GEOTOURISM and GEOCONSERVATION at the SUMIDOURO STATE PARK, MINAS GERAIS, BRAZIL

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Abstract

Topics such as geodiversity, heritage and geomorphological geosites have been at the centre of debates in different spheres and pointed out as important tools for geoconservation and management of protected areas. In order to strengthen these issues in the region of the Sumidouro State Park (Minas Gerais, Brazil) this paper is intended to highlight some Places of Geomorphological Interest in order to inventory, evaluate and classify them so that they could be valued as important abiotic heritage. The methodology was proposed by Pereira (2006) and adapted to the Portuguese karst by Forte (2008) and by Travassos (2010) for the Brazilian karst consisting of the identification and characterization of geosites with the presence of Places of Geomorphological Interest classified as isolated forms, area and panoramic types. The results allowed the proposal of geotouristic trails seeking the promotion of the geomorphological heritage, as well as the karst features in the region.

Keywords: Geodiversity, Geotourism, Geoconservation, Places of Geomorphological Interest, Sumidouro State Park.

Introduction

It took relatively a long time for the world population to increase the level of awareness regarding natural resources and their usage. After many world meetings and conferences, the main perspective to minimize anthropogenic impacts over nature is being more accepted, although conservationists and scientists think it is still a long "road for success" regarding the conservation of biodiversity and also of the geodiversity.

Therefore the abiotic heritage (e.g.: geology, geomorphology, paleontology, speleology, etc.) has only received more international attention starting in the 90s and in recent decades in Brazil. Even though more is known, the importance of the abiotic heritage (geodiversity) is still small if compared to studies focusing the biotic heritage, or biodiversity.

The concepts of geodiversity and the geological and geomorphological heritage are relatively new and involve the physical elements of the landscape such as rocks, soils and surficial forms. They are now being treated from the perspective of their appreciation and conservation in recognition of their importance for humankind. Such behaviour is associated with the fact that the structure of the Earth's surface, apparently robust, offers a false impression that it is constituted by a set of permanent and durable features (Evangelista & Travassos 2015).

According to Pereira (2010), this impression is false, as one can identify that the whole natural heritage is vulnerable to human action and has exceptional value to humanity, consisting of biotic and abiotic factors which together form the geodiversity. Thus, geodiversity is the result of a long and complex process that began with the creation of the Earth 4.5 billion years ago, considering the age of the sequence of rocks encountered and the evolution of living beings in a relative time scale considering the natural biotic and abiotic heritage.

The concept of heritage makes the connection with something important which is transmitted or passed over generations. According to Choay (2001) this term was used for other purposes covering areas such as genetics, culture and nature and is often used to refer a set of tangible or intangible goods. Pereira (2006) considers heritage as properties that by human perception and in time acquired special values which distinguishes them from other goods. Included in this definition are the geosites and the Places of Geomorphological Interest that stand out over others.

Consequently, facing society's need and dependence of natural resources, Brilha (2005) points out the idea of conserving the geodiversity is not to preserve all existing outcrops, but those which are endowed with a high scientific, cultural, touristic and educational value. One can mention this topic precisely in the centre of the epistemological discussion regarding the geological and geomorphological heritage in order to enhance the geoconservation's field of study.

In this perspective of conserving the abiotic heritage, one can identify the geological heritage, constantly modified by the system's natural dynamics (Ruchkys

2007). According to Pellegrini (2000) conservation promotes active management of natural and cultural objects, giving them at the same time a convenient function with appropriate solutions to the desired progress avoiding or minimizing losses. However, it is known that conservationist practices sometimes does not exclude uses that effectively lead to the destruction of the geological heritage, such as the case of mining activities and also tourism, if poorly planned and managed can generate negative impacts. Therefore, geoconservation is associated to the concept of sustainable use that seeks to reconcile nature's conservation with the sustainable use of part of its natural resources through geotourism.

The field of geotourism was strengthened by the growing number of mines that were being exploited due to socioeconomic growth of English society. In order to identify, protect and conserve its geosites this issue gained more adepts and became constantly updated. For this reason, Hose (2000) felt the need to review his own definition of geotourism as the provision of interpretive tools and services to promote the value and social benefits of places and geological/geomorphological materials in order to ensure its conservation for use by students, tourists and other people with recreational interest or pleasure (Hose 2000 apud Hose 2011a; Hose et al. 2011b).

