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Review Article

The Caminhos dos Cânions do Sul UNESCO Global Geopark (Brazil) in scientific literature: A review

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ABSTRACT

This research seeks to analyse scientific literature pertaining to Caminhos dos Cânions do Sul UNESCO Global Geopark (CCSUGGp) from 2007 to August 2024. The investigation involved searches utilizing the following keywords: "Geopark Caminhos dos Cânions do Sul," "Geoparque Caminhos dos Cânions do Sul," and "Southern Canyons Pathways." The databases accessed for this purpose included Google Scholar, Scielo, Scopus, Web of Science, Digital Library of Theses and Dissertations, Spell, and Oasis/IBICT. A total of 198 works were documented, and through the application of the established inclusion and exclusion criteria, 29 scientific articles were identified and examined in both national (Brazilian) and international journals that conducted direct research within the CCSUGGp. A significant portion of the articles emphasized geosciences, while geotourism and education were addressed subsequently. An increase in scholarly works was observed following the international acknowledgment of the region. The municipalities within Santa Catarina State have become pivotal centres for research endeavours. Although this newly established model of territorial management in Brazil is relatively recent, the UNESCO Global Geopark demonstrates considerable potential for scientific inquiry.

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1. Introduction

UNESCO Global Geoparks (UGGps) represent the most recent regions that promote sustainable development from a comprehensive vision, considering education, local development, scientific research, as well as the preservation and advancement of natural and cultural heritage (Rosado-González, Sá, & Palacio-Prieto, 2020, with references therein).

According to the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2023), UGGps are single, unified geographical areas where sites and landscapes of international geological significance are managed with a holistic concept of protection, education, and sustainable development.

It is crucial to highlight that a UGGp is a delimited area that encompasses not only geological heritage sites, but also the surrounding territories and communities (Martini et al., 2021; Mc Keever & Zouros, 2005; Rosado-González, Palacio-Prieto, & Sá, 2020; Rosado-González, Sá, & Palacio-Prieto, 2020; Stoffelen, 2019). Due to the collaborative efforts of the global community, numerous regions have endeavored to submit applications for UGGp designation, commonly known as the "new territories of the 21st century" (Sá & Silva, 2019). The application process for a territory to join the Global Geoparks Network (GGN) requires the existence of a management structure that guarantees conformity and compliance with the criteria established by UNESCO. Until July of 2024, UNESCO and the GGN have recognized 213 UGGps in 48 different countries worldwide (GGN, 2024).

The incorporation of Brazil territories into the GGN contributes to promoting policies and initiatives for sustainable territorial development (Silva et al., 2024). The UNESCO International Geosciences and Geoparks Program (IGGP) has designated 6 territories as UGGps in Brazil until 2024. The first of them, located in the State of Ceará in the Northwest of Brazil, was the Araripe UGGp in 2006. Following this, the Caminhos dos Cânions do Sul UGGp (Rio Grande do Sul and Santa Catarina) and the Seridó UGGp (Rio Grande do Norte) achieved the recognition in 2022. Subsequently, in 2023, the UGGp designation was given to two additional territories, Caçapava UGGp and Quarta Colônia UGGp, both situated in the State of Rio Grande do Sul. Finally, Uberaba UGGp, located in the state of Minas Gerais, also received approval to become a UGGp in 2024.

Geoparks in Brazil have been in development since the early 2000s, and their prominence has grown in recent years, leading to a rise in scientific studies conducted within these areas. In this context, Pérez-Romero, Álvarez-García, Flores-Romero, and Jiménez-Islas (2023) performed a bibliometric analysis that highlighted the global rise in scientific investigations taking place within UGGps. The authors identified Brazil as the fourth leading nation in terms of scientific output concerning the subject of UGGps.

In a similar context, Conti, Elicher, and Lavandoski (2021), in their bibliometric study on scientific tourism, emphasized the potential of the "geopark" concept in Brazil and its strong connection to scientific research in the field of scientific tourism. The main area of focus in this research was centered on geotourism.

On the other hand, Silva and Pioker-Hara (2022) conducted a study focusing on the predominant themes in publications related to UGGps and aspiring UGGps in Brazil. Their research highlighted that the primary emphasis of current studies in these Brazilian territories revolved around geotourism and geosciences.

Furthermore, Rodrigues, Affonso, and Nascimento (2022) supported the findings of those researchers by providing a comprehensive analysis of geotourism publications in Brazil, emphasizing the significance of this research area in the establishment of geoparks.

This study is positioned within this framework, with the primary aim of analysing academic articles produced in the Caminhos dos Cânions do Sul UNESCO Global Geopark (CCSUGGp). Considering that this UGGp is among the most recent in Brazil, it is essential to first comprehend the scientific research being undertaken within its boundaries. Although the CCSUGGp is relatively new, the concepts that lead to its establishment began in 2007. This UGGp took its current form in 2017, culminating in its approval by UNESCO in 2022. Consequently, scientific research has been conducted in this area for over a decade, as highlighted in the findings of this study.

Consequently, several research questions were formulated for this study to provide a framework for analysing the results and discussions. The primary inquiry was "what is the volume and trend of publications related to CCSUGGp, and what are the key scientific investigations conducted in this area since its inception?"

In effect, it is essential to examine the temporal progression of research by identifying which specific fields have seen advancements through academic contributions, determining if a consistent trend has developed over time, or if the publications have displayed thematic diversity. Additionally, it is essential to identify the main researchers active in this field, along with their geographical and academic backgrounds. Furthermore, an examination of the journals predominantly utilized by these researchers for disseminating their findings is necessary, taking into account the quality, scope, and language of the research presented. This research underscores its significance in addressing a deficiency in this area concerning the emphasis of the work conducted. This will help to identify new research opportunities and promote diversification, contributing to the ongoing expansion of scientific knowledge within this territory.

2. Material and methods

2.1. Study area

Within the CCSUGGp, it is possible to study and understand the geological, geomorphological, cultural, biological, paleontological, and other landscape aspects of the territory, from a perspective that encourages the diverse scientific research typical of a

UGGp. The delimitation of this area began in 2007, with a project led by João José de Matos, mayor of Praia Grande (Santa Catarina). This initiative focused on promoting research, environmental safeguards, and economic investments in the mentioned municipality. This vision was endorsed by multiple local and regional authorities who championed the development of the project (Appendix A; Sung, Beltrão, Melo, Silva, & Cristiano, 2019; Dos Santos et al., 2023).

Drawing upon the works conducted by Intermunicipal Public Consortium Caminhos dos Cânions do Sul (CPICCS), the aspiring UGGp received two evaluators in November 2021 to assess the project. Following the evaluation, they reported their findings and recommendations regarding the area. Subsequently, the UNESCO Geoparks Council approved the application in December 2021, which was officially confirmed during the 214th session of the UNESCO Executive Council in April 2022. The project initiated in 2007 was ultimately acknowledged as a region of global geological significance and officially integrated into the GGN.

Currently, CCSUGGp is made up of seven municipalities, with four situated in Santa Catarina State (Praia Grande, Morro Grande, Timbé do Sul, and Jacinto Machado) and three in Rio Grande do Sul State (Torres, Mampituba, and Cambará do Sul), creating a territory covering a total area of 2,830 km^2 (Fig. 1).

In terms of geological and geomorphological characteristics, the CCSUGGp is notable for its extensive variety of structures, lithologies, relief forms, and unique geomorphological processes (Rapanos & Valdati, 2024).

From a geological heritage perspective, this territory is home to one of the most significant magmatic events in Earth's history (135–119 Ma), characterized by volcanic activities that span a considerable portion of the region and are linked to the fragmentation of the Gondwanan continent (Dantas, Goulart, Jacques, Almeida, & Krebs, 2005; Godoy, Binotto, & Wildner, 2011). The magmatic occurrences within the CCSUGGP region are exemplified by the presence of various magmatic rocks, including basalts, diabases, and rhyolites, which constitute the Serra Geral Group.

