ISSN 1980-5772
eISSN 2177-4307
10.18227/2177-4307.acta.v18i49.8137 ACTA Geográfica, Boa Vista, v. 18, n. 49, maio-ago. VI FISA, 2024. Pp. 230-246

Geomorphosite Hill of Horto (lookout type) and its geomorphological value (Geopark Araripe/CE)

Geomorfossítio Colina do Horto (tipo mirante) e o seu valor geomorfológico (Geopark Araripe/CE).

Geomorfosito de Colina do Horto (tipo mirador) y su valor geomorfológico (Geoparque Araripe/CE).

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Resumo
Os estudos geomorfológicos sobre a geodiversidade têm se mostrado uma importante base teórico-conceitual para a compreensão e conservação dos fatores abióticos da paisagem. Neste contexto, o presente trabalho tem como objetivo determinar o valor geomorfológico do geossítio Colina do Horto, no Geopark Araripe, Ceará, Brasil. Do ponto de vista metodológico, o geossítio foi classificado e valorizado como um geomorfossítio do tipo mirante com base em 11 parâmetros de valores científicos e estéticos. Como resultado, conclui-se que o Horto se configura como um ponto de vista de médio valor científico (10 pts.), estético (20 pts.) e, consequentemente, geomorfológico (30 pts.), permitindo uma visão geral do valor de a geodiversidade do geomorfossítio no contexto do Geopark Araripe.
Palavras-chave: Geodiversidade. Geomorfodiversidade. Avaliação Quantitativa.

Abstract
Geomorphological studies on geodiversity have proven to be an important theoretical-conceptual basis for understanding and conserving abiotic factors in the landscape. In this context, the present work aims to determine the geomorphological value of the Colina do Horto geosite, in the Araripe Geopark, Ceará, Brazil. From a methodological point of view, the garden was classified and valued as a lookout-type geomorphosite based on 11 parameters of scientific and aesthetic values. As a result, it is concluded that the Horto is configured as a viewpoint of medium scientific (10 pts.), aesthetic (20 pts.) and, consequently, geomorphological (30 pts.) value, allowing a general overview of the value of the geodiversity of the geomorphosite in the context of Geopark Araripe.
Keywords: Geodiversity. Geomorphodiversity. Quantitative Valuation.

Resumen
Los estudios geomorfológicos sobre la geodiversidad han demostrado ser una base teórico-conceptual importante para comprender y conservar los factores abióticos del paisaje. En este contexto, el presente trabajo tiene como objetivo determinar el valor geomorfológico del geositio Colina do Horto, en el Geoparque Araripe, Ceará, Brasil. Desde el punto de vista metodológico el geositio fue clasificado y valorado como geomorfosito tipo mirador con base en 11 parámetros de valores científicos y estéticos. Como resultado, se concluye que el Horto se configura como un punto de vista de valor científico medio (10 pts.), estético (20 pts.) y, en consecuencia, geomorfológico (30 pts.), permitiendo una visión general del valor. de la geodiversidad del geomorfositio en el contexto del Geoparque Araripe.
Palabras clave: Geodiversidad. Geomorfodiversidad. Evaluación cuantitativa.

Introduction

Geodiversity is a new area in geological studies and research that has been discussed and investigated by various authors (FALCÃO SOBRINHO, et al., 2020). It began to be disseminated by geologists in the 1990s and by geomorphologists in the early 21st century (GRAY, 2004; BRILHA, 2005). It is unclear where and how the concept was first referenced, but there is a supposition that the term geodiversity may have been used by Sharples (1993), Kiernan (1994), and Dixon (1995) in studies of geological and geomorphological conservation in Tasmania, Australia.

Gray (2004, p. 6), mentions that later, in the Australian Heritage Commission of 2002, geodiversity was defined as "the diversity of geological (substrate), geomorphological (landscape forms), and soil characteristics, as well as sets, systems, and processes." Thus, geodiversity would be the diversity of abiotic aspects, such as geological and geomorphological features, integrated into the landscape.

Geodiversity would then be "[...] the natural range (diversity) of geological (rocks, minerals, fossils), geomorphological (landforms, processes), and soil features. It includes their assemblages, relationships, properties, interpretations, and systems [...]" (GRAY, 2004, p. 8).

