(Online) ISSN 2712-0554
Heritage and Sustainable Development *Original Research*
Vol. 7, No. 1, 2025, pp.521-542
https://doi.org/10.37868/hsd.v7i1.988

The preservation role of maritime natural and cultural heritage in Batu Bedil Geosite the Belitong Global Geopark area through a sustainable eco-culture tourism approach

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Received Dec. 12, 2024
Revised May 20, 2025
Accepted May 29, 2025
Online Jun. 3, 2025

Abstract
This article aims to provide a model for developing tourist destinations in the Batu Bedil Geosite, Belitong, Indonesia, by evaluating previous studies. Researchers use the evaluation results as a reference to develop eco-culture tourism in the Batu Bedil Geosite, focusing on cultural heritage and the surrounding natural environment. This research is a literature study, which involves the collection and analysis of data sources and information relevant to the research theme. Based on previous research, the management of the Belitong Global Geopark since its establishment has only focused on geodiversity and biodiversity. The Belitong Global Geopark has not fully integrated the contribution of cultural heritage to its development. Using cultural heritage in geopark areas provides a unique perspective on how communities adapt to their environment - a process in which audiences, as researchers, policymakers, and stakeholders, must put cultural aspects on par with economic and environmental considerations.

Keywords: Sustainable tourism, Ecotourism, Cultural heritage, Eco-culture tourism, Geopark

1. Introduction

In 2021, UNESCO designated Belitung Island as Belitong Global Geopark. This international recognition provides an excellent opportunity for the development of tourism and environmental preservation in the region and is an essential step for the Belitung Regency and East Belitung Regency Governments to enhance the tourism sector, utilize existing natural and cultural potentials, and support sustainable development. The Belitong Global Geopark consists of twenty-four geosites. Geopark Belitong implements UNESCO's goals in education and research through the Geopark Information Center. The aim of geo-education and geo-literacy is to cultivate knowledge, attitudes, and abilities within the community pertaining to geological, biological, and cultural variety, in accordance with sustainable development goals [1], [2]. The Belitong Global Geopark is the site to four significant geological sites: the granite rock waters on Belitung Island, the remnants of the ancient

underwater volcano Lava Bantal Siantu, the largest tin mineral discovery in Southeast Asia in the Kelapa Kampit area, and the meteorite (*satam* stone) scattered throughout the Quaternary alluvial zone [1], [3].

In general, geoparks do not only describe geological diversity. Geoparks explore and develop the relationship between geological diversity and natural and cultural resources. Integrating geological diversity, natural resources, and culture within the geopark concept aims to enhance awareness and understanding of how the earth's formation over 4.600 million years has shaped every aspect of people's lives and societies [4], [5]. Sustainable tourism, ecotourism, and cultural tourism are the most effective strategies for the preservation of geoparks and cultural heritage. Ecotourism and cultural tourism, which contrast with mass tourism, are classified as special interest tourist. This sort of tourism entails exploring regions of natural allure that are largely unspoiled or unaffected by human intervention to observe, appreciate, and experience the animals, geological features, and cultural expressions present in those areas [6], [7], [8], [9], [10]. This type of tourism focuses on sustainability, knowledge, and education about the value and existence of the natural environment [8], [11], [12]. Eco-culture tourism, which integrates the two concepts, prioritizes the implementation of responsible and sustainable tourism to preserve areas with unique natural features like geoparks and cultural heritage while also providing economic and scientific benefits for the community [13], [14], [15]. Eco-culture tourism, by integrating material cultural heritage with the surrounding natural environment, traditional practices, and traditional ecological knowledge, can provide environment-based education by managing and protecting geopark areas [16]. This integration can preserve cultural landscapes and increase the role of local communities in developing and managing areas [17].

Referring to the above description, although Belitung Island is now recognized as a UNESCO Global Geopark, there is still a significant gap between the goals of the local government's programs and the mission set by UNESCO Global Geopark. The local government has established various programs to improve infrastructure, introduce new tourist attractions, and develop human resource capacity in the tourism sector. However, these efforts are often not integrated with the principles of environmental preservation and sustainability at the core of the UNESCO Global Geopark mission. Although there has been an increase in the number of tourist visits in the past five years, data shows that environmental management and local community involvement in geopark management are still limited. This indicates that although there is a similarity in the long-term goals between government programs and UNESCO's mission, the planned and directed implementation to achieve that alignment remains challenging. Therefore, a more comprehensive management model based on sustainability principles is needed to bridge the gap between government policies and the standards the UNESCO Global Geopark sets. Along with UNESCO's recognition, it is important for local governments to formulate strategies that focus on increasing tourist visits and sustainable natural resource management, empowering local communities, and preserving existing geological and cultural heritage.

Integrating cultural heritage potential with natural heritage to develop geoparks requires a comprehensive approach involving natural and cultural resources in a balanced manner. The Batu Bedil Geosite area boasts a diverse range of cultural heritage, encompassing both tangible and intangible elements, not only on the mainland but also in the waters. The Batu Bedil geosite has a natural heritage that includes Triassic granite formations, views of the Natuna Sea, and biodiversity such as the mangroves of Rhizophora apiculata and Avicennia alba. In addition, this area also holds cultural heritage, which is in the form of tangible relics such as the site of a sunken ship in the waters around Belitung Island and the remains of settlements in the form of ancient tombs and ceramic fragments. In addition, there is also an intangible cultural heritage that is reflected in the traditions of the people of Sungaipadang Village. These communities retain local knowledge of traditional boatmaking and sea navigation, which is part of their cultural identity. The presence of cultural heritage objects in the waters demonstrates the hazardous navigation conditions in this area, which are influenced by the seawater tides. Meanwhile, intangible cultural heritage in the form of maritime tradition knowledge shows how the people in the Batu Bedil Geosite area adapt to the aquatic environment where they live. This article's novelty lies in integrating maritime cultural heritage into ecotourism at the Batu Bedil Geosite. This article aims to present an

overview of maritime culture and natural heritage and its role in the Batu Bedil Geosite area so that it can contribute to the development of tourism in the Belitong Global Geopark area. This study aims to establish a model for developing ecotourism and cultural tourism, also known as eco-cultural tourism, in the Batu Bedil Geosite area. This model is based on preserving the diverse cultural environmental heritage, such as archaeological remains and local cultural traditions, and their integration with the natural environmental heritage, such as geology and biology, to create an integrated sustainable tourism destination.

