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Analysis of Tourism Potential in the Toba Caldera Geopark for the Development of the Ambarita–Tuktuk–Tomok Geosite and the Batak Museum Simanindo–Batuhoda Geosite

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Abstract

This study analyzes the tourism potential of Geosite Ambarita–Tuktuk–Tomok and Geosite Batak Museum Simanindo–Batuhoda in the Toba Caldera Geopark, Samosir Regency, focusing on accessibility, accommodation, and attractions. It aims to develop these destinations by integrating activities and supporting facilities to enhance visitor experiences. Using a mixed-method approach with concurrent embedded design, qualitative data were collected through interviews, document analysis, focus group discussions, and literature review, while quantitative data were gathered from surveys and questionnaires. Data were triangulated through observations, interviews, and document studies, with content validity tested using Aiken's formula. The primary data sources included key stakeholders of the Toba Caldera Geopark and a sample of 90 tourists. The findings show that tourism development in both geosites is supported by good accessibility, quality accommodation, and unique cultural and natural attractions, which attract visitors and positively impact environmental and social preservation. Sustainable management of the Toba Caldera Geopark requires a holistic approach that balances tourism development with the conservation of geological, natural, cultural, and historical aspects. Improved infrastructure and government promotion are essential for these geosites, while adequate facilities and cultural activities can enhance their appeal while preserving local culture. Effective risk management, infrastructure sustainability, and environmental awareness are also recognized as critical for sustainable geosite development. Close collaboration among government, local communities, private sectors, and Non-Governmental Organizations is essential for sustainable geopark management, maximizing benefits for the local community.

Keywords: Geopark; Tourism; Sustainability; Development; Stakeholder Collaboration

INTRODUCTION

The tourism sector plays a significant role as one of the sources of foreign exchange revenue and can drive national economic growth, particularly in reducing unemployment and increasing a country's productivity. Tourism is a strategic sector that must be optimized for tourism development as part of national development (Yakup & Haryanto, 2019). Additionally, Presidential Regulation Number 9 of 2019 concerning Geopark Development emphasizes that a Geopark is a single or combined geographic area with valuable Geological Heritage (Geosite) and landscapes. Geoparks encompass aspects of Geological Heritage (Geoheritage), Geological Diversity (Geodiversity), Biological Diversity (Biodiversity), and Cultural Diversity. Geoparks are managed for conservation, education, and the sustainable economic development of communities with active participation from local communities and regional governments. The Geopark concept serves as an example of sustainable regional economic development management (Du & Girault, 2018).

Lake Toba, as one of Indonesia's premier destinations, has 16 geosites spread across seven districts, including the Ambarita–Tuktuk–Tomok Geosite and the Batak Museum Simanindo–Batuhoda–Stone Tombs Geosite. These geosites hold significant geological, archaeological,

geographical, and ecological value. However, their utilization remains suboptimal, particularly in terms of promotion, infrastructure, and supporting facilities. Previous studies have discussed Geopark area development. Farsani et al., (2011) underlined the need to integrate principles of education, research, and local economic construction to support tourism development. Recent studies by (Vebrianto et al., 2020) emphasized the importance of community involvement and ecotourism initiatives in Geopark management to enhance both conservation and local economic benefits. Sharron Dickman (1989) emphasized that effective destination development must consider five 'A's: Attractions, Activities, Accessibility, Accommodation, and Amenities. However, research specifically applying these principles to geosites in the Lake Toba area remains limited.

Szepesi et al., (2020) highlighted the necessity of addressing accessibility issues to improve tourist experiences in natural and cultural heritage sites. The lack of promotion and publication of tourist attractions at the Ambarita–Tuktuk–Tomok Geosite and the Batak Museum Simanindo–Batuhoda–Stone Tombs Geosite results in low awareness among tourists of their potential. Additionally, the level of accessibility, availability of accommodation, and supporting facilities such as public restrooms, information centers, and souvenir shops require further development. The lack of attractive and diverse tourism programs also poses challenges in drawing tourist interest.

The lack of promotion and publication of tourist attractions at the Ambarita–Tuktuk–Tomok Geosite and the Batak Museum Simanindo–Batuhoda–Stone Tombs Geosite results in low awareness among tourists of their potential. Additionally, the level of accessibility, availability of accommodation, and supporting facilities such as public restrooms, information centers, and souvenir shops require further development. The lack of attractive and diverse tourism programs also poses challenges in drawing tourist interest.

