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VISUAL QUALITY OF THE LANDSCAPE: THE TOURIST ATTRACTIVENESS OF SERRA DO AMOLAR, PANTANAL, BRAZIL

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ABSTRACT

In the state of Mato Grosso Sul, Brazil, there is a relevant landscape characterized as the largest floodplain in the world, the Pantanal Sul-Matogrossense. The Serra do Amolar stands out in this relief in contrast to the Pantanal plain, representing a complex landscape structure materialized by a variety of fauna, flora, slopes and water diversity. In this context, the present study investigated how the complexity of the physical elements of Serra do Amolar conditions its levels of visual quality, associated with the development of Nature Tourism activities. Field data were used in a Geographic Information System (GIS) to define analysis parameters and data crossing, generating a summary map of the investigation. Three different levels of visual quality were identified. The first predominates along the extension of the Serra do Amolar and is related to outstanding reliefs, native vegetation, and presence of water bodies. The second level is characterized by small transition areas. The third level presents plain areas with high rates of anthropic interventions. Each level highlights a variety of activities in the Nature Tourism segment that may be performed in line with the landscapes, according to the conservation and preservation proposals for the iconic area.

Keywords: Mato Grosso do Sul; Territory Management; Nature Tourism; Landscape; Geodiversity; Geoheritage.

