PerCursos

e-ISSN 1984-7246

Geopark Fourth Aspiring Colony UNESCO: a proposal for territorial development based on the geoconservation of the landscape and heritage in the center of the state of Rio Grande do Sul (Brazil)

Abstract

Since the 2000s, the proposal to recognize geoparks as territories that promote the heritage of the Earth and sustain local communities through the conservation and sustainable use of their heritage has been established as a new paradigm in terms of territorial development. In this sense, the objective of this article is to present the most relevant geopatronal and landscape aspects inventoried in the territory of the Fourth Colony (RS), as well as the construction trajectory of this project until the submission of the application dossier to the UNESCO World Geopark. The territory consists of nine municipalities, with just over sixty thousand inhabitants, extending for 2,923 km², demarcating the transition between the Brazilian Southern Plateau and the Peripheral Depression from Rio Grande do Sul. The main geopatrimonial highlight is the presence of one of the most important fossiliferous assemblies of the Triassic world. Added to this is the great diversity of natural landscapes found in the territory and the integrity of the cultural heritage associated with the migratory waves of the nineteenth century in the region, especially Italians and Germans. The territory dossier has 31 geosites of geopatrimonial value (distributed among the categories of fossiliferous, lithological/sedimentological, fluvial/hydrogeological and geomorphological value) and 23 sites linked to other forms of patrimonial value (ecological, scenic, historical-cultural and/or archaeological value). The article discusses, at the end, the strategies currently underway for a holistic management of the territory and its heritage.

Keywords: geopark; Fourth Colony; geopatrimony; holistic management.

To cite this article:

FIGUEIRÓ, Adriano Severo; PRETTO, Flávio Augusto; SELL, Jaciele Carine; PADOIN, Maria Medianeira; FILHO, Flavi Ferreira Lisbôa. Geopark Fourth Aspiring Colony UNESCO: a proposal for territorial development based on the geoconservation of the landscape and heritage in the center of the state of Rio Grande do Sul (Brazil). **PerCursos**, Florianópolis, v. 23, n.52, p. 08 - 105, maio/ago. 2022.

DOI: 10.5965/1984724623522022008
http://dx.doi.org/10.5965/1984724623522022008

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Geoparque Quarta Colônia aspirante UNESCO: uma proposta de desenvolvimento territorial baseada na geoconservação da paisagem e do patrimônio no centro do estado do Rio Grande do Sul (Brasil)

Resumo
Desde os anos 2000, a proposta de reconhecimento dos geoparques como territórios que promovem o patrimônio da Terra e sustentam as comunidades locais por meio da conservação e uso sustentável do seu patrimônio, tem se consagrado como um novo paradigma em termos de desenvolvimento territorial. Nesse sentido, o objetivo deste artigo é apresentar os aspectos geopatrimoniais e paisagísticos mais relevantes inventariados no território da Quarta Colônia (RS), bem como a trajetória de construção deste projeto até a submissão do dossiê de candidatura à Geoparque Mundial da UNESCO. O território é composto por nove municípios, com pouco mais de sessenta mil habitantes, estendendo-se por 2.923 km², demarcando a transição entre o Planalto Meridional Brasileiro e a Depressão Periférica Sul-Riograndense. Tem como grande destaque geopatrimonial a presença de uma das mais importantes assembleias fossilíferas do triássico mundial. Soma-se a isso a grande diversidade de paisagens naturais encontradas no território e a integridade do patrimônio cultural associado às levas migratórias do século XIX na região, em especial de italianos e alemães. O dossiê do território conta 31 geossítios de valor geopatrimonial (distribuídos entre as categorias de valor fossilífero, litológico/sedimentológico, fluvial/hidrogeológico e geomorfológico) e 23 sítios ligados a outras formas de valor patrimonial (valor ecológico, cênico, histórico-cultural e/ou arqueológico). O artigo discute, ao final, as estratégias atualmente em curso para uma gestão holística do território e seu patrimônio.

Palavras-chave: geoparque; Quarta Colônia; geopatrimônio; gestão holística.

Introduction

Geoparks are unique and unified geographical areas, in which sites and landscapes of international geological importance are maintained, through a holistic concept of protection, education and sustainable development (UNESCO, 2017). This innovative local development strategy, capable of stimulating new economic activities and additional sources of income, is especially directed to social and economically depressed rural regions, which have high-quality geological heritage (FARSANI; RABBIT; COSTA, 2011).

Created in 2004, under the auspices of UNESCO (McKEEVER; ZOUROS, 2005) , the World Network of Geoparks was strengthened as of 2015, when the 38th UNESCO General Conference adopted the International Geosciences and Geoparks Program, creating the "UNESCO Global Geopark" seal and officially approving the concept of geopark in its structure, merging it with the International Geosciences Program then (GONZALEZ-TEJADA *et al.* , 2017). This model remains a paradigm of rural development for peripheral territories (RAMOS; FERNANDES, 2016), combining the conservation of geodiversity and the production of local products and handcrafts, within a broader geotourism strategy that integrates innovation, entrepreneurship, local-based tourism and scientific dissemination, from a sustainability perspective (ROSADO-GONZÁLEZ; PRIETO PALACE; SA, 2021).

This is the proposal that is structured in the center of the state of Rio Grande do Sul (Brazil), from the Geopark Fourth Aspiring Colony UNESCO. The aim of this article is to present the most relevant geopatronal and landscape aspects inventoried in the territory since 2008, as well as the construction trajectory of this project until the submission of the UNESCO application dossier in 2021.

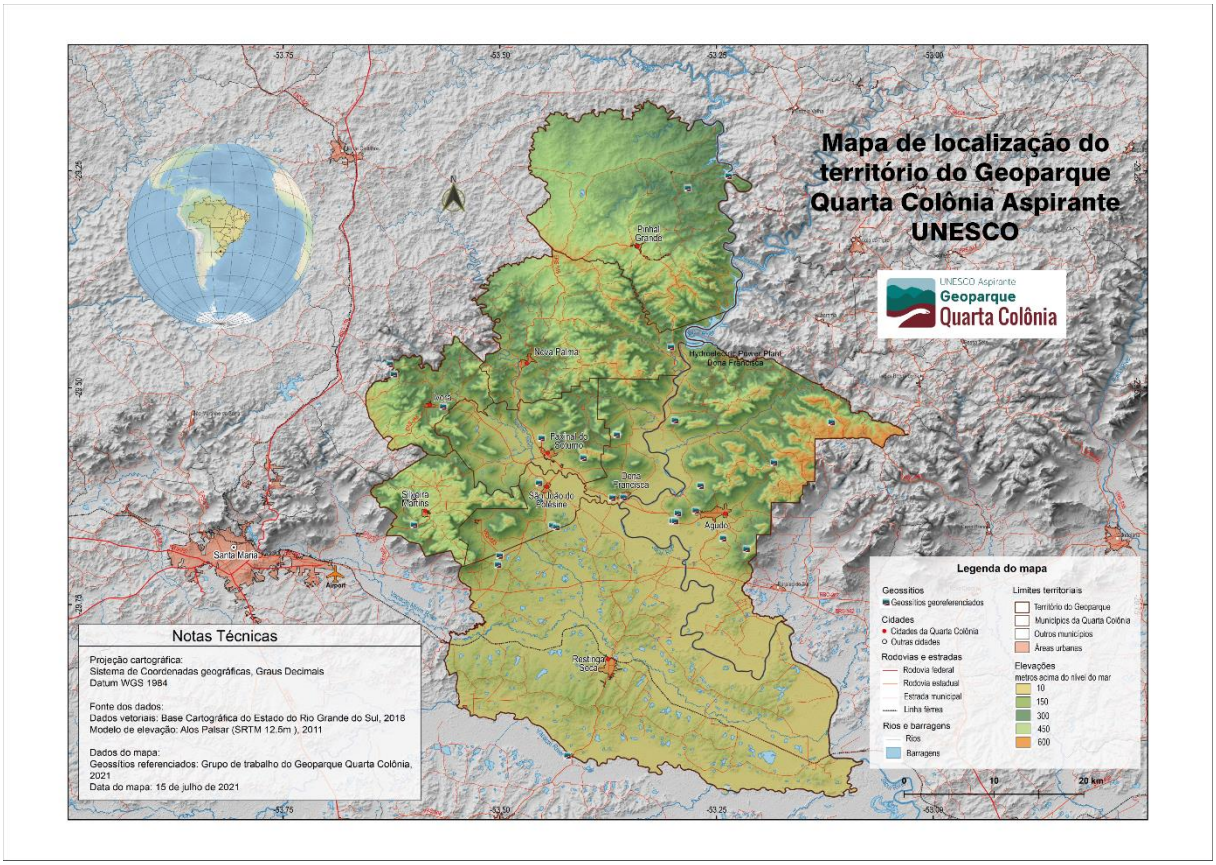
Characterization of the territory of the Fourth Colony