The development of Geopark areas has become a global strategy to promote sustainable tourism. Previous studies have predominantly focused on geological conservation and local economic development (Dowling & Newsome, n.d., 2018) while integrating the five 'A's analysis for specific geosites is still rare. Therefore, this research offers a unique approach by analyzing the potential and development of the Ambarita–Tuktuk–Tomok Geosite and the Batak Museum Simanindo–Batuhoda–Stone Tombs Geosite based on the five 'A's framework. This study contributes by specifically examining the tourism potential of these geosites, a topic that has not been holistically addressed. The contribution lies in integrating Accessibility, Accommodation, Attractions, and the application of sustainable management concepts based on the Geopark framework. This research introduces a unique approach by applying the five 'A's (Attractions, Activities, Accessibility, Accommodation, and Amenities) framework in a detailed manner to the geosites within the Lake Toba area.

This study aims to formulate sustainable tourism development strategies for the Ambarita–Tuktuk–Tomok Geosite and the Batak Museum Simanindo–Batuhoda–Stone Tombs Geosite. This approach includes: (1) Analyzing the tourism potential of both geosites by considering supporting facility aspects (Accessibility, Accommodation, Attraction) to identify existing gaps, and (2) Integrating Activities and Amenities aspects into destination management strategies to enhance the attractiveness and quality of visitor experiences while ensuring environmental, cultural, and economic sustainability.

This research can be integrated into local government policies with a focus on the management of the Toba Caldera Geopark. Previous studies have emphasized the significance of policy-driven strategies for sustainable tourism development. For instance, (Dowling & Newsome, 2018) highlight that the implementation of geotourism principles, such as conservation,

local community engagement, and education, plays a critical role in enhancing the value and sustainability of geopark destinations. Furthermore, (Bramwell & Lane, 2011) discuss the importance of collaborative governance in tourism, where partnerships between local governments, private sectors, and communities lead to effective planning and resource management. Policies based on these research findings can support the strategic planning of local governments to establish the Toba Caldera Geopark as a world-class sustainable tourism destination. Moreover, collaboration with local communities, the private sector, and non-governmental organizations can be initiated to create educational programs and engaging cultural activities. By utilizing these research findings, local governments can comprehensively guide the development of the Geopark, encompassing aspects of conservation, education, and local economic empowerment.

RESEARCH METHODS

This study employs a mixed-method research approach, combining both qualitative and quantitative methods conducted concurrently but independently. The design applied is a concurrent embedded design, an unbalanced mixed-methods design that integrates both approaches to gain a deeper understanding of the research problem, with a stronger emphasis on one method. According to (Sugiyono, 2011). this approach provides a more comprehensive understanding of the phenomenon under study. The main aim of this research is to analyze the tourism potential in the Toba Caldera Geopark area, focusing specifically on the Ambarita-Tuktuk-Tomok Geosite and the Batak Museum Simanindo-Batuhoda-Stone Tombs Geosite. The study analyzes several key variables, including the number of tourists, tourists' satisfaction with attractions, the number of tourism activities, and the facilities available in the area.

The research population consists of both local and international tourists visiting the Toba Caldera Geopark, tourism managers, and stakeholders involved in the area's development and utilization. The sampling technique utilized is multistage random sampling, beginning with purposive sampling to identify relevant groups, followed by random sampling to ensure sample representativeness. Data collection employs a triangulation approach, using a variety of techniques such as observation, in-depth interviews, document study, questionnaires, and online surveys to gather quantitative data on tourist numbers, available facilities, satisfaction levels, and comparisons between expectations and actual services offered in tourism.

This study follows an exploratory model, with a focus on data discovery and a deeper understanding of tourism development in the region. Qualitative data is analyzed using techniques such as data reduction, data presentation, and verification to draw conclusions, while quantitative data is analyzed through descriptive statistics to describe the conditions of visitors, their satisfaction, and the quality of available facilities. Data validity is ensured through triangulation of techniques and sources, verifying the accuracy of the data collected from various methods and sources.

To ensure the validity of the research instrument, an Aiken’s validity test was conducted with evaluations from three expert panelists. The test measured the accuracy, clarity, and relevance of the items, with a minimum threshold of 0.83. The results indicated that all items exceeded the threshold, confirming heir validity for data collection.