For these reason, knowing the importance of geotourism for karst conservation, this paper was developed in order to discuss the importance of the geological and geomorphological heritage of the Sumidouro State Park (Minas Gerais, Brazil), and also making an inventory and classification of Places of Geomorphological Interest which could be used for scientific, educational and sightseeing porpoises. The area is located in a region of high level of anthropogenic impacts, and urban expansion is a clear risk for conserving this abiotic heritage.

Methodology

The development of a methodology aimed at the geomorphological heritage arises simultaneously with the demand of valoration occurred in the 90s. It arises especially linked to the value of preserving elements of the natural environment, cultural and historical elements, especially the geological and geomorphological ones. These elements comprise karst regions with different values (e.g.: ecological, economic, scientific, etc.) and have undergone many changes, mainly due to urban sprawl. For Pereira, Pereira and Alves (2007), initiatives directed in the conservation and protection of the geological and geomorphological heritage gained emphasis due to its assessment beyond mere recognition of landforms as a potential touristic or scientific site. Furthermore, this evaluation process provides the comparison in terms of importance between other locations.

The methodology to evaluate the geomorphological heritage presented by Pereira (2006) has two main steps: an inventory that seeks to identify the places of interest and the quantification which gives values in order to better promote proper management of natural resources. The first is understood as a more qualitative step in which the researcher proposes the selection of places and their characterization according to the context in which they have developed. The second step is to quantify, a little performed task by most researchers mainly for not presenting a well-defined criteria. Therefore it is guided by the definition of the intrinsic value of each place, its potential use and the need for protection being as more objective and less ambiguous as possible (Brilha 2005), according to Table 1.

Table 1: Steps and sub steps of the geomorphological heritage evaluation

STEPS	SUB STEPS
Inventory	a. Identification of Places of Geomorphological Interests b. Qualitative evaluation c. Selection of Places of Geomorphological Interests d. Carachterization of Places of Geomorphological Interests
Quantification	a. Numercial evaluation b. Ranking

Source: adapted from Pereira (2006: 94)

In the inventory one should consider the additional values (e.g: ecological, cultural, aesthetic, economic, etc.) contemplated by a holistic view of the area. In this regard, the main highlights were places with high scientific value. Considered in this study as "macrostructures" the geosites presented more of one Place of Geomorphological Interest. Thus, the authors selected 6 main geosites and 10 Places of Geomorphological Interest (Table 2) classified as panoramic, isolated or area.

Study Area

The karst region of Lagoa Santa is located in the south central portion of the state of Minas Gerais about 50 km north of the state capital, Belo Horizonte . The region has a Conservation Unit called Sumidouro State Park, part of

Table 2 – Places of Geomorphological Interest from the Sumidouro State Park

ID	Name of the Place of Geomorphological Interest	Type
P 01	Gruta da Lapinha (Lapinha Cave)	Area
P 02	Mirante da Lapinha (Observation point of Lapinha)	Panoramic
P 03	Lapa do Sumidouro (Sumidouro Cave)	Isolated
P 04	Mirante do Sumidouro (Observation point of the Sumidouro)	Panoramic
P 05	Poljé do Sumidouro (Sumidouro Polje)	Area
P 06	Epicarste da Mineração desativada da Finacal (Epikarst of the Finacal deactivated quarryl)	Area
P 07	Cavernas preenchidas da Mineração desativada da Finacal (Filled caves of the Finacal deactivated quarry)	Area
P 08	Maciço do Baú (Bau Massif)	Area
P 09	Maciço da Fazenda Girassol (Massif of Girassol Farm)	Isolated
P 10	Mirante do Cruzeiro (Observation point of the Cruzeiro)	Panoramic

Source: Evangelista (2013)

the Environmental Protection Area of Lagoa Santa Karst. The Sumidouro State Park comprises the municipalities of Lagoa Santa and Pedro Leopoldo with total area of 2,004 hectares.

The Park was created in 1980 by Decree nº 20.375 in order to preserve the existing cultural and natural heritage of the region (IEF, 2012), even before the creation of the Environmental Protection Area of Lagoa Santa Karst on January 25, 1990 (Decree nº 98.881). With 36,000 hectares (356 km²), the Environmental Protection Area of Lagoa Santa Karst fully contains the Sumidouro State Park, the Cerca Grande State Park, Natural Monuments, and parts of the municipalities of Lagoa Santa, Pedro Leopoldo, Matozinhos, Funilândia, Prudente de Morais, and the entire municipality of Confins (Figure 1).