The name of the Geopark refers to the fourth nucleus of Italian colonization installed in the center of the state of Rio Grande do Sul as of 1877, which came to be added to German immigrants already installed in the same region since 1855 (PADOIN; FIGUEIRÓ; CRUZ, 2021). The deep fault valleys, excavated by a wide drainage network on the slope of the Serra Geral, covered by dense decidual seasonal forest, demarcate the southern border of the Brazilian Southern Plateau (Figure 1), occupying an area of 2,923 km².

This geomorphological frontier demarcated by the sandstone-basaltic escarpments of the Serra Geral, and which throughout history has served as a divisive milestone to the process of human occupation, also represents a transition between two major Brazilian biomes: the Atlantic Forest and the Pampa, with a huge biodiversity that involves forest and field ecosystems and their interfaces (SCHIRMER, 2015). This characteristic placed the territory as one of the priority areas for the implementation of biodiversity corridors within the state of Rio Grande do Sul, having, since 2014, the Ecological Corridor of the Fourth Colony (CURICACA INSTITUTE, 2016).

At the same time, the Fourth Colony Geopark is bathed by the second largest and most important hydrographic basin of the state of RS, the Jacuí river basin (ZIANI; FOLETO, 2019) , besides being located in a central strategic location, in a road junction for all regions of the state.

Figure 1 - Location map of the Fourth Aspiring UNESCO Colony Geopark



Source: adapted from FIGUEIRÓ *et al.* , 2021.

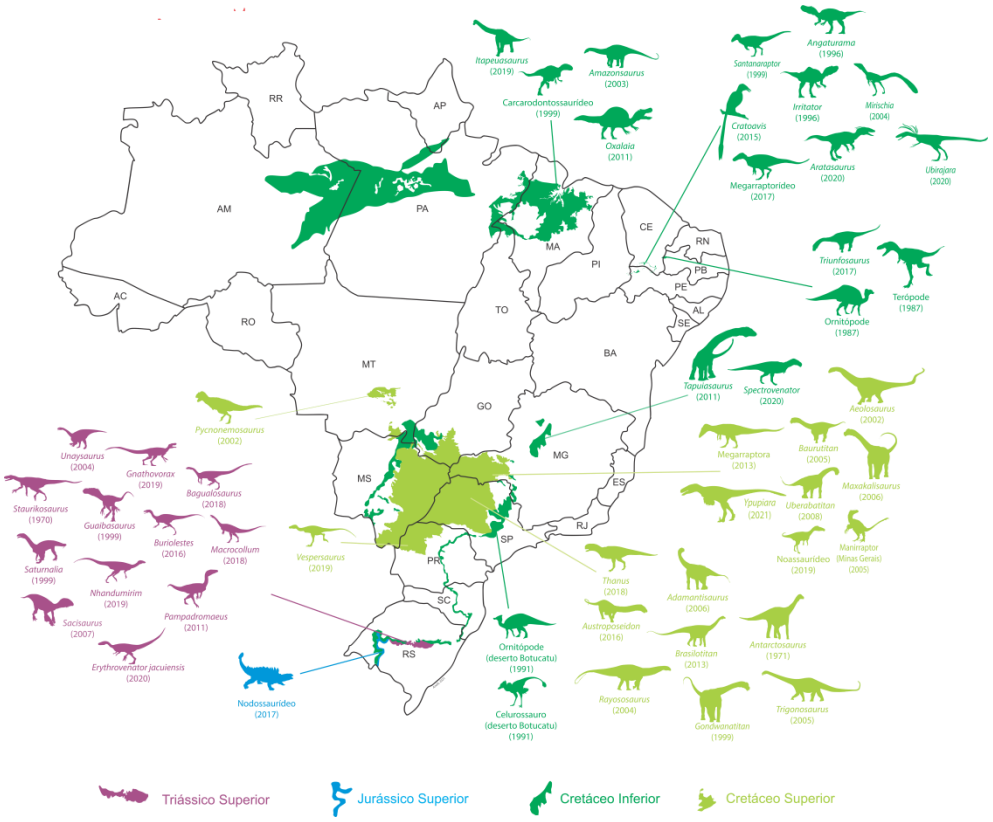
Among all the relevant natural aspects of the territory, the main highlight, which allows it to apply for the UNESCO World Geopark seal is represented by the fossiliferous heritage, a Triassic record of the most varied forms of animal and plant life, in the aurora of modern ecosystems (DA ROSA, 2015).

The Fourth Colony Geopark is located in the southern part of the Chaco-Paraná Basin, an intracratonic basin whose depositional history is directly related to the tectonic evolution of southwestern Gondwana (SOARES *et al.* , 2007).

The depositional interval of the Chaco-Paraná Basin extends from the Ordovician to the Cretaceous, and the region of the Fourth Aspiring Colony UNESCO Geopark involves strata that discontinuously extend from the Lower Triassic to the Lower Cretaceous (Figure 2). And it is precisely this temporal amplitude, associated with the

evolutionary and tectonic events that unfolded during the Mesozoic (SCHULTZ; SCHERER; BARBERENA, 2000; ZERFASS et al, 2004) that provide the region its main geological and geopatrimonial value.

Figure 2 - Distribution map of fossiliferous formations in Brazil and their dinosaur species found, with emphasis on the territory of the Aspiring Geopark Fourth Colony



Source: Adapted from Anelli (2020).

From the sedimentological point of view, the oldest layers of the territory of the Fourth Colony correspond to the Supersequence Sanga do Cabral (ZERFASS *et al.* , 2003). This unit, which has reworked fossil content (SCHULTZ *et al.* , 2020), is recognized by interspersed successions of very thin sandstone of wind origin and abundant intraform conglomerates resulting from interlaced channels that gained energy with the tectonic

reactivation of the Permian-Triassic transition. Additionally, the formation also occurs lacustrine facies with fossil record of better preserved specimens (DA ROSA; WAR-SOMMER; CAZZULO-KLEPZIG, 2013).