1.1. Literature review

1.1.1. Eco-culture tourism

Positioning global policies for sustainable development is becoming increasingly important in securing economic growth, social justice, and environmental protection in various sectors, including tourism [14], [18], [19]. In sustainable development,' sustainable tourism' aims to satisfy tourist demands while simultaneously promoting sustainability and creating opportunities for future generations to harness and enhance their diverse resources [20]. As a development approach, sustainable tourism integrates and organizes to address the needs of today's society, balancing the economic, social, and ethical concerns of resource management with the preservation of culture, ecology, biodiversity, and life support systems for future generations [21], [22]. The foundation of cultural tourism and ecotourism is sustainable tourism, which is no longer understood in the context of mass, standardized, and organized activities but rather in flexibility, segmentation, and diagonal integration. This approach has allowed for the growth of community participation, strengthening the sustainability of assets (environmental, socio-cultural, and historical) for future generations [22], [23], [24]. Tourism, as a multi-sector, multi-disciplinary, and multi-actor activity, necessitates the existence of general sustainability principles, such as community-based protection of local cultural intellectual property rights, carrying capacity, and responsible promotion, to guide sustainable development.

Special interest tourism also includes ecotourism and cultural tourism, which emphasizes responsible travel, conservation, education, and community involvement in the natural and cultural environment [6], [7]. This special interest in tourism began to develop along with the promotion of sustainable tourism, which focuses on the rejection of mass tourism and outdoor activities such as adventure tourism, ecotourism, sports tourism, and cultural tourism [24], [25]. The combination of ecotourism and cultural tourism in one concept, called eco-cultural tourism, prioritizes the sustainability of the natural and cultural environment and its value [26], [27], [28], [29], [30] (Figure 1).

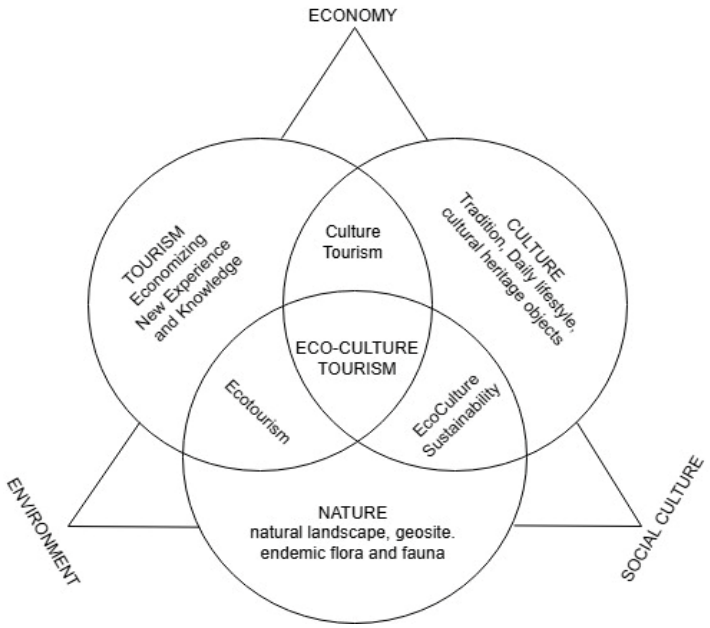

Figure 1. Eco-culture tourism model [31], [32]

A geopark is defined as a themed area to preserve unique geological features and utilize them for scientific, educational, and tourism purposes. Some geoparks focus more on conservation, while others prioritize tourism aspects, depending on the choices of the founders and managers of the geopark [33]. The existence of geoparks not only provides benefits in terms of environmental preservation but also contributes to the social and economic development of the local community by educating the public about the importance of geoconservation and raising their awareness of environmental issues [34]. The importance of geoparks is also inseparable from their role in strengthening the pro-environment attitudes of the community. With the existence of the UNESCO Global Geoparks network, there is an effort to expand the reach of geoparks in various countries, although there is a gap in the distribution of geoparks between more developed and less developed countries. This poses a challenge for geoheritage resource policies that need to be improved to be more equitable and provide positive social impacts, especially in countries with a low Human Development Index (HDI).

Eco-culture tourism, a concept that integrates the ecological and cultural elements of a destination known for its cultural and natural richness, is seen as a potential strategy to support the conservation of natural habitats and promote economic sustainability, particularly for local communities [21], [23], [35]. Local communities must actively participate in organizing eco-cultural tourism, using their knowledge of the environment and culture to attract tourists [23], [26].

In general, cultural heritage, a valuable resource in development, consists of tangible and intangible cultural heritage. Cultural heritage is a heritage that has significant historical, scientific, technological, and artistic values. According to several studies, preserving cultural heritage can enhance environmental, social, cultural, and economic sustainability, thereby contributing to the welfare and quality of life of the community [23], [24], [30], [36]. Cultural heritage is the community's common property and undergoes development from generation to generation in the flow of a tradition [37]. Law Number 11 of 2010 defines cultural heritage objects as tangible relics, including movable objects like artefacts (museum collections) and immovable objects like buildings, structures, sites, and areas.