The CCSUGGp territory is situated within the Paraná-Etendeka Sedimentary Basin, featuring various compartments and topographical forms that reflect the regression of the Serra Geral escarpment (Godoy et al., 2011; Valdati, Bechtel, Gomes, Ricetti, & Weinschütz, 2024a; Valdati, Furtado, & Provedan, 2024b). Within the CSSUGGp, the Paraná-Etendeka Basin is distinguished by

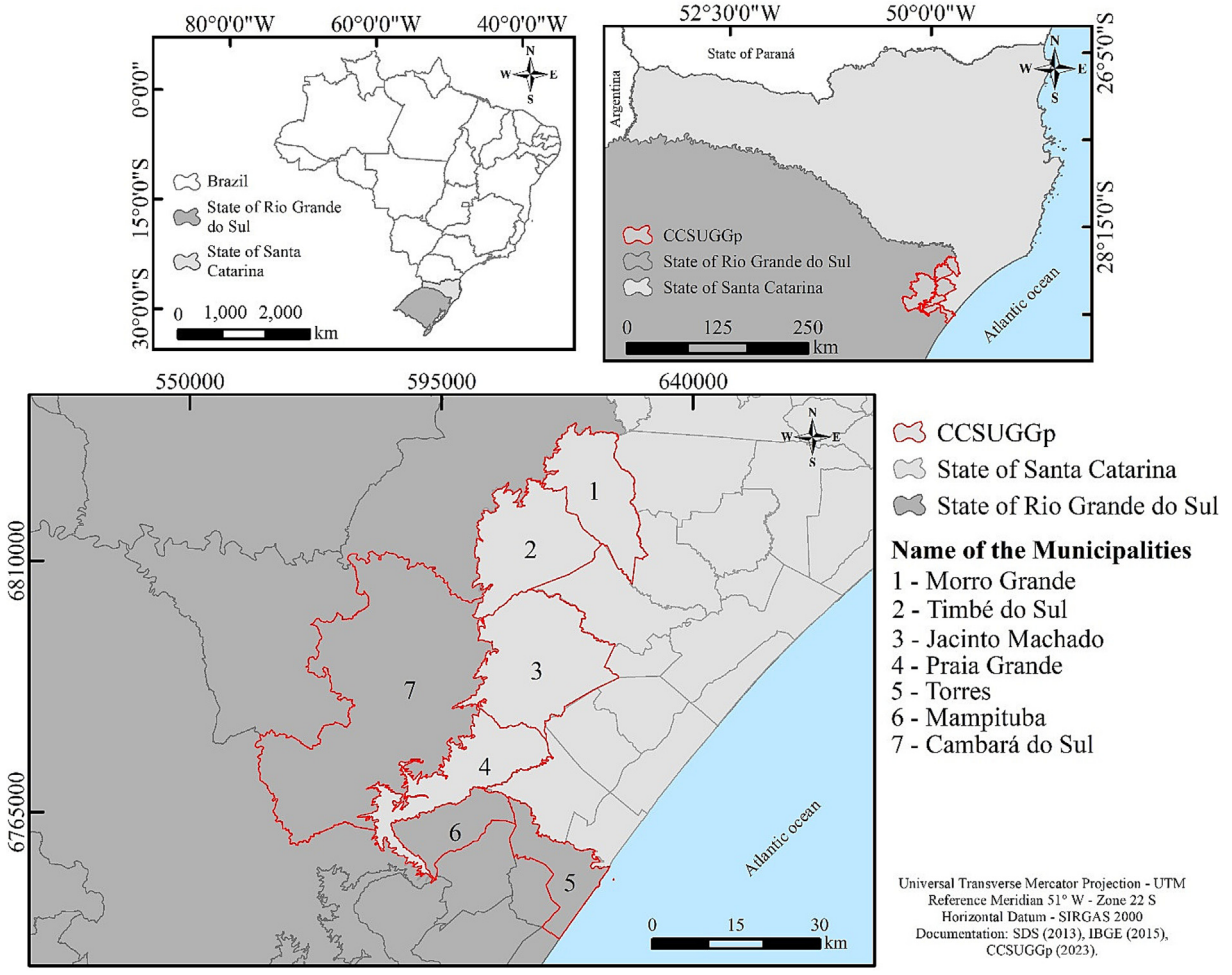

Fig. 1. Geographic location of CCSUGGp, Brazil.
Source: Authors, 2022.

the stratification of sedimentary rocks from the Rio do Rasto Formation, which includes claystones, siltstones, and fine sandstones that have emerged from diverse depositional environments. Overlying these formations are the sandstone deposits of the Botucatu Formation, which are the result of aeolian processes. The escarpment is underpinned by magmatic rocks from basic flows, primarily composed of basalts from the Serra Geral Formation (Valdati, Furtado, & Provedan, 2024b).

More recently, Rapanos, Valdati, and Gomes (2022) identified two additional morphosculptural units (Coastal Plain and Serra Geral Magmatism) along with six distinct morphosculptural units, which encompassed the Coastal Plain, Colluvial-Alluvial Plain, Serra Geral Plateaus, Rio Antas Dissected Plateau, and Serra Geral Plateau.

The region, when examined through a geomorphological lens, exhibits a topography that has been notably shaped by the retreat of the Serra Geral escarpment. This landscape encompasses various geomorphological units, including the Campos Gerais Plateau, the Serra Geral, the Serra Geral Plateaus, the Colluvial-Alluvial Plain, and the Coastal Plain (Catarina, 1986).

This escarpment features slopes that ascend to 1,000 m and is situated less than 50 km from the coastline. Over time, a vigorous process of dissection has taken place in this region, resulting in the formation of a series of deeper canyons that have not only characterized the landscape for many years but have also emerged as significant tourist attractions (Godoy et al., 2011; Rapanos et al., 2022). The total area encompassing these canyons spans approximately 250 km (Godoy et al., 2011). Fig. 2 illustrates various examples of canyon formations within the region, which are designated as Sites of Geological Interest (SIG) located in the CCSUGGp.

Valdati, Furtado and Provedan (2024b) also emphasized that in addition to the geological substrate and geomorphological processes shaping the reliefs and landscapes of the CCSUGGp, there was a notable presence of diverse cultural dimensions linked to land use. This encompassed widespread agricultural activities, especially irrigated rice farming and livestock rearing, which collectively contributed to a blend of natural and cultural characteristics, enriching the member municipalities with a remarkable variety of landscapes of significant value.

2.2. Methodology

This study employed a bibliographic review methodology, which was defined by a qualitative, exploratory, and descriptive framework, focusing on the scientific literature pertaining to the CCSUGGp region. In order to fulfil the primary aim of the research, a systematic approach was implemented involving a comprehensive search of databases. The time frame established for the review of academic literature extended from 2007 to August 2024, encompassing the inception of the CCSUGGp initiative up to its international designation.

The research utilized various scientific databases including Google Scholar, Scielo, Scopus, Web of Science, Digital Library of Theses and Dissertations (the Brazilian database of Postgraduate Programs, acronym in Portuguese BDTD), Speel, and Oasis

Fig. 2. Canyons at CCSUGGp. a. Cânion Fortaleza geosite, Serra Geral National Park. b. Malacara Canyon geosite. c. General overview of Itaimbezinho Canyon geosite, Aparados da Serra National Park. d. Observation deck of Itaimbezinho Canyon geosite, Aparados da Serra National Park.
Source: CCSUGGp, 2023.

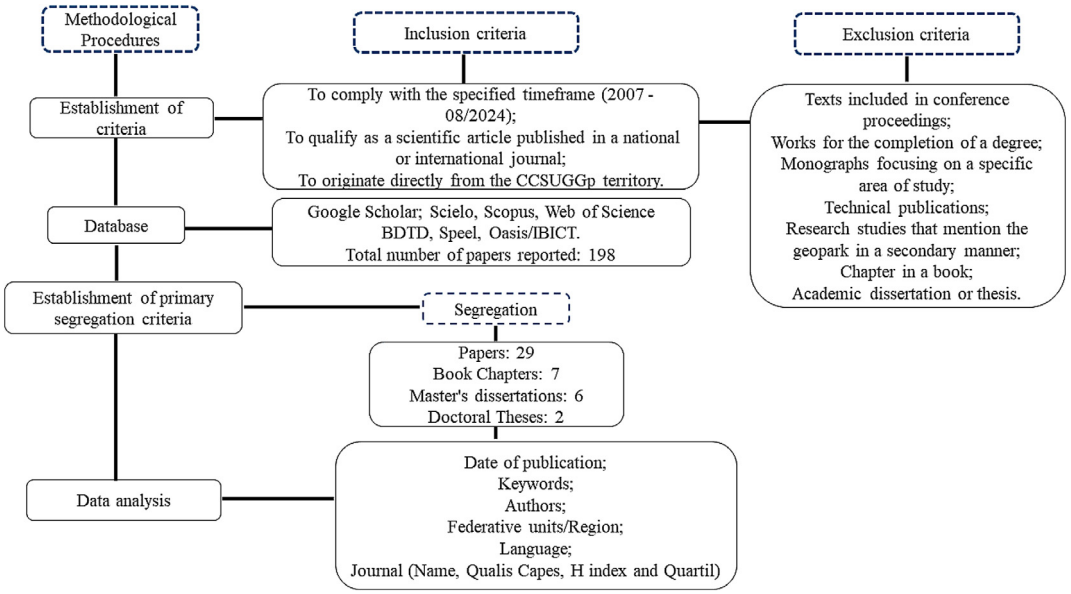

Fig. 3. Methodological flowchart of the research.
Source: Authors, 2022.

