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ESPINHAÇO RANGE BIOSPHERE RESERVE (MAB UNESCO) AND ITS IMPORTANCE IN PROMOTING GEODIVERSITY SITES

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Abstract

The Serra do Cipó National Park (PARNA Cipó) is a UNESCO-recognized site and part of the Serra do Espinhaço Biosphere Reserve (RBIO Espinhaço). However, the educational and interpretive materials in PARNA primarily focus on nature tourism and do not adequately explore the geodiversity related to abiotic attractions. This study evaluates the potential for geotourism practices in the conservation unit. The methodology involved developing thematic maps of didactic potential, recreational potential, and degradation risk, which were analysed through multicriteria analysis to generate a geotourism potential map. A public-use map of trails was also developed to contextualise the study using data from the Wikiloc application. The results indicate two significant areas with high potential for geotourism, including the Vale Mascate and Vale Bocaina Trails. The study's findings could contribute to the development of geotourism and promote the conservation and appreciation of the abiotic aspects of nature.

Keywords: Geotourism; Geoconservation, PARNA-Cipó, Geoheritage.

Resumo / Resumen

RESERVA DA BIOSFERA DA SERRA DO ESPINHAÇO (MAB UNESCO) E SUA IMPORTÂNCIA NA PROMOÇÃO DOS SÍTIOS DA GEODIVERSIDADE

O Parque Nacional da Serra do Cipó (PARNA Cipó) faz parte da Reserva da Biosfera da Serra do Espinhaço (RBIO Espinhaço), reconhecida pela UNESCO. Embora o turismo no PARNA seja focado no segmento de turismo de natureza, a geodiversidade, relacionada aos atrativos abióticos, não é explorada adequadamente em seus materiais educativos e interpretativos. Este estudo teve como objetivo avaliar o potencial para práticas de geoturismo na unidade de conservação. A metodologia aplicada incluiu a elaboração de mapas temáticos de potencial didático, potencial recreativo e risco de degradação, que foram analisados de forma integrada por meio de análise multicritério para gerar um mapa de potencial geoturístico. Um mapa de uso público das trilhas foi gerado para contextualizar a análise, utilizando dados do aplicativo Wikiloc. Os resultados apontam para duas grandes áreas de alto potencial para o geoturismo, incluindo os atrativos das Trilhas do Vale Mascate e do Vale Bocaina. Espera-se que esses resultados possam contribuir para o desenvolvimento do geoturismo, valorizando os atrativos relacionados aos aspectos abióticos da natureza.

Palavras-chave: Geoturismo; Geoconservação, PARNA-Cipó, Geopatrimônio.

RESERVA DE BIOSFERA DE LA SERRA DO ESPINHAÇO (MAB UNESCO) Y SU IMPORTANCIA EN LA PROMOCIÓN DE SITIOS DE GEODIVERSIDAD

El Parque Nacional da Serra do Cipó (PARNA Cipó) forma parte de la Reserva de la Biosfera de la Serra do Espinhaço (RBIO Espinhaço), reconocida por la UNESCO. Aunque el turismo en el PARNA se centra en el segmento de turismo de naturaleza, la geodiversidad, relacionada con los atractivos abióticos, no se explota adecuadamente en sus materiales educativos e interpretativos. Con el objetivo de evaluar el potencial para prácticas de geoturismo en la unidad de conservación, se aplicó una metodología que incluyó la elaboración de mapas temáticos de potencial didáctico, potencial recreativo y riesgo de degradación, que fueron analizados de forma integrada mediante análisis multicriterio para generar un mapa de potencial geoturístico. Para contextualizar el análisis, se generó un mapa de uso público de los senderos utilizando datos de la aplicación Wikiloc. Los resultados del análisis apuntan a dos grandes áreas de alto potencial para el geoturismo, que incluyen los atractivos de los senderos del Valle Mascate y del Valle Bocaina. Se espera que estos resultados puedan contribuir al desarrollo del geoturismo en el PARNA Cipó, valorizando también los atractivos relacionados con los aspectos abióticos de la naturaleza.

Palabras-clave: : Geoturismo; Geoconservación, PARNA-Cipó, Geopatrimonio.

INTRODUCTION

Biosphere Reserves are sets of territories of high relevance for the conservation of biodiversity, recognised by the Man and Biosphere Programme (MAB) of UNESCO (UNESCO, 1970). These territories are globally important and usually encompass mosaics of Conservation Units (CUs), ecological corridors, and watersheds. In Brazil, there are seven Biosphere Reserves (REBio) recognised by UNESCO: Atlantic Forest (1991), São Paulo Green Belt (1994), Cerrado (1993), Pantanal (2000), Caatinga (2001), Central Amazon (2001), and Espinhaço Range (2005).

