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Geoeducation and valorisation of ecocultural resources: contributions to tourism sustainability at Estrela Geopark (Portugal)

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Abstract

Geodiversity and geological heritage are eco-cultural resources of great scientific, educational and tourist value, and are of particular importance for the sustainable development of rural and natural areas. The aim of this study is to analyse how the geo-education strategies developed by the UNESCO Estrela Global Geopark contribute to the enhancement of eco-cultural resources, geoconservation, community engagement and the sustainability of tourism. A qualitative and exploratory approach, based on a case study, was adopted. The fieldwork took place over eight months and involved semi-structured interviews with 12 experts, observation of educational activities and interpretative trails, the compilation of field notes, and the analysis of documents, programmes and materials produced by the Geopark. The data were subjected to a thematic content analysis and organised according to the main objectives, actions and results identified. The results highlight five key areas of intervention: cooperation with local authorities and communities; establishing partnerships with schools; producing teaching materials and designing trails; installing interpretative panels; and developing a network for science and education for sustainability. It is concluded that geoeducation constitutes a central element in linking scientific knowledge, heritage enhancement, geoconservation and sustainable tourism, contributing to improving the interpretation of the territory, strengthening communities' sense of belonging and promoting more responsible behaviour amongst residents and visitors.

Keywords: Geoeducation, Tourism, Geotourism, Sustainability, Estrela Geopark

1. Introduction

Tourism activities have relevant meaning and expression as factors of transformation of the territories and their (re) organization, in terms of occupation, generated economies, and promoted socio-cultural relations. The growing demand for natural spaces, where the interpretation of nature and outdoor activities acquire significance and dimension, requires forms of cooperation and collaboration between destination managers, investors in the tourism and hospitality sector, and the respective communities.

Educational tourism should enable the coexistence of people of different cultures through a participative pedagogy, in which participants are encouraged to engage in an experiential interaction with the territory. This goal is achieved in the EG through the development of educational programs and the creation of a network of interpretative routes. These allow people not only to visit the territory but also to have access to scientific knowledge and ecocultural information about the geosites among others through interpreted tours and interpretative panels. The challenges for the Serra da Estrela as a UNESCO World Geopark, imply an increasing responsibility in the usufruct of its resources, promoting sustainable and valuative practices for tourism in the region. The aim is to establish the relevance of

education in the construction of sustainable tourism, describing the strategies of interpretation of the natural and cultural heritage through the development of different supports and experiences with pedagogical character, directed to different publics promoted by EG. The importance of the communities in the dissemination of the heritage knowledge of their territories is established, fostering their self-esteem, stimulating initiatives, promoters of social and economic welfare, based on the identities and ecocultural resources held.

2. GEOPARKS AND GEOEDUCATION: CONTRIBUTIONS TO THE SUSTAINABILITY OF TOURISM ACTIVITY

Non-formal education is a very relevant aspect in the perspective of sustainability, in the dissemination of geosciences and geoconservation, as in a process of tourist valuation, making known the geotouristic resources, their heritage value, and the importance of preserving their ecocultural and economic assets. In the context of the sustainable development of the territory and based on the principle of conservation of its natural and cultural heritage, the UNESCO Global Geoparks intend to implement projects for the maintenance and enhancement of natural spaces, to promote science, to increase the well-being of their communities, and to promote tourism (Frey et al., 2016; Zouros, 2004). Thus, geoparks must protect the geological heritage for future generations (conservation); educate and teach the public about themes related to geological land-scapes and environmental matters (education); promote research facilities in geosciences (science); and ensure sustainable development (tourism) Eder & Patzak, 2004). Geotourism is one of the main areas promoted by UNESCO Global Geoparks, with an emphasis on nature tourism and cultural tourism (Brilha, 2005; Catana & Alves, 2008). The organization of different actions with a focus on natural and cultural heritage aims to stimulate socio-economic activities through the creation and promotion of projects related to the tourism sector, to dis-seminate and promote visits and touristic circuits in the territory. Geo-education and geotourism have gained relevance in the projects of tourism development, above all in low-density territories. This new paradigm of "looking" at the territory has allowed the construction of a new narrative about the valorization of endogenous resources, the landscape, and the policies of territorial tourism development (Frey et al., 2016). Education and science play a key role in the conservation and maintenance of geological and cultural diversity, stimulating research in the territory and actively contributing to the existence of a network of initiatives (publications, information exchange, conferences, community projects, etc.) in a holistic view. Education is the basis of geotourism and a pillar for the sustainability of the territory's heritage and its local communities. The visitors develop attitudes according to the didactic and scientific information and interpretation tools that are available (UNESCO, 2023b). In this way, geotourism assumes a fundamental role in sustainable local development, while leisure activities may involve environmental education (Farsani et al.,2012; Fernandes, et al., 2021; Hose, 2005). Geoscience education can only be successful if direct contact with geodiversity is allowed. This premise is valid concerning formal educational activities, on a school scope, and non-formal educational activities aimed at the general public. In this sense, field trips allow geodiversity to have an educational value of great relevance (Brilha, 2005). The dissemination of heritage values has an educational value in itself and constitutes a relevant contribution to teaching, facilitating teaching activity, and the development of fieldwork (Brilha, 2005; Fernandes et al., 2016). The development of educational promotion strategies, using the region's heritage resources, in an integrated approach and designed in coordination with the pro-grammatic references of the different teaching cycles, constitutes stimulating educational resources for the teaching process outside the classroom, generating experiences and in situ learning. In this collaborative