This concept is also attributed to other elements, such as (geo)conservation of an element by assigning values. Many researchers have provided various definitions of values and methods to consider certain rock foundations, landforms, or soil characteristics and processes as valuable and/or to inventory geosites. Sharples (2002) presents in one of his works on geoconservation, intrinsic value (or 'existence'), ecological value (or 'natural process'), and (anthropocentric or (geo)heritage) values centered on humans.

Given these assumptions, the study area is located in the Araripe Geopark (GA), in the southern portion of the State of Ceará. It was created in 2006 through initiatives of the Government of the State of Ceará and studies in partnership with the Regional University of Cariri (URCA),

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becoming the first geopark in the Americas recognized by the Global Geoparks Network (MOCHIUTTI et al., 2012).

The geopark encompasses six municipalities in the State of Ceará: Barbalha, Crato, Juazeiro do Norte, Missão Velha, Nova Olinda, and Santana do Cariri. Within these municipalities are 11 geosites, attributed to various types of values, including hydrological, paleontological, geological, and geomorphological aspects in the Araripe Sedimentary Basin, both in the plateau and depression of the sedimentary basin (Geomorphosite Hill of Horto). Thus, the main objective of this study is to determine the geomorphological value of the Geomorphosite Hill of Horto in the Araripe Geopark (Ceará).

Theoretical Framework

Geodiversity is understood by many authors as the association of various abiotic elements, with its evolution and reformulations in the approach of the concept by Gray (2004), Brilha (2005), and Nascimento (2008).

Brilha (2005) also emphasizes that geodiversity can encompass testimonies from a geological past (minerals, rocks, fossils) and can determine the evolution of civilization through human conditioning by the availability of food and the existence of climate conditions, shelter locations, and materials for construction and survival. It is worth noting that these elements are directly related to human activities.

According to Panizza (2009), geomorphodiversity is considered a critical and specific evaluation of the geomorphological characteristics of a territory. While geosites are the sites of geological interest in geodiversity, in geomorphodiversity, sites of geomorphological interest are termed geomorphosites, which can take on two typologies: landforms and viewpoints. According to Nascimento and Falcão Sobrinho (2020), geosites reflect the richness of geological and geomorphological heritage in certain municipalities or regions, comprising a set of elements that are part of the Earth's structure and crust.

Furthermore, geomorphosites can exhibit specificities; Reynard et al. (2004b, cited in REYNARD; CORATZA; REGOLINI-BISSIG, 2009) address three main characteristics: aesthetic dimension, dynamic dimension, and scale imbrication. The authors argue that in the aesthetic dimension, geomorphosites assume a central aesthetic value, and often some nature conservation policies qualify them as "natural monuments," so the evaluation of these sites cannot be based solely on the aesthetic dimension, which remains an additional dimension of geomorphosites.

Among the sites of geomorphological interest, viewpoints also stand out because they provide the contemplation of different landscapes based on their altitude in a local/regional context,

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which according to Nascimento (2008), may be associated with igneous and/or metamorphic rocks with more pointed features or sedimentary rocks associated with viewpoints in areas with flatter tops.

Thus, besides corresponding to a type of geomorphosite, viewpoints, according to Fuertes-Gutiérrez and Fernández-Martínez (2010), have their primary interest for geodiversity, in this case, being geomorphological. Panizza (2001, p. 4) defines a geomorphosite as "a landform to which a value can be attributed and becomes a geomorphological resource if usable by society."

Many researchers in geodiversity and geomorphodiversity themes systematize and develop methods for valuing geosites through scientific, aesthetic, touristic, cultural, and didactic values (DINIZ; ARAÚJO, 2022). With cartography, typological classification is used, such as point, section, line, area/surface, viewpoint, and complex areas/surfaces (FUERTES-GUTIÉRREZ; FERNÁNDEZ-MARTÍNEZ, 2010; PERRET, 2014).

Another important perspective in geodiversity studies is the quantitative valuation of geosites and geomorphosites, where they can be quantified with geodiversity values. Although there are different valuation methods (ARAÚJO; CHAGAS; DINIZ, 2021; PEREIRA, 2010), in the more specific case of viewpoint-type geomorphosites, the proposal of Diniz and Araújo (2022) stands out.

Araújo, Chagas, and Diniz (2021) in their research on geomorphological valuation in the Coastal Zone of Icapuí/CE, through scientific (seven parameters), aesthetic (five parameters), touristic (five parameters), and use and management (seven parameters) value categories. Totaling 24 criteria, with a score from 0 to 4, being performed through summation, with equal importance for all parameters. This method was developed to quantify geomorphological heritage and reduce subjectivity in other valuation and/or inventory techniques.