The lithological successions of the Middle-Upper Triassic are part of the Supersequence Santa Maria (ZERFASS *et al.*, 2003), linked to the fluvio-lacustrino environment formed by crustal distension with formation of interior rifts at the beginning of the Mesozoic. This sedimentation can be subdivided into three distinct facies (Figure 3), the oldest being lithological characterized by a packet of grayish conglomeratic sandstone, characteristic of an interlaced fluvial system of moderate to high energy (DA ROSA; FACCINI, 2005; ZERFASS *et al*., 2003).

This facies, in turn, is overlapped by reddish pelithic massifs up to 50 meters thick, whose paleoenvironmental interpretation corresponds to wide plains of loess, occasionally disturbed by river channels. The stratigraphic unit is associated with a rich fauna of tetrapodies dominated by dicynodonts (SCHULTZ *et al.* , 2020), in what is called the Association Zone (ZA) of Dinodontosaurus.

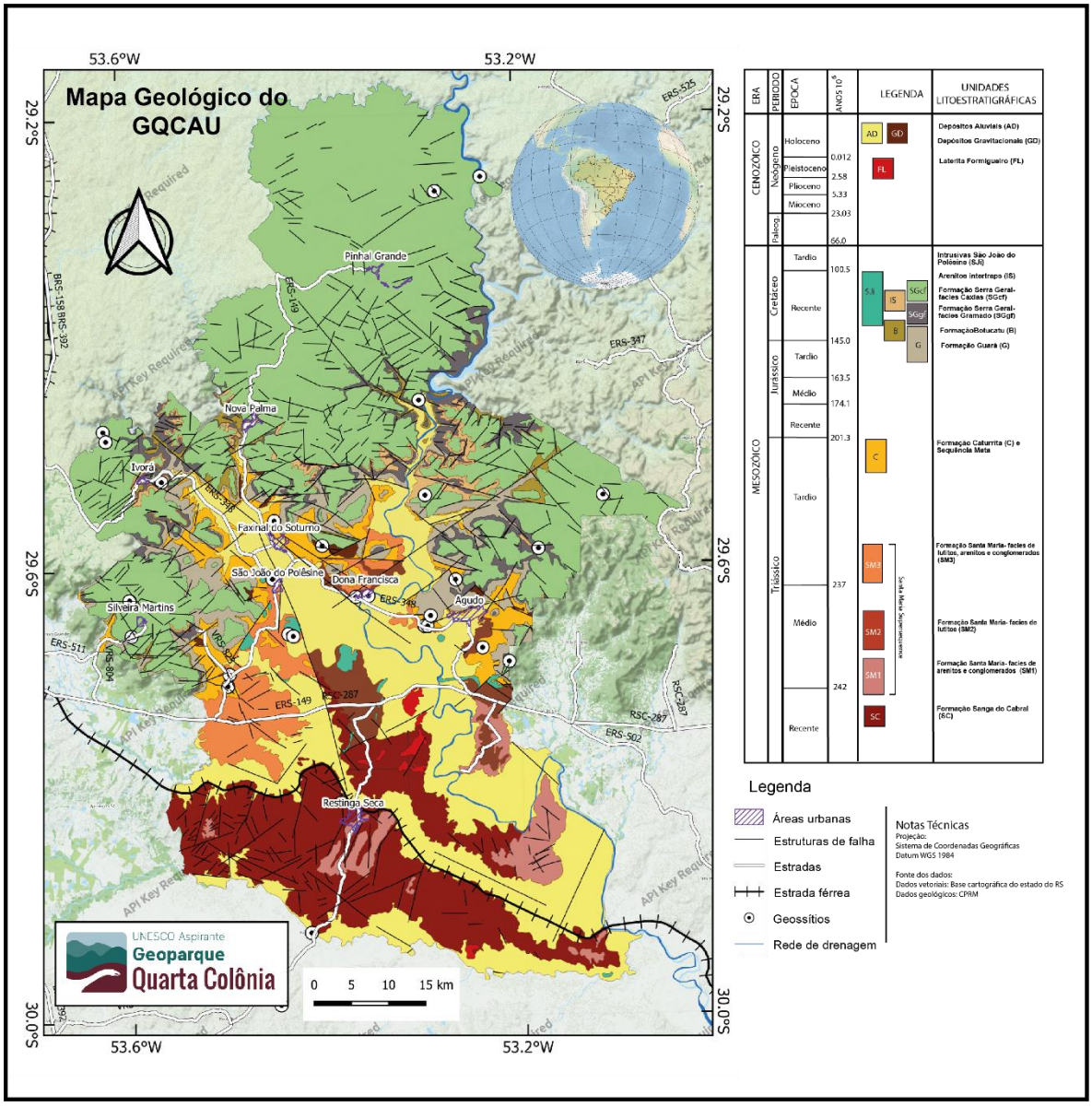
In this layer, correlated with the Ischigualasto Formation in Argentina, important records of dinosaurs, pseudosupechiae, basal pterosauromorphs, among others (figure 4), are attributed, presenting the unequivocal records of the oldest dinosaurs in the world (LANGER; BITTENCOURT; SCHULTZ, 2010).

Above the layer, a package of rosy and mostly massive sandstone is accumulated, without sedimentary structures, and occasionally incorporating intraclasts in a dispersed manner, related to mass flows caused by torrential rains of seasonal character.

This environment of ephemeral and hyper concentrated river systems, regulated by a monsoon rain regime, characterizes lithostratigraphically the basis of the Caturrita Formation (ZERFASS *et al.* , 2003). At these levels micro tetrapod faunas are attributed, nod. *Riograndia*, *Brasilodon*), associated with lepidosaurs, procolophonides or other very small-sized taxons that characterize Riograndia's ZA. The dinosaurs present in this unit, in turn, are represented by large animals, such as Macrocollum and Guaibasaurus, precursors of an ecological period dominated by the group.

Finally, overlapping discontinuously with deposits with tetrapod fossils, there is a sedimentary unit of sanders of greater granulometry, whose fossiliferous record is restricted to the presence of siliceous trunks of gymnosperms. This unit is understood within the Caturrita Formation,as a face corresponding to the Mata Formation, or Mata Sequence (ZERFASS *et al*., 2003).

Figure 3 - Geological map of the Aspiring Geopark Fourth Colony



Source: Adapted from Godoy *et al* (2012).

The southwest of Gondwana underwent a transition phase in the Jurassic, with virtually no deposition during almost that entire period in the Chaco-Paraná Basin, suggesting that this part of the South American platform was relatively stable and uplifted, reflecting itself as the most pronounced gap of its stratigraphic record (MILANI *et al*., 2007).

The first records of the Jurassic period found in the territory refer to the Guará formation, which belongs to the upper Jurassic (163.5 and 145 m.a.a.) . The Guará formation presents several traces of fossils (Figure 4) such as gastropods, reptiles and fish, being interpreted as a deposit of a humid wind system, with dunes and sand sheets.