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1. INTRODUCTION

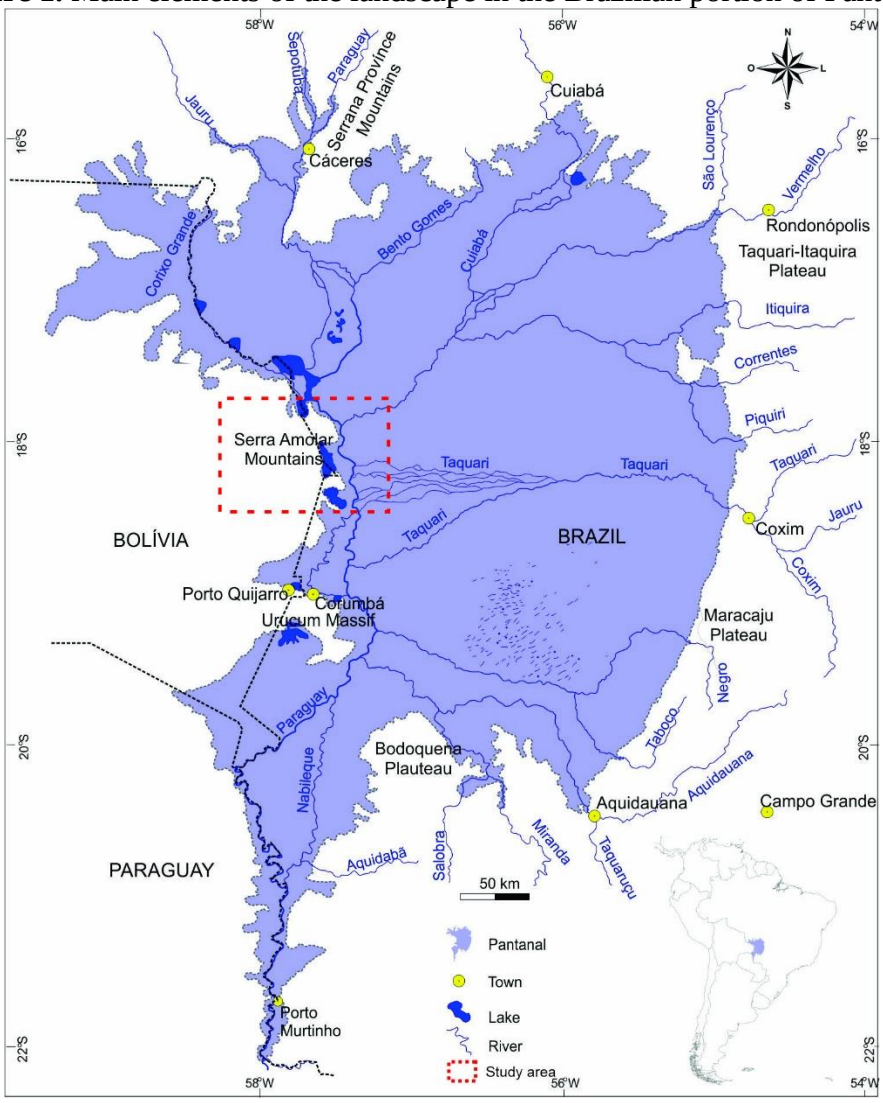
In South America, the region comprising Brazil, Bolivia and Paraguay presents a large regional topographic depression, subject to constant periodic flooding known as The Pantanal plain. The Pantanal, as it is known in Brazil, is the largest continuous seasonally flooded plain in the world (Padovani, 2010), and its exceptional value in the Brazilian portion has been given titles of Natural World Heritage and Biosphere Reserves by Unesco. In addition, it is a National Heritage Site and owns three international recognized sites by the Ramsar Convection (Brasil, 2021). In Brazilian territory, the relevance of such landscape motivated the rise of 29 formally protected areas, managed by public authorities (municipal, state and federal), and the private sector. The environmental diversity of this landscape is also analyzed from the perspective of the geoheritage concept (Brilha, 2002; Tavares *et al*., 2020; Németh *et al*., 2021). The geoheritage concept emphasizes the physical environmental elements (geological, geomorphological, hydrological) giving less focus to the biotic and social elements. From the perspective of natural heritage concepts (Unesco, 1972; Bezerra, 2018; Vieira & Verdum, 2019), the landscape analysis for nature tourism (cf. Martínez-Roldán & Goytia-Goyenechea, 2022) purposes may consider the biotic and social elements, as well, even in sites where the physical environment is visually preponderant or superlative. In addition, tourism plays a key role in supporting the conservation and use of landscapes (Carlos, 2017; Santos, 2019), which makes its development a fundamental strategy for territorial planning in unique areas (Whitelaw *et al*., 2014; Saarinen 2015; Prisco *et al*., 2021) and with prominent environmental fragility (Amaral & Ross, 2009). The analysis of tourist use involves the way in which the activity is carried out – preferably on a responsible basis and alternative to the mass model (Gabrielli, 2017) – and the motivations of tourists. In the context of market segmentation emerges the academic discussion to differentiate geotourists and ecotourists (Dowling, 2011; Dowling & Newsome, 2018). However, several studies (e.g Boley & Nickerson, 2013; Guerrero *et al*., 2020; Lee & Iwasa, 2020; Tomic *et al*., 2021; Hasana *et al*., 2022) have shown that the diversity of physical, biotic and social aspects of landscape, as well as its conservation and quality are relevant factors for the so-called geotourists and ecotourists. Therefore, a detailed comprehension of tourism complexity involves different perceptions of aesthetic quality (Lima *et al*., 2017a, b), conservation, and landscape diversity (Chen *et al*., 2017). Local social aspects (Castro, 2015) are key elements for measuring the level of visitation potential and visitor satisfaction, regardless of an alleged differentiated segmentation.

Comprehending the way landscape elements are observed by the agents involved in tourism (whether tourists/visitors, the market, public authorities or local community) presents itself as relevant data in studying the complexity of tourist activity in a given location. In the Serra do Amolar region, nature is taken as a significant market appeal (Lima *et al*., 2019) raising concerns about the relationship between the publicized and marketed landscape and the perspectives undertaken by agents who experience the tourism dynamics. Thus, starting from the spatial and conceptual delimitation and the assumptions presented, we performed a visual quality assessment of the landscape structure and its relevance for tourism practice in Serra do Amolar, an iconic site in Pantanal.

