

The Tourist and Educational Value of Geosites in the Bodoquena-Pantanal/MS Geopark: identification and hierarchy of geodiversity sites¹

Maria Cristiane Fernandes da Silva Lunas^a
Ademir Kleber Morbeck de Oliveira^b

Abstract

Geoparks are territories with areas capable of illustrating important phenomena and geological processes, which also add cultural and ecological values, and where a development process based on sustainability and the involvement of the local community is implemented. The correct cataloging of geosites in the areas where the implementation of a geopark is proposed can be an important tool to guide the development strategies of this territory. The objective of this study was to quantify the Potential for Educational Use, Potential for Tourist Use of Geopark Bodoquena-Pantanal, comparing them with their Potential Risk of Degradation. To reach the objectives, the methodological procedures were based on: pre-field activities – in which we sought to collect the existing information about the areas under study, as well as the initial contact for technical visit authorization; Field activities – in which the areas were visited, raising the necessary information for the study; Post-field activities – the inventory of geosites and geological sites. As a result, we identified that the best ranked sites are geodiversity sites, and with lower degradation risk, are distributed in the two regions: Southwest (Bonito-Serra da Bodoquena) and Pantanal, and that these areas have great potential to receive visitors in the short term, which may increase the chances of implantation and consolidation of the Bodoquena-Pantanal Geopark.

Keywords: Educational use; Tourist use; Geopark; Visitors.

Resumo

O Valor Turístico e Educacional dos Geossítios no Geopark Bodoquena-Pantanal/MS: identificação e hierarquização dos sítios da geodiversidade

Os geoparques são territórios que apresentam áreas com ocorrências capazes de ilustrar importantes fenômenos e processos geológicos, que agreguem valores culturais e ecológicos, e onde se pode implementar um processo de desenvolvimento pautado na sustentabilidade e com o envolvimento da comunidade local. A correta catalogação dos geossítios nas áreas onde se propõe a implementação de um geoparque pode se mostrar uma ferramenta importante para direcionar as estratégias de desenvolvimento desses territórios. O objetivo do presente trabalho foi realizar uma quantificação do potencial uso educacional e do potencial uso turístico dos geossítios do Geopark Bodoquena-

1. Paper presented at the 17th Abratur Forum, held in Recife, PE, from 7 to 9 June 2017. Chosen as one of the best articles of the event.
- a. PhD in Environmental and Regional Development from the University Anhanguera-Uniderp, Campo Grande, Mato Grosso do Sul, Brazil. Professor of Tourism from the State University of Mato Grosso do Sul, Dourados, Mato Grosso do Sul, Brazil. E-mail: crisfernandes_tur@hotmail.com
- b. PhD in Ecology and Natural Resources from Federal University of São Carlos, São Carlos, São Paulo, Brazil. Professor of the Graduate Program in Environment and Regional Development from the University Anhanguera-Uniderp, Campo Grande, Mato Grosso do Sul, Brazil. E-mail: akmorbeckoliveira@gmail.com

Pantanal, discutindo-os com seu potencial risco de degradação. Para atingir os objetivos os procedimentos metodológicos pautaram-se em: atividades pré-campo – nas quais se buscou levantar as informações já existentes sobre as áreas em estudo, bem como o contato inicial para autorização de visita técnica; atividades de campo – nas quais visitou-se as áreas levantando as informações necessárias para a pesquisa; atividades pós-campo – o inventário dos geossítios e sítios geológicos. Como resultado, identificou-se que os sítios mais bem ranqueados enquanto sítios da geodiversidade e com menor risco de degradação distribuem-se pelas duas regiões: Sudoeste (Bonito-Serra da Bodoquena) e Pantanal, e que essas áreas têm grande potencial para receber visitantes em curto prazo, o que pode elevar as chances de implantação e consolidação do Geopark Bodoquena-Pantanal.

Palavras-chave: Uso educacional; Uso turístico; Geoparque; Visitantes; Bodoquena-Pantanal.

Resumen

El Valor Turístico y Educativo en lugares de interés geológico del Geoparque Bodoquena-Pantanal/MS: identificación y jerarquía de lugares de geodiversidad

Los geoparques son territorios que presentan áreas con importantes ejemplos de fenómenos y procesos geológicos, que añaden valores culturales y ecológicos, donde se puede poner en práctica un proceso de desarrollo dirigido a la sostenibilidad y a la participación de la comunidad local. La correcta catalogación de los geosítios en las áreas donde se propone la implementación de un geoparque puede ser una herramienta importante para impulsar las estrategias de desarrollo de ese territorio. El objetivo de este estudio fue realizar una cuantificación del potencial uso educativo y del potencial uso turístico de los geosítios del Geoparque Bodoquena-Pantanal *evaluándolos* con su potencial riesgo de degradación. Para alcanzar estos objetivos, los procedimientos metodológicos se basaron en: actividades precampo –en que se buscó levantar las informaciones existentes sobre las áreas en estudio, así como el contacto inicial de permiso de visita técnica–; actividades de campo –en las cuales se visitó las áreas levantando las informaciones necesarias para la investigación–; actividades poscampo –un inventario de los geosítios y sitios geológicos–. Como resultado, se identificó que los sitios mejor ranqueados como sitios de la geodiversidad y los con menor riesgo de degradación se distribuyen por las dos regiones: Sudoeste (Bonito-Serra da Bodoquena) y Pantanal; y que estas áreas tienen un gran potencial para recibir visitantes en el corto plazo, lo que puede elevar las posibilidades de implantación y consolidación del Geoparque Bodoquena-Pantanal.