The sites were compared with each other in order to check their values, such as scientific and educational ones, to use them as Places of Geomorphological Interest. According to Forte (2008), these parameters guide the definition of the places which will be effectively evaluated and classified. Once selected, one starts the detailed characterization of each location. The Places of Geomorphological Interests here were grouped taking into account the geological and geomorphological aspects, cultural heritage, landscape features and possibility for geotouristic itineraries.

GEOLOGICAL AND GEOMORPHOLOGICAL ASPECTS

Located in the middle portion of the Velhas river, the Sumidouro State Park , displays significant karst features such as closed depressions, carbonate outcrops, various types of karren, and poljes amid flatter reliefs of large hills and slopes dissected due to sub horizontal dip of the layers slightly oriented NE and reflecting the regional geomorphological dynamics and the lithological context in which it is inserted (Kohler 1989). In the region one can also observe a succession of carbonate units covered by phyllites and affected by geological and tectonic events that caused ground and surface changes. The combination of these different factors enabled the existence of different morphological units found in the central portion of the state of Minas Gerais.

Among the morphological units and the physiographic sub-compartments found in the karst region of Lagoa Santa, NW- SE direction from the Ferradores ridge, Kohler (1989) highlights the gorges and pits with high walls, aligments or belts of uvalas, the Dolines Plateau, and the plains or karst poljes. Thus, the highlighted region is comprised by the so called karst compartment. Considering the most relevant features of geological and geomorphological point of view, the Sumidouro Polje and the Girassol Farm Massif stands out.

The Sumidouro Polje is located 678 m above sea level in the eastern portion of the Park in Fidalgo, Pedro Leopoldo. It is a scenic spot with good visibility where it is possible to observe all the corrosion plain, the Sumidouro Lake and the hum of the Fidalgo Massif in the Lagoa Santa Plateau, as characterized by Kohler (1989). One can note that the Sumidouro Lake undermines the massif of the same name as the chemical processes take place. For this reason, in the geological time, as the carbonate rocks are weathered, falling blocks occur, and those are found at the massif's base. A magnified view of the geomorphological elements becomes clearer during the dry season when the lake has its water table lowered (Figure 1 and Figure 2).

Figure 1 – Lake formed at the Sumidouro Polje, during rainy season
Photo: B. D. Rodrigues

Figure 2 – Intermittent behaviour of the Sumidouro Polje in extreme drought
Photo: L.E.P. Travassos

The Girassol Farm Massif (Figure 3), is considered to be an isolated place located in an altitude of 708 m, southwest of the Sumidouro State Park. Located on the Dolines Plateau in the same direction of the Lapinha Massif (W-E), it presents the typical karst ruiniform aspect featuring a large doline in its front (Figure 4). This geoform presents a rock shelter, various types of karren, and fallen rock boulders. The predominant vegetation is the dry forest which can lose almost all leaves during the dry season.

Figure 3 – Panoramic view of the Girassol Farm Massif and the dry forest on the top, during wet season
Photo: L.E.P. Travassos

Figure 4 – The doline at the base of the Girassol Farm Massif.
One can also see collapse boulders at the base, as well as speleothems. The researchers are serving as scale in front of the massif and they are approximately 1.80 metres tall.
Photo: L.E.P. Travassos

CULTURAL HERITAGE

According to UNESCO (2012) heritage is the legacy we have received from the past, live in the present and transmit to future generations. Therefore, the cultural and natural heritage is an irreplaceable source of life and inspiration, our identity. But this situation was not always so. Only after the Industrial Revolution that arises the concept of protecting the cultural heritage under the auspices of the governments. In the case of the Sumidouro State Park, it was created in 1980 by the Decree nº 20.375 in order to preserve the existing cultural and natural heritage of the region (IEF, 2012). Thus, this paper highlights the Lapinha Cave and the Observation point of the Cruzeiro.

Although it has geological importance, the Lapinha Cave has a high cultural value. It is located in the southwestern portion of the Park at the Lapinha district (Lagoa Santa), 733 m above sea level. It has 630 m of horizontal development and was discovered in 1835 by the Danish naturalist Peter W. Lund, being opened to visitors in 1965. Located in the region known as the Plateau of Dolines, the cave has its entrance in a rocky wall marked by horizontal karren and a thick layer of soil at some portions with dry forest (Evangelista & Travassos 2011). Some caves in the surroundings have been used a long time for religious practices as historical records shows.