2. CHARACTERIZATION OF THE RESEARCH AREA

The Pantanal Landscape unit rests on an active sedimentary basin with numerous geological faults (Assine, *et al*. 2016), and significant alluvial fans. It is a complex area due to its interdependence between the surrounding plateau areas and the plain, and the rainfall throughout the year and the hydrological dynamics. The peculiarity of its relief – flat areas surrounded by high lands (ridges, hills and mountains) with altitudes ranging from 200 to 1000 meters – contributes to form the iconic landscape. Its geomorphology is defined by a modern alluvial depositional tract composed by fluvial megafans, systems that have low altimetric amplitudes and reach areas of up to 50,000 km² (Zani *et al*., 2009; Assine *et al.*, 2015). The Paraguay River characterizes the trunk river of the entire hydrographic basin (Assine *et al*., 2015). There are seven megafans that compose the Pantanal depositional tract: Paraguay, Cuiabá, São Lourenço, Taquari, Taboco, Aquidauane, and Nabileque (Zani *et al.*, 2009). The Taquari megafan is the largest, covering around 50,000 km² (Zani *et al*., 2009; Assine, 2005). According to Ab'Saber (2006), it is an exceptional landscape, and the most significant quaternary dendritic basin in Brazil. Silva (2010) defines it as a *sui generis* fluvial morphology. Landscapes inserted in large landscape domains with unusual contrast of ecologies, such as small exceptions called enclaves, relicts, redoubts and refuges. The landscape grid is described as "diverse pantanal", given that each section of this immense topographic depression presents specific morphological characteristics, flood processes, vegetation, humidity, and microclimate (Hamilton *et al*., 1996; Silva e Abdon, 1998; Padovani, 2010, Assine *et al*., 2016; Martins, 2018). According to Calheiros and Fonseca Jr. (1996), several authors consider the name Pantanal (swamp) inappropriate, once the region does not present swamp characteristics. However, it reveals features recognized by the Pantanal people and ratified by studies such as Ab´Saber (2006). The most striking aspect of the Pantanal plain is its dynamics of flood pulses. They are complex both in their temporal and spatial distribution, and the complexity results in a heterogeneous landscape. The characteristics of the flood, its depth and duration, erosion, sedimentation, and the water physical characteristics are related to the activities that may be performed in the region (Junk *et al*., 1989; Halloy *et al*., 2005), as well as the peculiarity of its geomorphology, as previously highlighted. Thus, the dynamic of the region generates a diversity of terrestrial environments (mountains and capons), semi-aquatic (floodable fields, floodable forests, bays, lagoons and intermittent streams), and aquatic (perennial bays and lagoons, connecting channels). Such landscape diversification and heterogeneity contribute to the wide range of its biodiversity. There are more than 1,700 species of plants identified, more than 400 species of fish, 80 species of mammals, more than 1,100 species of butterflies, and 463 species of birds (Alho, 2011). Pantanal presents unique peculiarities related to the plateau-plain dynamics and the climate difference in relation to other wetlands (Schulz *et al*., 2019; Silva *et al*., 2022). The terraces, located in the high portions the plain, do not flood and are essential for the dynamics of Pantanal life. However, the portions locally called mountain ranges, and the low portions that are subject to flooding are called bays or lakes or even the drain. In contrast to the extensive plain, isolated hills occur such as the Maciço do Urucum, Amolar, Santa Tereza, Castelo, Zanetti, Satujá, and other short elevations, considered as residual reliefs (Boin *et al*., 2019). Figure 1 shows a summary of the elements described in the text.

Figure 1. Main elements of the landscape in the Brazilian portion of Pantanal.