The authors used criteria from Tricart (1977) – ecodynamics of environments; Pereira (2006) – ecological interest; Reynard (2016) and Reynard et al., (2007) – paleogeographical value; Brilha (2016) with items such as diversity of geological aspects, which was changed to geomorphological aspects, observation conditions, scenery, limited use, and population density; and Brasil (2020) – touristic categories and other modifications in the parameters. These parameters fall within the criteria of Scientific Value, Aesthetic Value, Touristic Value, and Use and Management Value.

Adopting a methodology for viewpoints/miradouros/viewpoints, considering the interest in geomorphosites for geomorphological value, Diniz and Araújo (2022) offer a method. The authors emphasize that their criteria are classified from zero (0) to four (4), considering only panoramas and

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other views, visibility, spatial constructions for comfortable observation, geological, and cultural value.

Diniz and Araújo (2022) adapted the valuation methodology for geomorphosites in the process of construction and formation in the Serra dos Martins in the semi-arid region of Rio Grande do Norte. For the valuation of geomorphosites, three values were used: scientific value (VCi), aesthetic value (VEst), and additional value (VAd), containing within VAd, touristic, cultural, and didactic values.

The authors justify the use of this Geomorphodiversity valuation methodology (DINIZ; ARAÚJO, 2022, p. 13), stating that "

> [...] it provides a new way to evaluate the geomorphological heritage of viewpoints, attributing essential characteristics to the realities of these sites without underestimating their potential for geoconservation [...]".

In Diniz and Araújo's (2022) research, viewpoints were considered geomorphosite sites of high scientific value (>75%) and high aesthetic value (>75%). According to them, very low values are considered <25% of the total value, low values are between 25% and 50% of the total, medium values are between 50% and 75% of the total, and high values are 75% or more of the total. Diniz and Araújo (2022) conclude that "[...] thus, observation, analysis, and evaluation are not only of the site itself but also of the viewpoint, that is, what is visualized in the landscape".

Methodology

From a methodological standpoint, the research has an applied nature, with a quantitative and descriptive approach to its objective, as it proposes to apply a quantitative methodology to a specific geomorphosite, aiming to describe phenomena based on different analyzed parameters. It is structured in six steps.

The first step consisted of the theoretical foundation of the research's structuring concepts, such as geodiversity (BRILHA, 2005), geomorphosite (REYNARD; CORATZA; REGOLINI-BISSIG, 2009), geomorphological value (ARAÚJO; CHAGAS; DINIZ, 2021), quantitative valuation of viewpoint-type geomorphosites (DINIZ; ARAÚJO, 2022), and finally, their cartographic representation (FUERTES-GUTIÉRREZ; FERNÁNDEZ-MARTÍNEZ, 2010).

The second step, in turn, involved selecting the most expressive geomorphological-type geomorphosite in GA, according to the classification regarding the main interest of geodiversity by Fuertes-Gutiérrez and Fernández-Martínez (2010). From this classification, the Geomorphosite Hill of Horto in Juazeiro do Norte was identified as the one that best represents this category in the Araripe Geopark.

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In the third step, fieldwork was conducted in November 2022 to survey the area aiming to identify the main processes, materials, forms, and geomorphological agents involved in the configuration of the area, as well as to identify the different types of land uses, mapping the areas of interest through Geographic Information System (GIS) software, QGIS® Desktop 3.22.9.

The fourth step consisted of the quantitative valuation of the geomorphosite, based on the scientific and aesthetic values proposed by the methodology of Diniz and Araújo (2022), which totals 11 parameters that received scores from one to four, where the maximum score corresponds to the most positive indicators of each parameter for the geosites.

The scientific value (VCi) was determined from the sum of four parameters: diversity of visible geological/geomorphological features (forms and processes), representativeness, integrity, and paleogeographical value (Table 1).

Table 1 – Scientific Value (VCi).

CRITERION	DEFINITION
A1 – Diversity of visible geological/geomorphological features (forms and processes)	Number of geological/geomorphological elements visible in the visualized landscape.
A2 – Representativeness	Indicates the relevance of the site as a record of elements or processes related to the geomorphological evolution of the region and the context in which it is located, as well as the use of geomorphology for society.
A3 – Integrity	Indicates the degree of conservation of the visible area and the possibility of viewing aspects of interest.
A4 – Paleogeographic value	The importance of the object for the reconstruction of Earth's climate and history (e.g. Cenozoic tectonic relief) is assessed by this criterion

Source: Adapted from Diniz and Araújo (2022).