Table 1. Aiken’s Validity Test Results

Item Description	Panelist Scores	Aiken's V	Threshold	Validity Status
Accessibility-related items	4, 5, 5	0.89	0.83	Valid
Accommodation-related items	5, 5, 4	0.87	0.83	Valid
Amenities-related items	4, 4, 5	0.86	0.83	Valid

The strong validity scores highlight the reliability of the research instrument, ensuring that the data collected accurately represents the studied variables.

Triangulation Analysis to enhance the credibility of the findings, triangulation methods were employed by combining multiple data collection techniques, including surveys, interviews, and observations. The triangulation of data sources ensured a comprehensive understanding of the geosites' potential.

a. Technical Triangulation: Data from surveys were compared with findings from interviews and field observations to ensure consistency in identifying gaps in accessibility and amenities.
b. Source Triangulation: Data were gathered from a variety of stakeholders, including tourists, local community members, and tourism managers, to provide a holistic perspective.

These triangulation methods align with (Sugiyono, 2015) recommendation to integrate various techniques and sources for robust data validation. The use of triangulation strengthens the credibility of the findings and ensures that diverse perspectives are considered, making the results more applicable for developing strategic tourism plans.

RESULTS AND DISCUSSION

Study Area

The study area is located in Samosir Regency, positioned between 2°24'–2°25' North Latitude and 98°21'–99°55' East Longitude, with elevations ranging from 904 to 2,157 meters above sea level. Covering an area of approximately 2,069.05 km², the region consists of 69.80% land (1,444.25 km²) and 30.20% water from Lake Toba (624.80 km²). The landmass includes Samosir Island, surrounded by Lake Toba, and parts of the mainland of Sumatra. Administratively, the region is bordered to the north by Karo and Simalungun Regencies, to the east by Toba Regency, to the south by North Tapanuli and Humbang Hasundutan Regencies, and to the west by Dairi and Pakpak Barat Regencies. Samosir Regency comprises nine subdistricts, with Pangururan as the capital. This study focuses on Simanindo Subdistrict, which spans an area of 198.20 km² and hosts two key geosites: Geosite Ambarita–Tuktuk–Tomok and Geosite Batak Museum Simanindo–Batuhoda–Stone Tombs.

The Geosite Ambarita–Tuktuk–Tomok is situated on a small peninsula formed by the dacitic lava dome of Tuktuk, which has been geologically active for over 12,000 years. Located within the Toba Caldera, the world's largest supervolcano, this geosite features unique geological formations, including dacitic volcanic rocks with flow-banding structures, pyroclastic deposits, and lake sediments. The area also holds significant archaeological and historical importance, as dacitic lava was utilized for constructing heritage sites such as the Stone Court (Batu Parsidangan) and Huta Siallagan (Siallagan Village). Additionally, ancient lake deposits in the region, which contain 25,000-year-old charcoal remnants, provide insight into the area's geological history. Beyond its natural attributes, Ambarita, Tuktuk, and Tomok are traditional Batak villages with rich cultural heritage. Research in this area highlights the interplay between natural phenomena and cultural practices, including traditions, art, and the everyday lives of local communities.

