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ASPECTS OF GEODIVERSITY IN THE WEST OF ACRE STATE - BRAZIL

ASPECTOS DA GEODIVERSIDADE NO OESTE DO ESTADO ACRE – BRASIL

ASPECTS DE LA GÉODIVERSITÉ DANS L'OUEST DE L'ÉTAT ACRE – BRÉSIL

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RESUMO
A geodiversidade está associada aos aspectos da geoconservação, patrimônio natural geológico e hidrogeomorfológico em cada domínio morfoclimático no Brasil. No domínio Amazônico, tais aspectos foram forjados em um ambiente de origem sedimentar desde o Cretáceo, identificado nas serras Rio Branco, Juruá-Mirim, Moa e Jaquirana, compostas predominantemente, de arenitos e siltitos. O Parque Nacional da Serra do Divisor (PNSD) está situado no estado do Acre, fronteira com o Peru e cordilheira do Andes. A região detém um patrimônio natural e uma estrutura geológico-geomorfológica, onde se encontram cachoeiras, grutas, vales e elevadas colinas, endógeno ao local. O presente artigo tem como objetivo geral apresentar elementos da Geodiversidade do Parque Nacional da Serra do Divisor (PNSD) voltados para a categoria do geoturismo visando à divulgação em âmbito regional, nacional e internacional.
Palavras-chave: Amazônia. Cretáceo. Serra do Divisor. Grutas. Igarapé.

ABSTRACT
Geodiversity is associated with aspects of geoconservation, natural geological and hydrogeomorphological heritage in each morphoclimatic domain in Brazil. In the Amazon domain, such aspects have been forged in an environment of sedimentary origin since the Cretaceous, identified in the Rio Branco, Juruá-Mirim, Moa and Jaquirana mountains, composed predominantly of sandstones and siltstones. The Serra of Divisor National Park (PNSD) is located in the state of Acre, on the border with Peru and the Andes mountain range. The region has a natural heritage and a geological-geomorphological structure, where waterfalls, caves, valleys and high hills are found, endogenous to the site. The general objective of this article is to present elements of the Geodiversity of the Serra of Divisor National Park (PNSD) focused on the category of geotourism aiming at dissemination at regional, national and international levels.
Key words: Amazon. Cretaceous. Serra of Divisor. Caves. Igarapé.

RÉSUMÉ
La géodiversité est liée aux aspects de la géoconservation, patrimoine naturel géologique et hydromorphologique dans chaque domaine morphologique au Brésil. Dans le domaine Amazonien, ces aspects ont été forgés dans un environnement d'origine sédimentaire depuis le Crétacé, identifié dans les montagnes Rio Branco, Juruá-Mirim, Moa et Jaquirana, composé principalement de grès et de siltites. Le Parc national de la scie du diviseur (PNSD) est situé dans l'état de l'Acre, frontière avec le Pérou et la cordillère des Andes. La région possède un patrimoine naturel et une structure géologique et géomorphologique, où se trouvent cascades, grottes, vallées et collines élevées, endogène au site. Le présent article a pour objectif général de présenter des éléments de la géodiversité du Parc national de la scie du diviseur (PNSD) tournés vers la catégorie du géotourisme visant à la diffusion au niveau régional, national et international.
Mots clés: Amazone. Crétacé. Serra do Divisor. Grottes. Igarapé

INTRODUCTION

Geodiversity in the Brazilian territory is closely linked to aspects of geoconservation, geological and hydrogeomorphological natural heritage for each morphoclimatic domain. For the Amazonian domain, the geodiversity of the natural elements are observed in the geological and geomorphological characteristics, intrinsically specific to the environment within the Serra of Divisor National Park (PNSD) in the west of the State of Acre.

The conservation of geosites, which includes the implementation of recovery strategies, can contribute, not only to their safeguarding, but also to adding patrimonial value to the territory where they are located, above all, being located in a conservation unit (HAAG; HENRIQUES, 2014 p.1279).

In this sense, geodiversity is connected to geoconservation which turns to the practice of geotourism as a proposal to enhance the natural heritage. According to CPRM (2006) geodiversity is the study of abiotic nature (physical environment), consisting of a variety of environments, composition, phenomena and geological processes that give rise to landscapes, rocks, minerals, waters, fossils, soils, climate and other surface deposits.