(Brazilian database of Brazilian Institute of Information in Science and Technology, acronym in Portuguese IBICT) in order to conduct a thorough search across the consulted databases. The search was conducted using the keywords "Geoparque Caminhos dos Cânions do Sul," "Geopark Caminhos dos Cânions do Sul," and "Southern Canyons Pathways",

It is important to highlight that a consistent search pattern was employed across all consulted databases, utilizing the aforementioned keywords. The two forms of registration were adopted to encompass both national (Brazilian databases) and international databases. Additionally, the rationale for searching these terms was supported by the observed lack of standardization in the terminology associated with research conducted on UGGps.

Specific criteria for selecting the works were established based on the methodological flowchart provided (Fig. 3).

The works were classified into articles, book chapters, dissertations, and theses. A total of 198 works were reported in the research across all databases, and after the exclusion criteria were applied, 44 works remained (22.2% of the initial sample universe).

The classification resulted in a descending order: articles (29), book chapters (7), master's theses (6) and doctoral dissertations (2). However, to provide more detailed analysis, only articles published in journals were included based on the exclusion criteria, which accounted for 14.6% of the initial sample size. Thus, we have obtained a sufficient sample for the purpose of this study.

It is important to highlight that the substantial quantity of reported works can be attributed to the thoroughness of the search, which encompass the aforementionated databases. Nevertheless, this study focused exclusively on articles published in peer-reviewed scientific journals, as it was posited that such publications offerred enhanced reliability concerning their content. Consequently, specific inclusion and exclusion criteria were established for the works reported.

The Mendeley Reference Manager software (version 2.118.0) was employed for arranging the downloaded references and previous analysis. Additionally, the VOSviewer software (version 1.6.20) was used to support the analysis by constructing and showcasing bibliometric maps, and also to recognize clusters and their reference networks (Perianes-Rodriguez, Waltman, & van Eck, 2016).

The software utilized in this study employed a dual strategy of mapping and grouping to present a comprehensive analysis of research themes within the collection of identified publications (Duarte, Braga, Marques, & Sá, 2020; Waltman, van Eck, & Noyons, 2010). The bibliometric maps developed in this research pertained to amalgamations of co-authorship and keywords.

3. Results

3.1. Description of reported studies

The total number of publications identify for the study period is shown in Fig. 4. There is a notable rise in the number of publications about the CCSUGGp, reaching its highest point in 2022.

The CCSUGGp project was initiated in 2007; however, the first scientific publication in journals did not emerge until 2012. This first publication was carried on the geopark area, particularly in the municipality of Timbé do Sul, and this research was about paleoburrows ichnofossils.

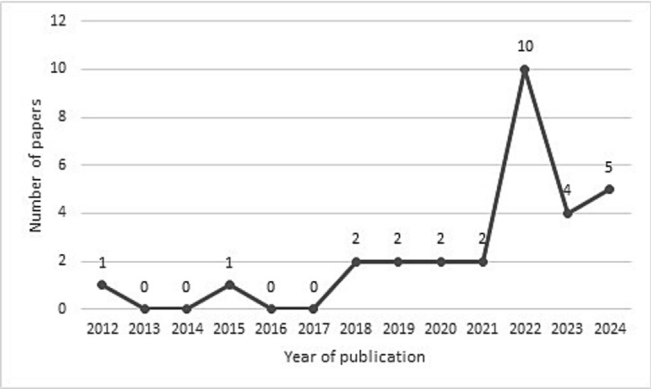

Fig. 4. Total publications in the CCSUGGp.
Source: Authors, 2024.

It is important to highlight that Schipanski, Santos, Martello, and Vogel (2021) explained that paleoburrows were naturally formed caves resulting from the excavation efforts of Pleistocene megafauna, serving as potential long-term or short-term shelters for these animals. The research outlined referred to the paleoburrow known as "Toca do Tatu" and examined how it was excavated by the megafauna that once inhabited the area, as well as the evidence of its use for housing by indigenous populations in the region. The engravings found at this site served as crucial archaeological records, shedding light on the past and providing valuable insight into human occupation in the area. The geosite features related to the initial study documented within the CCSUGGp area are illustrated in Fig. 5. Paleoburrows at CCSUGGp were part of a group of three officially cataloged geosites of this type that were accessible for visitors.

However, visits to these sites were related to their deterioration displayed in recent inscriptions on walls unearthed in easily eroded sedimentary rocks. Regarding CCSUGGp, the authors emphasize that:

"The establishment of a geopark in the region will further enhance the conservation of the speleological and archaeological heritage in the future. The proposed geopark, named "Caminhos dos Cânions do Sul," is currently being put forward by the Brazilian Mineral Resources Research Company (CPRM)" (Frank et al., 2012, p. 99).

No publications were reported during the 2013–2014 period, while only one was identified in 2015. This provides insight into the regional planning considerations for the geopark project, emphasizing its potential as a tourist attraction and its capacity for local development.

In this context, Rosa, Rocha, and Marimon (2015) emphasized the potential benefits of a well-planned geopark for the communities involved, refering to the potential of attracting visitors to engage with geotourism activities.

In 2018, two papers were published, discussing the municipality of Praia Grande. The first article focused on the tourism industry in this municipality, analysing secondary data to describe tourism resources. It emphasized the increase of accommodation options (hotels, hostels, inns) and dining establishments (restaurants, snack bars, ice cream parlors, rural cafes). The study covered the years from 2000 to 2015 (Lins & Rocha, 2018).

Another publication alluded to the geoconservation of the Malacara geosite, which corresponded to a 2 km trail along the Malacara River in the homonymous canyon. This trail standed out as a first-class geosite of the CCSUGGp. In this sense, Amaral and Beltrão (2018) established a database containing details about this attraction through a complimentary smartphone application. Initiatives such as this were highly appreciated in UGGps, given the growing digitalization of societies, since online information is easily spread.

Two more articles were published in 2019. The first one delved into the governance process of the CCSUGGp, mapping out a historical trajectory of the geopark's territorial delineations from its inception until the dossier submission to UNESCO. The authors underscored the creation of the Intermunicipal Consortium as a key accomplishment for the territory, encouraging the application process, and as the management structure of the CCSUGGp (Sung et al., 2019).

The second paper delved into the discussion of issues associated with geoeducation as a strategy to promote geotourism in the territory (Pereira Júnior, Gomes, Bondan, & Beltrão, 2019). At this point, it is important to mention that, in the context of UGGps, geotourism is understood as "tourism which sustains and enhances the identity of a territory, taking into consideration its geology, environment, culture, aesthetics, heritage and the well-being of its residents" (Organizing Committee of the International Congress of Geotourism, 2011).

In 2020, two publications emerged. One analysed the UGGp concept among students and professors in the region of Mampituba municipality (Carvalho, Silva, & Silva, 2020). This study aimed to determine if these students understood the CCSUGGp as a local development strategy with international recognition. The authors emphasized that education played a crucial role in the establishment of a UGGp. Crofts et al. (2020) referred that education could foster heightened awareness, engagement, and interpretation, all of which were essential for geoconservation, another key aspect of any UGGp.