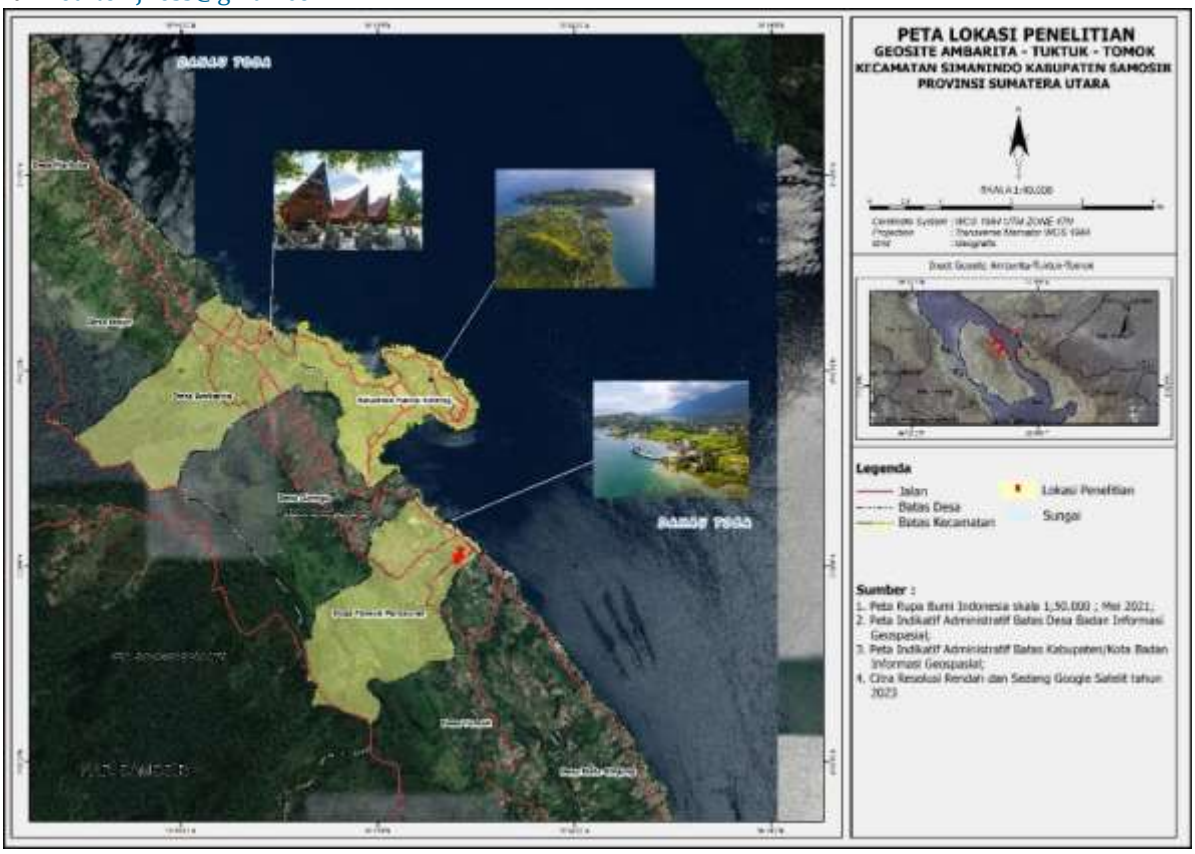

Figure 1. Map of the Location of Geosite Ambarita–Tuktuk–Tomok

Meanwhile, the Geosite Batak Museum Simanindo–Batuhoda–Stone Tombs, located in the northern part of Samosir Island, exhibits a landscape shaped by volcanic activity and tectonic uplift. The region is characterized by terraces and small islands formed from altered lake sediments (Youngest Toba Tuff - YTT). These geological features reveal the dynamic processes that have shaped the area over time. Materials from this geosite were used to construct the Batak Museum Simanindo, which serves as a cultural center preserving the traditions, customs, and arts of the Batak community.

Figure 2. Map of the Location of Geosite Batak Museum Simanindo–Batuhoda–Stone Tombs

Both geosites form part of the Toba Caldera Geopark, representing a unique blend of geological and cultural significance. The region offers opportunities to explore volcanic rock formations, uplift zones, and sedimentary deposits, while also preserving the cultural heritage of the Batak people through their traditions, historical sites, and social practices. This integration of natural and cultural elements underscores the area's potential for sustainable tourism development and heritage conservation.

Overview of Tourism Potential in Geosites

This research comprehensively evaluated the tourism potential of Geosite Ambarita–Tuktuk–Tomok and Geosite Batak Museum Simanindo–Batuhoda–Stone Tombs using the 5A framework: Attractions, Activities, Accessibility, Accommodation, and Amenities. These geosites, located within the Toba Caldera Geopark, offer a blend of geological, cultural, and historical assets that serve as the foundation for developing sustainable tourism.