context, the articulation of schools in a synergistic connection with the Estrela Geopark is encouraged, in the construction of active and experimental models, generators of transversal learning, and valorization of the territory (Eder & Patzak, 2004; Fernandes et al., 2021, Gomes et al., 2017).

Tourists are learning according to the didactic interpretation tools that are being offered. The more explicit the phenomena are and the more appealing the interpretation, the more efficient the dissemination of geology becomes. On the other hand, a citizen who may have had the possibility of having studied geosciences is more conscious and interested in the practice of geotourism. Furthermore, geotourism allows for the promotion of geo-heritage through the sensitization and the promotion of geology which becomes essential for a concerted geoconservation strategy.

The relationships among geoconservation, science, and tourism must be established in different ways, enabling an integrated approach to the territory, in the natural and human dimensions and their interactions, promoting knowledge, raising awareness of heritage values, and building attitudes and tourist practices that value the destination and enable their sustainable use. UNESCO Global Geoparks wants to motivate residents to realize the uniqueness of their place (Čtveráková et al., 2016). This scientific knowledge, combined with principles of preservation and sustainable uses, leverages value for the territory, promoting a deeper knowledge of its physical and natural history, as well as its functional and heritage relevance, promoting perceptions and tourist practices that promote its sustainability (Fernandes et al., 2020; Hose, 2005).

For a geopark to achieve its objectives, activities related to geotourism and ge-education must be developed, not just geoconservation. In addition, geoeducation, geoconservation, and geotourism must be developed considering that the uses of the territory presuppose a permanent and collective construction with the community, promoting economic and social well-being (Novaes & Pena, 2016).

The local community is the real driving force behind the Geopark. The participation of communities, the involvement of schools, local authorities, and tourism operators reflect UNESCO's vision of an inclusive and collaborative territory. The relational approaches here emerge in the form of co-creation: inhabitants are no longer mere guardians of the past but become active actors in the construction of new narratives of identity. In this context, tourism should be understood as an experience of encounter, promoting bonds and mutual recognition between visitors and the host community. The social dimension is at the very heart of the Estrela Geopark. Its management model is based on the participation of local communities, schools, local authorities, and scientific and cultural institutions, reflecting the principle that there can be no geopark without people (UNESCO, 2023).

3. GEOEDUCATION, GEOCONSERVATION, AND GEOTOURISM: CHALLENGES FOR THE VALORIZATION OF ECOCULTURAL RESOURCES AND SUSTAINABILITY

The territory results from the interaction between man and the environment, which produces different ways of organization and anthropogenic relationships with nature and culture, transforming these assets in terms of their leisure supply, entertainment, and knowledge to visitors and socio-economic inclusion of local people in related activities with tourism (Berma net al., 2008; Eder & Patzak, 2004). Geoheritage plays an educational role in society so as to raise awareness about the extent of the influence of geological forms and processes on our history (Górska-Zabielska, 2023; Miśkiewicz, 2016).