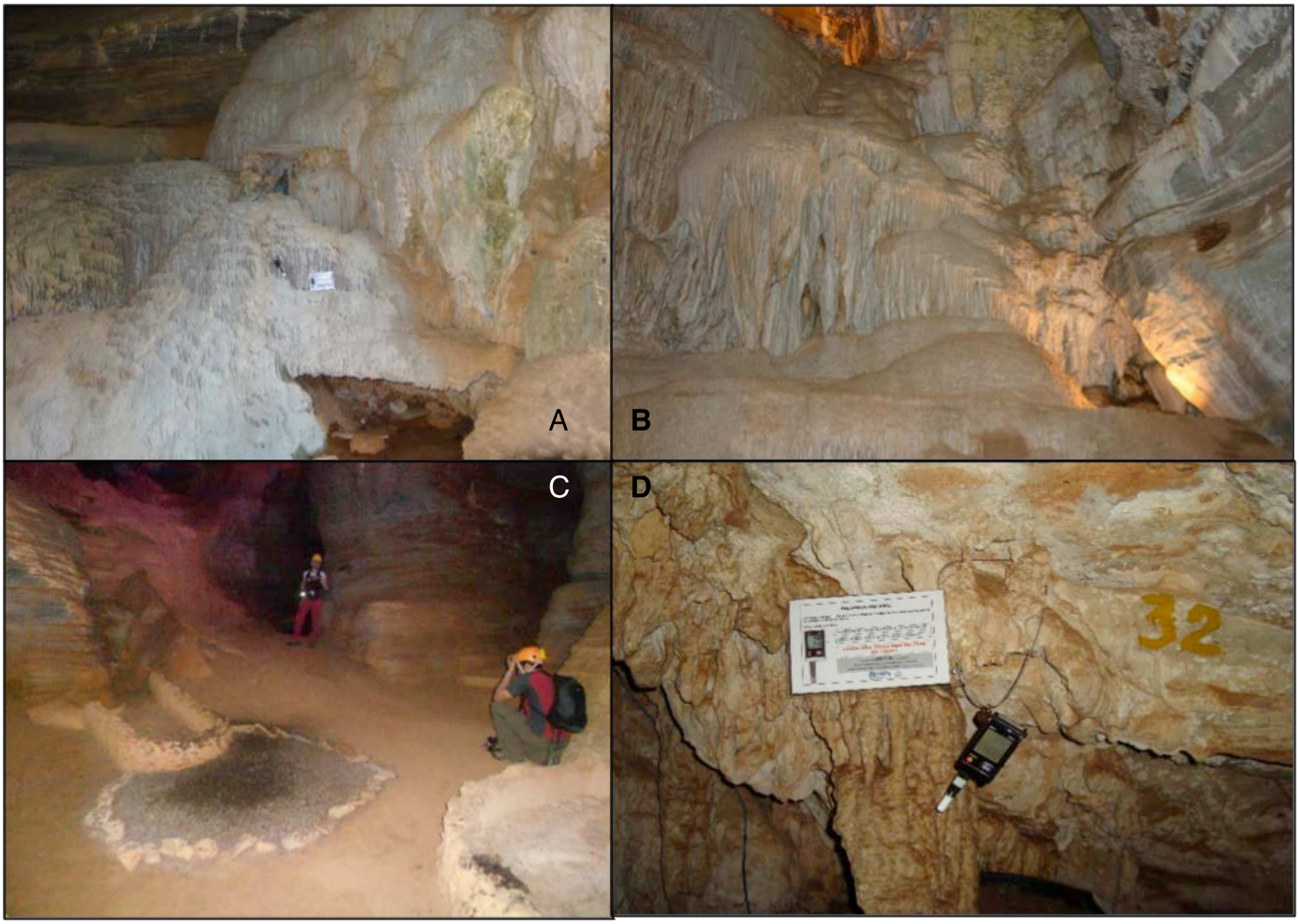


Figure 5 – General aspects of the Lapinha cave.
***A** Image of Our Lady of Aparecida, Patron Saint of Brazil which was put by the local population in the entrance of the cave in the past. **B** Flowstone inside the cave. **C** Guano deposits protected by placed stones in order to avoid trampling by tourists. **D** Temperature and Humidity monitoring from the Project CNPq 479945/2013-6*
Photo: L.E.P. Travassos