1. Attractions

The attractions at these geosites are diverse, encompassing unique geological formations, rich cultural heritage, and historical landmarks. The Ambarita–Tuktuk–Tomok geosite features dacitic lava structures used in historical sites like Huta Siallagan, which represent a rich volcanic history. Similarly, the Batak Museum Simanindo preserves cultural artifacts that reflect the region's identity. Natural attractions, such as the altered Youngest Toba Tuff (YTT) and traditional Batak cultural elements like the Sigale-gale dance and stone courts, captivate visitors by showcasing the interplay between nature and culture. These geosites offer valuable historical and cultural attractions:

a. Sustainable Attractions: Lake Toba and its surrounding geosites present sustainable tourism opportunities, with local wisdom, flora, fauna, and culture contributing significantly to the destination's appeal.

b. Natural and Cultural Beauty: The landscape of Lake Toba, along with historical sites such as Ambarita, Tuktuk, and Tomok, features remarkable geological formations, ancient tombs, and traditional Batak villages, which possess high historical and cultural value.
c. Cultural Appeal: In Tomok village, key attractions include ancient sarcophagi, traditional houses, Sigale-gale statues, and the royal Batak tombs. These features are essential in preserving and promoting Batak culture. Other sites like the Batu Parsidangan and the Huta Bolon Museum in Simanindo further enhance cultural exploration.
d. Hidden Tourism Potential: Locations such as Batak Museum Simanindo and Batu Hoda Beach, although less publicized, have strong potential due to their captivating natural beauty and geological phenomena, alongside cultural and historical sites.

Figure 3: Huta Siallagan Tourist Attraction

These findings suggest that Lake Toba, particularly its geosites, has immense potential to be developed as an international geopark destination. By leveraging its sustainable attractions and the rich cultural heritage of the Batak community, these geosites can contribute significantly to regional tourism. Collaboration among tourism managers, researchers, and stakeholders is crucial to enhance and promote these attractions effectively. These findings align with (Newsome & Dowling, 2010) perspective on geotourism's dual focus on preserving geological heritage and promoting cultural experiences, which strengthens the geosites' appeal to diverse visitor segments.

2. Accessibility

Accessibility is critical in enhancing visitor experiences and determining a destination's popularity. Both geosites are relatively easy to access via ferry connections and road infrastructure, yet challenges remain in public transportation and the availability of clear directional signage. Although 55% of respondents strongly agree that road quality is satisfactory, only 5% strongly agree that transport information is adequate. This disparity highlights the need for improvements in navigation aids and public transport systems to ensure seamless access to key attractions.

Table 2. Accessibility Ratings

Indicator	Strongly Disagree (%)	Disagree (%)	Agree (%)	Strongly Agree (%)
Road Quality	0%	5%	40%	55%
Public Transport	10%	40%	40%	10%
Transport Information	20%	50%	25%	5%

These findings are consistent with (Sunaryo, 2013) emphasis on accessibility as a fundamental aspect of tourism development. Enhanced transportation infrastructure and information systems could improve visitor convenience, particularly for international tourists who may face language barriers. Improving accessibility and transportation services is vital to ensuring that tourists have a seamless travel experience. Moreover, the development of informative resources, such as guides and maps, will enable tourists to plan their visits more efficiently. This aligns with the overall objective of enhancing the tourism infrastructure at both geosites.

3. Accommodation

Accommodations at these geosites range from homestays to mid-range hotels, offering options for diverse visitor preferences. However, there is a notable gap in high-end facilities, which limits the geosites' ability to attract premium international tourists. Respondents indicated high satisfaction with the cleanliness and safety of available accommodations. Accommodation is a key factor in the attractiveness of a destination.

a. Amenities and Facilities: Both geosites offer essential amenities such as souvenir shops, public restrooms, and places of worship. However, the study found that greater awareness about environmental cleanliness and sustainability is needed within the local community.
b. Local Economy Impact: The availability of suitable accommodation contributes to the local economy by attracting more tourists and encouraging longer stays, thus benefiting the hospitality and retail sectors.
c. Collaboration and Development: Cooperation with local communities and better management of accommodation facilities can enhance the overall tourism experience, particularly by offering a unique blend of local culture and modern services.

According to (Dickman, 1989) theory, the quality and variety of accommodations directly influence tourist satisfaction and destination competitiveness. Expanding lodging options to include more luxurious and sustainable accommodations could significantly enhance the geosites' attractiveness. The importance of enhancing accommodation services cannot be overstated, as they are integral to attracting tourists and ensuring their comfort. Additionally, improving cleanliness and the sustainability of facilities will help preserve the area's attractiveness. Collaborative efforts between local communities, tourism businesses, and government entities will be essential in improving the overall tourism infrastructure.