Meanwhile, intangible cultural heritage is an abstract form of cultural heritage. The UNESCO Convention states that intangible cultural heritage consists of five types: traditions and oral expressions; performing arts; community customs, rites, and celebrations; knowledge and behavioral habits about nature and the universe; and traditional craftsmanship skills [38]. According to the convention, Law Number 5 of 2017 defines intangible cultural heritage as encompassing oral traditions, manuscripts, customs, rites, traditional knowledge, traditional technology, arts, languages, folk games, and traditional sports, serving as the focus of cultural advancement for both extinct and living cultures.

1.1.2. Geopark

According to UNESCO, a geopark has several geological heritage sites protected by unique, rare, or beautiful geological values. Geoparks are places that combine the concepts of conservation, education, and local economic development to protect and preserve geological heritage that has international significance, is rare, or has aesthetic appeal [39], [40], [41], [42], [43], [44]. UNESCO Global Geoparks (UGGp) requires that a geopark must exhibit substantial geological legacy, possess clearly delineated boundaries, and be sufficiently expansive to facilitate a sustainable economic development strategy rooted in that heritage [5]. A geopark must utilize sites of archeological, ecological, historical, or cultural importance alongside its geological features, as these sites often relate to the underlying geology [39], [40], [45].

In 1991, the geopark concept was introduced to foster geological heritage and sustainable local development. It is a comprehensive approach that integrates the heritage of geo-diversity, biodiversity, and cultural diversity with the socio-economic development of local communities through sustainability [46], [47]. The main objective of the UNESCO Global Geopark is to use the designation to engage communities in protecting these assets in ways that contribute to the economic development of their region [40], [48]. Geopark design has three essential components: protection and conservation, tourism-related infrastructure development, and socio-

economic development based on a sustainable regional development approach [40], [42], [49]. Geoparks encourage sustainable development by providing additional income for residents and attracting private capital. The success of geopark education activities depends on the content of the tourism program [50]. Local community involvement is also essential for the success of a geopark [4], [5], [39], [43].

The integration of the potential attraction of cultural heritage with the surrounding natural environment in the management of geoparks will be important in education and conservation efforts in the region if supported by the process of interpretation (storytelling) of the diversity of these potentials [39], [51], [52], [53]. It is a comprehensive approach to conservation efforts that preserve the value and abundance of natural resources and protects and preserves the region's unique cultural heritage. In addition, it can also increase awareness and appreciation of geological and cultural heritage sites, so that the use of these resources becomes sustainable [29], [43].

2. Research method

This study employs a desk research method, documentary, or secondary research. Desk research involves collecting and analyzing data from existing sources relevant to the research theme [54], [55]. Desk research relies on data from specific keywords related to prior studies [56]. These studies are often accessible via digital platforms, governmental and non-governmental institutions, public libraries, educational institutions, and archival documents.

The research explores sustainable tourism, geoparks, and cultural heritage with a specific Belitong Global Geopark case study. Research results on geoparks from several government agencies have provided relevant data for this case study. The steps undertaken in this study include:

- Data Collection: The data collection process involved gathering research articles, reports, and documents relevant to Belitung Global Geopark. These sources included studies on ecotourism, cultural tourism, and eco-cultural tourism.
- Data Identification: We identified and categorized the collected articles and documents according to their specific research focus.
- Scoping Review: The study employed the scoping review method described by Arksey and O'Malley (2005) [57]. A scoping review is particularly suitable for mapping existing literature on a topic and identifying key concepts, research gaps, and relevant evidence. This step enabled the study to synthesize diverse information from previous research and reports.
- Contextual Analysis: This study's contextual analysis examines the factors that influence sustainable tourism development at Geosite Batu Bedil based on environmental conditions, cultural assets, governance, and stakeholder involvement. The data were analyzed descriptively to illustrate the existing dynamics and identify the challenges and opportunities for sustainable tourism development. This analysis focuses on understanding the interactions between environmental, social, and economic aspects in the geopark area and how the existing management can support or hinder tourism sustainability.

The contextual analysis's results were a foundation for developing a model to promote sustainable tourism within the Batu Bedil Geosite and its cultural environment. The model integrates the principles of ecotourism and cultural tourism, aligned with the global standards for sustainable tourism as established by the UNWTO-Global Sustainable Tourism Council [58].

3. Results and discussion

Administratively, the Batu Bedil Geosite is in Sungaipadang village, Sijuk District, Belitung Regency, on the north coast of Belitung (Figure 2). Sungaipadang Village is on the north side of the Belitung Regency, directly adjacent to the East Belitung Regency. Sungaipadang Village has a historical background and was one of the

first locations exploited for tin mining by the Dutch East Indies government in the late 19th century. Many cultural heritage objects in fragments of Chinese ceramics were found, such as several building facilities during the tin mining period and the road network used by Billiton Maatschappij. Heidhues [59] reports that the tin mining activities mobilized the people of Sungaipadang village to the coastal area. The new settlement continues to develop until now; the inhabitants are the Indigenous Malay tribes who have settled for generations [60].