The Serra do Espinhaço Biosphere Reserve (RBSE) is located within the mountain range of the same name in Minas Gerais, Brazil. It encompasses conservation units aimed at protecting its heritage. Among the contiguous protected areas within the RBSE, notable ones include the Serra do Cipó National Park, Sempre-Vivas National Park, Peruaçu Caves National Park, and Grande Sertão Veredas National Park, totalling 346,396 hectares of protected areas. Gontijo (2016) discusses the importance of RBSE as a suitable location for studying and researching interactions between tourism, nature, and culture. The author points out that despite the pressure of mass tourism in the region, tourism emerges as a possibility for economically utilising this same potential.

Serra do Cipó National Park is the largest strictly protected conservation unit within the Serra do Espinhaço Biosphere Reserve, covering 31,639 hectares. It encompasses one of the most stunning landscape ensembles and one of Brazil's largest formations of quartzitic Rupestrian Grasslands. Particularly, the Serra do Cipó region harbours 67% of endangered plant species, the highest number of endemic species in the Brazilian flora, and significant endemism of fauna associated with these plants (GONTIJO et al., 2021). In addition to its biodiversity significance, Serra do Cipó National Park boasts remarkable geodiversity characterised by unique rock formations such as canyons, waterfalls, caves, and cliffs, as well as a variety of soils, landscapes, and water resources, making it a site of great geological and touristic interest (SILVA et al., 2019).

These aspects indicate a significant potential for nature tourism, as highlighted by Oliveira & Souza (2018), emphasising the diversity of attractions and landscapes as motivating factors for tourists to choose to visit the park. Gontijo et al. (2021) emphasise ecotourism, sports tourism, and adventure tourism, involving activities such as hiking, ecological walks, adventure sports, and landscape contemplation. Although the park offers various natural attractions related to geotourism, this segment is not fully addressed in the educational and interpretive materials of Serra do Cipó National Park. In this sense, the discussion about valorising geodiversity elements provides opportunities to incorporate public use focused on geodiversity aspects, as proposed in geotourism.

Geotourism is a specific form of nature tourism that focuses on the geological, geomorphological, and landscape aspects of a region, aiming to promote the conservation of these elements and increase knowledge of Earth sciences (HOSE, 1995, 2004; RUCHKYS, 2007; NEWSOME & DOWLING, 2010). This tourism segment seeks to highlight the importance of geodiversity and provide a meaningful learning experience, aligning with ecotourism. Geotourism is considered a subcategory within nature tourism and a market strategy that offers considerable educational and environmental potential. This approach aims to provide an interpretation of geodiversity for tourists and local communities, making it a fundamental process for promoting geoconservation (BENTO & RODRIGUES, 2013).

Geoconservation through geotourism relies on the process of perception and environmental education to facilitate the communication of values associated with geodiversity (MARQUES & BRILHA, 2017). One of the communication approaches is environmental interpretation, which involves self-guided visits, the use of geotrails and viewpoints, guided tours, geo-activities, and the establishment of visitor centres at geosites (OLIVEIRA, 2012; NEWSOME & DOWLING, 2010). These initiatives aim to raise awareness about the importance of protecting geopatrimony.

The term geopatrimony refers to the concept of heritage or records of significant processes in Earth's history and is associated with at least one unique, didactic, scientific, or aesthetic value (BRILHA, 2005; BORBA, 2011; RUCHKYS et al., 2018; CHEN et al., 2020).

Geopatrimony is valued and protected through geoconservation measures, a term that gained prominence in the 1980s and 1990s with the development of various initiatives and legal mechanisms. Since the 1990s, geodiversity, geopatrimony, geoconservation, and geotourism have experienced

exponential growth in terms of publications, theoretical and methodological development (NASCIMENTO, SCHOBBENHAUS & MEDINA, 2008; CHEN et al., 2020; HERRERA-FRANCO et al., 2020).

Despite the significant recognition, the geotourism segment still faces crucial challenges regarding geoconservation. These challenges are related to the inconsistency in the process of geopatrimony identification, the lack of a transnational approach in the methodology, and the absence of a consensus on the definition of terms, which has affected the results' quality. Additionally, there is a need for specific legislation for geopatrimony, support for research and conservation efforts, and an increasing interest in the aesthetic value of the landscape (WILLIANS et al., 2020).