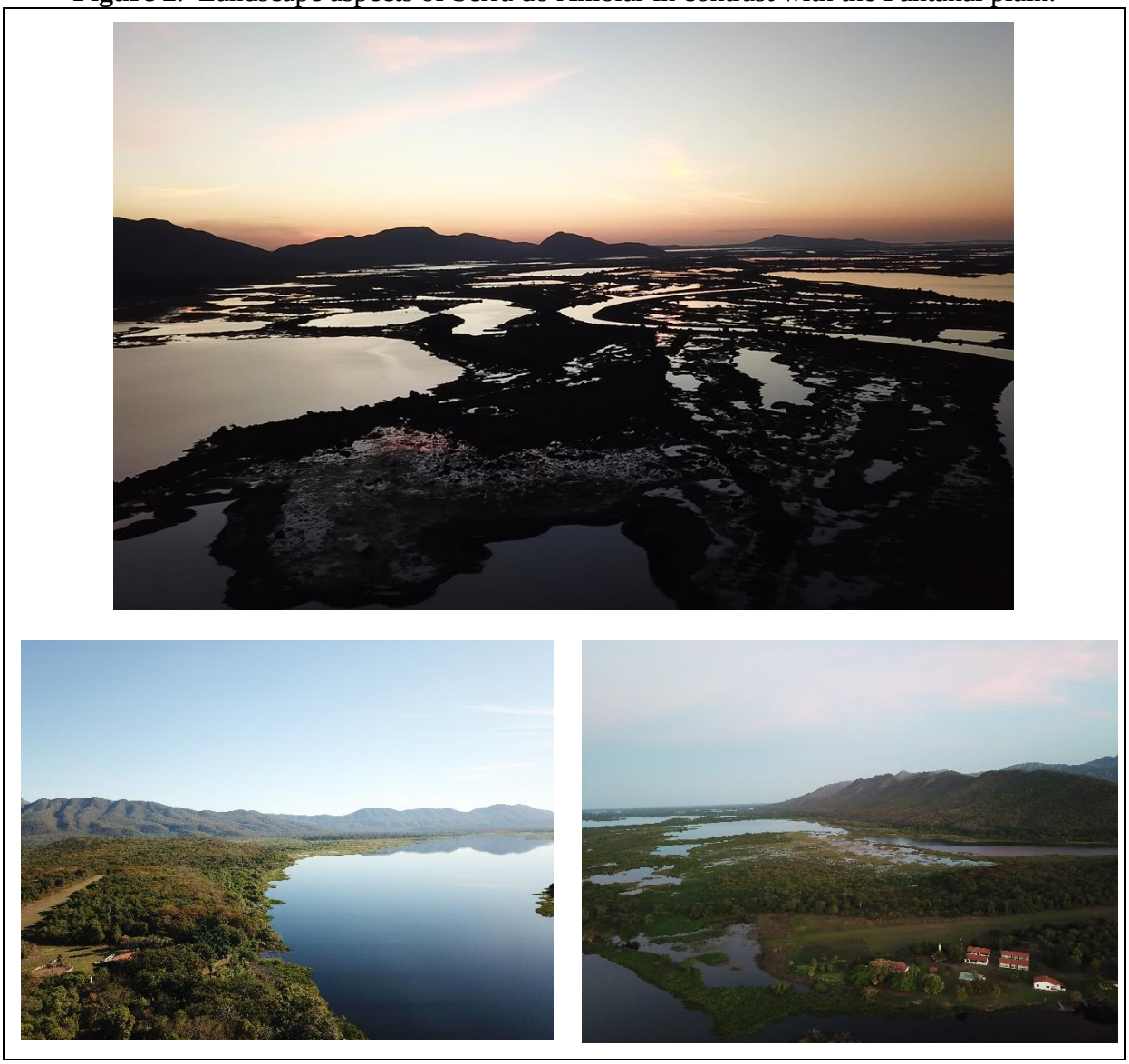


Source: Assine *et al.*, (2016); Boin *et al*., (2019).

The Amolar set stands out and dominates the plain of that portion of the Pantanal. It is the largest regional relief, either by the continuous aspect or by the altimetry, presenting absence of fault scarps (Garms, 1993). Gonçalves and Isquierdo (2011) define Serra do Amolar as a residual plateau that forms a 100-km-long and 10-km-wide alignment of hills. It is located about 180 km from the municipality of Corumbá/MS, and towards southeast-northwest for 40 km along the border with Bolivia, until it reaches the border with the State of Mato Grosso. Some of its elevations reach around 1,000 meters above the sea, alternating flat areas and hills. Pico do Amolar is the highest point, with an altitude of 979 m (Zucco *et. al*., 2011). According to Garms (1993), a series of large lakes, such as Uberaba, Gaíba, Mandioré and Baía Vermelha positioned in the same direction as the structural alignments complete the scenario. The Amolar region is an area of relevance for conservation due to its flora and fauna diversity with pieces of vegetation from the Chaco, the Amazon, and the Cerrado. According to Moreira (2011), the Serra do Amolar and the floodplain together provide a unique

ecological gradient. The region presents unique biodiversity and scenic beauty (Figure 2), in which the mountain-plain contrast forms a complex environment governed by the water cycle.