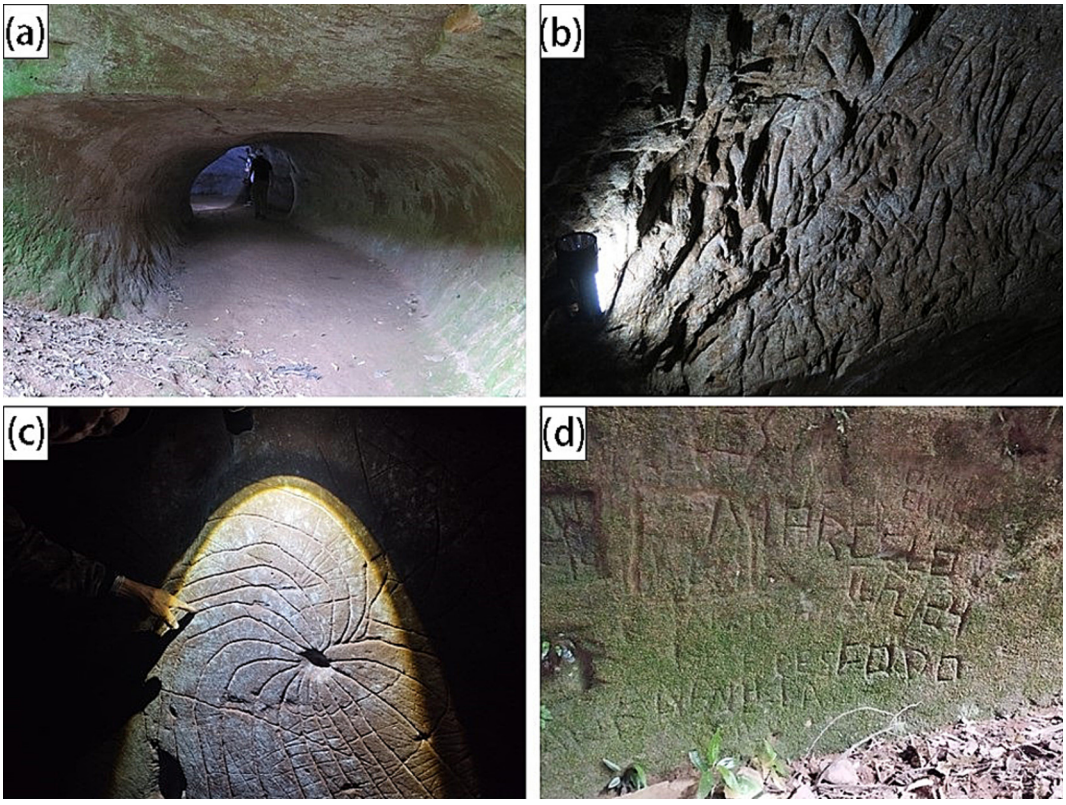

Fig. 5. Paleoburrow "Toca do Tatu" geosite in the municipality of Timbé do Sul. a. Entrance to the paleoburrow. b. Claw marks of paleofauna animals. c. Rock figures made in sandstone by indigenous populations. d. Inscriptions made on the sandstone made by visitors (vandalism).
Source: Authors, 2023.

The second publication of 2020 explored the research carried out by Zerfass, Anjos-Zerfass, Ruban, and Yashalova (2020), which specifically examined the geological importance of Torres municipality, with a particular focus on the geosites of "Torre da Guarita," "Morro das Furnas," and "Morro do Farol." The "Torre da Guarita" was distinguished by a picturesque collection of rock formations, comprised of a mix of sedimentary and volcanic rocks that created steep hills along the coastline (Geological Survey of Brazil, 2022). The authors underscored the potential for geotourism in the CCSUGGp, emphasizing its rich geological and geomorphological heritage.

Throughout the year 2021, there was a consistent number of publications. A featured publication, authored by Mazzali, Diaz, Campagnolo, and Kobiyama (2021), corresponded to a study for assessing the trail load capacity within segments of the "Rio do Boi" geosite trail. The primary objective of the study was to categorize the trail route based on the guidelines outlined in the Brazilian Standard 15505–2:2019.[1]

Other paper from 2021 discussed the participation of local stakeholders in the CCSUGGp, and how the UGGp could contribute to sustainable regional development through geotourism. The authors highlighted the significance of territorial management as a crucial aspect of a UGGp, which should be supervised by a specific managing organization (Rodrigues, Cardoso, & Felipe, 2021). In this regard, it was important to remember that the CCSUGGp had been under the management of the CPICCS since 2017.

In 2022, 10 articles were published, two in international journals and eight in national ones. Despite the territory already holding the UGGp designation, three articles continued to consider the CCSUGGp as a project. The persistence of some articles treating the UGGp as a project was probably attributed to the timing of the texts' presentation and evaluation. However, in 2022, there was a notable increase in the number of published works, indicating a growing interest among researchers in the UGGp approval in April 2022. Despite the relatively low number of works, considering the vast and diverse area available for scientific research, this year stood out as a significant one for scholarly output.

In this specific context, a recently published international article studied the geomorphology of the "Rio do Boi" geosite in Praia Grande municipality. The objective was to measure the resistance of the rock to the flow of the river. The authors underscored the limited understanding of the hydraulic structure of mountain rivers compared to lowland rivers, which had been more thoroughly investigated (Paixão & Kobiyama, 2022). The occurrence of this problem was attributed to the challenging logistics and hazardous characteristics of these sites (Buffington & Montgomery, 2013). Furthermore, Paixão and Kobiyama (2022) emphasized the unique

[1] This standard establishes criteria referring to trekking routes' classification with or without overnight stay as to their characteristics and severity. This standard applies to trekking routes that are offered as touristic products (ABNT, 2019).

nature of the “Rio do Boi” geosite, which presented a mountain river flowing through a canyon, thereby amplifying the challenges and dangers faced by both researchers and tourists.

The second international publication studied the wind related geomorphology in the Itapeva dune field located in the “Parque da Itapeva” geosite in the municipality of Torres. With a length of around 4 km, the authors emphasized the scientific importance of this geosite for the investigation of sedimentary environments and paleoclimates in Brazil (Rockett, Hesp, Portz, & Barboza, 2022). Furthermore, they pointed out the potential risk for the geoconservation, since these dune fields were very vulnerable environments to alterations and human activities.

The first article in national journals examined the application of foreign languages in attending international guests (Brocca, Porto, Velasques, & Garbuio, 2022). The study was based on knowing the perception of managers and staff members of the hotel sector in Praia Grande. The authors highlighted the lack of use of foreign languages in accommodation, as well as the fact that managers and employees used informal methods to communicate with visitors who did not speak Portuguese.

The limited use of foreign languages in one of the CCSUGGp municipalities required consideration by the managing consortium. With the UNESCO designation, an increase in the flow of international tourists was expected. Therefore, it was crucial that the territory's municipalities had trained personnel from the tourism sector to serve international visitors.

Another publication detailed the development of a geospatial database utilizing the My Maps tool, which granted online visitors unrestricted access to a variety of attractions (Bregolin, Alves, & Moeller, 2022). The study area for this research was comprised of the seven municipalities that were part of the CCSUGGp.

Another publication proposed a geotourism itinerary in the municipality of Timbé do Sul, with the aim of promoting the geodiversity within the CCSUGGp region. The study aimed to link five geosites located in the municipality. The authors highlighted that the recognition and safeguarding of geodiversity in an UGGp depended, in part, on the context of the geosites, encompassing scientific aspects derived from research carried out in the region (Valdati et al., 2020).

The research conducted by Szymanski, Kobiyama, Giehl, & Corseuil, 2022 examined the water flow speed in rivers within mountainous basins located in the southern region of Santa Catarina State. Specifically, the authors focused on the Malacara and Molha Coco rivers, which originated in the highlands above the Serra region, near the boundaries of the Serra Geral National Park. These rivers flew at a steep gradient towards the floodplain situated in the municipality of Praia Grande.

Another work published this year was based on the morphostructural characterization of the geosites in the CCSUGGp, as described in the UNESCO application dossier, which included 30 inventoried geosites (Gomes, Ferreira, & Valdati, 2022). The researchers highlighted that the majority of the geosites studied within the territory were located on the plateaus and escarpments of the Serra Geral. They also affirmed the importance of inventorying and categorizing other geosites beyond this axis, particularly those associated with areas of human occupation, in order to recognize and appreciate them as cultural geoheritage.

Rapanos et al. (2022) examined the morphostructural characteristics of the entire CCSUGGp to produce a detailed map and analysis of geological, hypsometric, and slope attributes. They identified two morphostructural units and six morphosculptural units within the area.

Additional work released in 2022 was distinguished by its investigation into mathematics education (Paraol & Stormowski, 2022). The authors' objective was to scrutinize the process of mathematical learning within the setting of students in the municipality of Jacinto Machado, a region characterized by its agricultural nature. Through the utilization of data derived from agricultural harvests and other pertinent information concerning rice production in the municipality, educators engaged in enhancing mathematical education in schools, thereby illustrating a correlation between students' real-life experiences and their educational surroundings (Paraol & Stormowski, 2022). The authors emphasized that the approach of CCSUGGp to schools through training courses could provide students with the opportunity to compare the theory and practice of the project. This allowed them to understand the concept of sustainable development, as well as the value of organic production in the real context of the municipality, understanding different agricultural practices such as the use of agrochemicals in irrigated rice crops. This article also illustrated the UGGps' approach to education as a fundamental component of the development of these areas. It allowed for critical environmental awareness in students, demonstrating a constructivist approach to education that values the community and its students as active participants (Freire, 2014).