The aesthetic value (VEst), in turn, resulted from the integration of seven parameters: overall view, visibility of geological/geomorphological landscape features, verticality, presence of water bodies, contrast of colors and individual elements, visible area (km²), and rarity (Table 2).

Table 2 – Aesthetic Value (VEst).

CRITERION	DEFINITION
B1 – Overview	Angle from which you can observe the landscape.
B2 – Visibility of the geological/geomorphological characteristics of the landscape	Elements viewed in the landscape.
B3 – Verticality	Height at the viewpoint.
B4 – Presence of bodies of water	Existence of water in the landscape.
B5 – Contrast of colors and individual elements	Contrasting RGB colors of an ichnographic document and the presence of individual elements, such as an inselberg. Homogeneous landscape-composed of few and mostly similar

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	elements. Heterogeneous landscape - composed of a complex configuration of very diverse elements, many contrasting colors and/or vibrant colors in the landscape.
B6 – Viewable area (km²)	Area where you can observe the landscape from the viewpoint.
B 7 – Rarity	Importance of the visualized area of the site in terms of its geomorphological occurrence in the investigated area.

Source: Adapted from Diniz and Araújo (2022).

The fifth step consisted of determining the geomorphological value (ARAÚJO; CHAGAS; DINIZ, 2021) and classifying it according to the level of this value into four classes: very low (<25%), low (25 to 50%), medium (50% to 75%), and high (>75%) using the formula: VCi + VEst = VGeom.

Finally, in the last step, the geomorphosite was classified according to its typological category: point, section, area, viewpoint, and complex area (FUERTES-GUTIÉRREZ; FERNÁNDEZ-MARTÍNEZ, 2010).

The geomorphosite Hill of Horto is located in the municipality of Juazeiro do Norte/CE and is one of the 11 geosites of the Araripe Geopark. It has coordinates 7°10'47.4"S and 39°19'48.0"W. According to Nascimento, Silva, and Moura-Fé (2020, p. 123), it is characterized as follows:

> Geosite Hill of Horto (Juazeiro do Norte): Geologically, it comprises the oldest rocks in the territory of the Araripe Geopark, consisting of granites (light-colored rocks with the presence of feldspars and quartz as main minerals) and diorites (dark-colored rocks with the presence of biotite and amphibole as essential minerals). These rocks represent the crystalline basement of the sedimentary rocks of the Araripe Basin, punctually overlain by rocks from the base of the basin, correlated with the Cariri Formation. This basement was formed about 650 million years ago, several kilometers deep, and has since undergone tectonic and erosive processes, being partially exposed on the surface as outcrops and numerous blocks. [...]

In light of these aspects, the geomorphosite was valued scientifically and aesthetically using the methodology (Figure 1) for valuing viewpoints by Diniz and Araújo (2022).