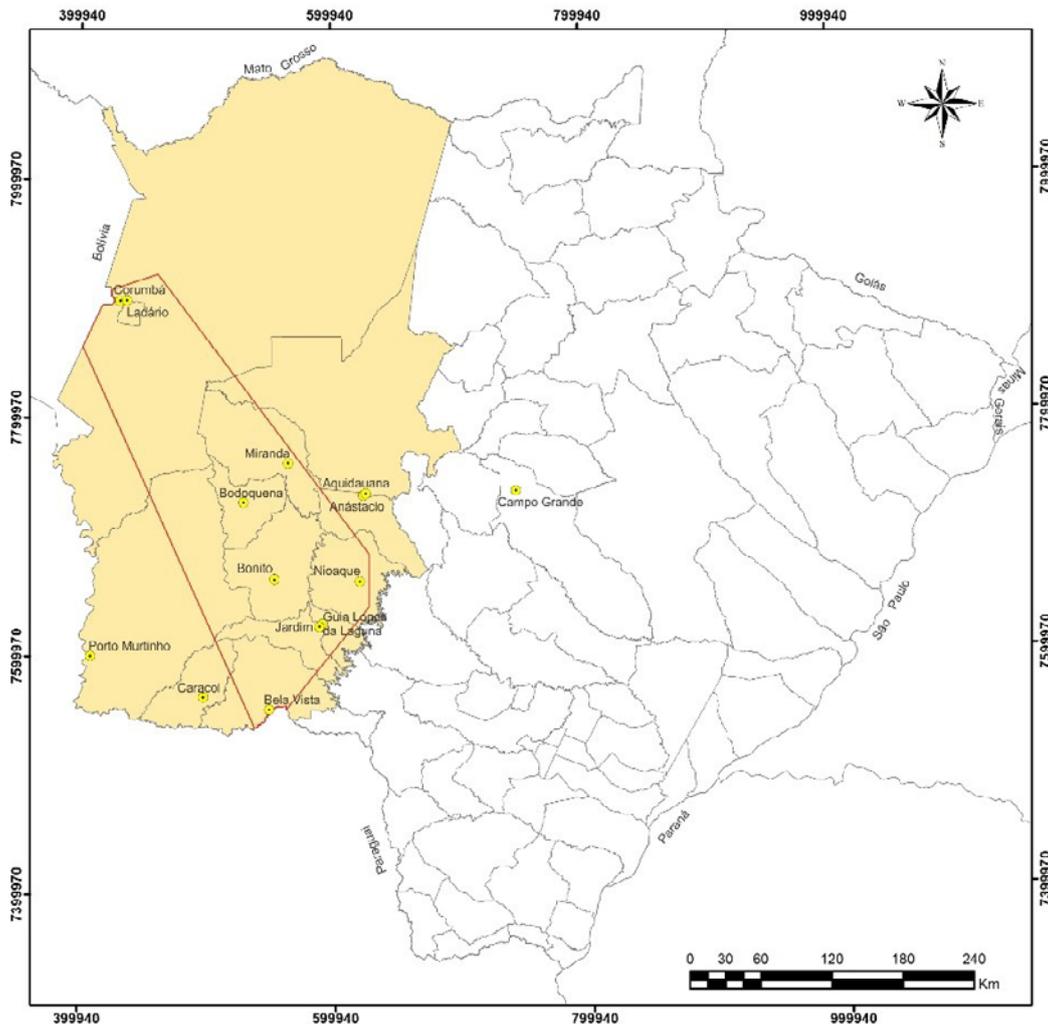
Palabras clave: Uso educativo; Uso turístico; Geoparque; Visitantes; Bodoquena-Pantanal.

INTRODUCTION

Decree nº 12,897 / 2009, which creates the Bodoquena-Pantanal Geopark, shown in Figure 1, with approximately 39,700 km² area, established 54 areas as geosites, ranging from geological, paleontological and ecological to landscape, historical and cultural interests. In the dossier of application for Unesco's Global Network Geoparks, as well as in the proposal contained in the Geoparques do Brasil Project, of the Companhia de Pesquisa em Recursos Minerais (CPRM – Mineral Resource Research Company), this area was reduced by about 50%, being established at 20,000 km², 45 geosites and two cultural sites.

Only the dossier and the proposal registered in the Geoparks Project present the description and characteristics of the geosites, as well as their main values. This means that eight of the areas established in the decree do not have this identification, whereas another area was split into two cultural sites in the dossier. However, even the studies conducted need further investigation to identify, in addition to its characteristics, their scientific and geodiversity values, encompassing their tourism and educational potential.

Figure 1 – Map of the state of Mato Grosso do Sul containing the limits of the Bodoquena-Pantanal Geopark, MS, Brazil



Source – Adapted from Decree No. 12,897/2009

This study is part of the research for a doctoral thesis, which addresses the development of the Bodoquena-Pantanal Geopark. At this stage of the thesis, geosites were originally hierarchized in the Geopark, regarding their scientific value, degradation risk, tourist and educational value. This article shows the results of the potential values for tourism and educational use of the studied areas, and their relation with the potential risk of degradation.

This study sought to understand and classify the geosites of the Bodoquena-Pantanal Geopark as geodiversity sites by quantifying several variables, which

revealed the potential for tourism and educational use of each site. Moreover, we sought to measure this geodiversity potential and compare with the potential risk of degradation of each area to identify which sites are more able to receive visitors in short term.

The survey, analysis and hierarchization of geosites were conducted with an adaptation of the methodology elaborated and described by Brilha (2016) and the methodology of hierarchy of attractions used by the World Tourism Organization (WTO) and the Brazilian Ministry of Tourism, which were adapted to the local reality, considering the limitations of the study.

This adaptation considered the territorial extension of the Geopark – about ten times larger than that recommended in the methodology – and the adequacy of the content to the available information, since there are no complete studies on the geology of each site.