Geoconservation is a management strategy for geo-heritage sites based on the high value of geological resources for science and tourism, requiring careful action in its conservation in the face of different human pressures. Geoconservation is currently defined as "the act of protecting geosites and geomorphosites from damage, deterioration or loss through the implementation of protection and management measures" (Hose & Vasiljevi 2012, p.16). To achieve geoconservation and the valorization of territories that have geo resources, it is essential to promote education and public awareness about the value of geosites, through their promotion and interpretation via geotourism (Miśkiewicz, 2016; Hose & Vasiljevi 2012; UNESCO, 2015). Geoconservation is more focused on the management of those geo-logical elements with exceptional scientific, educational, touristic, or cultural value in the geological heritage represented by geosites (Górska-Zabielska, 2023; Hose, 2005). Inventory and evaluation procedures play a decisive role in the implementation of subsequent conservation and the valuing and monitoring of the geo-heritage. It should be noted that geo-education cannot be interpreted only as teaching concepts related to earth science/geosciences, but rather as a set of knowledge and knowledge, both school and non-school, both for children and young people and adults, to prepare them to interpret and act in their territory, in search of better living conditions and maintenance of their collective heritage (Fernandes, 2021; Dowling, 2015).

The concept of geotourism has known different interpretations and approaches, depending on scientific areas and geographic contexts, currently having a less strict dimension with geology and a more extensive relationship with geographical aspects approached relationally with the geomorphology of places. In this context, Hose & Vasiljevi (2012) summarized and redefined geotourism as "the provision of interpretative and services facilities for geosites and their encompassing topography, together with their associated in situ and ex-situ artefacts, to build a constituency for their conservation by generating appreciation, learning, and research by and for current and future generations. Geotourism can promote geoconservation and an understanding of earth sciences through appreciation and learning. The interpretation and understanding of the landscape provided by geo-education trigger geoconservation, since the tourism and pedagogical activities in question start from the premises of sustainability and the need for conservation of geological heritage. Geotourism has developed methods of geo-education to prepare geosites available for visiting, using interpretation for a wide range of recipients (Mokhtari et al., 2019; Burek & Prosser, 2008). The social fruition of the geological heritage and ecocultural landscapes is mainly achieved in national parks and similar structures (natural parks, geoparks, natural reserves, and others, depending on the legal framework) where it is supported through informative and interpretative actions, namely panels, brochures, leaflets, field guidebooks, websites, museums, and interpretative centres (UNESCO, 2015; Kusumah, 2023). Geoconservation plays an important role in science, education, and geotourism, promoting an entire process of inventorying, cataloging, and sharing that promotes the tourist qualifications of the territories and their enjoyment, as a tourist space for interpretation and learning. One of the important issues that have attracted many researchers in the field of geotourism in recent years is the sustainability issue and how tourists view the exploitation and conservation of endogenous resources (Dowling, 2015). Mokhtari et al. (2019) observed that there is a positive and significant relationship between the tourists' education level and positive environmental reactions to geotourism resources. In this context, there is also a relationship between environmental behaviors and geotourism knowledge. An educational strategy is necessary to be set up in partnership with schools, universities, and local councils, to develop training packages and courses for local teaching staff and students, and to organize events for public awareness of natural and cultural heritage. Geo-education must

develop its own structure and tools based on the results of scientific research. It must be considered in a broader frame as part of education for nature conservation and ultimately an important part of education for sustainable development.

4. METODOLOGY

This research constitutes an exploratory study into the dynamics and strategies promoted by the UNESCO Estrela Global Geopark, in the context of its geoconservation efforts regarding its eco-cultural resources, as well as its interaction with local communities and visitors. The Geopark's mission and development strategies were assessed, and the main projects relating to the enhancement of resources, as well as the initiatives and principles aimed at promoting sustainability and tourism development, were systematized within the context of geo-education and the interpretation of geological heritage. The study focuses on the importance and relevance of geo-education in raising awareness of the geosciences and on ways of experiencing the area in a fun and educational manner, thereby contributing to its enhancement, geoconservation and sustainability.

The methodology involves immersive fieldwork carried out in collaboration with Geopark staff, with the aim of identifying and understanding the strategies and practices implemented. Interpretive trails are a particular focus, offering insights into the effectiveness of the Geopark's educational programmes. The collaborative nature of this research extends to the inclusion of researchers associated with the Geopark's Science and Education for Sustainability Network. Furthermore, perspectives are gathered through consultations with staff affiliated with the Estrela Geopark in each of the municipalities within its designated area.

The study involved 12 experts: three members of the Estrela Geopark Association and one representative from each of the nine municipalities that make up the designated area. All 12 participants took part in semi-structured interviews, whilst three experts from the Estrela Geopark Association were also observed during educational activities and interpretative walks. The fieldwork took place over eight months, between March and October 2024, and included eight field visits, amounting to approximately 40 hours of observation. Eight educational and geotourism activities were monitored, including six interpretative trails involving school groups, residents and tourists. The interview guide covered the participants' responsibilities, the strategies implemented, the partnerships established, educational practices, community involvement, perceived outcomes and the main challenges.