Figure 4 - Paleoart of some of the dinosaurs that make up the fossiliferous geoheritage of the Fourth Colony Geopark: a) *Buriolestes schultzi* b) *Sacisaurus agudoensis* c) *Gnathovorax cabreirai* d) *Macrocollum itaquii* e) *Pampadromaeus barberenai* f) *Erythrovenator jacuiensis* g) S *taurikosaurus pricei*

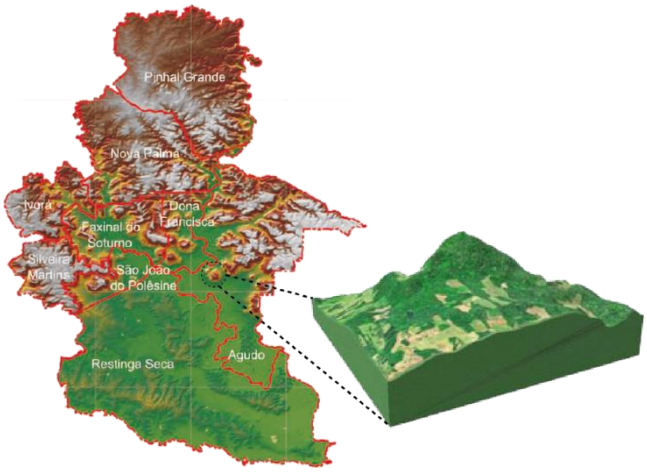
Source: a) Castro (2020a); b) Castro (2020b); c) Castro (2019); d) Castro (2018); e) Nogueira (2019); f) Castro (2020c); g) Hallett (sd).

With the increase in aridity in the cretaceous-transition and the, the Guará formation transitioned to the Botucatu formation, which corresponds to the immense desert environment of the Cretaceous Lower period (145 to 100.5 m.a.a.). This formation consists mainly of sandstone sedimentary rocks, cross-stratification of large and very large size, associated with wind dunes (GODOY *et al.* , 2012). In those portions where the sandstone is more siliceous, there is greater resistance to erosion, ensuring the structural maintenance of the top of the hills testimony that demarcate the erosive retreat of the plateau escarpment, representing a significant part of the geomorphological heritage existing there (Figure 5).

These geomonuments assume in the territory a patrimonial value not only from the scientific-geomorphological point of view (SCHIRMER; ROBAINA, 2013), but as well as ecological, for supporting current xerophyte relicts (IRGANG; SOBRAL, 1987) , as in the case of Morro Agudo (SILVA; QUOOS, 2021) , or for ensuring the conservation of expressive fragments of the Atlantic Forest, as in the case of Monte Grappa, in Ivorá, and cultural with religious pilgrimages, as happens in the Morro Santo Antônio, in Dona Francisca.

The Cretaceous in the Chaco-Paraná Basin was marked by the end of a first-order tectonic cycle, with the fragmentation of the Gondwana and the opening of the South Atlantic. In the territory of the Aspiring Geopark Fourth Colony, the records of this event are marked by the occurrence of aeolian sandstone of the Botucatu Formation and the volcanic spills of the Serra Geral Formation (Botucatu-Serra Geral Sequence), with intercalations of wide lenses of intertraps aeolian sandstone between successive spills (PETRY *et al.* , 2007).

Figure 5- Topographic representation of the territory, with emphasis on the prototyping of the geosite Morro Agudo (right), one of the witness hill geomonuments produced by the retreat of the escarpment of the Brazilian Southern Plateau



Source: (FIGUEIRÓ et al, 2021).

In these sandstone formations also highlight an important patrimonial value associated with hydrogeological behavior, especially in the case of Botucatu sandstone. Due to its great permeability, it receives an indirect recharge by descending drain from the overlapping volcanic spills (VOGEL, 2008) and, with this, this formation of the Paraná Basin is responsible for sustaining one of the largest aquifers on the planet, the Guarani-Serra Geral Aquifer system, with 1,200,000 km² of area, distributed between Brazil, Argentina, Paraguay and Uruguay, with an exploitable water volume of approximately 40 km3 (STALLBAUM; SCHEIBE, 2018), feeding the huge diversity of rivers, streams and waterfalls that exist in the territory.

Finally, the Cenozoic in the territory of the Aspirant Geopark Fourth Colony is marked by exposures of lateritic crusts, coluvionar deposits and large alluvial plains (SCHIRMER, 2015). The wide exposures of recent deposits, formed by sandy sediments and gravelly upstream (north) and sandy-clayey downstream (south), makeup the deposition plains of the most watery hierarchy canals, representing the second largest hydrographic basin of Rio Grande do Sul, the Jacuí river basin. In these plains, a diverse

range of geomorphological processes associated with the meandering dynamics of the channels, producing a mosaic of humid areas of distinct morphogenesis can be observed in an extremely didactic way.

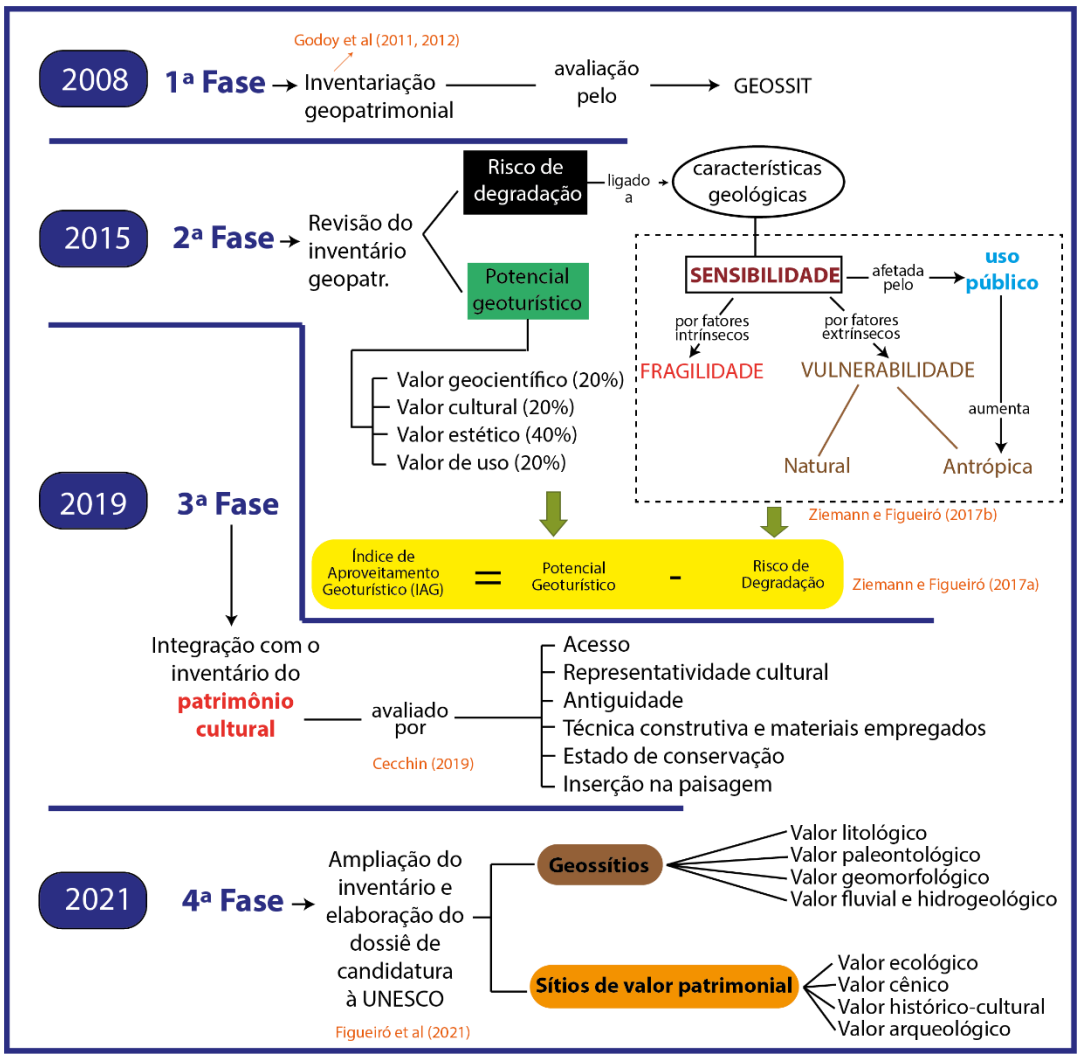
Despite the great geopatrimonial value represented by the geological formations described above and their fossilized records, added to the rich cultural heritage that survives among the descendants of immigrants (especially in language, gastronomy and built heritage), the lack of a territorial development policy capable of ensuring the permanence of the population in the Fourth Colony has resulted in a progressive abandonment social indicators that reflect impoverishment and increased inequalities (XAVIER *et al.* , 2013; SILVA, 2014; DOTTO *et al.* , 2018) .