Scientific Value

Aesthetic Value

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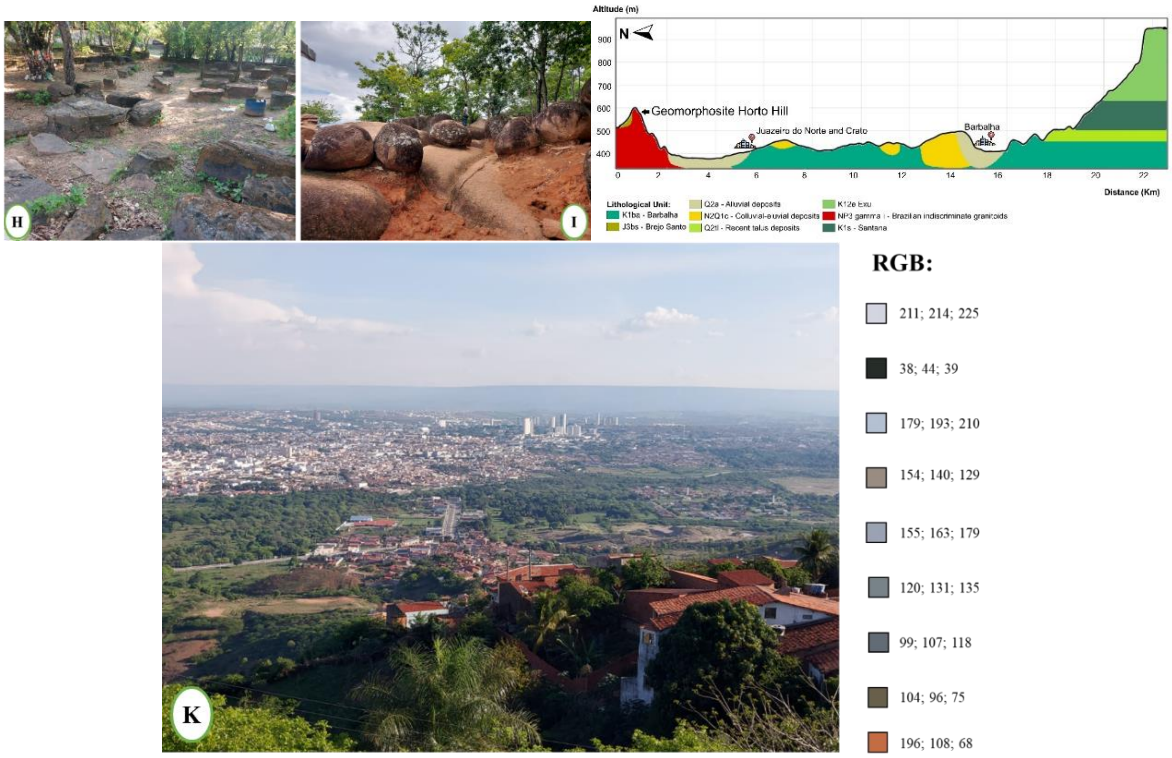

Figure 1 – Scientific and Aesthetic Values.

Source: Authors' collection (2022/2023).

The first parameter, of scientific value, evaluated is the visualization of geological/geomorphological diversity and its characteristics, both the forms and the processes (A1). The Hill of Horto presents three visible elements in the landscape, scoring 1. The horto is located in the depression of the Araripe sedimentary basin.

The three visible elements in the landscape are specific features and processes such as the split rock, the Stone of Sin (A), which are "[...] secondary fractures (i.e., shearings not involved in the delineation of block jointing) within the original mass [...]" (TWIDALE; VIDAL ROMANÍ, 2005, p. 262, our translation), the field of large rocks present in the Trail of the Holy Sepulcher (B), and thermoclasty, erosion through physical weathering in rocks due to layer fracturing (C).

The second parameter to be evaluated is representativeness (A2), which is directed at the relevance of the site as a record of elements or processes related to the geomorphological evolution of the region and the context in which it is inserted, as well as the use of geomorphology for society. It scored 3, for presenting elements of land use for society, the religious use of the Horto for prayers and Catholic worship influenced by Padre Cícero (D); occupation (E) on the crystalline basement of the inselberg (2) and the use of sandstone rocks in constructions (1) on the crystalline basement; fracturing process in the rocks of the Trail of the Holy Sepulcher of the Hill of Horto (F); and the use of rocks in the Holy Sepulcher as a religious request (F).

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The third parameter, integrity (A3), indicates the degree of conservation of the visible area and the possibility of visualizing aspects of interest. Since its observable area presents anthropic alteration but does not limit the visualization of the features of interest, as mentioned earlier, it scored 3. The geomorphological aspects are visualized in the Horto and the trail, such as the smaller large rocks, which are in the Horto, and the larger large rocks together with the erosive processes, already mentioned, in the Trail of the Holy Sepulcher.

The fourth and last parameter, of scientific value, is the paleogeographical value (A4), which corresponds to the importance of the object for the reconstruction of Earth's climate and history. As it is a significant area for local paleogeographical understanding that can be visualized, it scored 3. As mentioned earlier, being the base of the Araripe Sedimentary Basin, recording the large rocks and the horto itself that was exposed in the form of an inselberg. According to Lino and Moura-Fé (2020, p. 3):

> The Hill of Horto is a small massif and comprises, lithologically, the oldest rocks in the southern region of Ceará, composed of granites (light-colored with the presence of feldspars and quartz as main minerals) and diorites (dark-colored, with the presence of biotite and amphibole as essential minerals) [...]

Even with these mentioned aspects, there are other geomorphological processes that result in paleogeographical understanding present in this geomorphosite, the first starting where the horto is located, containing darker granite rocks (H), and the second where the Stone of Sin is located (on the Trail of the Holy Sepulcher) with reddish granites (I), originated from the pluton process, characterized as a saprolitic relief.