Methodological triangulation was employed, combining interviews, observations, field notes and documentary sources, to enhance the systematisation and consistency of the results. To summarise the conclusions and insights gained, the research presents a comprehensive table (Table 1) to aid understanding of the geopark's territory. In addition, a summary framework outlines the main objectives, strategies/actions and results. This framework serves as a practical guide for feasible initiatives that not only deepen knowledge of the heritage but also promote geotourism. Fundamentally, it stands as a testament to best practice in geo-education and to the active involvement of communities in defining collective development strategies.

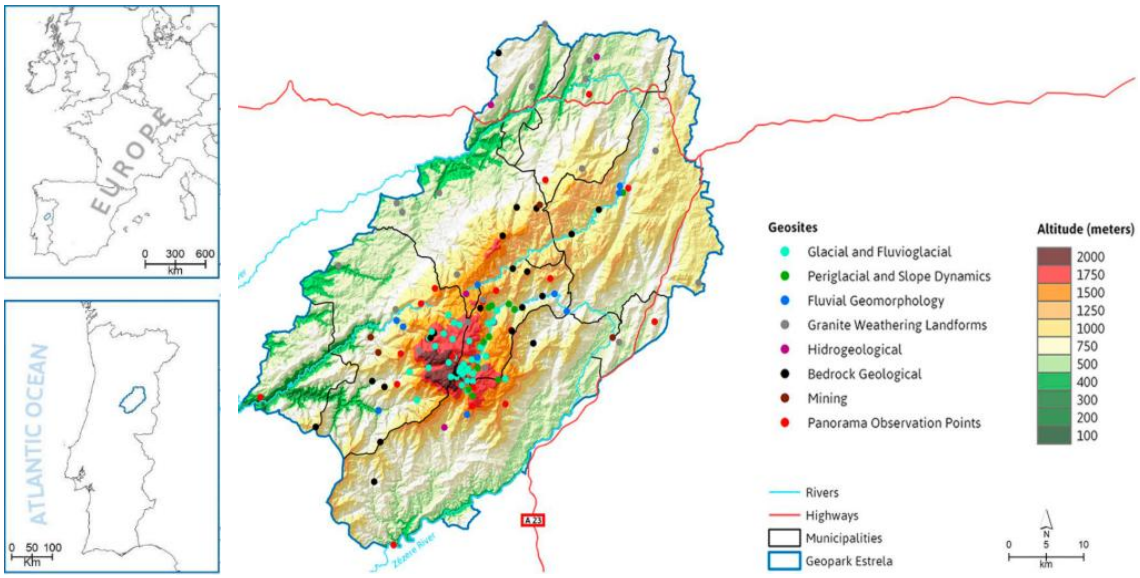
5. ESTRELA GEOPARK EDUCATIONAL PROGRAMS AND FORMATS FOR INTERACTION WITH THE COMMUNITY - RESULTS

Estrela Geopark has the mission of contributing to the protection, valorization, and dynamization of the natural and cultural heritage, with special emphasis on geological heritage, intending to deepen and disseminate scientific knowledge and to promote tourism and sustainable development of the Serra da Estrela. Overall, the geopark seeks the

development of an integrated development strategy that will enhance heritage; foster geoconservation, education, and tourism; and support the construction of development strategies for the good of the community.

EG emphasizes the development of a collective strategy, reconciling environmental, social, and economic responsibilities, which articulates for the first time all municipalities of Serra da Estrela which are engaged in value action, conservation, and territorial promotion. The EG (figure 1) consists of nine municipalities (Guarda, Seia, Gouveia, Celorico da Beira, Fornos de Algodres, Manteigas, Belmonte, Covilhã, and Oliveira do Hospital) with a total area of 2216 Km2 and about 170.000 residents. It is coordinated by the Associação Geopark Estrela (AGE), which has as its founding partners, besides the nine municipalities, the Polytechnic of Guarda and the University of Beira Interior, and it intends to be extended to other local agents such as educational institutions, local associations, clubs, and the different stakeholders of Serra da Estrela.

Figure 1 - Location of the Estrela Geopark, Geosites, and its altimetry.