4. Amenities

Amenities are essential for ensuring a comfortable and enjoyable visitor experience. The current offerings, including souvenir shops, dining facilities, and restrooms, are moderately satisfactory but require significant upgrades to meet international standards. For example, while 55% of respondents strongly agree that souvenir shops offer diverse and attractive products, only 35% strongly agree that public restrooms are clean and well-maintained.

Table 3. Amenities Ratings

Indicator	Strongly Disagree (%)	Disagree (%)	Agree (%)	Strongly Agree (%)
Availability of Souvenirs	0%	5%	40%	55%
Restroom Cleanliness	5%	10%	50%	35%

The findings emphasize the need for upgraded amenities, especially dining facilities and restrooms, to enhance the overall visitor experience. Kabes et al., (2022) highlight that well-maintained amenities directly impact visitor satisfaction and retention, making them a priority for sustainable tourism development at these geosites. Enhancing amenities is critical not only for improving the overall visitor experience but also for stimulating local economic development. It

is important for all stakeholders, including the government, private sector, and community organizations, to work together to ensure that the necessary infrastructure is in place.

5. Activities

Interactive and diverse activities are vital for engaging tourists and enriching their experiences. Current activities include cultural performances, guided tours, and traditional cooking workshops, which have been well-received by visitors. However, there is a clear demand for more varied activities, such as eco-adventure options, hiking trails, and interactive cultural exhibits. These additions could appeal to a broader demographic, particularly younger and adventure-seeking travelers.

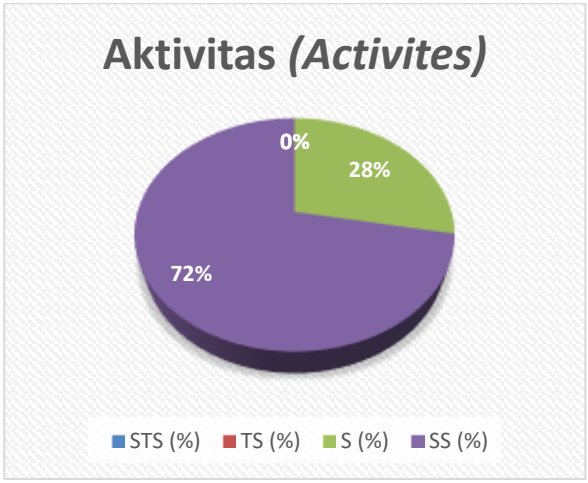

Figure 4. Activities

The integration of local culture into tourism activities enriches the visitor experience and creates sustainable economic opportunities for the community. Furthermore, promoting cultural heritage through storytelling and traditional performances contributes to the preservation of Batak traditions while enhancing the attractiveness of the geosites. Developing additional activities aligns with (Gotham, 2005) insights on leveraging local heritage and natural resources to diversify tourism offerings. By expanding the range of experiences, the geosites can enhance visitor engagement and lengthen the average duration of stays.

The interconnectedness of the 5A elements underscores the comprehensive potential of the geosites within the Toba Caldera Geopark. While attractions and cultural heritage are strong pillars, addressing gaps in accessibility, amenities, and activity diversity is crucial for achieving long-term tourism sustainability. Furthermore, integrating local communities into tourism management is vital for preserving cultural and environmental integrity, as highlighted by (Newsome & Dowling, 2010).

The findings also validate (Dickman, 1994) 5A framework, demonstrating that balanced development across accessibility, attractions, activities, accommodations, and amenities is essential for maximizing tourism potential. By strategically addressing these elements, the geosites can position themselves as leading examples of sustainable geotourism.

CONCLUSION

The conclusion of this study indicates that both geosites, Ambarita–Tuktuk–Tomok and the Batak Museum Simanindo–Batuhoda–Stone Tombs, have significant tourism potential due to their rich Batak culture and natural beauty. While aspects such as accessibility, accommodation, and tourist attractions are relatively adequate, there is still a need to raise environmental awareness around the geosites to support sustainable tourism. The development of the destination should integrate cultural activities and supporting facilities, such as traditional Batak performances, Tortor dance workshops, as well as dining and souvenir shops, to enrich the tourist experience and support the local economy. The concept of geopark sustainability, which emphasizes the conservation of culture and the economic well-being of local communities, must be a key focus in any tourism development strategy for this area.

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