In Brazil, nature tourism is generally associated with ecotourism. However, nationally and internationally significant natural attractions are related to elements of geodiversity, such as in the case of Iguaçu National Park. In this context, the values of geodiversity mostly serve as a backdrop for visitors (MANTESSO-NETO et al., 2012). However, there are examples in the country where tourism activities are directly linked to geodiversity-related attractions. Some of these examples include various national and state parks that encompass mountain formations, such as Itatiaia National Park (MG/RJ), Serra dos Órgãos National Park (RJ), Chapada Diamantina National Park (BA), Serra do Mar State Park (SP), and Serra do Caparaó National Park (MG/ES).

Law No. 9,985, dated July 18, 2000, establishes the National System of Conservation Units (SNUC) and sets criteria and rules for creating, implementing, and managing conservation units in Brazilian territory. This legislation ensures the realisation of recreational activities and ecotourism in these areas. Currently, the system has approximately 2,300 registered units distributed in all regions of the country. According to the Ministry of the Environment (2022), in 2021 alone, the number of visitors to conservation units exceeded 16.7 million visits. This context demonstrates that Brazil has great geotouristic potential, primarily due to the geodiversity of its territory, which enables the practice of nature tourism. Among the privileged spaces for geotourism are areas recognised by UNESCO as heritage sites: World Heritage Sites (WHS), Biosphere Reserves (BR), Ramsar Sites (RS) (SENA et al., 2022), and Global Geoparks (GG).

Considering the spaces recognised by UNESCO, GGs have geotourism as a driving force for local development, requiring establishing cooperation networks for geopark recognition. In Brazil, there are five UNESCO Global Geoparks. The Araripe Geopark, in Ceará, was the first to be designated in 2006; two others had their nomination approved and were included in 2022, namely the Seridó Geopark (Rio Grande do Norte) and the Caminhos dos Cânions do Sul Geopark (Santa Catarina). In 2023, the Caçapava and Quarta Colônia parks were also designated by UNESCO as Global Geoparks.

In 2006, the Brazilian Geological Service (CPRM) launched the Geoparks Project to identify and evaluate potential areas of geological and touristic interest for the creation of geoparks in Brazil. The project listed 26 potential geoparks in different regions of the country. This study served as the basis for the Geoparks Program of Brazil, which identifies and promotes the development of outstanding geological areas throughout the country. The program is based on the criteria and guidelines established by UNESCO for creating and managing geoparks. Currently, the program has 14 proposals at different stages of development and evaluation (CPRM, 2006).

In addition to geoparks, geotourism in areas covered by the Man and the Biosphere Program (MAB) can be developed through education focused on the elements of geodiversity, promoting knowledge of the geological and geomorphological characteristics of the area, as well as the development of related tourism products (BRZEZINSKA-WÓJCIK, 2021).

Based on the presented context, this study aims to evaluate the potential for geotourism practices in the Serra do Cipó National Park and identify associated risks. Through spatial analysis and the evaluation of attractions, the study seeks to contribute to the management and valorisation of geological, geomorphological, and scenic elements, as well as their use within the scope of the Serra do Espinhaço Biosphere Reserve (RBSE).

STUDY AREA

The RBSE encompasses the Southern Espinhaço Range (from the Diamantina region to the Serra do Cipó) and the Iron Quadrangle (QF) (Figure 1). The Espinhaço Range is of great importance regarding water resources, as it includes parts of three major nationally significant river basins: Doce River, Jequitinhonha River, and São Francisco River. The Iron Quadrangle is considered one of the world's main metallogenic provinces, and it was where the occupation of the territory of the state of Minas Gerais began. Due to this geological importance and its role in mining history, Ruchkys (2007) demonstrated its potential for creating a UNESCO geopark. This relevance for geotourism and geoconservation is seen in the QF and throughout the RBSE territory, which encompasses important geological and gemological provinces associated with the Jequitinhonha River basin.