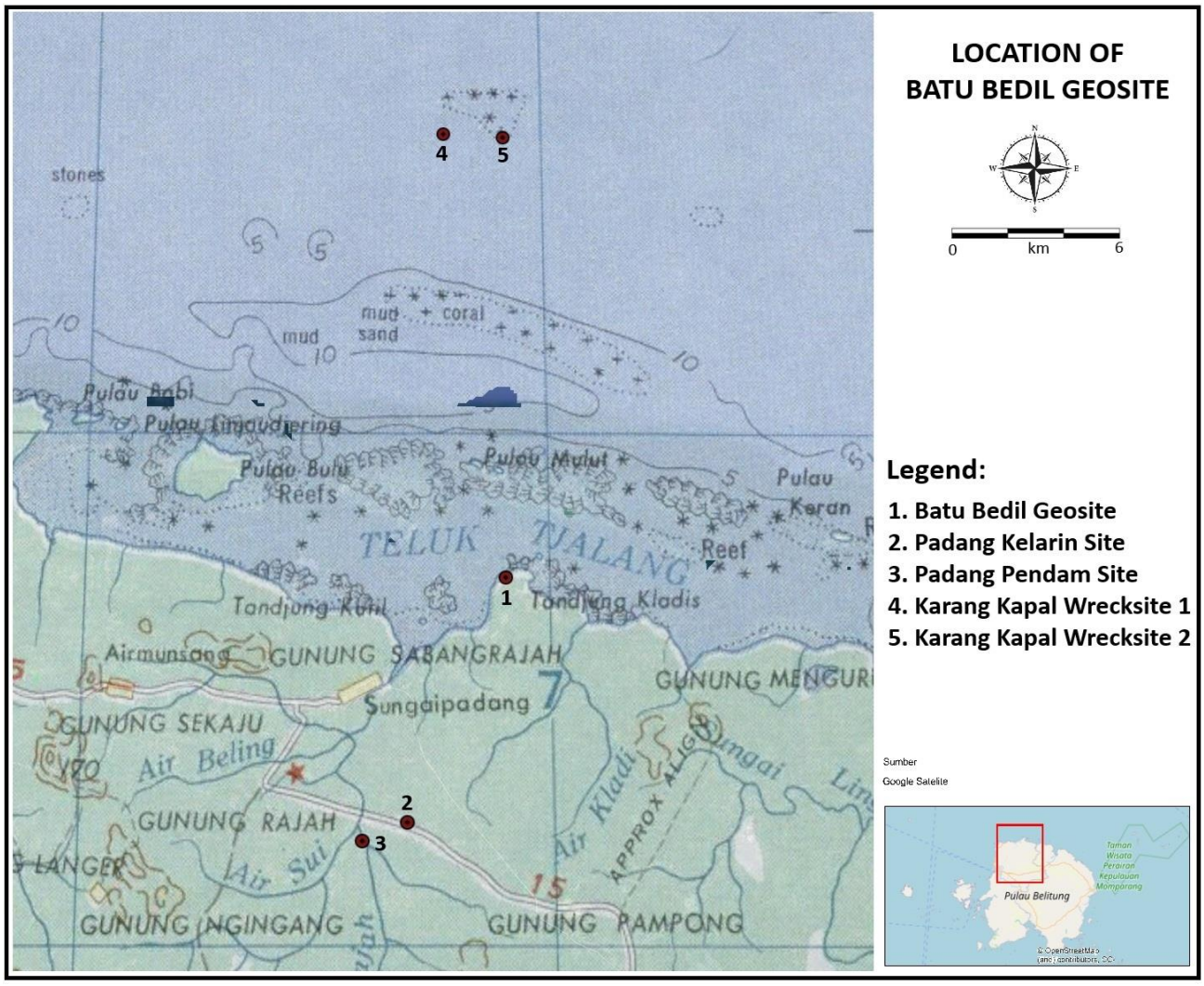

Figure 2. Location of Batu Bedil Geosite (Source: Result of The Study 2024)

3.1. Previous Belitong Global Geopark research

Researchers have conducted several studies on Belitong Global Geopark. Research on how the public, tourists, and tourism actors perceive tourism on Belitung Island reveals that Belitong Global Geopark represents a renewed hope for the community to revive environmental-based tourism on the island [61]. Efforts to realize these expectations require the involvement of all stakeholders in maintaining the uniqueness of Belitong Global Geopark, which consists of geological, biological, and cultural aspects. Stakeholders in this case include local communities, tourists, and tourism actors [1].

Priyono and Anggraini focus their research on the marine resource sector. Villages in Belitung have the potential to develop cooperation patterns due to their potential fishery products. This study suggests that the government should facilitate the development of cooperation patterns among villages, enabling each village to effectively manage its potential in supporting geopark areas, including security, transportation, and promotion. Joint village-owned enterprises in the geopark area may manage and market potential commodities like coffee, pepper, herbal drinks, souvenirs, and seafood processing. If supporting facilities and infrastructure are available,

villages can effectively implement the concept of development through a pattern of cooperation to support geopark development [62].

If local communities are not included in implementing ecocultural tourism, which combines ecotourism and cultural tourism in the geopark area, numerous obstacles and conflicts will likely be encountered. The importance of community participation provides opportunities, encourages willingness, and improves the community's ability to develop natural and cultural environment-based tourist attractions such as geoparks by paying attention to the community and the local environment [63]. Djapani et al. conducted research at four geosites, namely Bukit Peramun Geosite in Sijuk District, Belitung Regency; Juru Sebrang Geosite in Tanjungpandan District, Belitung Regency; Namsalu Open Pit Geosite in Kelapa Kampit District, East Belitung Regency; and Tebat Rasau Geosite in Simpang Renggiang District, East Belitung Regency. This study shows that local communities have an excellent ability to develop and formulate geosite development planning. Local communities have generally been the basis for development concepts. However, through capacity-building strategies for human resources in geosite management, we can further enhance these capabilities by optimizing knowledge, participation, and technical skills in planning [64].

Based on several research results, the management of the Belitong Global Geopark has only focused on aspects of geodiversity and biodiversity since its establishment. The management of the geopark itself still only addresses the social aspect of the community. We have not fully utilized cultural diversity, particularly cultural heritage, which encompasses tangible and intangible elements. We still need to optimize the contribution of cultural heritage to the development of the Belitong Global Geopark to provide more comprehensive benefits to various strategic aspects, including environmental, socio-cultural, scientific, economic, and recreational aspects.