The Observation point of the Cruzeiro is located in the central portion of the Park, east of the Lapinha Massif in Lagoa Santa. The observation point is a prime viewing spot for much of the regional geomorphological heritage, composed by the Ferradores ridge and the flattened hilltops of Confins, southwest of the Tancredo Neves International Airport (Figure 4). From this point one can observe the karst depression comprising the Lapinha Lake, the district of Lapinha, the massif of the same name to the west, a set of massive limestone to the southeast and dolines which surround much of the area. Located at one of the highest points of the Sumidouro State Park (773 m), the Observation point of the Cruzeiro has a cross, which for many years attracted religious groups that used to go to the location in order to thank God for the rain after long periods of drought.

LANDSCAPE ASPECTS

The records preserved in rocks and landscapes are unique and surprisingly fragile, so they must be conserved to ensure this heritage for future generations. Brilha (2005) considers observing a natural landscape is something spontaneous and automatic, but compare it to others is debatable, because all landscapes are endowed with some kind of aesthetic value to residents and visitors alike. The socioeconomic and environmental activities are closely associated with the landscape morphology of a given region and thus it is necessary to maintain as far as possible the natural systems. For this study, the Baú Massif and the Observation point of the Sumidouro are considered important Places of Geomorphological Interest.

Figure 6 – Panoramic view of the Observation point of the Cruzeiro
Photo: V.K. Evangelista

The Baú Massif is located 724 metres above sea level in the western portion of the Sumidouro State Park in the district of Fidalgo, Pedro Leopoldo. Although out of the Parks's limits, this site was incorporated into the geomorphological heritage of the Park by its magnitude and its proximity to other abiotic elements that composed the geomorphological unit of the Dolines Plateau. The massif stands out also for its morphological set of more generally convex or elongated hilltops and epikarstic areas with dry forest and dolines (Piló 1998). The massif gets its name because of the elongated shape which resembles a "key" or "lock" of a "chest" or in Portuguese, "Baú" (Figure 7 and Figure 8).

Figure 7 – General overview of the Baú Massif and its doline during the dry season
Photo: L.E.P. Travassos