In these areas, large rocks, the result of the exhumation of the granitic pluton, can be observed, that is, a body of igneous rock with characteristics of deep intrusion such as laccoliths, batholiths, and stocks (WINGE, 2001, online), demonstrating a paleogeographical record of the formation of these witness rocks among the inselbergs (Hill of Horto and the Trail of the Holy Sepulcher) that emerged in the sedimentary basin.

The colors of the granites are due to the fact that it is a region of contact between two groups, the Logradouro Pluton, the Hill of Horto, and the Santo Sepulcher Pluton, the Trail of the Holy Sepulcher, marked by intrusive contacts, such as magmatic breccias formed by angular clasts isolated by a network of hololeucocratic veins of various orientations (ALENCAR, 2022).

This coloration is associated with the minerals present in the pluton process of the two inselbergs. The Logradouro Pluton where the Horto is located comprises the predominant intrusion, and the largest occurrence area, is marked "[...] by whitish-gray to pinkish-gray granitoids of medium grain size [...]" (ALENCAR, 2022, p. 86).

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On the other hand, the Santo Sepulcher Pluton, where much of the trail is located, the rocks are characterized as:

> "[...] biotite leucogranites to strictly hololeucogranites ranging from pink to reddish-pink, which were separated into four facies according to their grain size and texture: The main facies of the pluton, called Se1, is characterized by leucocratic/hololeucocratic biotite monzo- to syenogranites with a coarse porphyritic texture marked by phenocrysts of K-feldspar, predominantly sub-idiomorphic and rich in inclusions, in a matrix composed of quartz, plagioclase, and biotite without a defined fabric. [...] Subvertical veins of muscovite, albite, and milky quartz are commonly found in this facies, especially near the edge [...]" (ALENCAR, 2022, p. 96).

It can be concluded that the Hill of Horto geomorphosite has significant paleogeographical value in its local evolution, with its visible elements already mentioned in other analyzed parameters.

For aesthetic value, the first parameter evaluated is the overall view (B1), which is the angle from which the landscape can be observed. The Hill of Horto scored 3 because the panorama is observed from two sides between approximately 120° to 180°. With characteristic of a viewpoint, one can observe the landscape of the three municipalities that make up a conurbation - Crato, Juazeiro do Norte, and Barbalha, known as Crajubar, and in the background, the Chapada do Araripe.

The second parameter evaluated is the visibility of geological and geomorphological characteristics of the landscape (B2), that is, the elements observed in the landscape, which can indicate the relevance of the site as a record of elements or processes related to the geomorphological evolution of the region and the context in which it is inserted, as well as the use of geomorphology for society. It scored the highest, 4, as it has an excellent view of all the details observed, as mentioned in the scientific value in the criteria of diversity of geological and geomorphological features, and integrity.

The third parameter evaluated is verticality (B3), which is scored according to the height of the viewpoint. Since the geomorphosite Hill of Horto is on an inselberg, it has a lower altitude than in relation to the Chapada do Araripe to the south, it scored lower, 3, as a consequence, the verticality (J) is lower.

The fourth parameter evaluated is the presence of water bodies (B4) in the landscape. Since the hill is located at one end of the Araripe Sedimentary Basin, there are no water bodies at the viewpoint, it scored 1.

The fifth parameter evaluated is the contrast of colors and individual elements (B5), which is the Red-Green-Blue (RGB) color contrast, which can be a homogeneous or heterogeneous landscape. Since the Hill of Horto is located in the urban perimeter, it obtained the maximum score of 4, due to the heterogeneous landscape by color contrast, accounting for 7 contrasts (K). This

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heterogeneity is associated with a complex configuration of very diverse elements and contrasting colors, due to the demographic occupation in the geomorphosite.

The sixth parameter evaluated is the visible area (km2) (B6), which is the area where the landscape can be observed from the viewpoint. It scored 3, as it stands out with a viewing area of approximately 400 km², with the possibility of observing elements already mentioned in the paleogeographical value criterion of the scientific value.

The last and seventh parameter evaluated is rarity (B7), highlighted by the importance of the visualized area of the site in its geomorphological occurrence. Since it is a granitic feature that emerged in the depression of the sedimentary basin, its visualized occurrence area is common in the study area, between 6 and 10 formations with similar characteristics in the area, within the same geomorphological context in a radius of 200 km, therefore, it scored 2. Since it is a radius that extends to the inselbergs seen in the municipality of Quixeramobim.