Based on these studies, the management of Belitong Global Geopark has been more oriented towards geodiversity and biodiversity aspects since its inception. However, this management is still limited to those aspects and has not fully considered the social dimension of the community. Cultural diversity, both in the form of tangible and intangible cultural heritage, has not yet been maximally utilized. Therefore, the contribution of cultural heritage to the development of the Belitong Global Geopark needs to be enhanced to provide a broader impact in various sectors, such as the environment, socio-culture, science, economy, and recreation. This indicates the need for more in-depth research focused on ecoculture. Although the management of geodiversity and biodiversity in the Belitung Geopark has been carried out, the potential of cultural heritage and ecotourism has not yet been fully maximized to support sustainable tourism.

3.2. Natural heritage of Batu Bedil Geosite

The geosite has stunning landscapes, including Triassic granite rock formations, and offers coastal views overlooking the Natuna Sea. The name, Batu Bedil (Bedil, meaning rifle), originates from a legend that describes a loud sound akin to an eruption rifle, which can be heard up to 30 km away due to the impact of large waves and small holes in the rock that connect to a cavity in the Triassic granite Batu Bedil Geosite area.

The geosite located in the cape on the eastern side of the Padang watershed has various extraordinary natural attractions. Estimated to be between 208 and 245 million years old, or from the Triassic period, the Tanjungpandan granite formation, rich in the primary mineral cassiterite, is a unique example of granodiorite rock. The Batu Bedil Geosite area is also rich in mangrove plant diversity, such as *Rhizophora apiculata*, *Avicennia alba*, and *Bruguiera gymnorrhiza*, which adds to its ecosystem richness. The Kelapa Kampit Formation, composed of granite rocks, also influences the topography of the Padang watershed. At the same time, the series of hills including Gunung Keladi, Gunung Palempang, Gunung Sabangraya, Gunung Kedongdong, Gunung Bulin, and Gunung Bayang form the landscape in the northern part of the Padang watershed, resembling an enchanting natural "fortress." On the western side, the Padang watershed is surrounded by hills, such as Gunung Munsang and Gunung Kebu, as well as small hills that form the eastern boundary of the Tanjungpandan granite formation.

However, the beauty and diversity of Geosite Batu Bedil also present challenges in its management, especially related to educational and sustainable tourism. The existence of this area has excellent potential to become an educational ecotourism destination, providing visitors with insights into the importance of geological conservation and mangrove ecosystems. On the social and economic side, this area can provide direct benefits to the local community through sustainable tourism activities. Still, it should be noted that this sustainability must be balanced with appropriate conservation efforts. Its vulnerability to ecosystem damage and environmental degradation requires serious attention to ensure that tourism development does not harm this area. Therefore, careful management based on sustainability principles is essential to balance tourism development and nature conservation.

3.3. Cultural heritage at Batu Bedil Geosite

Geosite Batu Bedil, located in Sungaipadang Village, is rich in natural diversity and possesses a wealth of cultural heritage, including tangible (material) and intangible heritage. This area holds extraordinary potential for developing sustainable ecotourism and cultural tourism. In this case, it is essential to conduct integrated management between the preservation of nature and culture to support the development of the area as a tourist destination that can enhance the community's welfare. Therefore, analyzing the cultural heritage present in this area is crucial for formulating effective management and development strategies for the region.

3.3.1. Tangible cultural heritage

Tangible cultural heritage includes sites and artifacts that can be seen and studied physically, reflecting the lives of past societies. At the Batu Bedil Geosite, tangible cultural heritage includes wrecksites (maritime archaeology), remnants of ships, trade commodity artifacts, and burial sites. Each of these findings provides an insight into the life and interactions of the local community with the outside world, whether in the context of trade, fishing, or maritime activities. Here is a detailed explanation of each category of tangible cultural heritage:

Wrecksite (Maritime Archaeology)

Two shipwreck sites have been discovered in the waters around Geosite Batu Bedil, namely Karang Kapal 1 and Karang Kapal 2. Both locations contain evidence of ships that sank due to collisions with coral reefs. At Karang Kapal 1, the wreck of a wooden ship was found, severely damaged, with wooden beams scattered at depths of 7 to 16 meters. At this location, several other components were also found, such as iron pipes, fiber-coated wood, and iron screws, indicating that the ship is approximately 30 to 50 years old. At Karang Kapal 2, iron shipwrecks damaged by corrosion and coral growth were found. These ships indicate that the area was once a dangerous shipping route, posing a threat to vessel traffic due to shallow waters and dense coral reefs.(Figure 3)

(a) (b)

Figure 3. Wrecksite in the water around Batu Bedil Geosite, Karang Kapal 1 (a) and Karang Kapal 2 (b) (Source: South Sumatra Archaeological Research Office)

Remaining ship components

The ship components found, such as wooden beams and iron pipes at Karang Kapal 1 and 2, provide insights into the shipbuilding technology used then (Figure 4). Some other components show the influence of shipbuilding techniques from abroad, such as using iron nails to connect parts of the ship. These findings provide important indications about the structure and design of the ships used during the tin industrialization period in Belitung.

(a) (b)

Figure 4. Ship Components of Karang Kapal 1 (a) and Karang Kapal 2 (b) (Source: South Sumatra Archaeological Research Office)

Trade commodity artifact

Chinese and European ceramic fragments found around the village of Sungaipadang, dating from the 13th to 20th century, indicate trade interactions between the local community and foreign societies (Figure 5). These ceramics have archaeological value and indicate that this area has been part of trade routes connecting Southeast Asia with China long before the tin mining era.