Geotourism is considered an important tool for the promotion of knowledge, mainly about the natural heritage developed by endogenous and exogenous agents in geological and geomorphological time.

The state of Roraima has a diversity of landscape scenarios linked to the ceiling-structural and lithological history that conditions the modeling of hills, mountains and extensive planed areas. The municipality of Mucajaí, stands out in the surprising set of rapids, waterfalls and river beaches, in addition to mountains, hills and extensive flattened areas covered by a floristic diversity (VERAS, 2014).

According to Veras (2014) when applying the geographical view in the interpretation of the landscape characteristics, in its geological and geomorphological aspect it was possible to identify potentialities for the geotourism category, even though overshadowed by the ignorance of managers and the community, which results in possibilities of integration with other products of economic, scientific and pedagogical value.

In Acre, the PNSD is an area that has good potential for geotourism projects, given the incidence of numerous natural attractions (canyons, waterfalls, rapids, natural pools, caves and natural viewpoints), in addition to land favorable to the implantation of a Geopark, the despite the fact that it is a virtually unpopulated region (ADAMY, 2015a). The author's cited highlights the elements of Geodiversity and aspects in the PNSD and those elements mentioned can be observed in the west of the State, and indeed demonstrates the geotouristic potential in Acre.

The geoglyphs found and identified in the state of Rondônia. A 2004 study identified 45 archaeological sites of the geoglyph type in the state, distributed in several municipalities, especially the municipalities of Porto Velho, São Francisco do Guaporé and Guajará Mirim. These data characterize the spatial continuity of these structures to the east, particularly in the region known as Ponta do Abunã, where a large number of geoglyphs are concentrated (ADAMY, 2016b).

With the felling and burning of natural vegetation, led by the advance of pioneer fronts, from the 1970s, geoglyphs began to be revealed to Acre. These earth structures, designed on the clayey soil of the region, are part of the landscape of Acre and thus need to be treated, studied and cared for (RANZI, 2010b).

In the state of Pará, among many natural beauties Andrade; Andrade; Carneiro (2017) demonstrated the geotouristic potential of Santarém, which is located in the Alter of ground district located 37 km away. This place is known as the “Brazilian Caribbean” due to the fact that a bank of river sand is used as a beach during the less rainy season of the year with the surrounding clear waters of the Tapajós River.

The authors in their case study point out that urban geotourism also brought reflections where, on several excursions, they addressed heritage and geological education from urban structures with rocks in churches, historic buildings and city sidewalks (ANDRADE; ANDRADE; CARNEIRO, 2017).

MATERIAL AND METHODS

For the development of this work, the following steps were carried out: 1) definition of the area with the object of study the Serra of Divisor National Park (PNSD); 2) work in a cabinet to select bibliographic material; 3) acquisition and assembly of the PNSD digital cartographic database; 4) definition of the thematic category Geotourism; 5) elaboration of this article.

NATURAL ENVIRONMENT OF WESTERN ACRE

Acre undoubtedly stands out for the presence of fossiliferous localities, broadly spread throughout its territory, associated largely with the Solimões Formation, but also with sedimentary deposits from the Cretaceous period (such as shark teeth found in the Serra of Moa) (RANZI, 2000a; CAMPBELL, *et al*., 2001; SANTOS *et al*., 1991). The PNSD can be considered an area of relevant diversity and distribution of fauna, confirmed by the number of species of large and medium-sized mammals (CALOURO, 1998).

The geological history of the Acre Basin involves primarily the deposition of sediments at the edge of a craton located to the east, forming a marginal basin, open from the Paleozoic, resulting in very weathered continental sediments, interspersed with marine sediments (ACRE, 2010).

In the west of the state of Acre lies the “Residual Plateau of Serra of Divisor, with the Jaquirana, Moa, Juruá-Mirim and Rio Branco Mountains, comprising the highest altitudes in the Western Amazon (between 270 and 750 m)” (CAVALCANTE, 2006 p.14-15).