Figure 2. Landscape aspects of Serra do Amolar in contrast with the Pantanal plain.



Source: the author's (2018).

3. RESEARCH PROCEDURES AND STEPS

In view of the structural and visual significance of landscapes for Tourism (Pires, 2011; Chen *et al*., 2017; Santos, 2019), the present analysis aims to present discussions about the visual quality of the landscapes of Serra do Amolar. The discussion is based on the assumptions of Lothian (1999), Nohl (2001), Arriaza *et al*. (2004), Kang & Liu (2022), and Vieira *et. al*. (2018), who highlight the visual quality indicator may be taken as a territorial management tool. The visual quality of the landscape qualifies the different components and the comprehension of processes that interrelate them, allowing the safeguarding of such

landscape sets associated with tourism practices (Santos, 2019; Lima, 2022; Lima, Silva, Martins, 2019).

Table 1. Parameters of visual quality analysis for tourist activity.

LEVEL OF RELATIONSHIP BETWEEN NATURE TOURISM AND THE ENVIRONMENT	LANDSCAPE ASSESSMENT PARAMETERS	TYPES OF RELIEF IN SERRA DO AMOLAR	TYPES OF VEGETATION/LAND USE IN SERRA DO AMOLAR	WATER MASS IN SERRA DO AMOLAR	ATTRIBUTE WEIGHT IN DATA CROSSING
LEVEL 1	- Landscapes with high levels of nature; - Landscapes that gather greater possible number of elements withrelevant degree of nature; - Landscapes composed of unique elements; - Landscapes that provide direct support to the types of Nature Tourism; - Landscapes that gather greater possible number of elements able to directly support the Nature Tourism;	Amolar Hill series	Savanna	----------	5
LEVEL 2	- Landscapes with medium level of nature; - Transition landscapes between areas of high or low nature; - Landscapes composed of elements with low uniqueness index; - Landscapes that provide indirect support to the types of Nature Tourism;	Uberaba/ Mandioré Pantanal	Semi-Deciduous Seasonal Forests	Water mass	3
LEVEL 3	- Landscapes with low level of nature; - Landscapes linked to areas with high degree of anthropic interventions; - Landscapes composed of elements with little or no uniqueness. - Nature as a background priority; - Landscapes with significant changes of natural conditions.	Plains and Wetlands	Pasture Areas	----------	1

Source: organized by the authors.

In order to carry out such an analysis, in addition to providing bibliographic material that deals with the themes in question (landscape, natural heritage, tourism, visual quality), a Geographic Information System (GIS) was used to perform the data cross-referencing on the main elements that comprise the visible aspect of the landscapes (relief, water courses, and vegetation/land use). This approach established three levels of visual quality: high quality, medium quality, and low quality, corresponding, respectively, to weights 5, 3, and 1 (Figure 3). Through the established methodology, each level was defined from the characteristics of the analyzed elements. The model was applied from the reclassification of secondary data and, later, in the construction of the Serra do Amolar visual quality map. The methodology follows the theoretical bases of Pires (2005), and comes from reflections on the analysis model of environmental fragility (Ross, 1994; Amaral and Ross, 2009; Lobo *et al*., 2013), as well as the tourist potential (Lima, Silva and Boin (2017a, b; Cetin *et al*., 2018).