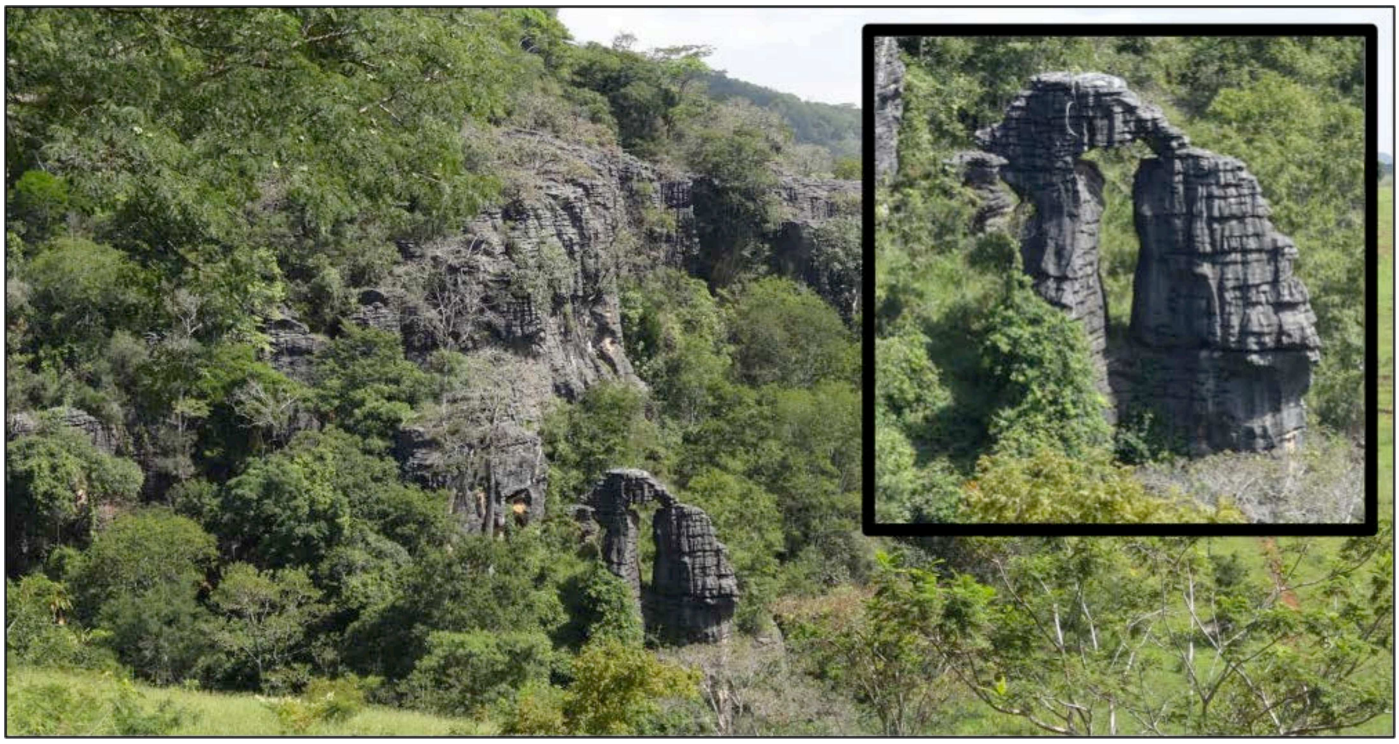


Figure 8 - Panoramic view of the Baú Massif. In the detail one can see the shape in the rock similar to a "key" or the "lock" of a chest, true to the popular imagination in the region

Figure 9 - View of the Sumidouro Lake on the top of its massif during the wet season
Photo: L.E.P. Travassos

Figure 10 - View of the Sumidouro Lake on the top of its massif during the wet season
Photo: R. Tavares, Park Manager

The Observation point of the Sumidouro is located 700 metres above sea level on the Fidalgo/Sumidouro Massif, at Fidalgo, Pedro Leopoldo. It was identified as a scenic spot due to its altitude and the magnificent view of Sumidouro Lake and its floodplain. From this point, one can also observe part of the regional karst dynamics, including the Samambaia creek that feeds the lake.

CONCLUSIONS

The Sumidouro State Park can be considered a privileged area in terms of geodiversity. Located in a sedimentary basin, the park holds a natural heritage of great scientific and cultural significance in the national and international scenario. Its unique geographical position and the variety of notable geomorphological features favored the creation of the Park in the 80s. The regional karst dynamics which led to the elaboration of forms and unique landscapes, today is considered to be a high heritage value. However, it was not always seen that way, as evidenced by the clear interventions suffered, both in limestone exploration itself, and in the unplanned urban and industrial expansion.

Due to the need of protecting the geological and geomorphological heritage of the Park this work was based on methods which evaluate the geosites found in the region, making its inventory and quantification. The methodology used proved to be the most suitable for the study area, because when using quantification one seeks to minimize the subjectivity inherent in the evaluation process by intrinsic values. This method helps to address, more objectively, the relevance of the heritage to be protected and maintained.

In this work the selected sites were considered as places to be preserved as geosites and they are most significant Places of Geomorphological Interest due to the fact they are expressions of the regional karst landscape. After selected and quantified, the sites were classified according to their representation in terms of geological and geomorphological aspects, cultural heritage, landscape features and geotouristic attractiveness.

The proposal of heritage development and promotion of the Sumidouro State Park is intended to enhance and encourage the use of the Park trails as well as the development of educational panels for the panoramic Places of Geomorphological Interest (Figure 12, 13 and 14). Currently the Park has three hiking trails:

a) the Travessia ("Crossing" which connects the Lapinha Cave area to the Sumidouro Lake),

b) the Sumidouro trail (which takes the visitor to the Sumidouro Cave and the limestone massif which is the observation point of) and

c) the surroundings of the Lapinha Cave Massif. One can also suggest a new hiking trail which connects natural aspects and cultural heritage: the Sumidouro Lake – Water mill. This trail features three notable points subject to observation. This route starts at the Sumidouro Lake and ends at the Research Centre of the State Park. One can observe the major karst feature of the lake and its massif, as well as the creek which used to move the water mill in the past. At the beginning of the trail one can observe the polje and the dynamics of the Samambaia creek. In the middle of the route, tourists can observe the magnificence of the karst depression and its hum. Following the Samambaia creek the visitor arrives at the water mill which was used in the past for providing electricity to the farm. The trail has approximately 2.5 km and can be made on foot from the Casa Fernão Dias, one support base of the Sumidouro State Park.