Adopting the classification of geomorphological value (ARAÚJO; CHAGAS; DINIZ, 2021), based on scientific and aesthetic values (DINIZ; ARAÚJO, 2022), the analyzed geomorphosite obtained the following scores according to Table 3 below.

Table 3 – Scientific and aesthetic value scores.

SCIENTIFIC VALUE					
Parameter	**Punctuation**				**Total**
	A1	**A2**	**A3**	**A4**	
	1	3	3	3	**10**
Classificação					
Very low					**1-4**
Low					**5-8**
Average					⇨ **9-12**
High					**13-16**

AESTHETIC VALUE								
Parameter	**Punctuation**							**Total**
	B1	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	
	3	4	3	1	4	3	2	**20**
Classification								
Very low								**1-7**
Low								**8-14**
Average								⇨ **15-21**
High								**22-38**

Source: Prepared by the authors.

The 10 points obtained in the quantitative assessment of the scientific value reveal a geomorphosite of medium value, with positive highlights for the parameters representativeness (A2), integrity (A3), and paleogeographic value (A4), while the negative highlight was the diversity of geological/geomorphological features (A1), with only three visible elements in the landscape among the mentioned forms and processes.

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The aesthetic value, on the other hand, was quantified with 20 points, with positive highlights for the parameters visibility of geological/geomorphological characteristics of the landscape (B2), contrast of colors and individual elements (B5), overall vision (B1), verticality (B3), and visible area (km²).

The negative highlight in the evaluation lies with the parameters of the presence of water bodies (B4) and rarity (B7). The latter, as mentioned earlier, is a common feature in its visualized area of occurrence, where between 6 and 10 formations with similar characteristics can be observed within a radius of 200 km. Regarding water bodies, the methodology needs to be adjusted for the valuation of viewpoints in inland areas, therefore far from the coast, as it assigns maximum value only to viewpoints capable of ocean visualization.

In terms of geomorphological value, obtained from the sum of scientific and aesthetic values, the Horto obtained 30 points (Table 4), thus being classified as a geomorphosite of medium value, maintaining the classification of the previous base values.

Table 4 – Geomorphological value of the geomorphosite.

GEOMORPHOSITE	VALUES		TOTAL
	VCi	VEst	
Horto Hill	10	20	**30**
Classification			
Very low			**1-11**
Low			**12-22**
Average			⇨ **23-33**
High			**34-44**

Source: Prepared by the authors.

The medium geomorphological value of Colina do Horto is associated with its peculiar characteristics, such as the religious use of the inselberg, the paleogeographic value as a significant area for local paleogeographic understanding, being the base of the Araripe Sedimentary Basin; the visibility of geological/geomorphological characteristics of the landscape, and the contrast of colors.

From the typological category perspective of geosites, classified by Fuertes-Gutiérrez and Fernández-Martínez (2010) as point, section, area, viewpoints, and complex areas, we confirm that the geomorphosite named Horto is a complex area, as it presents the following peculiarities observed in Figure 2 below.