The most recent publication in 2022 discussed the utilization of a conservation unit (CU) and its adjacent areas for tourism in the municipality of Torres, specifically focusing on the CU “Refúgio de Vida Silvestre da Ilha dos Lobos (REVISIL).” This particular place, notable for being the only oceanic island along the coast of Rio Grande do Sul State, had rich biodiversity and functions mainly as a sanctuary for various species of wildlife such as sea lions and seals (Kellermann et al., 2020; Teixeira et al., 2022). In this scope, Teixeira et al. (2022) conducted a study on 205 online survey participants to examine visitors' perceptions. The findings indicated that the sun and beach tourism segment was the most popular among respondents, with diving and surfing being the most common activities, typically associated with adventure and nautical tourism. Regarding this, UNESCO (2022) emphasized the role of UGGps in preserving coastal biodiversity and geodiversity, specifically highlighting the “Ilha dos Lobos” geosite as the first marine geosite in Latin America in its document.

In the year 2023, four paper were published regarding the educational activities. The initial publication provided a comprehensive review of the sustainable development strategies implemented by the management consortium in relation to local communities (Dos Santos et al., 2023). The second publication focused on the enhancement of the abiotic environment as a means of fostering regional development through geotourism, specifically proposing a geotouristic itinerary in the municipality of Timbé do Sul/SC (Provedan, Valdati, & Gomes, 2023).

The third article focused on examining the strategies employed for the advancement of geotourism and socioeconomic development within the region, utilizing the framework of dynamic capabilities (De Souza, Camilo, Watanabe, & Gianezini, 2023). An additional paper of 2023 addressed the assessment of susceptibility to debris flows across the various hydrographic basins that constituted the CCSUGGp. As previously noted, the region encompassed a significant expanse of steep terrain, prevalent in most municipalities, which were typically highly vulnerable to hydrogeomorphological phenomena, including debris flows (Sugiyama & Gomes, 2023).

In 2024, there was a notable rise in the volume of published articles. It is crucial to highlight that this analysis encompasses publications up to August 2024. The first article released this year focused on examining the composition of landscape-cultural relationships associated with the Manoel Alves River, which served as a vital element of the cultural landscape in the municipality of Morro Grande (Valdati, Mizieski, & Martins Bandeira, 2024c). The second article presented a comprehensive geomorphological mapping of the northwestern section of the Areia Branca Massif in Timbé do Sul, an area deemed by the authors to possess significant geomorphological and stratigraphic importance for the CCSUGGp (Rapanos & Valdati, 2024).

Another paper suggested the development of a georoute within the Três Barras community, located in the Morro Grande municipality, aimed at investigating the area's tourist and educational potential to enhance the appreciation of geodiversity (Valdati et al., 2024b). Other papers examined the cultural heritage of the municipalities in Santa Catarina that fell within the territory and evaluated how collaboration between these municipalities could be promoted. The UGGp could aid in the enhancement of these cultural assets (Dos Santos et al., 2024). The final article presented a classification system for the diverse structures created in sedimentary rock by megafauna, referred locally as paleoburrows (refer to Fig. 6). This study provided a comprehensive description of the mapped structures, focusing on both external (physiognomic) and internal (morphological) attributes (Valdati et al., 2024a).

3.2. Authorships and working groups

Based on the articles inventoried, a total of 70 authors were involved in scientific production within the CCSUGGp. Among them, six authors contributed to multiple works (Fig. 6).

The authors were affiliated to public institutions of higher education, encompassing both undergraduate and postgraduate programs. More specifically, six authors were part of the same research group at the State University of Santa Catarina (UDESC), one author was affiliated with the Instituto Federal Catarinense (IFC), and another author was associated with Universidade Federal do Rio Grande do Sul (UFRGS). Notable contributions also came from guest authors affiliated with the University of Joiville Region (UNIVILLE) and the University of Extremo Sul Catarinense, indicating a collaborative effort between these institutions. The examination of the research clusters within the 29 articles using the VOSviewer revealed the identification of 15 distinct clusters (Fig. 7). The substantial number of groups and authors signified the extensive research activity at CCSUGGp. Nevertheless, these research groups functioned in isolation, without direct connections, and did not engage in collaborative co-authored work.

The primary research team (Cluster 1) with the highest number of published articles was affiliated with UDESC. Their research primarily centered on geoconservation processes, with a particular emphasis on the inventory and evaluation of geoheritage. This was especially relevant to the geomorphological formations of the CCSUGGp (Gomes et al., 2022; Rapanos et al., 2022). This particular research theme was the most prevalent in studies conducted within UGGps (Duarte et al., 2020; Herrera-Franco, Montalván-Burbano, Carrión-Mero, Jaya-Montalvo, & Gurumendi-Noriega, 2021; Silva & Pioker-Hara, 2022; Stoffelen, 2019). More recently, they focused research efforts on paleontology, specifically examining the structures of paleoburrows. Additionally,

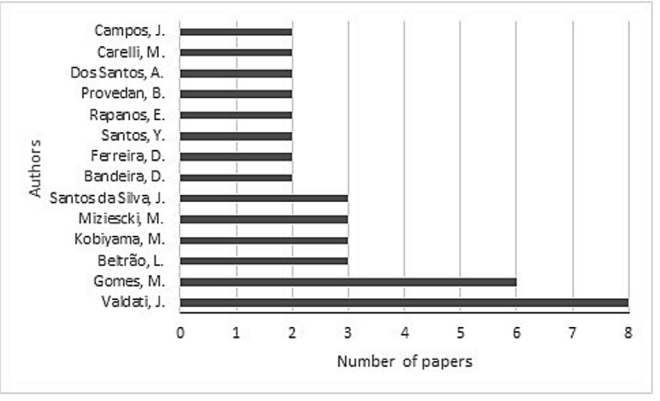

Fig. 6. Authors with the most publications.
Source: Authors, 2023.

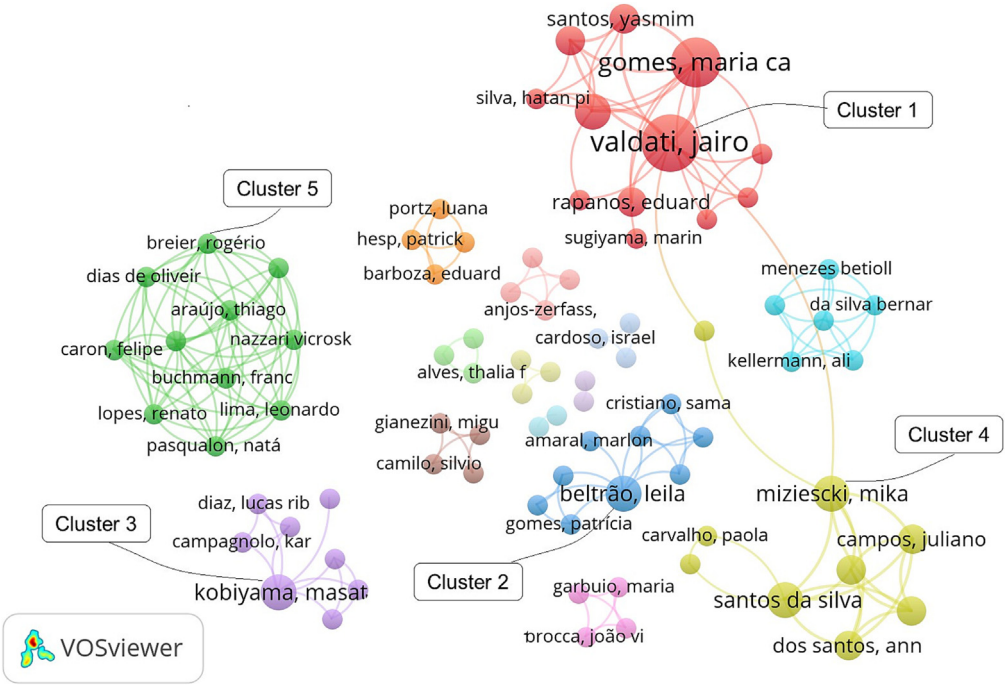

Fig. 7. Cluster of co-authors of publications about CCSUGGp.
Source: Authors, 2023

the group was involved in research related to geotourism, emphasizing the development of geotourism itineraries within the CCSUGGp (Valdati et al., 2020).

The UFRGS research team (Cluster 2) was recognized for its focus on hydrological aspects, with a particular emphasis on water flow resistance in the rivers of the region (Szymanski, Kobiyama, Giehl, & Corseuil, 2022; Paixão & Kobiyama, 2022). Moreover, in this specific cluster, they developed studies on evaluating the load capacity of trails (Mazzali et al., 2021). All research within this group was conducted at geosites intersected by rivers, such as the Rio do Boi and the Malacara.