Since 1996 , the nine municipalities that make up the territory (Silveira Martins, Ivorá, São João do Polêsine, Agudo, Dona Francisca, Restinga Seca, Nova Palma, Faxinal do Soturno and Pinhal Grande), and which are home to a population of 62,193,000 inhabitants (IBGE, 2010), they came together to create the Consortium for Sustainable Development of the Fourth Colony – CONDESUS-QC (XAVIER *et al.*, 2013), which currently heads unesco's proposal for the creation of the Fourth Colony Geopark.

Methodology

The work of patrimonial inventory and preparation of the application of the territory of the Fourth Colony to the UNESCO World Geopark represented a process of more than a decade, and can be divided into four main phases (Figure 6). Each phase corresponded to a distinct moment of maturing of the understanding of the proposal of a geopark and refinement of the methodology of patrimonial inventory in search of a holistic management of heritage and territory (BRILHA, 2018).

Figure 6- Methodological synthesis of the four phases of construction of the Fourth Colony Geopark project, from the initial inventory of geoheritage, from 2008, to the construction and submission of the application to the UNESCO World Geopark in 2021.



Source: authors' elaboration (2021).

The first phase began in 2008, with the hiring by CONDESUS of a geopatrimonial inventory conducted by the Geological Service of Brazil (GODOY *et al.* , 2011), which resulted in the first proposal for the distribution of geosites in the territory (GODOY *et al.* , 2012). These geosites were inventoried in the field and automatically quantified

according to the criteria of the web application developed by CPRM using php 5.3 programming language tools and free software MySQL 5.1 database, called GEOSSIT (LIMA; ROCK; SCHOBBENHAUS, 2010). In this phase of the work, closed in 2011, the central concern was focused on the identification of the places of greater geopatrimonial expression, with a view to the development of conservation strategies.

The second phase, which began in 2012 and was completed in 2015, was assumed that: a) several significant assets were not included in the inventory of the first phase, especially with regard to geomorphological heritage; b) some of the fossilized geosites inventoried have a high degree of risk of degradation, and it is necessary to analyze with greater care which of them could be opened to visitation and which would need to be restricted to research; we opted, therefore, for the use of the concept of risk of degradation of García-Ortiz et al (2014); c) it would be necessary to seek a geotourism evaluation of geosites, in order to allow geoheritage to become part of the tourism offer of the territory, incorporated into its development proposal; for such, we sought an adaptation of the criteria proposed by Zimmer and Grassmann (1996).

For the calculation of the Risk of Degradation (RD), the data collected in the field were submitted to an algebraic operation involving two main variables: the Associated Risk -RA (calculated from six indicators, namely: natural vulnerability of the geosite to degradation, fragility of the present geoheritage, site ownership regime and access control – public or private, accessibility, current use and proximity to potentially degrading activities) and the State of Conservation - EC (related to the integrity of the geosite and the existence of management and supervision). All variables were evaluated between 1 (best condition) and 10 (worst condition), with the AR weighted to 50% of the RD value and the EC for the other 50%.

Geotourism evaluation of geosites was performed based on four main criteria (geoscientific value, cultural value, aesthetic value and use value), deployed in 21 different indicators (ZIEMANN; FIGUEIRÓ, 2017a). Each indicator was evaluated in the field from a Likert Scale of four values (0 - non-existent, 1- bad, 5- moderate, 10- good), calculating the Geotourism Potential (PG) from a weighting on each of the analyzed criteria.

At the end, the application of a Geotourism Utilization Index (IAG) of geosites was proposed, based on the subtraction of the Risk of Degradation of the value of geotourism potential (ZIEMANN; FIGUEIRÓ, 2017a), so that some geosites (especially those of paleontological value), even presenting a high PG, were removed from public disclosure due to the high RD.

The third phase of the project included the inventory of cultural heritage built in the territory and its integration with the geosites already proposed in phase 2, through integrated Geotourism itineraries. For the work of inventorying immovable cultural assets, the field records proposed by Colombia (2005) were adapted, based not only on the object, but also on the context in which it is part of the landscape (PONTES, 2012). From this, the equity was inventoried and selected based on six main indicators: a) access; b) cultural representativeness; c) seniority; d) constructive techniques and materials used in construction; e) state of conservation; f) insertion in the context of the landscape.

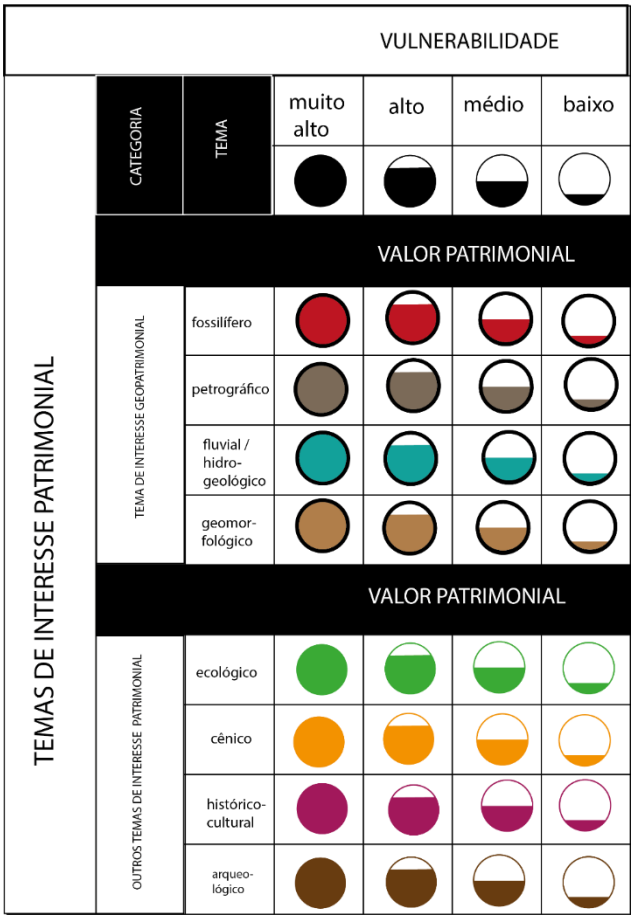
The review and expansion of the inventory carried out in the fourth phase of the project, between 2019 and 2021, focused on the production of the UNESCO World Geopark application dossier. To this end, we felt the need, based on the proposal of Brilha (2016), to separate geopatrimonial sites with predominantly scientific value (which continued to be classified as geosites), from sites with other types of values (ecologic, scenic or cultural), which began to be classified as "heritage sites". While the former, as indicated by White and Wakelin-king (2014), were grouped according to the predominant structures or processes (lithological, geomorphological, paleontological or fluvial / hydrogeological), the seconds were grouped according to the main value of prominence (ecological value, scenic value, historical-cultural value or archaeological value). Therefore, a wide review of the inventoried sites in the previous phases and new sites were included.