Inventory and hierarchization of tourist attractions, geosites and geodiversity sites

The choice to adapt a broader methodology, encompassing the tourism and educational uses of the Geopark, since we understood the main goals of a geopark is to promote economic and sustainable development with geotourism, the identification of each site is necessary. Such identification considers not only its geological conditions and relevance, but also its visitation structure.

In Brazil, the main initiative for the recognition of geological sites is headed by the Brazilian Commission of Geological and Paleobiological Sites (Sigep). This committee has a permanent work of collecting and registering new proposals of geological sites, assessing their importance and their degradation risk. This study has the participation of independent researchers who conducted their study on this subject and forwarded it to the Committee.

In 2015, Sigep registered 208 geological and paleobiological sites in Brazil. six areas are listed in the state of Mato Grosso do Sul: Morraria Urucum and Pedreira Saladeiro (approved proposals), Pedreira Laginha (canceled proposal) and Morraria do Puga, all in Corumbá; the Gruta do Lago Azul in Bonito; and the Tufas Calcárias da Serra da Bodoquena (Integrated Public Management System [SIGEP], 2015). Of these, only the Pedreira Laginha is not listed as a geosite of the Geopark.

Some authors as Brilha, 2005, 2016; Nascimento, Ruchkys, & Mantesso-Neto, 2008 and Ruchkys, 2007, describe criteria that establish whether an area is a geosite. These criteria include even the vision of international geoconservation programs such as Global Geosites and Global Geoparks Network. Representativeness, uniqueness, complexity and geodiversity, protection and management, willingness to promote interdisciplinary studies, and potential for educational and cultural purposes are some of a geosite characteristics.

Brilha (2016), in a review of her own work on the inventorying and quantification of geological sites within geoparks, recommends that there should be a division between geosites of greater scientific relevance and others that, even without high scientific value, are capable of illustrating geological processes for educational and tourism purposes, promoting the integration and development of the territory where they are inserted.

Brilha (2016) also proposes, that geosites are areas with high scientific value or significant potential to understand geological history. Other geological sites that have high educational and tourist values can be classified as geodiversity sites. Geological sites necessarily need, to a greater or lesser degree of occurrence and importance, to present geological formations and/or processes.

The identification of an area of special scientific interest requires protection and use control measures, which depend on prior planning and political-institutional articulation between those involved to be implemented. Likewise, the implementation of tourism activity in a given area requires detailed planning of the steps to be followed, as well as an implementation schedule.

In this case, the level of planning and efforts required depend on the degree of development of the locality, the amount of tourism goods and services to be available for consumption, and the level of involvement of the local community, private initiative and the public power in the process.

The diagnosis is one of the first and most relevant stages of a tourism planning process. An inventory of the resources and attractions that will form the tourist heritage to be commercialized is made, among other surveys, when the diagnosis is performed. Inventory is a basic step in tourism planning, but it is not enough when it comes to resources and attractions.

A survey of their existing hierarchy, checking their level of development and attractiveness, is critical to prioritize specific planning actions to optimize the time and resources available.

This is the precept governing the Methodology of Hierarchization of Tourist Attractions, created in the 1990s by the World Tourism Organization (WTO) and adopted by the Centro Interamericano de Capacitação Turística (Cicatur – Tourist Capaciousness Interamerican Center). In Brazil, authors such as Ruschmann (2001) and Beni (2004), in addition to the Ministry of Tourism, have defended and described the use of evaluation methodologies and hierarchization of tourist attractions when dealing with activity planning.

For Beni (2004), the hierarchization seeks to rank the attractions according to their importance for tourism activity. According to Ruschmann (2001), the attractions are the basis of tourist activity, and therefore, the evaluation of its elements should be a key part of any tourism planning process.

The assessment of attractions determines their tourism potential and is a key element in making strategic decisions for a locality and provides input to determine the scope of projects and the quantity and quality of equipment and infrastructure to be installed. (Ruschmann, 2001, p. 142)

The Brazilian Ministry of Tourism (2005) understands that assessment and hierarchization techniques that promote ranking among attractions provide valuable information to understand the size of each attraction and, consequently, the type of action each one needs to receive to become a marketable product. OMT's original technique of hierarchizing attractions, adapted to the national reality, is used by the Brazilian Ministry of Tourism (2005) in the Tourism Regionalization Program – Routes of Brazil, the flagship of national tourism development.

Assessment and hierarchy are used to measure the importance and relevance in planning processes of various segments, not just tourism. Quantifying the relevance of a resource against others of the same purpose and within the same geographic space is one of its main functions. In addition to relevance, some hierarchical techniques allow identifying other possibilities of use and the measuring of different values for these resources.

In this study, we show a classification of the Bodoquena-Pantanal Geopark geosites as geodiversity sites, defining their potential value for educational and tourist use, as well as measuring their degradation risk.

METHODOLOGY

The methodological procedures necessary to achieve the objectives were divided into three stages:

The first stage consisted of pre-field activity, in which geosites and the existing information about them were previously surveyed. We researched on official websites of the institutions involved in the development of the Geopark, in scientific articles on the areas of study and information gathering *in loco* at the Geopark Management Committee office. Then, visits to the geosites were scheduled.

An observation script was elaborated in parallel and used to assess the information collected in the field, as well as to survey the hierarchization methodologies of geodiversity sites and tourist areas, which resulted in the previous model of the hierarchization matrix.

The second stage consisted of a field research, with the visit and observation of information necessary to fill in the hierarchization matrix. Photographic records were also made as well as the confirmation and / or determination place description and its geographic coordinates.

In this study we considered the 54 geosites described in the state decree, since the Geopark exists legally and within the administrative structure of the state government, while the area and the geosites mentioned in the dossier are still in the proposition phase. Thus, six field trips were conducted, from May to November 2015, to cover the 42 sites surveyed, covering approximately 5,800 km within the Geopark's territory. The unlisted geosites were not visited due to the lack of authorization to research and difficulty or lack of security in accessing the area.