Finally, it is believed that the geodiversity of the Sumidouro State Park may be the basis for the growth of geotouristic activities that should ensure conservation of geosites and regional landscapes. To ensure that these activities achieve success it is necessary to prepare strategies together with the local community, Park managers, visitors and the scientific community.

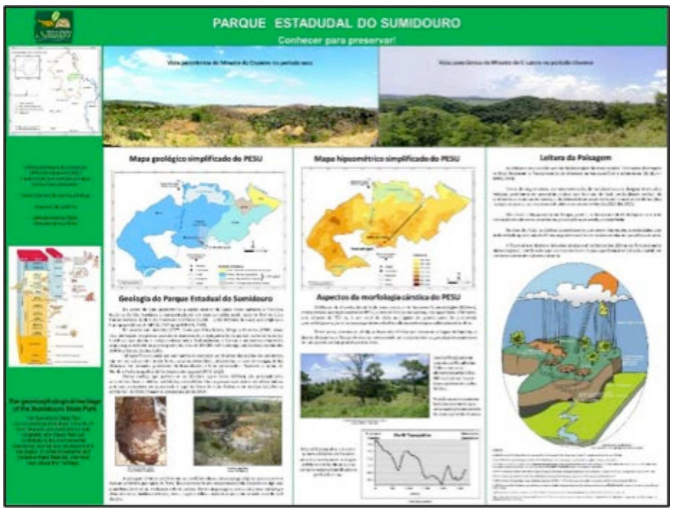
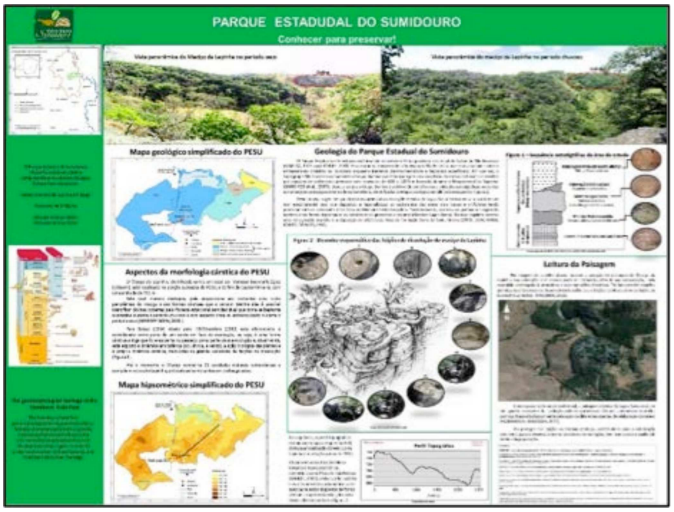
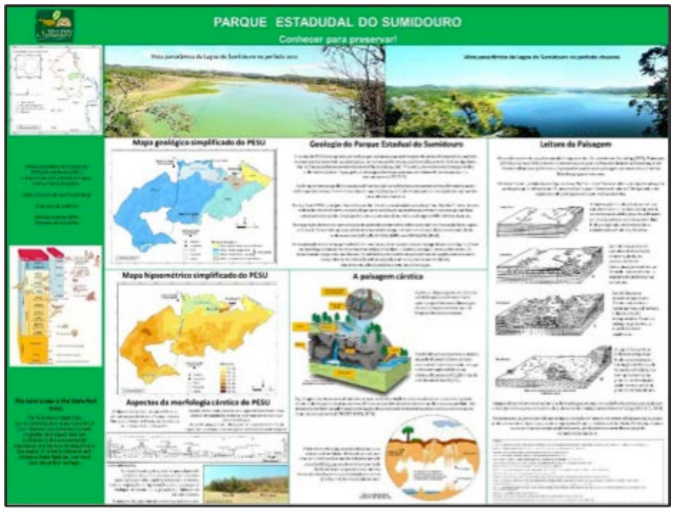


Figure 12 above and next page – Examples of information panels proposed by this work to the Sumidouro State Park. All panels describe the karst landscape with geological, geomorphological and hypsometric maps, as well as schemes, pictures and comprehensive texts.





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