Unlike the first and second phases, we chose in this fourth phase to seek a simplification of the evaluation process so that, on one hand, a sufficiently comprehensive assessment could be established to assess the patrimonial value and vulnerability of the sites using the same levels of value/vulnerability; on the other hand, we sought a classification capable of being more easily interpreted by public managers and by the community involved in the conservation and management of inventoried sites. Thus, a quali-quantitative evaluation of the equity was created, with four value classes, taking advantage of the database of the previous phases and the indications of Nazaruddin (2019), Stevanovic (2015) and Perotti *et al.* (2019). These are the value classes expressed in terms of graphic symbols (Figura 7), capable of allowing a direct interpretation of the evaluation result.

Results and Discussion

In the first phase of the inventory, 20 geosites were catalogued, 11 of them directly linked to fossil heritage (GODOY *et al.* , 2012). Of the total of 20 geosites inventoried, 6 would be highlighted at the national level, 1 at the international level and 13 at the regional level, according to the criteria established in the Geositt algorithm.

Figure 7 - Evaluative synthesis of the classes of patrimonial value and vulnerability adopted in the fourth inventory phase of the Fourth Colony Geopark project



Source: authors' elaboration (2021).

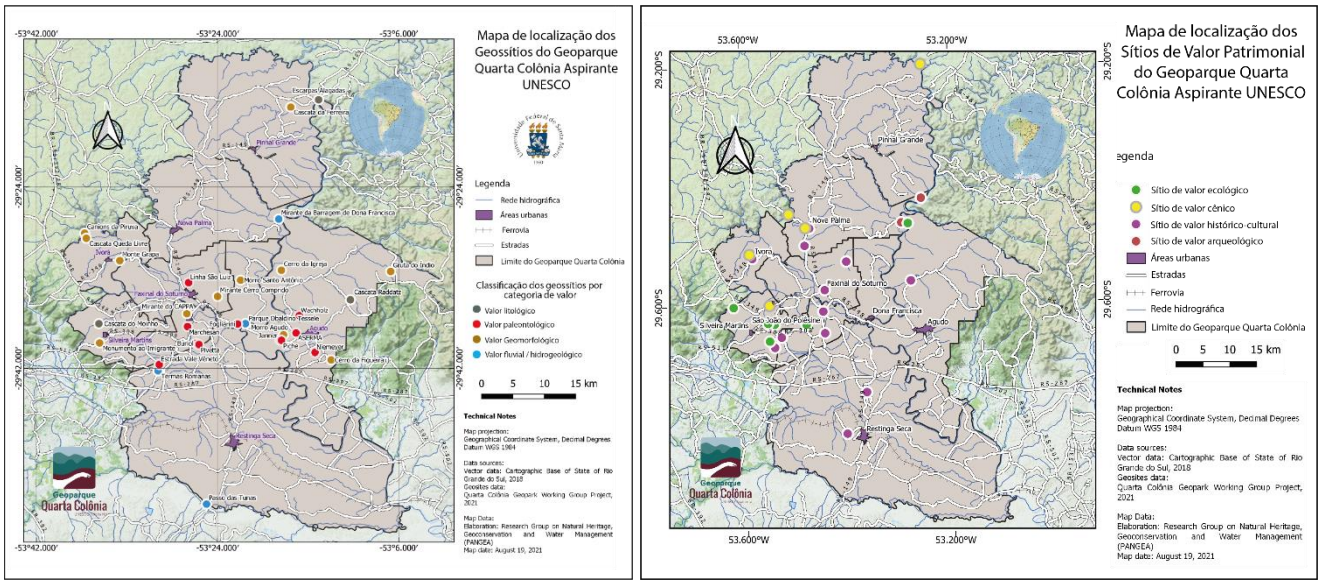
In the second phase of the inventory, the research developed by Ziemann (2016), taking into account the possibility of expanding the inventory in geomorphological aspects, proceeded to a review of 43 geosites (including 20 of the first phase and 23 new geosites), seeking to establish a hierarchy of the these with regard to the tourist value of each (ZIEMANN; FIGUEIRÓ, 2017a). From this evaluation, it was possible to identify that 24 geosites could be considered as appropriate for geotourism use (when the tourist value overcomes the risk of degradation, IAG becomes positive), while 19 geosites still needed greater investments for their better use (negative IAG, generated from a risk of degradation higher than geotourism value).

From the research of Cecchin (2019), these 24 geosites were integrated in geotourism itineraries that involve approximately 32 other places in the territory with significant value of cultural heritage built, among the 334 goods inventoried by the author. This integration was based on proposals of geotourism itineraries of nature and culture, which are still being formatted to be offered as geoproducts of the territory.

In the fourth phase of review and inventory, the authors of this work selected for the Geopark Fourth Aspiring Colony UNESCO, 31 geosites of regional to international geopatrimonial value (distributed among the categories of fossil value, lithological/sedimentological, river/hydrogeological and geomorphological) and 23 sites linked to other forms of patrimonial value (ecological, scenic, historical-cultural and archaeological value), totaling 54 sites of patrimonial value (Figure 8), on which the implementation of an interpretative plan is underway, which obeys the different possible forms of use (research, educational use, cultural memory, geotourism use, biodiversity conservation and ecosystem services).

Although most geosites and sites of geotourism value (Figure 9) are not all geosites open to self-guided visitation, especially in the case of fossil geosites, where the vulnerability of the collected material requires greater access control. In these cases, visitation, when possible, only happens with the educational purpose and with the presence of specialized conductors.

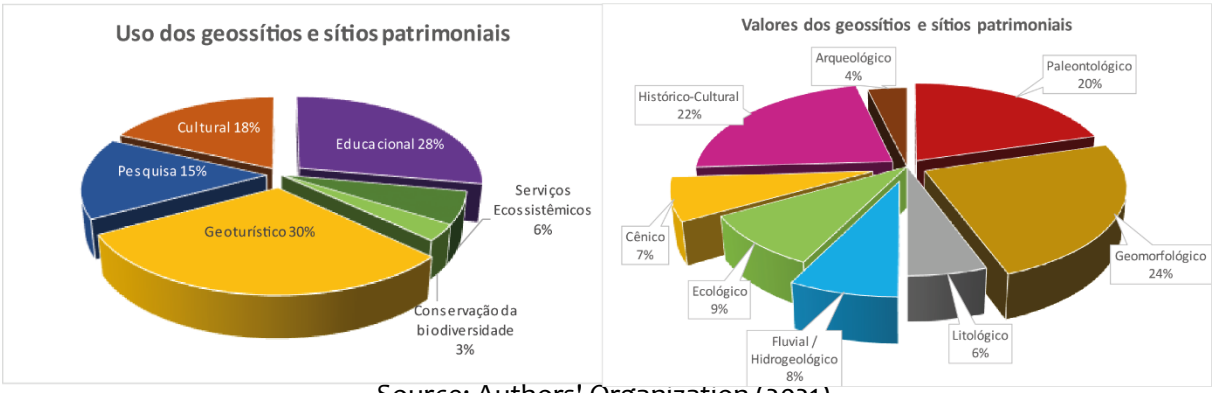
Figure 8 - Location maps of the 31 geosites (left) and 23 Heritage sites (right) that make up the dossier of the Aspiring Geopark Fourth Colony.