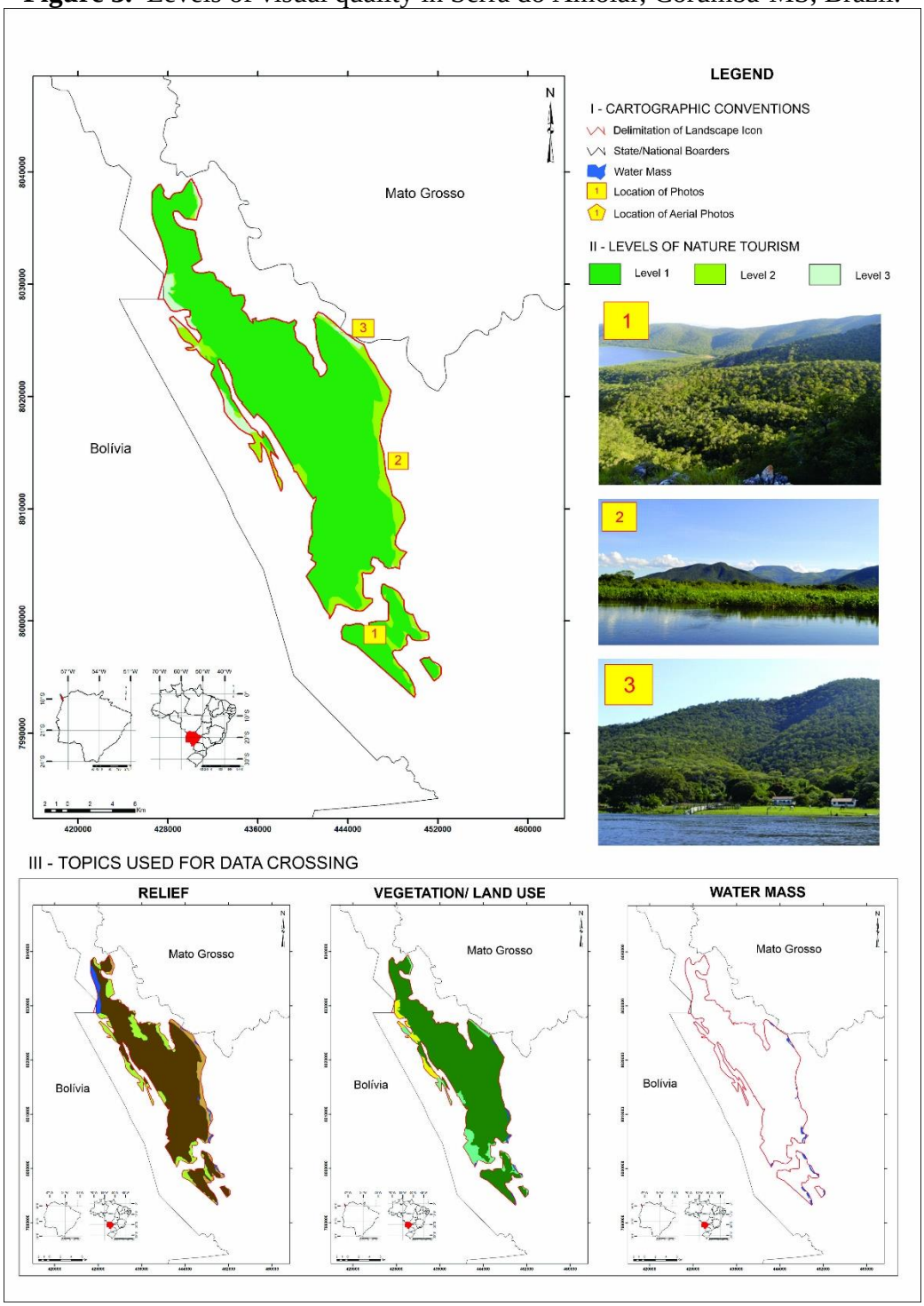
By using the ArcView GIS 10.2.2 software, data referring to relief and vegetation/land uses were reclassified using the reclass tool, which allowed to generate the visual quality map using the Weighted Overlay function. We highlight that the field work significantly contributed to assist in the construction, comprehension, and interpretation of the visual quality map of Serra do Amolar. The field work occurred in 2018, and supported the authors to build a photographic database to illustrate different aspects of the landscape, allowing the interpretation of elements that make up its landscapes.

4. THE VISUAL QUALITY OF THE LANDSCAPE STRUCTURE OF SERRA DO AMOLAR FOR HERITAGE TOURIST ACTIVITY

The visual quality assessment of Serra do Amolar (Figure 3) showed the main elements that make up the visible field of the landscapes (relief, vegetation and water courses). The parameters of assessment (determination of weights) provided the construction of a map with levels, which allowed identifying the possible development of tourist activities.