In the last stage we used a methodology called panel of experts, which consists in adapting the Delphi method (Buarque, 2002; Molina & Rodrigues, 2001). This methodology was used to consult experts in geology and geoconservation to establish the "rarity / uniqueness" value of the geosites of geological and paleontological interest, as this is a technical assessment of a specific area.

Experts were selected using the Lattes Platform, with keyword searches such as "geology" and "geoconservation", and specific filters such as "doctorate". The questionnaire was sent to the selected specialists and the average of the answers obtained was considered as result.

Then, the hierarchization matrices were completed, organized, valued and assessed using the adaptation of the Methodology for Inventory and

Quantification of Geosites and Geodiversity Sites (Brilha, 2016), which discusses important variables for assessment and hierarchization of geosites. This adaptation also considered the Methodology of Hierarchization of Tourist Attractions (Brazilian Ministry of Tourism, 2005) and the reality of the study area, which is quite different in size and context from the examples reported by Brilha (2016).

Thus, the potential for educational use (EU) and potential for tourism use (TU) were quantitatively assessed. Finally, the information collected was presented and discussed, also considering the degradation risk (DR) observed for each site.

QUANTITATIVE ASSESSMENT OF GEODIVERSITY SITES

In total, 14 indicators were used to assess the geodiversity sites, nine of which are common to the potential for educational and for tourist use. The indicators “accessibility” and “proximity” to communities were also used for the assessment of the degradation risk discussed below. A value from 0 to 3 was assigned for each indicator.

In some cases, the assessment and the weight given to the indicator are the same, which is the case of the indicators “vulnerability”, “accessibility” and “safety” and assessed potential for educational and for tourism use. In other cases, the same indicator has different weights and assessments, depending on its importance for the analysis in question. The item “scenic beauty”, for example, has a weight of 15 for tourist use and of 5 for educational use. The sum of the indicator weights reaches 100 in all assessments. Another differentiation of the assessment refers to the positive or negative focus of the indicator, as “Population density”, for example. When an indicator is assessed for the potential for educational use, the closer is the site to populated areas the better, as the number of people that may potentially enjoy the site as a teaching area increases. When assessing the same indicator for the potential risk of degradation, the closer to populated areas, the worse, since this proximity increases the deterioration risk and use of uncontrolled area.

In these cases, geosites very close to communities received the value 3. However, for educational and tourist use, the higher the value, the better the site rating, whereas to assess the degradation risk, the higher the value, the riskier.

The common indicators for assessing the potential for educational and tourism use were:

- **Vulnerability:** geodiversity elements that could be damaged by visitors;
- **Accessibility:** easy access to the site, considering distance and road conditions;
- **Usage limitations:** existence of obstacles that may hinder the development of educational and tourist activities;
- **Security:** degree of risk that visitation offers to students and visitors;

- **Infrastructure:** Local facilities to serve visitors and students (food and beverages, toilets, parking etc);
- **Association with other values:** existence of other natural or cultural elements that may be added to the values of the site, increasing its interdisciplinary potential;
- **Scenic beauty:** the beauty of the geological element and the scenery as a whole, which may increase interest in visiting the site;
- **Singularity:** rarity of the geological elements existing. The rarer the greater the interest;
- **Observation conditions:** better conditions to appreciate the geological elements.

Potential for educational use

The potential survey of the sites defined by the state decree creating the Geopark sought to rank this potential according to items that go beyond the ability of the site to be used as a tool for all educational levels. In addition to the didactic potential and geological diversity, considering the type of access, usage and infrastructure limitations is also necessary. However good a place to exemplify a geological process or phenomenon for the various educational levels, its use potential is undermined when located over long distances or with poor infrastructure.

In addition to the nine common site indicators, three other specific indicators were used to assess the potential for educational use:

- **Proximity to Communities:** Distance between nearby sites and communities that could potentially use it for educational purposes;
- **Didactic Potential:** Potential for didactic purposes by different educational levels (it was considered that all geosites have a high potential for the development of educational activities at different educational levels, depending on the applied didactics);
- **Geological diversity:** number of geodiversity elements in the same site.

The final value to each site after the analysis of the variables is shown in Chart 1, ranked from highest to lowest potential.

Chart 1 – Hierarchization of potential for educational use

	Site	Value		Site	Value
1	Marina Gatass Park - Cloudina	2.9	22	Mineração Horii	2.5
2	Parque Ecol. Cacimbas - Corumbela	2.8	23	Tufas Calcárias Balneário Presidente Correia	2.5
3	Escadinha e Mirante da XV	2.8	24	Paleomar do Tamengo	2.5
4	Mina Urucum-Vale	2.7	25	Anticlinal Anhumas	2.5
5	Porto Sobramil / Pedreira Saladeiro	2.7	26	Embasamento Cristalino / Borda Oeste da Serra da Bodoquena	2.4
6	Mina Urucum Santa Cruz	2.7	27	Buraco das Araras	2.4
7	Lentes Calcárias do Rio Miranda	2.6	28	Estramatólito de Porto Morrinho	2.4
8	Gruta de São Miguel	2.6	29	Tufas Calcárias Balneário Presidente Correia	2.4
9	Tufas Calcárias do Rio Miranda	2.6	30	Mirante da Fazenda Esperança	2.3
10	Mom. Natural Rio Formoso / Ilha do Padre	2.6	31	Morraria Campo dos Índios	2.3
11	Estramatólito / Mirante Morraria do Sul	2.6	32	Crosta Laterítica com inscrições Rupestres Fazenda Salesianos / Banda Alta	2.2
12	Lateritic Crust with Cave Inscriptions Figueirinha Farm	2.6	33	Morro do Jacadigo	2.2
13	Afloramentos da Formação Cerradinho	2.6	34	Recanto Ecológico Rio da Prata	2.2
14	Abismo Anhumas	2.5	35	Icnofósseis Formação Botucatu	2.1
15	Lagoa Misteriosa	2.5	36	Mina Santana / Morraria do Rabichão	2
16	Mina dos Belgas	2.5	37	Nhandipá	2
17	Estância Li	2.5	38	Gruta Nossa Senhora Aparecida	2
18	Tufas Calcárias Parque das Cachoeiras	2.5	39	Morro do Azeite	2
19	Gruta do Lago Azul	2.5	40	Gruta do Mimoso	1.9
20	Rio do Peixe	2.5	41	Gruta do Urubu Rei	1.8
21	Nascentes e Grutas Ceita Corê	2.5	42	Cemitério dos Heróis	1.6