Source: Figueiró et al (2021).

These are 54 sites of heritage value (sites and geosites) are distributed over the nine municipalities of the geopark and cover the best existing specimens of the geological, ecological and cultural heritage of the territory. Many of them are already incorporated into the culture of the communities of the territory, serving as a reference of territorial identity for its residents.

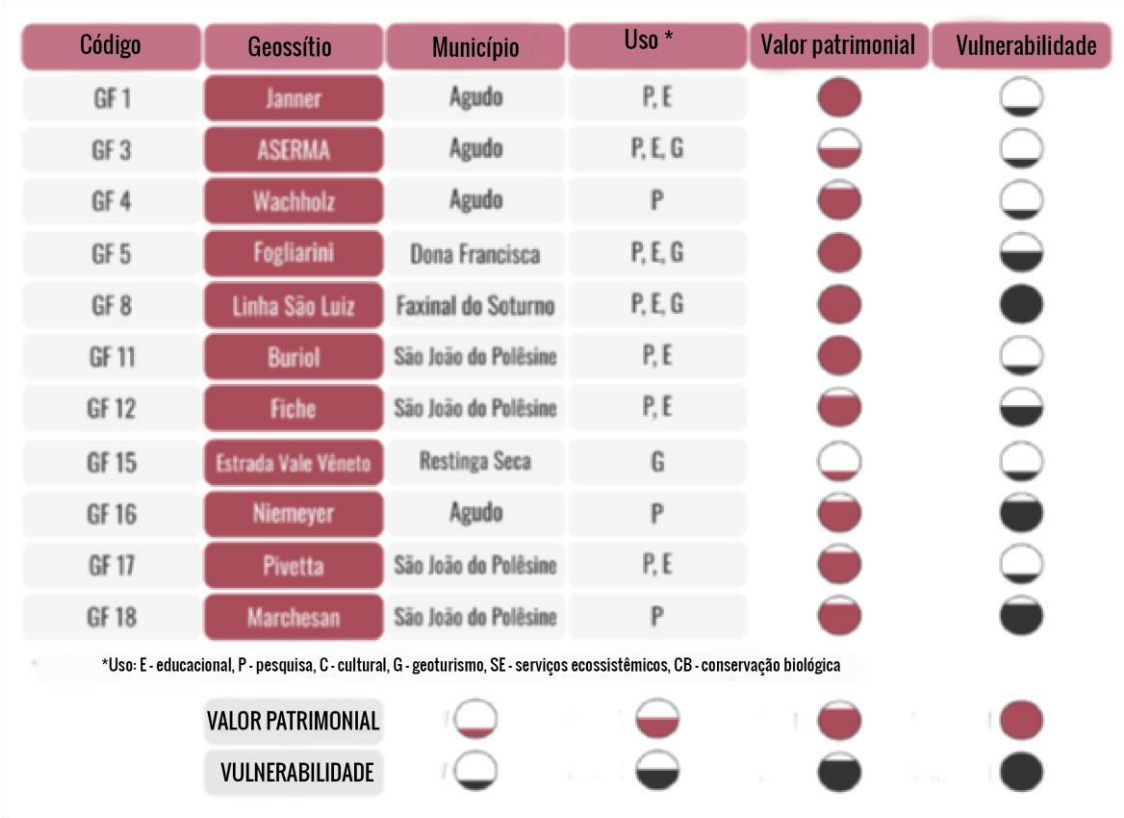
Figure 9 - Percentage distribution graphs of the 54 sites of patrimonial interest (geosites and sites) between the six forms of use and the eight classes of values used in the geopark inventory



Source: Authors' Organization (2021).

All sites were inventoried in the field by experts from the scientific committee of the geopark, with a detailed description of the property characteristics of each and the vulnerability indicators (Figure 10) that assist in the elaboration of a geosite management plan, currently under preparation.

Figure 10 - Example of a summary table for the assessment of patrimonial value and vulnerability for paleontological value geosites of the Fourth Colony Geopark. This table is the result of a combination of a set of indicators inventoried in the field, and a summary table was produced for each group of geosites and sites, according to their main value.



Código	Geossítio	Município	Uso *	Valor patrimonial	Vulnerabilidade
GF 1	Janner	Agudo	P, E		
GF 3	ASERMA	Agudo	P, E, G		
GF 4	Wachholz	Agudo	P		
GF 5	Fogliarini	Dona Francisca	P, E, G		
GF 8	Linha São Luiz	Faxinal do Soturno	P, E, G		
GF 11	Buriol	São João do Polêsine	P, E		
GF 12	Fiche	São João do Polêsine	P, E		
GF 15	Estrada Vale Vêneto	Restinga Seca	G		
GF 16	Niemeyer	Agudo	P		
GF 17	Pivetta	São João do Polêsine	P, E		
GF 18	Marchesan	São João do Polêsine	P		

*Uso: E - educacional, P - pesquisa, C - cultural, G - geoturismo, SE - serviços ecossistêmicos, CB - conservação biológica

VALOR PATRIMONIAL

VULNERABILIDADE

Source: Figueiró et al (2021).

The geosites of greatest vulnerability within the Geopark are those of fossil value, either by the risk of the destruction of outcrops due to urban or agricultural expansion, or by the invasion of exotic species, such *as Pinus sp.* (ZIEMANN; FIGUEIRÓ, 2017b).

These exotic species, if not managed, tend to cover the outcrops and hinder the collection operations for the research. A study by Ziemann and Figueiró (2017b) evaluated

the set of fossil geosites regarding their degree of vulnerability, based on 11 different criteria, following the indications of Siqueira *et al*. (2011). The criteria served as the basis for the calculations of the assessment of the risk of degradation of the geosites of paleontological interest, and each criterion was evaluated from a Fuzzy logic, in which it is possible to define quantifiable parameters for qualitative variations that are established within each of the analyzed criteria. From this, monitoring priorities were established in these geosites, which are inspected every six months.

Another risk of degradation that worries the Geopark steering committee refers to geosites with sandstone outcrop, since many of these rocks have been the target of vandalism throughout history.

Finally, those geosites and sites that involve possibilities of carrying out trails and waterfall baths in a self-guided way, therefore, without the presence of conductors and interpreters, present not only a risk of damage to the natural heritage, but also a safety problem for less prepared visitors. The Geopark seeks to address this issue from an information campaign on safety in trails, especially from materials of wide distribution in the territory and the network of partners, as well as by quarterly monitoring of geosites, checking safety conditions and working in cooperation with the owners, in the case of geosites located in private properties.

Also in this regard, is in planning, for implementation in 2022, a training course for drivers in geotourism, in order to form the first class of drivers certified by geopark, seeking to improve the safety conditions in the visitation and expand the knowledge about geopatrimonial interpretation.

In cases of higher risk, as it happens in the Morro Agudo geosite (isolated and covered testimony of Atlantic forest), where not only the flow of visitors increased a lot in recent years, but also bovine creations hinder the local natural regeneration of the habitat, a dialogue is underway with the city hall and the Municipal Council of Environment of the municipality, for the creation of a conservation unit. This will allow better management of the area, controlling the visitation and protecting *Dyckia agudensis*

Irgan., an endemic and critically endangered species (CR), because it is the only place of occurrence, presupposition for priority protection area (IRGANG; SOBRAL, 1987).