LOCATION OF THE SERRA OF DIVISOR NATIONAL PARK (PNSD)

In the State of Acre, protected areas and conservation units play an important role when we consider their historical context and the traditional populations (riverside, rubber tappers and extractivists) that depend on the available natural resources available, thus maintaining a harmonious relationship with the forest. (RANDO; MARANHO; SCARCELLO, 2017).

The Serra of Divisor National Park covers an area of 843,012.28 hectares. Its name originated from an important geomorphological feature that exists in the area, the *divortium aquarum* region (watershed) of the hydrographic basins of the Middle Valley of the Ucayali River, in Peru and the Upper Valley of the Juruá River, Acre/Brazil (Associação SOS Amazônia *et al*., 1998; PENA DOS REIS; HENRIQUES, 2009).

PNSD is a conservation unit and is located in the west of the State of Acre. The PNSD area covers lands in the municipalities of Cruzeiro do Sul, Rodrigues Alves, Mâncio Lima, Marechal Thaumaturgo, Porto Walter. The PNDS still borders Peru in all of its western portion (LIRA, 2015) and occupies approximately 5.5% of the territorial area of Acre (KOGA; SILVA; BROWN, 2019).

The drainage network consists of the Moa, Azul, Juruá Mirim, Rio Branco, Ouro Preto, Minas Gerais rivers, both tributaries of the left bank of the Juruá River. The vegetation is of the Open Ombrophilous Forest type of Palms, bamboo and vines and, in its great majority, the occurrence of Ombrophilous Dense Forest, Sub-Montana and Dense Forest (BRASIL, 1977; CALOURO, 1998).

OPERATIONAL PROCEDURES

The study area was chosen based on criteria that contemplate the elements that make up the natural heritage existing in the Serra of Divisor National Park (PNSD) in the geological-geomorphological and geotouristic context in the state of Acre.

The bibliographic material of national, regional and local literature that contains information on the PNSD's geodiversity and natural heritage was selected in RADAMBRASIL, sheet SB / SC.18 Javari / Contamana; data from the economic ecological zoning of Acre / ZEE and EMBRAPA newsletters on the evolution of the landscape in Acre. Digital data in shapefile format on the PNSD location and delimitation was obtained from the Chico Mendes Institute for Biodiversity Conservation - ICMBio. With the LANDSAT 7 satellite images that were extracted from the INPE (National Institute for Space Research) website, orbit / point (5/65; 5/66; 5/67; 6/65 and 6/66) of the TM sensor (Thematic Mapper) a mosaic was produced that contemplates the Vale do Juruá and the limits of the PNSD.

RESULTS AND DISCUSSION

We also used some data from the EEZ containing the hydrographic network and political delimitation of the municipalities in the park area. Based on the selected data, it was possible to organize and elaborate in a GIS environment and, with the support of the ArcGIS geoprocessing software version 10.3, developed by ESRI (Environmental Systems Research Institute), the map of the characteristics of the PNSD's geological and geomorphological natural heritage, which will be presented in the result and discussion item of this article.

The thematic category Geotourism was chosen because it has a greater relationship in the expression of the natural heritage and the geological and geomorphological geodiversity of numerous areas in the Brazilian territory. For the case of PNSD in the state of Acre, it becomes important because it has expression within the regional tourist context, once the characteristics of the geology and geomorphology of the Serra of Divisor National Park have been identified.