All sites have a good degree of potential for educational use at first, with a small difference between them. The lowest score observed is 1.6, and the highest 2.9. We also notice that 25 of the 42 areas surveyed have a score between 2.5 and 2.9. Of these, 16 belong to the southwest region of Serra da Bodoquena.

However, by placing the minimum and maximum observed in five ranges, six sites in the Pantanal Region were classified in the highest value range (2.7 to 2.9 points): Parque Marina Gatass (Cloudina), Parque Ecológico das Cacimbas (Corumbella), Escadinha e Mirante da XV, Mina Urucum, Porto Sobramil/Pedreira Saladeiro (Cloudina e Corumbella) and Mina Urucum Santa-Cruz, as shown in Figure 2.

Figure 2 – Partial view of Morro Santa-Cruz, which houses the Sítio Urucum Santa-Cruz em Corumbá, MS, Brazil



Only one area was classified in the lower value range: the Cemitério dos Heróis. This site of historical interest has no geological interest or diversity, and is located 5 km from an urban area, but with reasonably difficult access, and without infrastructure.

Most of the sites, 23 in total, are in the second value range (2.4 to 2.6 points), almost always consisting of sites that have a mix of minimal infrastructure – or close proximity to some place with infrastructure – easy access and geological relevance.

Generally, the areas with the least potential for educational use are those with little or no geological significance, which generally have some kind of access restriction since they are closed to visitors or have difficult access to the general public, and without security conditions. Moreover, the high vulnerability of sites counts as a restrictive item to constant group visits.

Potential for tourist use

The two geographic regions where the Geopark is located are the ones with the largest number of tourist attractions in the state of Mato Grosso do Sul. Corumbá (Pantanal region) and Bonito (Southwest region) are inducing destinations of the Brazilian Ministry of Tourism with internationally consolidated tourist attractions.

This consolidation as a tourist destination radiates to some vicinal municipalities that are part of the Geopark and have some relevant attractions, but this does not reach all.

The assessment of the potential for tourist use considered the nine indicators common to geodiversity sites and two specific indicators to assess tourist attractions:

- **Interpretive potential:** potential to be interpreted by visitors without specific geology education;

- **Distance from tourist centers:** Distance between the site and the municipalities considered tourist distribution centers, from where the region-based tourists usually depart to visit specific points.

The final values of the potential for tourist use of the 42 sites surveyed are shown in Chart 2, from the highest to the lowest.

Chart 2 – Hierarchization of the potential for tourist use

	Sítio	Valor		Sítio	Valor
1	Parque Marina Gatass - Cloudina	2.8	22	Mineração Horii	2.2
2	Escadinha e Mirante da XV	2.7	23	Lentes Calcárias do Rio Miranda	2.2
3	Gruta de São Miguel	2.7	24	Tufas Calcárias Balneário Presidente Correia	2.2
4	Mom. Natural Rio Formoso / Ilha do Padre	2.7	25	Estromatólito / Mirante Morraria do Sul	2.1
5	Crosta Laterítica com inscrições Ruprestres Fazenda Figueirinha	2.7	26	Embasamento Cristalino / Borda Oeste da Serra da Bodoquena	2.1
6	Parque Ecol. Cacimbas - Corumbela	2.6	27	Afloramentos da Formação Cerradinho	2.1
7	Rio do Peixe	2.6	28	Paleomar do Tamengo	2.1
8	Tufas Calcárias Estância Mimosa	2.6	29	Morro do Jacadigo	2.0
9	Gruta do Lago Azul	2.6	30	Anticlinal Anhumas	2.0
10	Mina Urucum	2.6	31	Tufas Calcárias	2.0
11	Recanto Ecológico Rio da Prata	2.5	32	Gruta Nossa Senhora Aparecida	2.0
12	Abismo Anhumas	2.5	33	Estância Li	2.0
13	Tufas Calcárias Parque das Cachoeiras	2.5	34	Morraria Campo dos Índios	1.8
14	Lagoa Misteriosa	2.5	35	Estramatólito e Porto Morrinho	1.8
15	Buraco das Araras	2.5	36	Gruta do Mimoso	1.8
16	Porto Sobramil / Pedreira Saladeiro	2.5	37	Icnofósseis Formação Botucatu	1.7
17	Mina dos Belgas	2.5	38	Mina Santana / Morraria do Rabichão	1.7
18	Mina Urucum Santa Cruz	2.4	39	Morro do Azeite	1.6
19	Nascentes e Grutas Ceita Corê	2.4	40	Nhandipá	1.5
20	Mirante da Fazenda Esperança	2.4	41	Gruta do Urubu Rei	1.5
21	Crosta Laterítica com inscrições Ruprestres Fazenda Salesianos / Banda Alta	2.3	42	Cemitério dos Heróis	1.4

Rescaling the sites into five value ranges, according to the list, we notice that the ten sites with the highest score (2.6 to 2.8 points), and consequently, the best potential for tourist use, are equally divided between the Pantanal regions, with five sites in Corumbá, and Southwest, with five sites in the municipality of Bonito.