The third research team (Cluster 3) dedicated its efforts to examining the governance process within the region (Sung et al., 2019). Additionally, this group delved into discussions surrounding geoeducation (Pereira Júnior et al., 2019), as well as topics concerning tourism and the conservation of geological heritage (Amaral & Beltrão, 2018).

The fourth cluster concentrated its efforts on exploring a variety of themes, with a primary emphasis on three key areas: heritage education, archaeology, and sustainable development. The cluster five stood out due to the number of authors; however, this group presented only one paper published within the territory (the oldest) and there was no continuation of the thematic.

3.2.1. Keywords correlation

The analysis of keywords indicated the existence of ten distinct clusters, with four of these groups exhibiting interconnections. In the initial group, "geotourism" emerged as the most commonly referenced term, while "geopark" and "geoheritage" were predominant in the second and third groups, respectively. These three pivotal terms established a connection among the first four groups, as depicted in Fig. 8. The terms that most frequently co-occurred included "geological heritage," "geomorphological cartography," "geosite," "relief compartment," "taxonomic cartography," "geomorphological sites," "geomorphological units," "Praia Grande" (a municipality), and "sustainable development."

In examining the historical development of research domains, we aimed to categorize our analysis into five distinct phases, as illustrated in Fig. 9. A notable progression was evident, not only in the volume of studies conducted within the region but also in the broadening of research fields. The most prominent areas included geosciences which encompassed ten studies across various subfields such as paleontology, geology, geomorphology, and landslides. Additionally, the tourism sector was represented by nine studies, with some focusing specifically on geotourism while others addressed tourism in a more general context. Furthermore, the field of education, particularly geoeducation, was highlighted by four studies that explored relevant issues within this research area.

Recently, there has been a growing body of literature that addresses topics concerning cultural landscapes and the cultural heritage associated with the CCSUGGp. Additionally, four studies focused on matters pertaining to territorial planning, governance, and sustainable development.

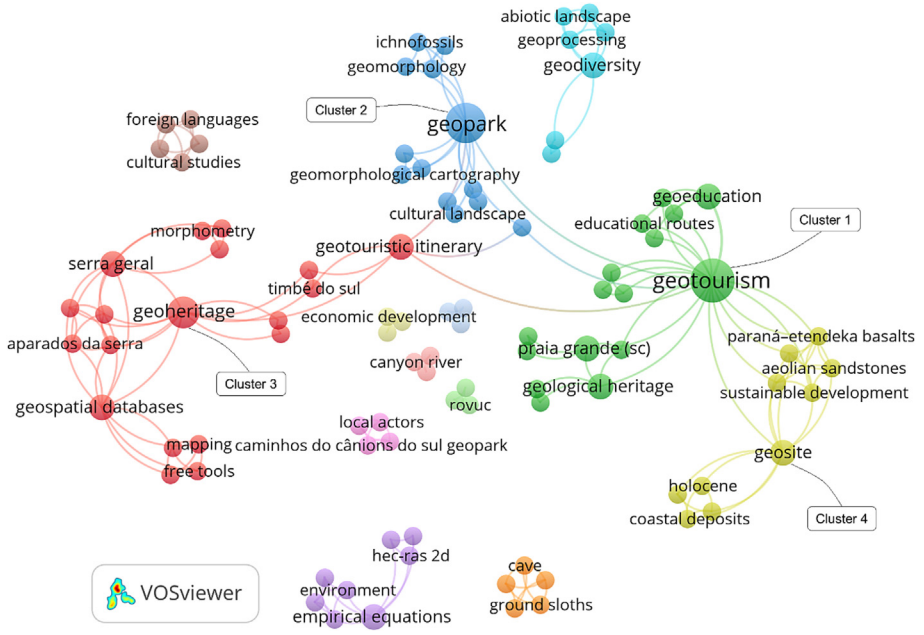

Fig. 8. Keyword clusters of publications in the CCSUGGp.
Source: Authors, 2023.

3.2.2. Geographical origin of papers

In terms of the geographical distribution of the published literature, the articles included in the study were primarily authored by researchers based in Brazil, although there were also some contributions from authors outside the country. The majority of the articles originated from the southern region of Brazil, with 19 articles coming from Santa Catarina State, eight from Rio Grande do Sul State, one from São Paulo, and one from Rio de Janeiro State (Fig. 10).

The research groups operating within the CCSUGGp were affiliated with the two Brazilian states where the CCSUGGp was situated. The establishment of an UGGp in this region generated much interest among the local scientific community towards the territory.

With the consolidation of the territory in the implementation region and the growing scientific interests, regional development was enhanced. It was crucial to conduct research that generated data and information about the territory, particularly to assist local decision makers in aligning their regional development policies.

The research institutions producing more scientific works within the CCSUGGp territory were the UDESC, Federal University of Santa Catarina (UFSC), University of Extreme South of Santa Catarina (UNESC), IFC, UFRGS, and UNIVILLE (Table 1). The authors from four different countries contributed to this research, with Russia having the highest participation, followed by Colombia, Australia, Portugal, and Spain.

Notably, the journals that were distinguished by publishing multiple papers included *Revista Brasileira de Geografia Física* (with 3 papers) and *Biodiversidade Brasileira* (with 2 papers). The remaining journals each published only a single paper, as illustrated in Table 2. The majority of the works were from national journals (21 papers), with only three being international.

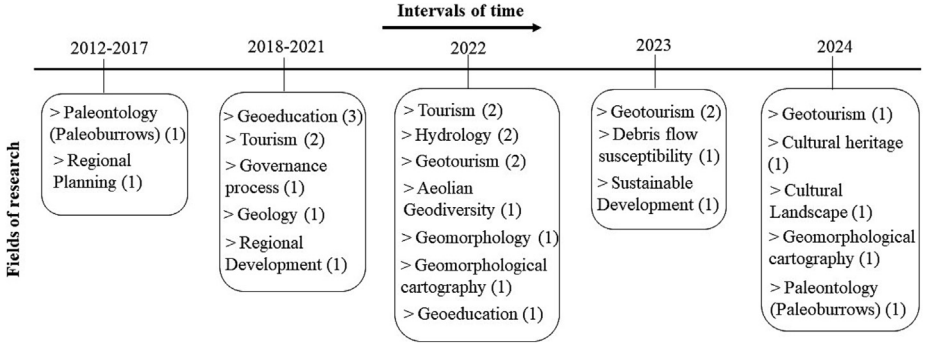

Fig. 9. Evolution of research fields.
Source: Authors, 2023.

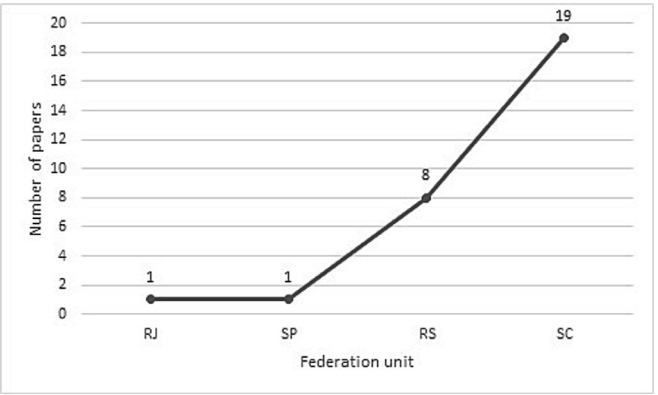

Fig. 10. Geographical origin of papers at CCSUGGp. (RJ) Rio de Janeiro.
Note: RS: Rio Grande do Sul; SC: Santa Catarina; SP: São Paulo.
Source: Authors, 2023.

The quality of the journals was evaluated based on three indicators: a metric established by the Coordination for the Improvement of Higher Education Personnel of Brazil (CAPES) to gauge the editorial quality of Brazilian and international scientific journals (Freire & Freire, 2019), along with the *h*-index and quartile, which were utilized for international comparative analysis.

Among the 25 journals listed, only six of them were included in the *h*-index classification, with the *Journal of Hydrology* having the highest impact, followed by two other international journals (*Journal of South American Earth Sciences* and *Geoheritage*).

The only Brazilian journals included in the *h*-index classification among those listed were the *Revista Brasileira de Geomorfologia*, *Revista Brasileira de Geografia Física,* and the *Revista de Gestão Social e Ambiental*. When it came to classification quartiles, only these same journals had a classification.

Based on the research findings, the texts were categorized into different categories. The highest category (A1) was comprised of four journals, including one that had an international orientation and three that were oriented towards a national audience. In category A2, which had the largest number of journals, there were five papers reported, two international and four national.