Source: Associação Geoparque Estrela - AGE

The educational programs aim to empower communities, in the areas of citizen science of knowledge, to develop sensitivity and attitudes for the preservation and enhancement of ecocultural resources, and sustainable tourism practices, given the fragility that many of the resources present. In this context, pedagogical paths and programs were structured for the different levels of education, which aim to stimulate curiosity and interest in the geosciences, contributing to the conservation and enhancement of the natural and cultural heritage of Estrela. The practices developed allow the dissemination of information about geodiversity, biodiversity, and mountain lifestyles, stimulating interest in the discovery and knowledge of the geopark's territory. Programs promote tourism attitudes and practices with protection and preservation concerns, enhanced resource preservation, and sustainability. Methods for the logical dissemination of knowledge, strengthening geoconservation attitudes, and development of resources are identified, and guidance in analyzing the functions and effects of their use on the environment and community. The logic of action, education practices, and geoconservation are systematized for sustainable tourism and for responsible behavior, and a sense of belonging with the territory and its values.

In terms of education and sustainability in tourism, the Estrela Geopark, with the development of these pedagogical routes, promotes:

a) an approach to local communities and territorial enhancement in connection with municipalities;
b) the development of protocols with all the schools in the dissemination of Estrela Geopark;
c) the creation of didactic materials to support visits and definition of routes;
d) development of interpretive panels for visitors to Estrela Geopark;
e) development of the Education and Science Network for Sustainability in conjunction with higher education institutions, research centers, and the school community.

These activities, adapted to different groups and ages, include recreational actions dedicated to geodiversity (educational games, photography, quizzes, interpretative drawings) and more formal initiatives such as field classes, workshops, seminars, and/or laboratory activities that promote multidisciplinary (Table 1). In this way, aspects of biodiversity, culture, and ways of life in the region are integrated, promoting a broad and rigorous knowledge of Serra da Estrela, and raising awareness of sustainable tourist appropriation of its resources. The most efficient way to achieve geoconservation is to increase public awareness about the value of geo-heritage sites (scientific, aesthetic, educational, tourism, economic, intrinsic) through promotion and interpretation via geotourism (Dowling, 2015; Henriques et al. 2011, Kusumah, 2023). Scientific research, courses, and use of the geosciences in activities for groups and finally geotourism are activities that require a decreasing amount of scientific transfer but, conversely, provide more economic benefits and possibilities for development and well-being for the communities (Fernandes et al., 2020; Meléndez, et al., 2001). The arrival of tourists can, in effect, promote the construction of access infrastructures, hotels, restaurants, tourist facilities, marketing products, and souvenir trade. In a process of collaboration and stimulation of entrepreneurial actions for the enhancement of the Serra da Estrela destination, the Estrela Geopark operates to integrate the interactive processes between local governance and territory management, population and economic activities, schools and the scientific community, and nature conservation and local ways of life. It seeks to contribute to a transversal qualification of the territory and its communities, with the effective participation of municipalities in the development of strategies and promotion of heritage resources, in a close relationship with nature conservation plans, policies, and involvement of the communities. EG has promoted synergistic conjugations between nature and mountain lifestyles, conservation and economic activities, and governance and the academic community, generating collaborative networks and building a territory of science, education, and tourism. Study interests are established or renewed on the territory, its resources, and current dynamics, from a perspective of applied research and knowledge transfer to society. They constitute cooperative approaches that foster self-esteem and a qualified image of the territory and the resources it holds.

Table 1 - Systematization of activities, objectives, and results of the education and awareness process for geoconservation and geotourism.

Goals	Activities	Results
a) Approach to local communities and territorial enhancement in connection with municipalities	- Promote a collective development strategy; - Create synergistic connections between the territory and the communities	- Construction of a collective strategy for valuing geo-resources and promoting the territory by the 9 municipalities, materialized in the UNESCO Global Geopark application - Promotion of local products and tourism through the diverse "Mountain Markets"