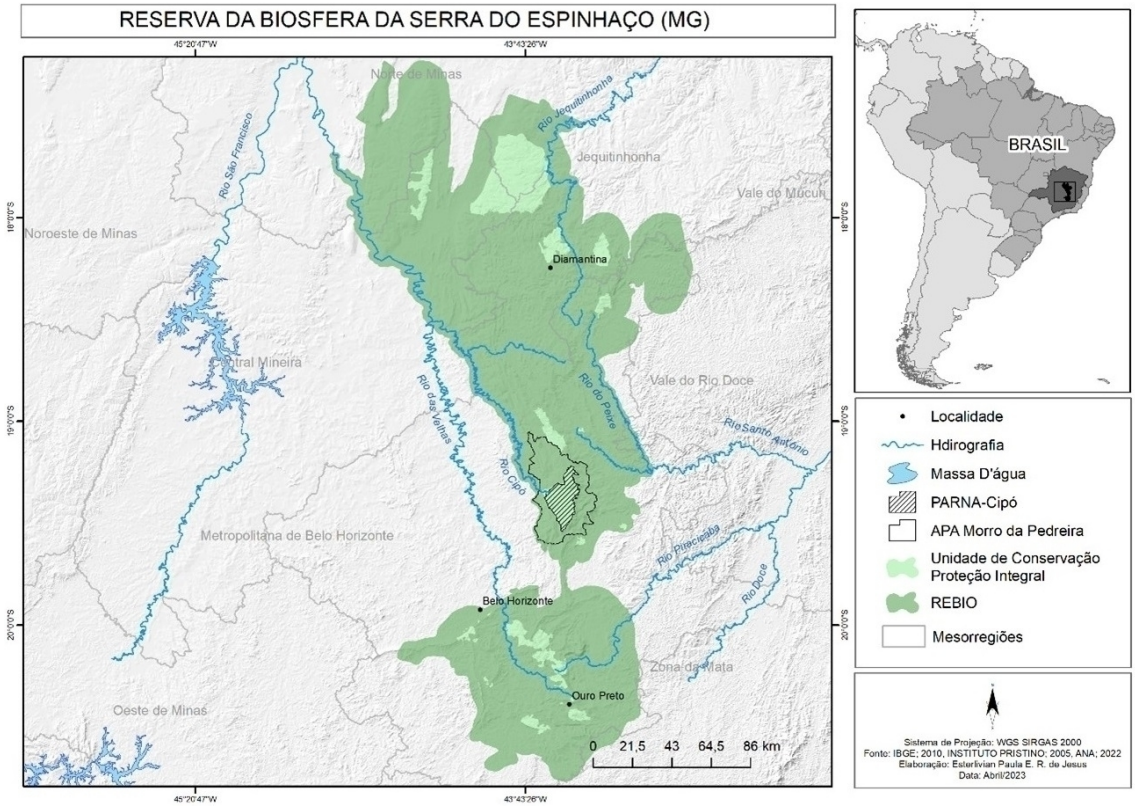

Figure 1 - Serra do Espinhaço Biosphere Reserve. Source: Authors' elaboration

The Serra do Cipó represents the most extensive and continuous Precambrian orogenic belt in the Brazilian territory (ALMEIDA-ABREU & RENGER, 2002). Its genesis is related to the crustal extension processes of the Transamazonian Event and the Brasiliano Cycle, processes responsible for the formation of a rift that resulted in the deposition of paleo/mesoproterozoic quartzites of the Espinhaço Supergroup. The Brasiliano Tectonics, in turn, marked the end of tectonic activities that affected the Brazilian continental platform, leading to the structuring and deformation of the Serra do Espinhaço (DUSSIN & DUSSIN, 1995). On the western margin of the Serra do Cipó, at the contact between this orogenic belt and the São Francisco Craton, the marbles of the Bambuí Group occur, belonging to the Sete Lagoas Formation (SOUZA et al., 2019). On the eastern margin, a west-east thrust belt is observed, consisting mainly of phyllites, iron formations, and quartzites of the Serro Group that borders the entire eastern part of the Serra do Cipó, with altitudes ranging from 591m to 1704m (ALMEIDA; ABREU; RANGER, 2002).

Despite iron formations in the Serra do Espinhaço, the region is recognised as an important ecological tourism hub and originates in the gold cycle. Although the Serra does Cipó was not a major gold extraction center, its strategic location and nearby trade routes made the region play an important

role in the economic and social context of the time (DELGADO & ROCHA, 2012). While the towns of Serro, Diamantina, and Ouro Preto were established due to mineral resources, the Serra do Cipó region served as an important food supply centre for the main productive centres of the Captaincy of Minas Gerais in the 18th and 19th centuries. With the end of the gold cycle and the transfer of the state capital to Belo Horizonte in 1897, the region experienced economic stagnation. This context persisted until the mid-1990s when a series of investments focused on tourism and infrastructure were made in the region. In recent decades, the region has had its economy anchored in tourism focused on the Estrada Real region, an important national tourist circuit (FERREIRA, 2010; GOULAR, 2009; INSTITUTO ESPINHAÇO, 2014; MINAS GERAIS, 2000).