In categories A3 and A4, it was noted that there were two journals documented for each category. Within category B1, only a single national journal was reported. In category B2, there were six publications, while in categories B3, B4, and C, there was only one journal each. It was important to note that the publications *Revista Brasileira de Observatório de Turismo* and *Margarida Penteado-Revista de Geomorfologia* did not align with any of the established categories, given that they were newly launched journals.

The results of the bibliographic review indicated that about half of the publications were published in journals with a medium to high impact factor in Brazil. This suggested that articles on CCSUGGp were being disseminated in recognized journals to connect with other researchers and institutions in the country. However, the number of publications on an international scale was limited.

The majority of the publications (21) were released in Portuguese in national journals in Brazil. Additionally, one of the publications was available in both Portuguese and English. A small number (5) of works were published in English, resulting in a limited reach of the publications in the international scientific community, given that English was the universal language for the communication of scientific knowledge.

4. Discussions

One can reflect on the findings discussed in the preceding section. To begin with, it is crucial to emphasize that by delineating the academic research conducted in the field of CCSUGGp, one can gain insights into the trajectory of current investigations, as well as pinpoint their specific areas of concentration and the distinct interests of the researchers engaged in this domain.

The range of research subjects addressed in the published articles is remarkable, especially with regard to geosciences. This phenomenon is recognized globally, as noted by Stoffelen (2019) who emphasized that the field of research in UGGps continued to maintain a strong presence within geosciences. Furthermore, this study has identified that certain research areas have become increasingly significant over the past two years, particularly those that investigate themes related to tourism/geotourism, geoeducation, and sustainable development.

The scope of the initiatives developed within the CCSUGGp is centered on the essential components of a UGGp, which can be referred to as the "4Gs": geopark, geoconservation, geoeducation, and geotourism. These findings align with the prevailing research trends observed in other UGGps worldwide. Comparable conclusions have been reached by Stoffelen (2019), Herrera-Franco et al. (2021), and Pérez-Romero et al. (2023) in their comprehensive examinations of academic contributions related to UGGps.

Table 1
Teaching and research institutions that have published works on CCSUGGp, Brazil.

Research institution and related authors	*f*	Country
Santa Catarina State University	18	Brazil
Federal University of Santa Catarina	13	Brazil
University of Extreme South of Santa Catarina	13	Brazil
Catarinense Federal Institute	11	Brazil
Federal University of Rio Grande do Sul	8	Brazil
University of the Joinville Region	7	Brazil
Chico Mendes Institute for Biodiversity Conservation	6	Brazil
State University of São Paulo	4	Brazil
University of Caxias do Sul	3	Brazil
Brazilian Petroleum S. A – Petrobrás	2	Brazil
Federal Institute Santa Catarina	2	Brazil
Federal University of Rio Grande	2	Brazil
State University of Rio de Janeiro	2	Brazil
University of Contestado	2	Brazil
Regional Education Coordination of Araranguá – State of Santa Catarina	1	Brazil
Lusófona University of Humanities and Technologies	1	Portugal
University of Vale do Itajaí	1	Brazil
University of Passo Fundo	1	Brazil
University of Vale do Rio dos Sinos	1	Brazil
Paulista State University	1	Brazil
Federal University of Pampa	1	Brazil
K.G. Razumovsky Moscow State University of Technologies and Management	1	Russia
Southern Federal University-Rostov-on-Don	1	Russia
Cherepovets State University	1	Russia
Flinders University	1	Australia
University of La Costa	1	Colombia
Autonomous University of Madrid	1	Spain

Note: f: frequency.
Source: Authors, 2023.

Table 2
List of journals that have published about CCSUGGp.

Journal	Quality-CAPES 2017–2020	Country	Quartil	*h*-index	*f*
Journal of Hydrology	A1	Netherlands	Q1	274	1
Caderno de Geografia (PUC Minas)	A1	Brazil	–	–	1
Revista Brasileira de Geomorfologia	A1	Brazil	Q3	9	1
Caminhos de Geografia	A1	Brazil	–	–	1
Revista Continentes (UFRRJ)	A2	Brazil	–	–	1
Journal of South American Earth Sciences	A2	United Kingdom	Q2	89	1
Geoheritage	A2	Germany	Q2	44	1
Revista de Ensino de Ciências e Matemática	A2	Brazil	–	–	1
Revista Brasileira de Geografia Física	A2	Brazil	Q4	9	3
Geoambiente On-line	A3	Brazil	–	–	1
Revista de Gestão Social e Ambiental	A3	Brazil	Q3	8	1
PerCursos	A4	Brazil		–	1
Revista Brasileira de Planejamento e Desenvolvimento	A4	Brazil	–	–	1
International Journal of Scientific Management and Tourism	A4	Brazil	–	–	1
Desenvolvimento Socioeconômico em Debate	B1	Brazil	–	–	1
Revista Científica Digital - Publicidade e Propaganda, Jornalismo e Turismo	B2	Brazil	–	–	1
Revista Confluências Culturais	B2	Brazil	–	–	1
Revista Turismo: Estudos & Práticas	B2	Brazil	–	–	1
Revista Textos de Economia	B2	Brazil	–	–	1
Revista Brasileira de Ecoturismo	B2	Brazil	–	–	1
Revista de Tecnologia e Ambiente	B2	Brazil	–	–	1
Applied Tourism	B3	Brazil	–	–	1
Biodiversidade Brasileira	B4	Brazil	–	–	2
Espeleo-Tema	N/C	Brazil	–	–	1
Revista Brasileira de Observatório de Turismo	N/C	Brazil	–	–	1
Margarida Penteado – Revista de Geomorfologia	N/C	Brazil	–	–	1

*Note:*N/C, no classification; *f*: frequency.
Source: Quality-CAPES journals (2017–2024) and Scimago Journal & Country Rank (2024). By the authors, 2024.

In the research undertaken by Herrera-Franco et al. (2021), the authors emphasized that the primary domains of investigation pertained to the regions designated as "geoparks." This term was frequently encountered in the literature, a phenomenon noted in this study and illustrated in Fig. 8 (Cluster 2).

A notable critique can be articulated regarding the terminology employed by researchers affiliated with UGGps. The term "geopark" is unsuitable as a keyword for two main reasons. First, since it already appears in the research title, its repetition is redundant. In additon, this redundancy may hinder the study's discoverability in academic databases. Second, it is important to recognize that "geopark" represents a field of study rather than the focal point of the research itself. The principal objective of establishing a UGGp in relation to scientific inquiry is to encompass a diverse array of thematic areas, utilizing the territory as a context for research aimed at promoting the sustainable development of the region.

Considering the issues identified, comparable findings have emerged from the data collected in this study, specifically concerning the CCSUGGp where the thematic area of "geopark" exhibit the second highest frequency of occurrence. The thematic area that demonstrates the highest frequency, as illustrated in the results (Fig. 9), is geotourism. This area is recognized as the most effective strategy within these regions for the dual objectives of preserving geological heritage and fostering sustainable economic development for local communities (Organizing Committee of the International Congress of Geotourism, 2011; Farsani, Coelho, & Costa, 2011; Farsani, Coelho, Costa, & Amrikazemi, 2014; Hose, 2012).

The findings presented herein indicate a significant concentration of research themes within the domain of geosciences (Fig. 10). Comparable outcomes are observed in the study conducted by Koupatsiaris and Drinia (2023), which examined scientific output in Greek UGGps. The authors highlighted that the majority of research conducted in Greek regions predominantly pertained to natural sciences and management-related topics. Furthermore, they noted a relative deficiency in research concerning social and human sciences. Even in studies associated with geotourism, the focus tends to be primarily on the geological characteristics of the area in relation to tourism applications.

It is additionally conveyed by Pérez-Romero et al. (2023), who indicated that the predominant trend in UGGps was centered on geology and paleontology, noting that the majority of the works analyzed in their study were concentrated in these fields. Furthermore, they emphasized that, although there was a significant focus on geology and paleontology, the past five years had witnessed a notable expansion and diversification of studies within UGGps.

The findings of this study align with previous research, indicating that new themes within the CCSUGGp are beginning to surface, particularly following the year 2022. This analysis emphasizes research focused on evaluating the potential of this territory to support the sustainable development of its surrounding region (Dos Santos et al., 2023). The pursuit of sustainable development is a critical component of all scientific inquiries conducted within a UGGp, offering substantial opportunities to advance the 2030 Agenda and its 17 Sustainable Development Goals (SDGs).