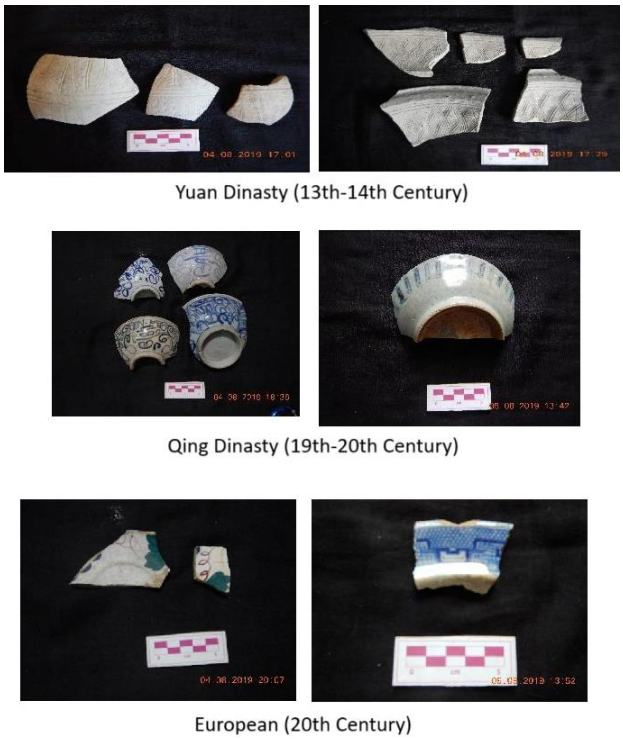

Figure 5. Ceramic fragments that suggest trade interactions between the local community and foreign societies from long ago (Source: South Sumatra Archaeological Research Office)

Cemetery site

The ancient cemetery site found around the village of Sungaipadang also provides insights into the lives of past communities, particularly with the spread of Islam. Some tombs indicate the presence of communities that have settled in this area since the 19th century, particularly communities influenced by Demak and Aceh. These tombs prove that Sungaipadang Village has become a stopover and settlement for various ethnic groups who brought their own traditions and cultures (Figure 6). In addition, the existence of these tombs also proves that the early settlement of the Sungaipadang village community was located in the inland area.

(a) (b)

Figure 6. Ancient tombs which indicate the presence of communities influenced by Demak (a) and Aceh (b) (Source: South Sumatra Archaeological Research Office)

Table 1. Categories of tangible cultural heritage at the Batu Bedil Geosite

Category	Description	Advantages	Challenges	Opportunities
Wrecksite	The ships that sank in the waters around Geosite Batu Bedil due to a collision with a coral reef.	As a wreck dive tourism destination, which is one type of special interest tourism.	Diving tourism requires special skills and cannot be done at any time because it is highly dependent on the season and weather conditions.	Improving the local economy to provide boat rentals and diving equipment.
Remaining Ship Components	Artifacts of ship components such as wooden beams, iron pipes, and iron screws that demonstrate shipbuilding technology during the tin industrialization era.	One of resource on the historical development of tin industrialization on Belitung Island.	The condition of the artifact, which is only a fragment, reduces its appeal as a tourist attraction.	Develop games and esteemed books that narrate the history of the tin industry on Belitung Island.
Trade Commodity Artifact	Fragments of Chinese ceramics from the 13th to 14th century illustrate the trade relations between local and foreign communities.	As a source of information regarding the historical transoceanic exchanges integral to the	The condition of the artifact, which is only a fragment, reduces its appeal as a tourist attraction.	Develop games and esteemed books that narrate the history of the history of Belitung Island such as the historical

Category	Description	Advantages	Challenges	Opportunities
		history of Belitung Island.		transoceanic exchanges.
Cemetery Site	Ancient tombs that indicate the presence of settlements influenced by Demak and Aceh in this region.	As a source of knowledge regarding the past of the Malay Belitung society.	The location is situated in the middle of an oil palm plantation and in the interior of Padang River, making it difficult for tourists to visit.	Developing a trip package that integrates environmental tourism with archaeological sites along the Padang River.

3.3.2. Intangible cultural heritage

The intangible cultural heritage in Sungaipadang Village encompasses various aspects of community life that cannot be seen physically, yet hold deep cultural value. This intangible heritage includes local wisdom, traditions, social norms, folklore, and knowledge passed down through generations [65]. In the context of the Batu Bedil Geosite, the intangible cultural heritage found includes knowledge of maritime navigation, fish hunting traditions, traditional boat making, and folk tales that contain historical and moral values.

Local wisdom in maritime navigation

The people of Sungaipadang Village possess deep knowledge of the sea weather conditions and surrounding waters, which has been passed down through generations. They can read natural signs such as the appearance of storms, giant lightning, or differences in sea surface color, which serve as indicators for them to determine the time and location for fishing. In addition, they also understand the importance of preserving coral reefs in their fishing activities.

Boat-making tradition

The traditional sailboat making tradition in Sungaipadang Village combines the influences of Southeast Asian and Chinese maritime cultures (Figure 7). The structure of the boats used by the Sungaipadang community retains a pointed bow shape, and employs materials and techniques that reflect a combination of local and Chinese cultures. This boat is used in fishing activities in the surrounding sea, and this tradition is an integral part of the coastal community's life.

Figure 7. The traditional sailboat-making tradition in Sungaipadang Village (Source: South Sumatra Archaeological Research Office)

Folktales and legends

Folktales and legends developed in the Sungaipadang community reflect local cultural values and history. The legend about the origin of Sungaipadang Village and stories related to certain places, such as Pulau Mulut, have become an essential part of the local community's cultural identity. These stories teach morals and strengthen the residents' social bonds.

Currently, the people of Sungaipadang Village already have an institution that plays a role in developing tourism in their area, known as the tourism awareness group (*kelompok sadar wisata/pokdarwis*). Still, it has not yet played an active role in its implementation. The facilities available in the village are still minimal. This group only provides boat rentals for recreational fishing. This indicates that tourism management in this village has not yet integrated with the existence of the Batu Bedil Geosite. Therefore, the *pokdarwis* in Sungaipadang Village must create educational tourism packages that are consistent with eco-tourism principles.

