 2017). Such dimensions can be unified, generating complex products and studies such as those presented in the articles analyzed here and in the proposal adapted from Ross (2006).

Finally, the present study assumes that landscape should be rooted in the territory of human beings and in the long history of nature. This would favor a better analysis of the use of landscape mosaics in a paradoxical scenario between socioeconomic development and biodiversity and geodiversity continuity, in order to build new rationalities for the social appropriation of nature and the construction of a sustainable common future. It is also necessary to place landscape in long-term scientific and political commitments, guaranteeing the knowledge of its trajectories and trends, both in a practical and theoretical way, seeking a scientifically skillful and socially fair path.

The connections and advances observed in landscape research allow asking the following questions, which indicate pathways for new studies on the topic: (1) Is it necessary to expand the work scale to better define landscapes and their characteristics? (2) Could a comparative table be drawn containing the characteristics of each major landscape unit in Brazil? (3) Is it possible to make better use of current techniques of geoprocessing and geographic information system (GIS) to monitor the landscape dynamics by social action? (4) It is possible and useful to evaluate general or synthetic geoecological indicators (stability, fragility, ecological quality, singularity, and diversity, for example) about the current and/or future social (capitalist) pressure on the landscape units delimited here? (5) Is the current trend for increasing integrated landscape studies at the local and regional scale sufficient to consolidate this geographical approach (since it has been so important for environmental studies as a basis for spatial planning)? Finally, (6) is it necessary to consolidate national and international research groups and graduate programs with this integrated approach? - which refers to the need to encourage the teaching of specific subjects on landscape in undergraduate and graduate courses in Geography, as well as to encourage scientific networking, through research centers and networks.



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