The relationship between the SDGs and UGGps is essential and has been extensively documented in various research studies that explore the role of UGGps in promoting sustainable development through the core principles that characterize these areas, namely geoconservation, geoeducation, and geotourism (Ferreira & Valdati, 2022; Henriques, Canales, García-Frank, & Gomez-Heras, 2018; Henriques, Castro, Félix, & Carvalho, 2020; Rosado-González, Palacio-Prieto, & Sá, 2020; Rosado-González, Sá, & Palacio-Prieto, 2020). Additionally, a notable recent focus has emerged on the cultural dimensions of these territories (Dos Santos et al., 2024; Valdati et al., 2024a, 2024b, 2024c).

The findings of this study reveal a thematic imbalance, despite the recent expansion of research topics. This discrepancy can be attributed to two primary factors. It appears that researchers still possess a limited understanding of the concept of a UGGp. There is a prevailing notion that such territories are merely geological parks or specialized areas designated for the exploration of geodiversity-related aspects.

A UGGp not only conserves and promotes geodiversity but also embodies an innovative approach to sustainable regional development that prioritizes local community needs and perspectives (Martini et al., 2021; Mc Keever & Zouros, 2005; Rosado-González, Sá, & Palacio-Prieto, 2020; Sá & Silva, 2019). As noted by Stoffelen (2019), the geological heritage is intrinsically linked to the activities and interpretations of the inhabitants of these areas, emphasizing that a UGGp fundamentally consists of its people.

It is proposed that an increase in the diversity of research domains and themes within a UGGp will enhance the consolidation of the territory. Conducting scientific research aimed at comprehending the geodiversity of the area and cataloging the SIGs represent a fundamental and strategic initial step; however, this constitutes merely one facet of the multifaceted nature of a UGGp.

One challenge in diversifying thematic research areas involves motivating the UGGp's core management team to establish multiple working groups. These groups should engage in discussions with economists regarding questions such as the economic implications of implementing a UGGp for local communities. Additionally, collaboration with sociologists and anthropologists is essential to explore the perceptions and needs of local populations. Furthermore, interactions with tourism specialists are crucial for examining the socioeconomic effects of tourism in the area, as well as for profiling and understanding the demands of tourists visiting the region.

In addition, it is essential for contemporary researchers in UGGps to prioritize climate change as a significant area of investigation (Koupatsiaris & Drinia, 2023), given that these alterations result in numerous environmental and human detriments (Dietz, Shwom, & Whitley, 2020).

This research theme is particularly significant due to the observation that numerous UGGps globally are situated in regions prone to various risks, including landslides, flooding, and arid or semi-arid environments (Berred & Berred, 2021). Furthermore, the potential impacts of climate change could jeopardize the geological (Migoń, 2024), cultural (Veiga-Pires et al.,

2024), ecological (Youssef, Abdelaziz, Aboubakre, Hasib, & Boulli, 2024), and demographic attributes of UGGps (Astarini et al., 2024).

As highlighted by Koupatsiaris and Drinia (2023), UGGps as used through research and education can (and should) play a significant role in fostering resilience to climate changes. These represent just a few illustrative examples of potential research topics; numerous other studies could use these territories as both backdrop and case studies.

One additional concern that emerges from the findings is the quantity of publications identified. The authors argue that this number is comparatively modest considering the potential of the area in question. It is essential to consider two key factors. First, although this territory has been undergoing development since 2007, its effective consolidation did not take place until a decade later, with UNESCO recognition occurring only in 2022. Consequently, awareness regarding the establishment of this new territory within the region remains relatively limited, even among researchers in the field of geoscience. The phenomenon can also be contextualized within a national framework, as the recognition and development of UGGps in Brazil commenced in 2022, and they have yet to achieve widespread acknowledgment among the general populace (Silva et al., 2024). Second, the international collaborations in this domain remain underdeveloped. Evidence indicates that partnerships involving Brazilian researchers have been established with counterparts from only five countries. This situation may suggest that the involvement of foreign researchers is irregular, manifesting intermittently across the documented studies.

The significance of this study can be emphasized through two key dimensions. On one hand, the insights provided will enable the managers of this region, particularly those involved in the scientific committee of this UGGp, to gain a clearer understanding of the academic and scientific trajectories that are shaping the research landscape. Consequently, they will be equipped to advocate for either the broadening or the refinement of specific areas of interest within their management framework and professional networks. This is particularly pertinent, as fostering scientific research is a primary objective for these regions. On the other hand, it is important to highlight that recent literature has not identified any studies specifically examining scientific production within a particular UGGp. Instead, the existing works predominantly focus on the overall scientific output in these regions. This observation underscores the significance of specific studies, like the one discussed here, as they may reveal regional research trends.

5. Conclusions

According to UNESCO (2016, p. 9), "a UNESCO Global Geopark is not a museum, it is an active laboratory where people can become engaged in science from the highest academic research level to the level of the curious visitor." UGGps are advised to collaborate with academic institutions to leverage scientific research in these territories and to enhance the knowledge spanning various disciplines such as geology, biology, archaeology, culture, history, paleontology, geography, among others. Consequently, scientific research plays a vital role in the formulation and implementation of a UGGp within a specific region.

This study allows us to understand that although the CCSUGGp recently obtained UNESCO recognition, it has been actively establishing partnerships and serving as a research centre for numerous academics from universities in the region. Ongoing research on various topics demonstrates its importance and potential as a territory for sustainable local development.

This study, along with the numerous references cited, shows that the establishment of a UGGp in a region increases the participation of researchers, particularly geoscientists. The international recognition of this territory has boosted interest in conducting in-depth studies, thus promoting a broader range of research initiatives.

Some of the key findings derived from this study are presented below.

(i) The findings of this literature review indicated a substantial volume of scientific research in the CCSUGGp. The study also indicated the existence of book chapters, doctoral theses, and technical articles on the territory.
(ii) Most of these studies were published after the creation of the CPICCS in 2017 and after the recognition of the CCSUGGp in 2022.
(iii) It is worth highlighting the variety of research topics addressed in the published texts, with a particular emphasis on the field of geosciences. This was accompanied by topics relevant to research in tourism/geotourism, education/geoeducation, as well as the more recent focus on cultural heritage and cultural landscapes.
(iv) The municipalities within the State of Santa Catarina were identified as the primary focus of research, overshadowing those located in the State of Rio Grande do Sul.
(v) The peak number of publications occurred in 2022, immediately following the UNESCO designation.
(vi) It was observed that a significant number of researchers were engaged, particularly highlighting the contributions from the group affiliated with UDESC, alongside those from other institutions including UFSC, IFC, UNIVILLE, and UNESC.
(vii) The leading researchers were predominantly Brazilian and situated within the study area.
(viii) The geographical origin of the works coincided with the location of the researchers, predominantly stemming from the states where CSSUGGp was based, suggesting a pronounced regional representation.
(ix) The majority of the studies were published through national (Brazilian) journals, with only a limited number appearing in international publications.
(x) Regarding journal quality, most were considered acceptable, classified as tier "A" according to Brazil's national indexing systems. However, only three journals met internationally recognized standards of excellence.
(xi) The majority of the publications were in Portuguese, with a limited number available in English or in a bilingual format.

It is recommended that future studies continue to examine the scientific literature generated in this region and other UGGp or aspiring UGGp in Brazil. Furthermore, in the future, authors should strive to disseminate their findings in English to broaden the audience interested in this topic. It is also suggested that future authors diversify their research areas, particularly in the scientific areas of tourism, archaeology, paleontology, and education, as these studies can benefit local development.

The CCSUGGp demonstrates significant potential for scientific exploration, as it represents a novel approach to territorial management in Brazil. However, the globalization of knowledge has raised standards in these areas, including geotourism, educational purposes, and scientific activities. In this context, this work shows that the UGGps represent promising territories for the advancement of scientific research in various areas of scientific knowledge.

CRediT authorship contribution statement

José Gustavo Santos da Silva: Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation, Conceptualization. **Ricardo Eustáquio Fonseca Filho:** Writing – review & editing, Visualization, Validation. **Juliano Bitencourt Campos:** Writing – original draft, Supervision, Project administration. **Mikael Miziescki:** Investigation, Formal analysis. **Nilzo Ivo Ladwig:** Supervision, Formal analysis. **Álvaro José Back:** Project administration, Data curation, Conceptualization. **Emmaline M. Rosado-González:** Writing – review & editing, Visualization, Supervision. **Artur Abreu Sá:** Writing – review & editing, Validation, Supervision.

Ethical statement

Not applicable, because this article does not contain any studies with human or animal subjects.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the author(s) used Ahrefs Free AI Paragraph Rewriter (https://ahrefs.com/writing-tools/paragraph-rewriter) in order to enhance the document's readability in English, considering that English is not the authors' native language.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijgeop.2024.10.002.

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