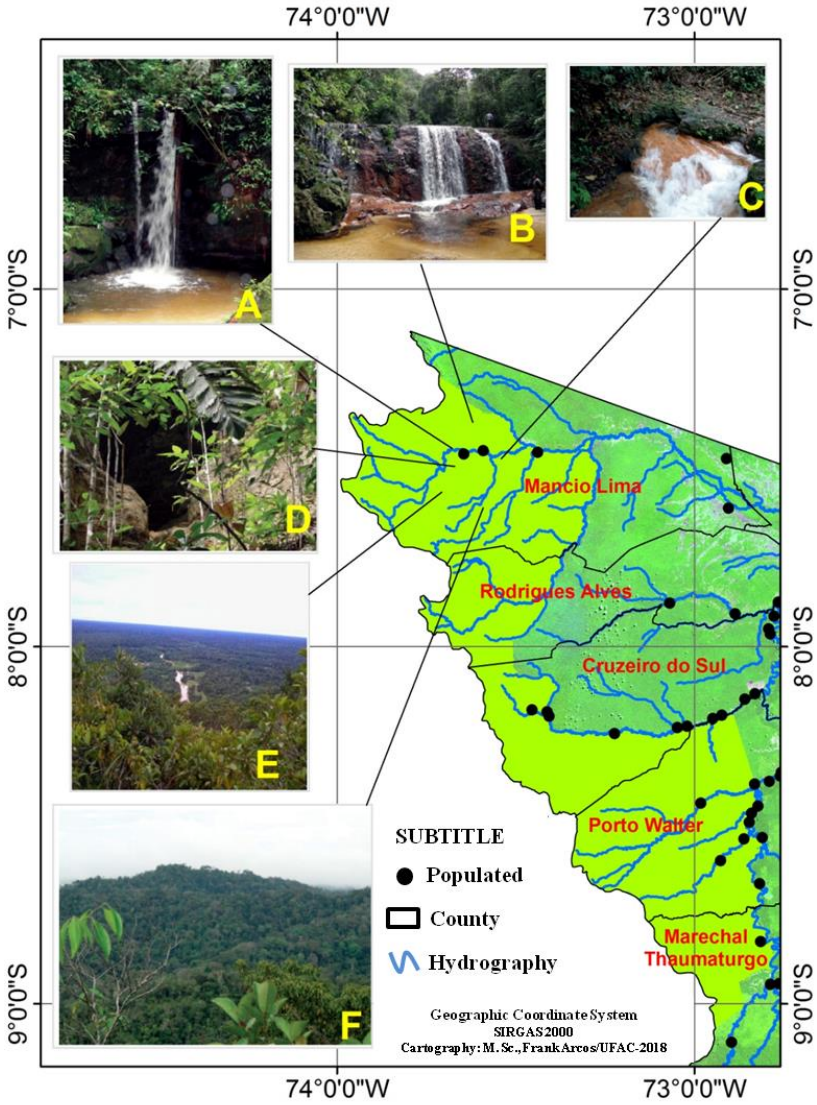
In Brazil, the evolution of landscapes on a space-time scale gives places their own marks of their intrinsic geodiversity in the context of geotourism and, of the characteristic elements of the geology and geomorphology of each region, which, in this case, we emphasize the Serra of Divisor National Park (PNSD) in Acre, southwest of the Brazilian Amazon. In the state of Acre, “a mountain range that is very busy due to tectonic events develops, with differences in levels greater than 600 meters, called Serra of Divisor. This mountain range includes numerous sites of real interest for the introduction of ecotourism” (ADAMY, 2015a p. 270).

The characteristic elements of the geology in the PNSD have intrinsic specificity in the evolutionary context of the landscape, occurring in synergy with the processes resulting from the tectonic activity in the Peruvian Andes that, with this, can be identified in the park area some waterfalls, caves and rocky outcrops that exist only in this part of Acre.

As for the aspects of the geomorphology of the PNSD area, the very busy relief that appears in hills forming valleys where the structural control guides the rivers and streams, which flow over metamorphic and sedimentary rocks. Many of these rivers have a dark color due to the contact and the physical-chemical actions of the water on the rock. The Acre landscape is the result of profound changes in geological time that are present throughout Acre, especially the elements of natural Geodiversity in the geological-geomorphological context, where, we highlight (Figure 1) elaborated based on Adamy (2015a) the Cachoeira of air-conditioned (A) on the sandstones of the Moa formation, which among the others in the area is one of the most sought after by visitors; (B) over syenitic rocks, the Formosa waterfall on the Anil riverbed; (C) central hole, borehole of a survey carried out by Petrobrás that

reached the water table and, the water gushes uninterruptedly inside the National Park of Serra of Divisor.

Figure 1 - Elements of Geodiversity / PNSD, Acre / Brazil.



Source: ACRE (2010); ADAMY (2015a); LIRA (2015). Org. by the author (2018).