Of these ten best qualified sites, eight are tourist attractions or areas suitable for visitation such as public parks. The Mina Urucum is not open for general visitation, but has such structure, and guided and pre-scheduled tours as specified interest already occur. Only the Crosta Laterícia, with cave inscriptions of Fazenda Figueirinha, shown in Figure 3, is not adapted to visitation; however, its suitability for visits does not require major changes, initially, and its associated elements increase its potential for tourist use.

Figure 3 – Partial view of cave inscriptions at Fazenda Figueirinha in Corumbá, MS, Brazil



In the second value range (2.3 to 2.5 points), we can see all other consolidated attractions of the Southwest region, which appear as geosites. These attractions have all the necessary conditions to visitation and have, to a lesser or greater extent, geological value. In this range are also some areas with infrastructure poorly adapted to visitation, but with significant elements associated such as “scenic beauty”, “geological importance” and “accessibility”, among others.

In the other value ranges, we emphasize the Mineração Horii and the Lentas Calcárias do Rio Miranda, with some kind of adaptive infrastructure nearby. The other sites, in addition to the absence of infrastructure, have no elements associated such as “interpretative potential”, “uniqueness” and “proximity to tourist centers”, among others.

We emphasize that the potential for tourist use of the analyzed sites refers to their use as tourist activities developed within a geopark, which means, with the geotourism aspect. Thus, even consolidated attractions such as the Rio da Prata, shown in Figure 4, with international recognition and thousands of visitors a year, presents a good score when placed under the perspective of a geological assessment, but does not occupy the position that has within the ranking of commercialization of tourism products in the region. Given that, their geological attributes, especially the hydrogeological ones, are not so prominent in the observation.

Figure 4 - Beginning of the floating activity in the Recanto Ecológico Rio da Prata (Jardim), one of the main tourist attractions of Mato Grosso do Sul



From this perspective, the insertion of tourist areas with little geological potential as geosites may sound more negative than positive. However, this does not mean that these areas cannot fit into regional development to be leveraged by the Bodoquena-Pantanal Geopark. In this context, the importance of the differentiation between geosites and geodiversity sites is evident. According to Brilha (2016), geosites should be attributed to areas with unique geological potential, while geodiversity sites are those whose educational and aggregate development potential are more prominent than any other value.

Geodiversity sites with the highest use potential

Geodiversity sites are those that are theoretically of minor importance for geological and scientific studies. However, this can be offset by their ability to illustrate processes and phenomena for a wider audience, mostly lay in geology, but with the ability to benefit from the education and leisure provided by these areas. This are the potential for educational and for tourist value.

Chart 3 shows the analysis of these potentialities on a new aspect, observing the potentials for educational and for tourist use combined.

Chart 3 – Hierarchization of geodiversity sites with the values of potential for educational and for tourist use combined

Sítio	Valor	Sítio	Valor		
1	Parque Marina Gatass - Cloudina	5.7	22	Mineração Horii	4.7
2	Escadinha e Mirante da XV	5.5	23	Tufas Calcárias Balneário Presidente Correia	4.7
3	Parque Ecol. Cacimbas - Corumbela	5.4	24	Recanto Ecológico Rio da Prata	4.7
4	Mina Urucum	5.3	25	Mirante da Fazenda Esperança	4.7
5	Gruta de São Miguel	5.3	26	Paleomar do Tamengo	4.6
6	Mom. Natural Rio Formoso / Ilha do Padre	5.3	27	Estância Li	4.5
7	Crosta Laterítica com inscrições Rupestres Fazendo Figueirinha	5.3	28	Anticlinal Anhumas	4.5
8	Porto Sobramil / Pedreira Saladeiro	5.2	29	Embasamento Cristalino / Borda Oeste da Serra da Bodoquena	4.5
9	Tufas Calcárias Estância Mimosa	5.2	30	Crosta Laterítica com inscrições Rupestres Fazenda Salesianos / Banda Alta	4.5
10	Mina Urucum Santa Cruz	5.1	31	Tufas Calcárias	4.4
11	Gruta do Lago Azul	5.1	32	Estromatólito de Porto Morrinho	4.2
12	Rio do Peixe	5.1	33	Morro do Jacadigo	4.2
13	Abismo Anhumas	5.0	34	Morraria Campo dos Índios	4.1
14	Lagoa Misteriosa	5.0	35	Gruta N. S. Aparecida	4.0
15	Mina dos Belgas	5.0	36	Icnofósseis Formação Botucatu	3.8
16	Tufas Calcárias Parque das Cachoeiras	5.0	37	Mina Santana / Morraria do Rabichão	3.8
17	Nascentes e Grutas Ceita Corê	4.9	38	Gruta do Mimoso	3.7
18	Buraco das Araras	4.9	39	Morro do Azeite	3.6
19	Estrada Parque Pantanal Sul	4.8	40	Nhandipá	3.5
20	Estromatólito / Mirante Morraria do Sul	4.7	41	Gruta do Urubur Rei	3.3
21	Afloramentos da Formação Cerradinho	4.7	42	Cemitério dos Heróis	3.0

The sites with the best potential for geodiversity (equal to or greater than 5 points) are well distributed in the Pantanal and Southwest regions. The sites near Corumbá are generally of high scientific interest, and the sites of Bonito municipality and region are the ones with the best structure to receive visitors. The Parque Marina Gatass, in Corumbá, stands out for having the best potential for exploration of tourist and for educational use. This is

a public park, structured to receive visitors and with great paleontological interest.