Table 2. Categories of intangible cultural heritage at the Batu Bedil Geosite

Category	Description	Advantages	Challenges	Opportunities
Indigenous Knowledge	Strategies for local community adaptation to geographic environmental conditions	Evidence of the local community's expertise in the sustainable management of environmental resources	Commercialization of indigenous knowledge	Potentially serves as a basis for the formulation of sustainable environmental resource management policy
Traditional sailboat making tradition	Local community tradition in boat making	Showing that traditional boat-making has become a community skill.	The population of individuals proficient in traditional boat construction is becoming increasingly scarce.	Traditional boat-making training was organized among the youth.
Folktales and Legend	Local community adaptation strategies to local geographic environmental conditions	Folktales and legends that develop in society contain very good moral teachings that are relevant in various times.	Individuals who are able to recount these stories and legends in a convincing manner are becoming increasingly scarce	In order to encourage the interest of the younger generation in the study of folktales and legends, a number of different training sessions and storytelling competitions were established

In order to explicitly evaluate the outcomes of past research and observations made in the field, an evaluation of both tangible and intangible cultural assets was carried out.The benefits, difficulties, and opportunities related to each kind of heritage in the Batu Bedil Geosite area are compiled in the table below,

Table 3. Evaluation of tangible and intangible cultural heritage in the Batu Bedil Geosite Area

Type of Heritage	Description	Advantages	Challenges	Opportunities
Tangible Heritage	Remains of maritime activity, evidence of previous navigation, and trade routes	A valuable resource for historical research and education; a strong visual attraction for visitors.	Due to human activity and the underwater environment, preservation can be challenging to achieve.	Programs for marine archaeology and underwater tourism development.

Type of Heritage	Description	Advantages	Challenges	Opportunities
Intangible Heritage	Indigenous knowledge of local community sustainable aquaculture, weather patterns, and marine conditions.	Explains profound environmental insight and presents opportunities for educational initiatives and cultural tourism.	Modernization and the younger generation's reduced engagement have the potential to lead to knowledge degradation.	Enhancing cultural identity; inclusion into environmentally friendly travel activities.

3.4. Discussion

The existence of material cultural remains around the Batu Bedil Geosite indicates that this area has been inhabited for a considerable period, from the 13th-14th century to the early 20th century.Meanwhile, the intangible cultural heritage in this region includes knowledge of maritime navigation, fish-catching traditions, traditional boat-making, and legends or folktales that contain moral messages or norms applicable to the Malay Belitung community. The current condition of the tangible and intangible cultural heritage at Batu Bedil Geosite reflects both preservation opportunities and critical challenges. The tangible heritage, particularly the shipwrecks and submerged artifacts, exhibits signs of natural degradation due to prolonged exposure to underwater currents, biological colonization, and sedimentation processes. Some artifacts are partially buried or fragmented, complicating conservation efforts and reducing their visibility for tourism purposes. Meanwhile, the intangible heritage, primarily embodied in the traditional maritime knowledge of the local communities, remains vibrant among older generations. However, this knowledge is increasingly at risk of erosion, as modernization and the influence of contemporary lifestyles have reduced its transmission to the younger population. This evaluation highlights the urgent need for integrated conservation strategies that address both the physical preservation of artifacts and the safeguarding of intangible cultural practices, ensuring the sustainable management and promotion of the Batu Bedil Geosite.

Biodiversity at the Batu Bedil Site includes landscapes, mangrove forests, cultural heritage, and archaeological relics that manifest in the norms, customs, and life of the Sungaipadang Village community. The community's welfare depends on the scientific and economic value contained in natural and cultural resources, both tangible and intangible. Therefore, the management of this area needs to be carried out in an integrated and sustainable manner with a focus on the protection, development, and utilization of these resources.

The Batu Bedil Geosite area and its surroundings have great potential as a sustainable tourist destination, which must prioritize the preservation of cultural heritage and the natural environment. One of the appropriate approaches is eco-cultural tourism, which integrates natural diversity, past cultures, and local community life into a cohesive whole. This development aims to create conservation-based tourist destinations.

Sustainable tourism aims to minimize negative impacts on the environment and society. In this case, tourism development must pay attention to local cultural norms, support community involvement (people), and maintain a balance between environmental sustainability (the planet), community well-being (prosperity), and social harmony (peace). These are achieved through collaboration (partnership) based on inclusive and environmentally friendly principles. However, to ensure the sustainability of this area, integrated management is required, emphasizing protection, development, utilization, and cultivation to maintain preservation and sustainability for future generations.

The United Nations World Tourism Organisation (UNWTO) recognises sustainable tourism destination guidelines as one of the standards for managing the Batu Bedil Geosite area and its environment. The Guidelines for Sustainable Tourism Destinations is a regulation of the Minister of Tourism and Creative Economy number 9 of 2021, which can be used as a standard for governance for the development of the Batu Bedil Geosite area and its surrounding environment as a sustainable and integrated tourist destination by implementing its pillars.

The first is Sustainable Management, which focuses on the management structure and framework, stakeholder involvement, and pressure and change management; the second is Socio-Economic Sustainability, which focuses on local economic benefits and welfare and social impacts; the third is Cultural Sustainability, which focuses on the protection of tangible and intangible cultural heritage and the arrangement of cultural site visits; and finally, Environmental Sustainability, which focuses on geosite conservation, natural heritage, resource management, and waste and emission management. As an alternative model for preserving geoparks, cultural heritage, the environment, and surrounding communities, destination management must apply the concept of integrated sustainability in effective and holistic planning [22].