The same has already occurred in the geosite Monte Grappa, in Ivorá, which became a protected area in the category Municipal Natural Park by law no. 1425 of 2020. Currently, the development of the management plan for this geosite is currently underway.

For planning purposes, GQCAU geosites are divided into two categories, including geosites and public heritage sites and private geosites and heritage sites, and for each of them the categories use different management and conservation instruments (formal management plan for CUs, management program for public access sites without legal conservation status, monitoring and specific management rules for private sites based on geopark partnership agreements).

It is important to highlight that the management and conservation of geosites for geotourism purposes within the geopark follows some principles clearly established from its steering committee and endorsed in the tourism and environment and education, communication and culture committees of the geopark:

- Visitation is an essential instrument to bring society closer to its natural and cultural heritage, awakening awareness of the importance of conservation;
- The visitation should be promoted in the most democratic way possible, allowing access of all social segments to geosites and heritage sites and their interpretation;
- Visitation is an alternative for the sustainable use of the territory and its heritage;
- The visitation should contribute to the promotion of economic and social development for the community that receives visitors;
- Visitation activities must comply with the rules established in the planning provided for each geosite or heritage site;

• The development of visitation activities requires the existence of a minimum infrastructure that guarantees the safety of the visitor and the quality of the geotourism experience;

• Maintaining the integrity of geosites and heritage sites is essential to sustain the environmental services derived from them, including the economic benefits of visitation;

• The visitation should seek to meet the expectations of visitors with regard to the quality and diversity of experiences, safety in the visit and need for knowledge.

Educational programs in the territory

Geoeducation is one of the central pillars for the implementation of a geopark, and cannot be interpreted only as teaching concepts related to Earth Sciences, but it is a set of knowledge, school and non-school, aimed at children, young people and adults, in the sense of preparing them to interpret and act in their territory, in search of better living conditions and maintenance of their collective heritage (FIGUEIRÓ *et al*., 2019). In this sense, the work of geoeducation, collaborates in the formation of the identity of a collective, valuing and preserving diversity. Through work, the feelings of belonging to the territory are strengthened and reinforced.

The educational program of the Aspiring Geopark Fourth Colony supports the geoconservation process and is composed of an expressive set of actions that aim to value the heritage (natural and cultural) in order to strengthen the identities and their sense of belonging to the territory, stimulating the citizen exercise of right to the territory and landscape (CHECA-ARTASU, 2017). An example of this is the awareness activities that are carried out during PaleoDia, a scientific dissemination event for the community, held annually since 2018.

The main strategy of the educational program originates in actions that predate the construction of the candidacy for the World Network, and concern the very foundation of CONDESUS, with mobilization of the municipalities, museums and schools and their links with higher education institutions that operate in the territory, especially

UFSM. The strategy gained its main contours from 2018, with the construction of a permanent process of continuing education for teachers of the basic teaching network of the Fourth Colony on concepts such as geopark, heritage education, landscape, cultural heritage and natural heritage. Within the program, three editions (one face-to-face and two virtual) of the "Interdisciplinary Training Day of Teachers in Heritage Education" have been held so far, which have gathered more than 1,000 entries between 2020 and 2021, with lectures that involved the most different aspects of the property education process in the territory.

As a result of this engagement, all the municipalities that make up the geopark approved in 2020 the inclusion of a pedagogical component in the curriculum of schools, related to heritage education. In this sense, the committee of education, culture and communication of the geopark has as one of its most strategic tasks, to promote the production of educational materials and instruments that can support and qualify the pedagogical component of schools.

The second strategy of the educational program relates to the reception of visitors in the interpretive center of the geopark, where people can have diverse information about the territory and its heritage. Having suspended its services during the pandemic, the interpretive center works with the care of UFSM scholars and servers, in addition to voluntary work of researchers to serve the general public. At the moment, the geopark has only one interpretive center, in the municipality of São João do Polêsine, next to the Paleontological Research Support Center (CAPPA-UFSM), but two other thematic interpretive centers are already under planning, in the municipalities of Silveira Martins and Agudo.

Also included in the educational strategies of the geopark are the association with the UNESCO Chair "Geoparks, Sustainable Regional Development and Healthy Lifestyles" held at UTAD - University of Trás-os-Montes and Alto Douro of Portugal.

This UNESCO Chair, created in 2016, has as main objective to launch and create an innovative and integrated network of research, teaching, knowledge transfer and advanced training for master's and doctoral students in topics such as geoparks,

geological heritage and geoconservation, geotourism, education for sustainable development, local development, economic dynamics and socio territorial cohesion and healthy lifestyles. Thus, GQCAU's support for the chair is directly linked to the articulation of the Fourth Colony Aspirating Geopark to the objectives of the UN 2030 Agenda.

Final considerations

The municipalities that make up the territory of the Fourth Colony have a history of development policies very similar to many other municipalities on the periphery of central economies; the search for exogenous development in the last three decades, based on the traditional sectors and technologies of the global production circuits was followed by a loss of competitiveness, impoverishment, emptying of the field, reduction of social indicators and, in most municipalities, absolute loss of population in the last ten years. However, in recent years, with the change in the focus of development, focusing on the conservation, dissemination and sustainable exploitation of its natural and cultural heritage, there is a clear reversal of trends of impoverishment and cultural erosion. For this to be materialized, the geopark seeks an interconnection between the economy based on the local community, conservation with equity and the integration of the economy with the environment.

In a holistic and systemic way, the impacts produced by the Fourth Colony Geopark reach different areas and actors, mainly from the purposes of using knowledge in geoconservation as part of sustainable development. In a valuable and unique way, the presence of the Geopark has allowed the protection of geological heritage assets, the articulation and involvement of social actors in the safeguard process and, at the same time, the incentive to social interaction and educational practices for tourism activities throughout the territory. New entrepreneurs emerge at all times , geoproducts are being thought and tested by the entrepreneurs themselves, schools live a unique moment of "discovery" of their territory and the community in general is increasingly proud of its heritage stakes and roots, which has heated the real estate market and attracted new investments.

One of the central points for the geopark's endogenous development strategy to work is the need for networking, involving processes of circulation, articulation, participation, in addition to association and communication between the social actors involved. The collaborative sense, increasingly, is shown as a potential for the organization of initiatives in territorial tissues. In these, the joint actions, developed from various purposes, carry out significant social transformations, since they occur through the exchange of information, institutional and political articulation for the implementation of joint projects.

In the case of the Fourth Colony, the associative processes are linked to the history of the construction of the territory; poor immigrants, "abandoned" by the state in the midst of a unfriendly nature and full of a strong sense of religiosity, ended up developing strategies of cooperation and mutual help, which were strengthened amid the large number of festivities and social events that last to this day. The numerous festivals of the religious calendar of the Fourth Colony, always have a huge voluntary and collaborative work, which expresses a deep social interaction, also portrayed in groups of artisans, folk dance groups, cooperatives and organized rural communities. Thus, the strategy for the implementation of the geopark has benefited from the characteristic of the territory, which recognizes the central role of the institutional actors involved and attributes the necessary level of trust to the subjects and the project coordinated by them.

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Authorship contributions:

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Received in: 23/11/2021
Approved in: 12/04/2022

Universidade do Estado de Santa Catarina – UDESC
Centro de Ciências Humanas e da Educação - FAED
PerCursos
Volume 23 - Número 52 - Ano 2022
revistapercursos.faed@udesc.br