	-Promote events of territorial promotion and valorisation of endogenous resources.	and attendance at fairs and events related to tourism; - Promotion of entrepreneurship and territorial innovation through thematic seminars developed in the municipalities;
b) Development of collaborative protocols with interest groups in the dissemination of Estrela Geopark	- Foster the connection of school communities with the actions of Geoparak (educational, scientific and touristic); - Promote the territory as a learning resource; - Stimulate the teaching of geosciences and the construction of projects.	- Creation of educational plans/projects with schools and school groups; - Implementation of the "mother earth" contests for good practices in geoconservation and biodiversity; - Dissemination of geoscience and geoeducation through educational programs, interpretive paths, and guided study visits. - Creation of a network of EG's partners, with principles of collaboration in the conservation of heritage resources, their promotion and responsible tourism practices.
c) Creation of didactic materials to support visits and definition of routes	- Create information materials in different formats about the geopark and its heritage; - Stimulate visitation, knowledge of resources, and good practices in geoconservation and geotourism.	- Creation of promotional videos about the territory and its endogenous resources; - Development of didactic leaflets; - Participation in technical, didactic, and scientific events; - Lectures at Schools and Universities; - Dissemination of studies in national and international journals.
d) Development of interpretive panels for visitors	- Promote informative support for the visit and interpretation of the Estrela Geopark territory; - Promote geosciences and ecocultural resources in the territory	- Placement of 24 interpretative panels to interpret the geossites and landscapes of the territory; - Geopark interpretive and dissemination leaflets with scientific illustrations; - Brochures on tourist routes and formats.
e) Development of an Education and Science network in conjunction with higher education institutions, research centers, and the school community	- Promotes projects to qualify the territory and protect ecosystems and late lifestyles - Develop scientific collaboration partnerships with IEs and CR&D; - Encourage studies/research on the territory and good geoconservation practices. - Stimulate practices os sustainable to tourism.	- Establishment of a Research Network applied to the territory; - Development of workshops and seminars on tourism and sustainability, communication - Promotion of geosciences in the process of outdoor learning Programming and monitoring visits with interpretation guided by AGE technicians; - Promotion of research with schools; - Allocation of R&D scholarships;

Source: Authors elaboration

By the time the fieldwork was completed in October 2024, 24 interpretive panels had been installed and were operational. This figure updates the survey carried out in 2021, which identified 19 structures covering 28 geosites and envisaged the subsequent expansion of the

network.

These combinations have received leverage, stimulus, and financial support from management/governance entities in the realization of events, dissemination of local products, and the enhancement of tourism. The growing participation of entities responsible for nature protection and biodiversity conservation is developed through the elaboration of interpretative panels, placement of signs, support for training actions and collaborations in tourism projects and valorization of natural resources (geological, water, forest), promoting their approximation to local communities. The economic activities recognize the role of the EG and are part of a network of partners that benefit from the various initiatives promoted, recognize the stimulus given to tourism, and the international valorization of the destination Serra da Estrela by UNESCO classification. The link with the academy emphasizes the role of research and training, with courses, integration in school projects, and development of applied master theses. The promotion of informal learning contexts and their relevance in the qualification of different publics and generating territorial valorization, with emphasis on training in tourism, should be highlighted.

6. Conclusion

The geoconservation of heritage is one of the most important activities in a geopark, in the context of the sustainable development of the territory, promoting the implementation of projects for the preservation of natural spaces, environmental education, the enhancement of tourism and activities that increase the well-being of local communities. Education is the basis of geotourism and the sustainability of the heritage and its local communities. The means and supports for knowledge, educational interpretation, and dissemination are crucial for both the enhancement and protection of these resources. Geotourism allows for the promotion of geological heritage, science, and community appreciation, raising awareness of concerted geoconservation.

The Estrela Geopark's strategies for enhancing ecocultural resources show a dynamic approach to building and promoting collective actions and projects, which are based on five major objectives, including interactive work with local communities, the involvement of the territory's main players through partnerships and protocols, the development of educational materials to support the dissemination of geoscience resources and their interpretation, the establishment of information and communication supports for the different audiences of the geopark's heritage and the construction of a science and education network, linking the territory, research centers and the different teaching and education actors. In this context, the research made it possible to systematize actions and good practices that support the valorization and conservation of EG's georesources, with the involvement of local communities and stakeholders, constituting benchmarks for the consolidation of local geoconservation strategies, the promotion of sustainable tourism practices and their application to territories with similar characteristics.

7. Limitations of the Study and Future Avenues of Research

This study has several limitations. Firstly, as this is an exploratory case study focusing on the Estrela Geopark, the results cannot be directly generalised to other geoparks or nature destinations. Secondly, the qualitative approach and the use of a purposive sample of professionals may introduce subjectivity and institutional bias. The study did not include a systematic assessment of the perceptions of visitors and local communities, nor did it measure the effects of the initiatives on knowledge, conservation behaviours or tourism and socio-economic development. Furthermore, the data reflect a specific period within a territorial strategy that is constantly evolving. Future research should include longitudinal

studies, quantitative indicators, consultation with different stakeholder groups and comparative analyses with other geoparks.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data supporting the findings of this study are available upon reasonable request.

ETHICS STATEMENT

This study did not involve human participants or animals and therefore did not require ethical approval.

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