The areas designated as level 1 predominate the perimeter of Serra do Amolar (Fig. 3), presenting exceptional landscape quality. According to the established parameters, level 1 is associated with places of relevant visual prominence of reliefs, native vegetation, and presence of water masses. Boley & Nickerson (2013), Chen *et al.* (2017), Lima *et al*., (2017a, b), Guerrero *et al*., (2020), Lee & Iwasa (2020) Tomic *et al*. (2021) and Hasana *et al.* (2022) have already evidenced such elements as positive actors in tourist attractiveness. The relief of hills is predominant and noteworthy in the delimitation at this level, including areas related to the Uberaba-Mandioré Pantanal. The savanna-type vegetation predominates the level, while seasonal forests occur in fragments of the south face of the hill. Thus, the exploitation of tourist activities, such as hiking/trails, may be associated to the contemplation of the lithological, geomorphological, and fauna and/or flora landscape. The water diversity may be associated with activities such as diving, canoeing, and stand up paddle. The suggested activities are within the general scope of Alternative Tourism (cf. Gabrielli, 2017), in agreement with responsible tourism models (Espiner *et al*., 2017) and ecotourism (Fennell, 2020).

Figure 3. Levels of visual quality in Serra do Amolar, Corumbá-MS, Brazil.



Source: adapted from Lima (2021).

The areas established as level 2, occur in small areas of Serra do Amolar (Fig. 3), on the east face. The reliefs of the plains and wetlands stand out in the level, as well as fragments of

the Uberaba-Mandioré Pantanal. The types of vegetation are related to savannas and seasonal forests, and water bodies are constrained. Within the scope of the landscape quality in the level, we highlight tourist activities of aerial adventure (Marinho, 2007; Viana & Nascimento 2009; Brasil 2010), such as hang gliding (as long as structured for such practices), paragliding, ballooning, and parachuting. Other possible activities may be cycling practices, trails/hikes, camping, and recreation in nature. The water courses that occur around the hill favor the performance of fishing, windsurfing, and nautical tourism (provided that in agreement with the legislation).

The areas defined as level 3 occupy small portions in the west face, and a small portion to the east of Serra do Amolar. The occurrence of reliefs of the Uberaba-Mandioré Pantanal, as well as plains and swamps. In the western portion, the predominance of pasture areas, however, in the east, we identified small fragments of seasonal forests. The characteristics of the level point to activities related with rural tourism, such as horseback riding, experience of planting different crops, experience in raising animals. Other practices may involve the coexistence of the local riverside communities of Serra do Amolar.

Therefore, according to the the analyzes carried out here, we may associate the Serra do Amolar in what Whitelaw *et al*. (2014), Saarinen (2015) and Prisco *et al*., 2021 define as iconic areas. By studying the singularity of the landscapes materialized by the structure of the Serra do Amolar, a relevant index of visual quality may be identified (represented by level 1). The premise underscores the premise of preservation/conservation of landscapes, allowing tourists to contemplate them as opposed to urban landscapes, or landscapes presenting significant rates of human intervention.

5. CONCLUSIONS

The Serra do Amolar is highlighted as an iconic set of landscape diversity proposed by the Pantanal biome, beyond the widely known and visited areas of Pantanal. In this context, the authors sought to highlight the different physical characteristics of Serra do Amolar to associate different levels of visual quality, and to propose a wide range of responsible tourist activities associated with such singularities. In the analysis carried out, the visible elements (relief, vegetation and watercourses) present relevant significance in the planning of tourist activities in nature, which vary from contemplation to adventure, ecotourism, rural tourism, etc. Independent of the activity, it may be linked to the functional and visual condition of the landscapes. Furthermore, tourist activity has been growing in the Pantanal over the years. Studies of tourist potential and landscape fragility may support the market advance in order to reconcile development with conservation. The perspective enables a productive-conservationist arrangement that may lead to new tourism economic opportunities for residents and foreign investors. Thus, the present study aims to bring fundamental contributions, either to the academic discussion of the theme of visual quality of landscape, or to support public policies and tourist practices that promote the conservation of geodiversity and biodiversity in the Pantanal.

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