The consolidation and structuring of tourism in the region are recent, although the activity has always been part of the Serra do Cipó region. With the creation of the Serra do Cipó National Park (PARNA) during the 1980s, the region's natural attractions gained greater prominence, and the need to conserve its heritage emerged (MADEIRA, 2009). The UC is approximately 98 km from Belo Horizonte and covers the municipalities of Jaboticatubas, Santana do Riacho, Itambé do Mato Dentro, and Morro do Pilar. The potential for geotourism in the Serra do Cipó National Park was evaluated from the perspective of visitors by Fonseca et al. (2016), who, through interviews, identified that visitors could be considered "accidental" and "curious" geotourists, with the potential to become "conscious" of the relevance of the park's geodiversity.

METHODOLOGICAL PROCEDURES

This study aimed to evaluate the geotouristic potential of the Serra do Cipó National Park (PARNA) using the methodology proposed by Lima (2015). The approach presented by the author combines the assessment of geodiversity sites of interest with spatial analysis of the obtained ranking. The evaluation focuses on the integrated spatial analysis of three fundamental issues related to the region's natural attractions: didactic potential (DP), recreational potential (RP), and degradation risk (RD), with the ultimate goal of assessing the geotouristic potential of the area (GP). The geotouristic potential is later analysed concerning the public use of trails in the Serra do Cipó National Park.

A usage density map was created using the online collaborative platform Wikiloc to analyse the public use of park trails. This platform allows users to share, discover, and download hiking, cycling, running, and other outdoor activity trails worldwide. The trail geolocation data was acquired in .kml format and processed in ArcGIS software to perform density analysis, resulting in a heat map highlighting the density of public use in different areas of PARNA Cipó. This product is based on the methodological proposal developed by Sena and Alvarenga (2017).

A geographic database was created containing information about the Serra do Cipó National Park attractions, which were quantitatively assessed in terms of their didactic and recreational potential. Each attraction was evaluated on a scale of 1 (low potential) to 4 (high potential), considering criteria such as travel time, accessibility, signage, proximity to other attractions, didactic potential, and association with cultural or ecological elements.

In the case of didactic potential, the geodiversity variable of the attractions was also considered, while for assessing recreational potential, the spectacularity variable was added. The number of different abiotic elements present in each attraction measured geodiversity. At the same time, spectacularity was based on the scenic beauty of each attraction, considering its promotion and contribution to the image of the PARNA at a regional level. To assess the risk of trail degradation in the Serra do Cipó National Park, the following variables were considered: travel time, accessibility, and proximity to potentially degrading areas. It is important to note that, even though it is a Conservation Unit within an Environmental Protection Area, there is still a minimum risk of degradation, especially when there are no restrictions on the number of visitors.

All criteria were evaluated with a score from 1 (high risk of degradation and consequently low geotourism potential) to 4 (low risk of degradation and therefore high geotourism potential). A weighting was also assigned to each evaluated criterion, which refers to the criterion's relevance concerning the studied potential, following the assumptions of Lima (2015) and Lima (2008) (Table 1). A weighted sum of the evaluated criteria was performed to obtain the final score. It is important to

emphasise that the scoring logic is reversed in evaluating degradation risk compared to the didactic and recreational potentials. The total score of each attraction regarding the variables defines the geotouristic potential.

CRITERIA	*WEIGHT*		
	DIDACTIC POTENTIAL (DP)	RECREATIONAL POTENTIAL (RP)	DEGRADATION RISK (DR)
Travel time	22	12	22
Accessibility	8	6	33
Signage	8	6	-
Proximity to other attractions	4	8	-
Didactic potential	46	32	-
Association with cultural and/or ecological elements	4	12	-
Geodiversity	8	-	-
Spectacularity	-	24	-
Proximity to potentially degrading areas.	-	-	45

Table 1 - Weighting. Source: Adapted from Lima (2008)

Map thematic maps of didactic potential, recreational potential, and degradation risk were used to assign scores to the attractions using inverse distance weighting (IDW). Subsequently, the results were classified into low, medium, and high. It is important to note that the spatial analysis of attractions for each thematic map (DP, RP, and DR) considered an influence radius of 2 km, as the concentration and proximity of attractions tend to form tourist corridors. A multicriteria analysis was carried out to obtain the geotouristic potential (GP) of PARNA Serra do Cipó. The study considers the combination and weighting of the three thematic maps obtained in the previous step, following the equation:

$$GP = (DP*45\% + RP*40\% + DR*15\%)$$

The weights for each variable in the analysis are based on the studies by Lima (2015) and Peñalver (2013). The authors indicate the weights based on the relevance of each variable to the conceptual and spatial representation of geotourism, with DP and RP as the main components of the analysis. To enhance the spatial presentation of the results, Kriging interpolation was employed using ArcGIS software.