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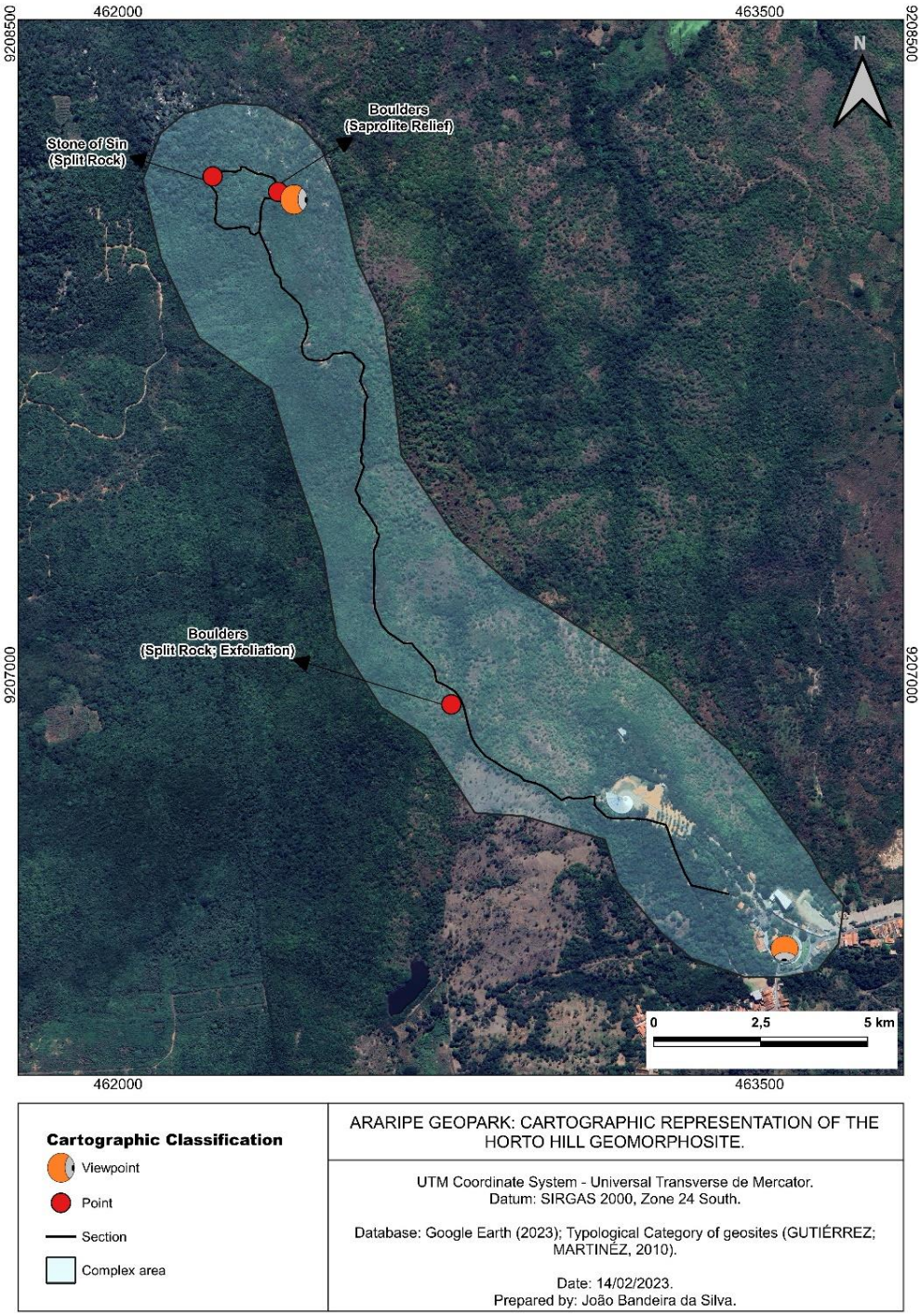

Figure 2 - Cartographic representation of the Horto hill geomorphossite

Source: Organized by the authors.

The Colina do Horto and its geomorphological and geological characteristics have been overlapped by the occupation and appropriation of the population through religion. Nevertheless, its medium value is associated with peculiar characteristics of a Complex Area, not only for presenting elevated points for landscape visualization like the viewpoint where the statue of Padre Cícero is located and the viewpoint at the end of the Santo Sepulcro Trail, but also for presenting, along the Santo Sepulcro Trail (Section), various elements of geomorphodiversity such as large rocks (Points)

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that are susceptible to erosion and weathering processes, like split rock fractures and the Pedra do Pecado.

The classification of geosites and geomorphosites regarding their typology is of paramount importance for selecting geoconservation strategies for geopatrimony, which, in the case of viewpoints, concern both the observation point and the area to be observed.

Conclusions

Based on the results of the present study, it is concluded that quantitatively assessing the geomorphological value of geodiversity is a significant challenge, primarily from a methodological standpoint, as forms and processes of different origins and scales, some determined from subjective parameters, complicate valuation.

In the valuation process, it is concluded that Colina do Horto is configured as a viewpoint-type geomorphosite with medium scientific, aesthetic, and consequently geomorphological value, which, combined with other values such as tourism, educational, and cultural proposed by the methodology of Diniz and Araújo (2022), provide an overall panorama of the valuation of the geodiversity of the analyzed geomorphosite.

Regarding the adopted methodology, some difficulties were recorded, mainly regarding subjectivity and the different criteria adopted in the same parameter, therefore requiring adjustments and greater methodological application in other geomorphological contexts for validation and consolidation of studies on geomorphodiversity and geomorphological heritage in the context of Geomorphology.

Acknowledgments

Acknowledgments to the Foundation for Support of Scientific and Technological Development of Ceará (FUNCAP).

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