The ten sites with the least potential for geodiversity are sites of historical value only (cemitério dos Heróis and Nhandipá) and those whose access is extremely difficult (Gruta do Urubu Rei, Gruta do Mimoso, Morraria Campo dos Índios, Icnofósseis da Formação Botucatu and Morro do Jacadigo) or restricted (Morro do Azeite, Mina Santana and Gruta Nossa Senhora Aparecida).

In addition to infrastructure, accessibility and other elements relevant to these uses, the impact that such visitation may have on geodiversity sites must be considered even in the use for educational and tourist purposes. This impact is measured using the potential risk of degradation.

To show the degradation risk (DR) degree of each site, five indicators were evaluated:

- **Geological elements deterioration:** possibility of geological loss, considering the natural fragility and vulnerability (susceptibility to anthropic actions);
- **Proximity to areas that may cause degradation:** how close the site is to mining areas, industrial sites, urban areas, busy roads etc.;
- **Legal protection situation:** the site is, or is within, an area with some sort of legal protection;
- **Accessibility:** conditions of access to the general public. The easier the access, the greater the degradation risk;
- **Proximity to Communities:** The nearer the site is to populated areas, the greater the risk of misuse and, consequently, degradation.

The variables of each indicator were listed based on the adaptation of the methodology, keeping in mind their adequacy to the local reality. To better understand the organization of these variables and their quantitative assessment, we use as an example the “legal protection situation” indicator, in which a localized geosite is considered:

In an area without legal protection and without access control = 3;

In an area without legal protection, but with access control = 2;

In a legally protected area but no access control = 1;

In a legally protected area with access control = 0.

DR assessment tends to indicate the site vulnerability and fragility, especially regarding the already occurring or potential human action. This potential works as complementary information to other values for decision-making regarding the planning and management of the Geopark.

We have a new hierarchical configuration of these sites by subtracting the value of potential risk of degradation to each site from the values of potential for educational use and for tourist use combined to each geodiversity site shown in Chart 3, as shown from the lower to the highest in Chart 4.

Chart 4 – Geodiversity sites with lower degradation risk: (educational value-VE) + (tourist value-VT) – (degradation risk-RD)

	Sítio	Valor		Sítio	Valor
1	Gruta de São Miguel	3.9	22	Mina Urucum Santa Cruz	2.4
2	Gruta do Lago Azul	3.7	23	Gruta do Mimoso	2.3
3	Mom. Natural Rio Formoso / Ilha do Padre	3.6	24	Crosta Laterítica com inscrições Rupestres Fazenda Salesianos / Banda Alta	2.3
4	Abismo Anhumas	3.6	25	Morraria Campo dos Índios	2.2
5	Buraco das Araras	3.3	26	Estrada Parque Pantanal Sul	2.0
6	Lagoa Misteriosa	3.3	27	Gruta do Urubu Rei	2.0
7	Nascentes e Grutas Ceita Corê	3.2	28	Estromatólito / Mirante Morraria do Sul	1.9
8	Tufas Calcárias Estância Mimosa	3.1	29	Mineração Horii	1.9
9	Gruta N. S. Aparecida	3.1	30	Tufas Calcárias Balneário Presidente Correia	1.9
10	Rio do Peixe	3.1	31	Morro do Jacadigo	1.9
11	Parque Marina Gatass - Cloudina	3.1	32	Morro do Azeite	1.9
12	Recanto Ecológico Rio da Prata	3.0	33	Afloramentos da Formação Cerradinho	1.8
13	Escadinha e Mirante da XV	2.9	34	Paleomar do Tamengo	1.7
14	Tufas Calcárias Parque das Cachoeiras	2.8	35	Estância Li	1.6
15	Crosta Laterítica com inscrições Rupestres Fazenda Figueirinha	2.8	36	Anticlinal Anhumas	1.6
16	Mina Urucum	2.6	37	Tufas Calcárias	1.5
17	Porto Sobramil / Pedreira Saladeiro	2.6	38	Mina Santana / Morraria do Rabichão	1.5
18	Mina dos Belgas	2.6	39	Icnofósseis Formação Botucatu	1.3
19	Embasamento Cristalino / Borda Oeste da Serra da Bodoquena	2.5	40	Estromatólito de Porto Morrinho	1.2
20	Mirante da Fazenda Esperança	2.5	41	Nhandipá	0.5
21	Parque Ecol. Cacimbas - Corumbela	2.4	42	Cemitério dos Heróis	0.3

In this new configuration, 11 of the 12 best ranked sites are in the Southwest region, and of these, ten are consolidated tourist attractions. The Gruta Nossa Senhora Aparecida, in Bonito, which is currently closed to visitors, and Parque Marina Gatass, an open urban park, in the city of Corumbá, also stand out.

The best ranked sites, with higher value, as a geodiversity site and lower potential risk of degradation, have better conditions to act immediately as geodiversity sites, receiving a higher number of visitors, as characteristic of educational and touristic use. However, adequate planning is necessary

to control the degradation risk by anthropic action in areas still without a visitation structure.

We emphasize that mitigating measures of impacts caused by visitation, as well as the implementation of conservation actions, should be individually analyzed, to preserve its educational and tourist capacity, without losing its environmental and geological characteristics.

FINAL CONSIDERATIONS

The Bodoquena-Pantanal Geopark has great potential to illustrate the geological processes of its sites, with good accessibility in most of them, and great educational potential, which is one of the pillars of the idea of a geopark. Particularly, the Pantanal region had the sites with the highest potential for educational use, as they have a high degree of associated values, especially the paleontological, archaeological and landscape due to the typical characteristics of the Pantanal region. This can be exemplified by the two best-placed sites in the hierarchy: Parque Marina Gatass (with *Cloudina* fossil occurrence) and Parque Ecológico das Cacimbas (with *Corumbella* fossil occurrence), both on the Paraguay River banks, in the urban area of Corumbá.