This interpolation method estimates the values of a variable in locations without available data, supporting the spatial analysis of geotouristic potential. The technique considers the spatial dependence structure of the data, i.e., the correlation between the variable values at different locations. The final map was divided into three classes, indicating the geotouristic potential of PARNA Cipó: low, medium, and high.

RESULTS

The geotouristic potential of PARNA-Cipó results from a quantitative evaluation of the didactic, recreational, and degradation risk values. The assessment of these values presupposes criteria considered important to the visitor and may or may not favour the interpretation of the attractions.

Based on previous experience and analysis of the available documents on the ICMBio website, thirteen visitation areas were identified, distributed among three tourist itineraries: Vale do Rio Mascates, Vale Bocaina, and Travessia Alto Palácio - Serra dos Alves. All identified geodiversity sites were quantitatively assessed and classified according to the earlier criteria (Table 2).

ATTRACTIONS	TIME OF TRAVEL	ACCESSIBILITY	SIGNAGE	PROXIMITY TO OTHER ATTRACTION	DIDACDIC POTENTIAL	ASSOCIATION WITH CUTURAL AND/OR ECOLOGICAL ELEMENTS	GEODIVERSITY	SPECTACULARITY	PROXIMITY TO DEGRADED AREAS
Circuitos Das Lagoas	4	4	3	3	4	3	4	1	1
Cachoeira Capão dos Palmitos	2	2	3	3	3	3	4	1	2
Mirante do Bem	4	2	3	3	4	3	4	2	1
Córrego das Pedras	3	4	3	3	2	3	4	1	2
Cachoeira da Farofa	2	4	3	2	3	3	4	2	4
Cânion das Bandeirinhas	1	4	3	1	4	3	3	4	4
Bambuzal	4	4	3	3	3	3	4	1	2
Cachoeira das Andorinhas	2	4	3	3	3	3	4	1	3
Cachoeira do Gavião	2	4	3	3	3	3	3	1	3
Cachoeira do Tombador	1	3	3	3	3	3	4	2	3
Travessão	2	2	3	2	4	4	4	4	4
Casa de Tábuas	1	2	3	1	2	4	3	1	4
Casa dos Currais	1	2	3	1	2	4	2	1	4

Table 2 - Quantitative Evaluation. Source: Authors' elaboration

The multicriteria evaluation highlighted relationships that were expected in the assessment of the potential of each attraction. Among these relationships, the concentration of sites classified with high didactic and recreational potential stands out in the western portion of the UC, near the Areias Gate and Retiro Gate. This region has the highest concentration of attractions and the greatest geological diversity, allowing tourists to contemplate different morphologies.

The evaluation of criteria such as travel time, accessibility, and proximity to other attractions also influenced these results. Both reinforce the assumptions presented by Brilha (2005), which indicate that tourists tend to explore the most accessible attractions. Another observation is that proximity between attractions encourages tourists to visit attractions farther from the entrance gate (Figure 2). It can be said that the Cânion das Bandeirinhas reflects the combination of these factors. The attraction is located about 11 km from the Areias Gate; however, the combination of these factors and the positive evaluation in other criteria leads it to have a high didactic and recreational potential.

On the other hand, the obtained results also highlight that the higher the accessibility and the shorter the travel time, the greater the risk of degradation to the geopatrimony. It is observed that the attractions with the highest risk of degradation are located on the western edge of the UC. However, it should be noted that the results may also be related to other factors, such as already degraded areas or potentially degrading activities, such as farms and highways near the UC boundaries. Mostly, these factors are related to the historical process of occupation and regional development that favoured infrastructure investments on the western face of Serra do Cipó, where major highways prevail. In contrast, the eastern front still has secondary and less extensive road networks.

The quantitative assessment of the attractions was conducted on a point-by-point basis; however, the methodology allows for a spatial analysis of the potential of the sites considering a 2 km radius of influence. It is based on the understanding that the proximity and concentration of these attractions form tourism corridors. Both in the point-based analysis and the spatial analysis, the interpolation of the results did not result in the formation of actual tourism corridors but rather in the shape of patches (Figure 3). However, the spatial representation of public use (Figure 4) demonstrates that there is a connection between the attractions through the trails and that the intensity of visitation also varies based on the distance to be covered by visitors.