In the image (D) a small cave located in the sandstones of the Moa formation that deserves speleological studies; (E) Valley of the Moa River and its floodplain that in the floods of rivers in the Amazon reaches the interior of the forest; “The Moa crosses the Serra of Divisor through a series of failed lines, forming a canyon, reaching the Juruá floodplain through the dissected plains' (MENDONÇA *et al*., 2020 p.3); (F) Set of hills amid cretaceous sediments in the Serra of Divisor National Park (ADAMY, 2015a, p.164-165 and 167), which represent the main and positive characteristics aimed at boosting geotourism in the PNSD.

For the PNSD, the direct effects are linked to the conservation and maintenance of natural elements and actions aimed at protecting the way of life of communities inserted in protected areas and of sustainable use. This relationship with sustainability creates new practices that aim to benefit local actors, seeking to associate economic activity, income distribution and enhancement of the physical environment with sustainability.

Geotourism can promote geoconservation, as well, the latter can promote geotourism, because by providing tourists with a more scientific than contemplative view of the landscape,

geotourism ends up enabling the promotion of geoconservation and this, in turn, is a tool indispensable in the conservation of world geodiversity, whether it is represented by geosites or by geological heritage (BENTO; RODRIGUES, 2010a).

In the context of geotourism, all actions must link the bases of sustainable development. Environmental sustainability must be prioritized, since, in this perspective, the valuation of physical attributes and of products and services that can be created by local communities will occur directly, and this will provide work and income generation, in a way that guarantees environmental sustainability, cultural and socioeconomic.

One of the points of paramount importance is the co-participation of local social actors, which comes with the possibility of tools and the "use of economic instruments in environmental management and environmental policy, such as the Compensation for Environmental Services - CSA" mechanisms (RANDO; BROSE; ARCOS, 2013, p.1) active in promoting the reduction of deforestation, protection of biodiversity, elements of geology and geomorphology as natural heritage within the scope of geotourism in the PNSD in all its breadth.

According to Moreira (2014), different actions produce some positive impacts of geotourism related to the conservation of geological heritage, the generation of direct and indirect jobs and the understanding of the environment through a geological and environmental education of visitors, generating an increase in the awareness of local population and tourists regarding geological heritage. As for negative impacts, damage to geological sites, resulting from excessive and / or incorrect use, the collection of souvenirs, vandalism and illegal removal of items such as fossils and minerals can be cited. In addition, the generation of economic benefits can be limited if the majority of employed people are not from the local community.

As a positive point, the PNSD has all the characteristics for Geotourism, as it presents natural elements of a geological order that can only be observed due to the proximity to the Andes and the action resulting from a very influential tectonics in the Acre region.

However, Bento and Rodrigues (2013b) express that geotourism and geoconservation can also be seen as inducing local economic development, providing the management and use of geodiversity, provided it is carried out in a planned and sustainable way.

The PNSD is a strategic area for geotourism in the Amazon region, since it includes promoting actions aimed at training local actors who live inside the park. Such action will provide improvements in the quality of life and, increase in the conditions of maintenance and conservation of biotic and abiotic elements that can in turn attribute value to the existing natural heritage in the PNSD area.

The Serra of Divisor National Park (UC for Integral Protection), based on legal bases, aims at the preservation of natural resources, as well as encouraging actions for the promotion of scientific research and environmental education. The PNSD represents an important world heritage among the other protected areas in the Neotropics zone (ESTEVES; LUZ, 2019).

FINAL CONSIDERATIONS

Brazil is rich in natural landscapes and has a very diverse geological and geomorphological geodiversity in all its regions. In the northern region one can mention the elements found in the west of Acre within the Serra of Divisor National Park with beautiful waterfalls, small caves, huge river valleys and a hydrographic network that allows access to locations in the PNSD.

In the case of the State of Acre, some areas have a specific natural heritage and, that the structures diverge when we consider their evolutionary phase in geological time from the point of view of their foundation and lithological differences that some occur in only a certain location in the state.

The consensus that Geotourism for some authors has synergy with other practices, for example, ecotourism, which does not apply to the PNSD as the public authorities argue, in a simplistic reading that values only the flora and fauna segment, leaving aside the elements of existing geology and geomorphology moving away from geoconservation and enhancement of natural heritage.

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