The potential for tourist use was equally divided between the Pantanal and the Southwest. “Infrastructure”, “scenic beauty” and “proximity to tourist centers” stand out in best ranked areas. The Southwest region has many of its sites already consolidated as tourist attractions due to its consolidated tourist activity.

Many of them stand out also due to the uniqueness of the geological phenomena such as the natural cavities (Gruta do Lago Azul, Grutas de São Miguel e Abismo Anhumas) and the sites with waterfalls and rapids, which have the tufas calcárias, known in the region as “the growing waterfalls”. Despite the regular tourist flow, working better on the perspective of geotourism both in the dissemination of attractions and in the approach by local collaborators and guides is necessary for a greater integration of Southwestern sites with the idea of a geopark.

We noted that, although more sites with potential for educational use equal to the tourist use are located in the Pantanal Region, the Southwest region has the areas with better use conditions, considering its potential risk of degradation. Much of this is due to the intense tourist activity that occurs in the region. Despite the intensive use required, the tourism activity implemented in the Southwest has a more organized management, which implies strict access control, visitation limit and the local environmental legislation.

Generally, in the various assessments, the sites of historical value included in the Geopark appear in the last places. Although theoretically these sites present significant conditions for educational potential, their low placement are justified since they have few geological attributes and little or no visiting infrastructure. Even not considered as the most relevant geodiversity sites, their historical-cultural importance adds value to the Geopark.

Many of the areas described in Decree No. 12,897 / 2009 as geosites are already somehow commercially exploited (tourism, livestock, mining), as areas of cultural interest or leisure. In this sense, promoting development with their use, focusing on the principles of sustainability, community involvement, education

and enhancement of geological heritage and local culture, should be the objective of integrating these areas into the Geopark.

Thus, the hierarchical organization of geodiversity sites puts into perspective the articulation between public power, private initiative and community, to use these areas properly, exploiting their educational and tourist potential, benefiting the community development without ignoring the conservation of geological attributes, which will ultimately be the key to site attractiveness.

Finally, this assessment, which sought to understand and classify the Bodoquena-Pantanal Geopark geosites as sites of geodiversity, should only work as a guide to priority actions in these sites, and not to limit their functioning. Geodiversity sites cannot have their scientific value neglected, they need to be acted upon to ensure the protection of their geological aspects.

The original methodologies that were basis for this evaluation are about a very different reality from Brazil and, specifically, from the Geopark of Mato Grosso do Sul, especially regarding the size of the area, which is ten times larger than recommended by the original study.

This study is not intended to end the discussion of the assessment performed. On the contrary, it is understood that the adaptation of the methodology and the research exercise should work as an initial opportunity for discussions on the geosite vocation and the imminent need for intervention in each one. Therefore, we address the potential values and uses on this article.

We recommend this study to be continued and, above all, institutionalized as part of the priority list of institutional actions for the Bodoquena-Pantanal Geopark, which requires the formation of a multidisciplinary team able to assess accurately all points and determine definitively the eminent values and uses of each site.

REFERÊNCIAS

- Beni, M. C. (2004). *Globalização do turismo: megatendências do setor e a realidade brasileira*. São Paulo, SP: Aleph.
- Brilha, J. (2005). *Patrimônio geológico e geoconservação: a conservação da natureza na sua vertente geológica*. Braga, BR: Palimage.
- Brilha, J. (2016). Inventory and quantitative assessment of geosites and geodiversity sites: a review. *Geoheritage*, 8(2), 119-134. Retrieved from <https://bit.ly/2Mt3OK1>
- Buarque, S. C. (2002). *Construindo o desenvolvimento local sustentável: metodologia de planejamento*. Rio de Janeiro, RJ: Garamond.
- Decreto No 12.897, de 22 de dezembro de 2009. (2009, 23 de dezembro). Dispõe sobre a criação do Geopark Bodoquena-Pantanal, e dá outras providências. *Diário Oficial de Mato Grosso do Sul*, (7610), 7-10.
- Ministério do Turismo. (2005). *Programa de regionalização do turismo: roteiros do Brasil*. Brasília, DF: Secretaria Nacional de Políticas de Turismo.
- Molina, S., & Rodrigues, S. (2001). *Planejamento integral do turismo: um enfoque para a América Latina*. Florianópolis, SC: Edusc.
- Nascimento, M. A. L., Ruchkys, U. A., & Mantesso-Neto, V. (2008). *Geodiversidade, geoconservação e geoturismo: trinômio importante para a proteção do patrimônio geológico*. Natal, RN: Sociedade Brasileira de Geologia.

Ruchkys, U. A. (2007). *Patrimônio geológico e geoconservação no Quadrilátero Ferrífero, Minas Gerais: potencial para a criação de um geoparque da UNESCO*. Tese de Doutorado, Instituto de Geociências, Universidade Federal de Minas Gerais, Belo Horizonte.

Ruschmann, D. (2001). *Turismo e planejamento sustentável: a proteção do meio ambiente*. Campinas, SP: Papirus.

Sistema Integrado de Gestão Pública. (2015). *Inventário de geossítios do Brasil*. Goiânia, GO: Sigep. Retrieved from <https://bit.ly/31F02lf>

Received on: 07/17/2017

Approved on: 07/30/2017

CONTRIBUTIONS

Maria Cristiane Fernandes da Silva Lunas: Definition of the research problem and objectives, development of the theoretical proposition, bibliographical review and theoretical foundation, choice of methodological procedures, data collection, data analysis, preparation of charts, graphs and figures, realization of estimates and projections, writing of the manuscript, adaptation of the manuscript to the RTA rules.

Ademir Kleber Morbeck de Oliveira: Definition of the research problem and objectives, development of the theoretical proposition, choice of methodological procedures, critical review of the manuscript.