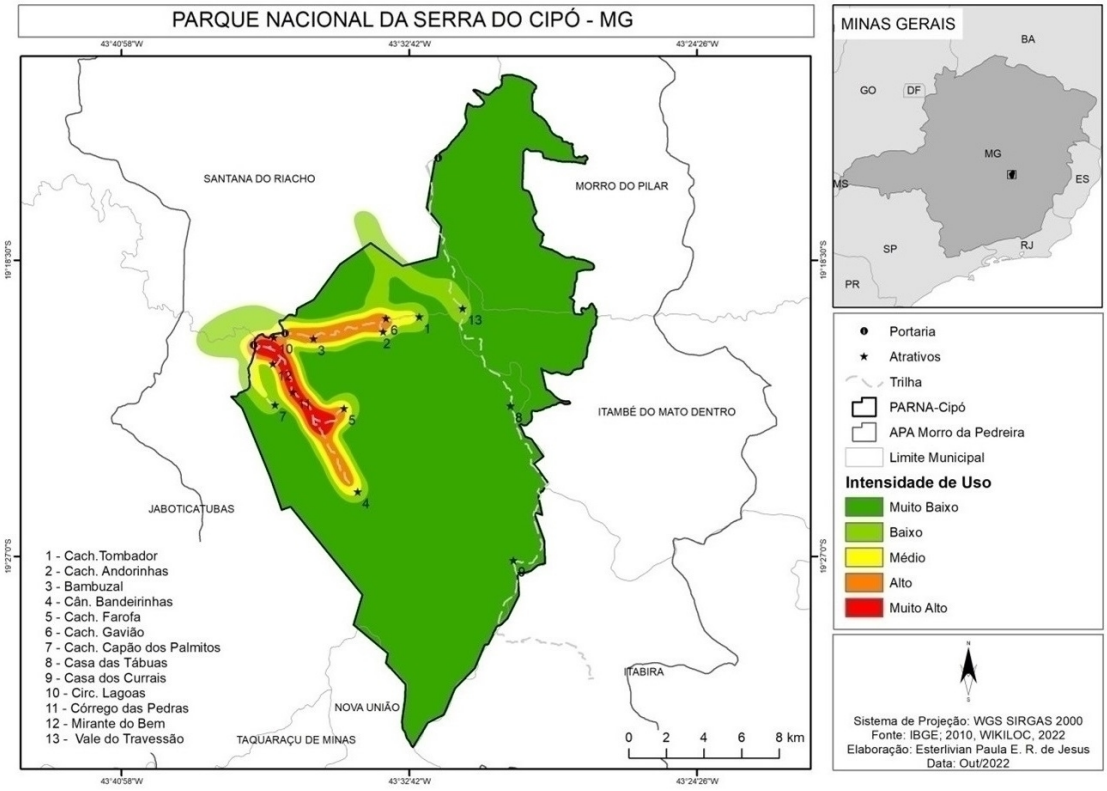

Figure 2 - Usage Density. Source: Author's elaboration.

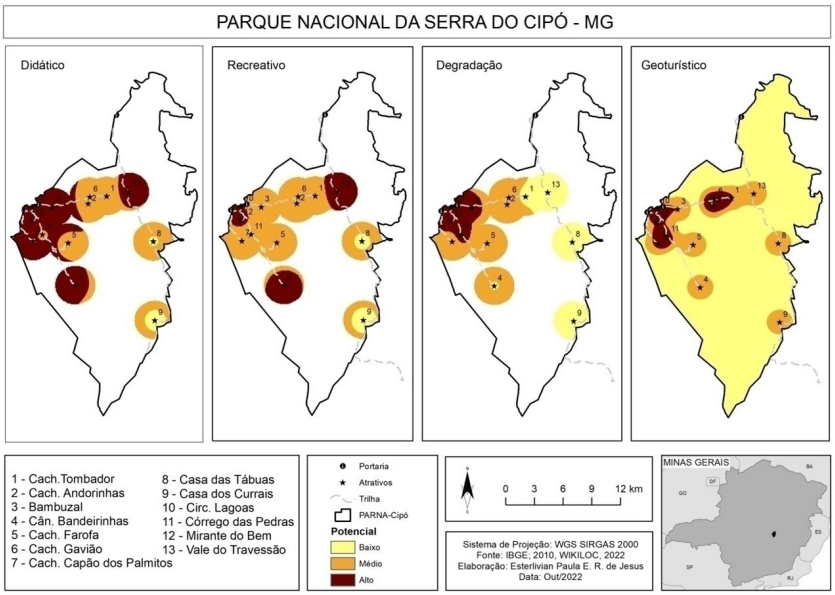

Figure 3 - Attractions with High Potential. Source: Author's elaboration

It is observed that three patches with didactic potential were generated: the first one, located on the western edge of the UC, encompasses Bambuzal, Mirante do Bem, and Circuito das Lagoas. The second patch comprises Cânion das Bandeirinhas and, due to the distance, does not have connectivity with the other attractions; in this case, the distance between the sites proved to be a barrier for forming a corridor with didactic potential. The third patch comprises Vale do Travessão.

Three patches with high recreational potential were observed in the interpolation of the results for recreational value. The first patch is more restricted west of the UC, encompassing only Circuito das Lagoas and Mirante do Bem. The second patch contains only Vale do Travessão, and the third patch encompasses only Cânion das Bandeirinhas.

Regarding the risk of degradation, only one patch with high potential was formed, concentrated on the western face of the UC, encompassing the attractions with the easiest access.

Finally, the spatial analysis of the geotouristic potential showed the formation of two patches with high geotouristic potential. The first one, located on the Vale Mascate Trail, encompasses Circuito das Lagoas, Mirante do Bem, Córrego das Pedras, and Cachoeira Capão dos Palmitos. The second one, located on the Vale Bocaina Trail, encompasses Cachoeiras do Tombador, das Andorinhas, and do Gavião.

Once again, the relationship between the results obtained in the spatial analysis emphasises the importance of accessibility, proximity between attractions, and geological diversity for forming patches and corridors with high geotouristic potential. Although Cânion das Bandeirinhas did not integrate the geotouristic corridor patches, the attraction is considered relevant for didactic and/or recreational use. Therefore, in the study, only those attractions that achieved good performance in geotouristic potential relevance were selected as attractions with high geotouristic potential. Among them are Mirante do Bem (Figure 4), Circuito das Lagoas (Figure 5), Cânion das Bandeirinhas (Figure 6), and Vale do Travessão (Figure 7).

Figure 4 - Panoramic view from Mirante do Bem, Serra do Cipó National Park, Minas Gerais. Photo: By the authors

Figure 5 - View of Lagoa da Capivara, in the Circuito das Lagoas, Serra do Cipó National Park, Minas Gerais. Photo: By the authors

Figure 6 - View of Cânion das Bandeirinhas, Serra do Cipó National Park, Minas Gerais. Photo: By the authors

Figure 7 - View of Vale do Travessão, Serra do Cipó National Park, Minas Gerais. Photo: Renata Aguilar

CONCLUSION

Geotourism has been experiencing considerable growth due to its ability to promote conservation through human-environment interaction. Consequently, studies involving this theme are becoming increasingly demanding regarding a holistic approach. Therefore, studying the geotourism potential of Serra do Cipó National Park allowed for an understanding of these relationships and the identification of attractions that can be enhanced based on the characteristics associated with geodiversity.

The selected methodology assisted in the inventory of geodiversity sites in Serra do Cipó National Park. Applying the proposed methodology in the research proved efficient in the initial quantitative assessment of geodiversity sites. It resulted in identifying sites with potential for geotourism development in the park and identifying spatial relationships and patterns that were expected, considering the tendency of tourists to visit the most accessible sites close to each other. However, the distance between locations emerged as the main obstacle to forming tourist corridors within the park.

The Degradation Risk assessment demonstrated that sites near the park entrance are the most vulnerable. In line with the principles of geoconservation and geotourism, geopatrimony and geodiversity sites should be managed to reduce the risks associated with visitation, especially concerning the aspects that contribute to the landscape. Therefore, strengthening preventive measures such as wildfire prevention and closure of irregular trails becomes necessary, as reported in the park's

official channels and observed in the analysis of usage intensity.

It is also worth noting that in addition to the sites presented in the research, Serra do Cipó National Park has other sites that are not available for visitors. Thus, the present study represents only a portion of the park's real geotourism potential. However, further in-depth studies are necessary, particularly regarding developing an inventory, identifying new potential geosites, and developing activities to enhance geodiversity appreciation in a virtual environment, for example.

Finally, it is understood that the spatial representation of geotourism potential in Serra do Cipó National Park contributes to the park's territorial management by indicating priority areas for implementing geotourism initiatives. It also assists in identifying areas susceptible to risks associated with this activity. The methodology used proved to be effective for the quantitative representation of attractions, and by considering the association of the assessment of didactic and recreational potentials with public use, it was possible to identify priority areas for the installation of informative resources for visitors. The same principle applies to the combined analysis of general use and degradation risk, fostering initiatives for geoconservation.

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