The concept of eco-culture Tourism is further used as a tool or way to manage efforts to protect, develop, and utilise (preservation) the existence and important value of various aspects of the diversity of potential attraction resources in the Batu Bedil geopark area as a tourist destination, including:

1. Environmental Aspects. As a sustainable tourist destination, the Batu Bedil Geosite area and its surrounding environment play a crucial ecological role in maintaining the continuity of the ecosystem. Geosite Batu Bedil has a diversity of mangrove plants of various types. These plants' presence can become a tourist attraction in this geosite area. Introduction to mangrove plants can provide visitors with knowledge about the benefits of these plants, which serve as protectors of coastal areas from ocean waves, as well as act as sediment traps and simultaneously deposit them, thereby protecting the seagrass bed and coral reef ecosystems [66].
2. Social and cultural aspects. The area around the Geosite Batu Bedil has material cultural remnants that indicate the interaction of the Sungaipadang Village community with the outside world has occurred since ancient times. As a tourist destination, archaeological sites can provide information about the history of the Sungaipadang Village community and the role of this region in the history of civilization on Belitung Island. Moreover, the presence of material and tangible cultural remains also indicates that the people of Sungaipadang Village do not solely depend on the resources provided by their environment. However, they have chosen to adapt to their environment based on a system of knowledge passed down through generations. Agricultural activities dominate the adaptation strategies of the Sungaipadang village community for survival. However, they also use marine resources as a source of food [67].
3. Aspects of Science Education. The Batu Bedil Geosite area and its surrounding environment, as a sustainable tourist destination with a rich diversity of resources, are a source of information that can be used as an educational medium for various historical and cultural sciences as well as natural environmental ecosystem science for the community, including local communities and current and future visitors. An information board about the Batu Bedil Geosite has been installed, but other objects around this geosite have not yet been explained. The objects in the Batu Bedil Geosite area need to be explained scientifically but conveyed in a popular language style so that the general public can easily understand them. In addition, knowledge about Batu Bedil Geosite can be used as local content in student learning at school.
4. Economic Aspect. The Batu Bedil Geosite area and its surrounding environment, as a sustainable tourist destination have provided benefits to its people, who have long taken advantage of the economic value of existing resources as a place to depend on for their livelihoods in their daily lives. The local community can be empowered to manage eco-tourism-based tourism. This involvement can be carried out by collaborating with the Indonesian Tour Guide Association by providing guide training. The community is encouraged to develop homestays as accommodation facilities, create souvenirs, and provide traditional food. Pokdarwis is encouraged to create tour packages in the area around Batu Bedil Geosite, such as tracking tours, mangrove tours, traditional fishing, and providing boat rentals for diving tours.

5. Aesthetic and Recreational Aspects. The Batu Bedil Geosite area and its surroundings boast a diverse range of natural resources, including naturally formed landscapes and natural phenomena, as well as a range of people's daily lives, lifestyles, traditions, and cultural heritage objects. These beauty (aesthetic) values can serve as a unique and authentic attraction, acting as a magnet to motivate and attract visitors. The community in Batubedil Village is encouraged to optimize the facilities provided by the Belitung Regency Government in the form of an open theater to showcase traditional art attractions of the local community.

As policymakers and stakeholders, the government must consider cultural aspects on the same level as economic and environmental considerations. Furthermore, conducting more comprehensive research on tangible and intangible cultural heritage can provide a more holistic understanding of Geopark. The environment plays an essential role in maintaining the balance of the local ecosystem. This is due to the interdependent relationship between people's lives and other living things with the local environment, so it is necessary to educate visitors about the importance of environmental preservation. The limited proportion of cultural aspects in geosite management can affect the comprehensive preservation and use of geosite. Therefore, recognizing the cultural value of geosites is very important as a unique combination of geological and cultural heritage. Geopark management will be carried out through more inclusive and holistic methods by understanding the challenges, benefits, and strategies related to cultural integration. This effort is an alternative model for preserving geosites and their cultural heritage. Using cultural heritage for tourism at geosites presents many opportunities, including sustainable development, cultural preservation, economic growth, and cross-cultural exchange. Local communities can maintain their unique identities by adopting responsible tourism practices, enhancing environmental awareness, and socio-economic well-being.

The Belitung Regency Government is collaborating with the East Belitung Regency Government in managing the Belitong Global Geopark by forming a geopark management body under the supervision of the Ministry of Energy and Mineral Resources and the Ministry of Tourism. The Belitong Global Geopark can support and facilitate the local community in managing the Batu Bedil Geosite, as is done at the Tebat Rasau Geosite in Lintang Village, Simpang Renggiang District, East Belitung Regency. At the Tebat Rasau Geosite, educational activities and tourism promotion based on local wisdom involve the local community as guides or main drivers of educational tourism. For example, there is an information center on site that provides knowledge about the history of geology, natural resources, and local customs related to the traditional use of these resources. In addition, cultural preservation activities such as the introduction of medicinal plants known to the community, as well as cultural events that highlight folklore and customs of the surrounding community, are also carried out to increase visitors' understanding of local wealth and strengthen the preservation of culture and nature in the area [68].

The Belitong Global Geopark can also help organize activities that use local knowledge to support conservation and develop geosites. This includes programs that involve Indigenous communities in looking after lakes and plants, like using rasau plants (*pandanus helicopus*) in a way that meets local needs without harming the environment. Communities are also taught how to manage environmental resources based on traditional knowledge and are empowered in sustainable tourism management that utilizes natural and cultural wealth as the main attraction so that conservation efforts can improve the local economy [68].

There are three important components of a geosite, namely protection and conservation, the development of tourism-related infrastructure, and socio-economic development based on a sustainable regional development approach. The application of these three aspects must be balanced and involve the local community so that it can provide long-term benefits for the local community without damaging the existing natural and cultural heritage [69].

From the standpoint of eco-cultural tourism, the utilization of natural and cultural resources in Batu Bedil can enhance appreciation for a profound comprehension of a community's cultural roots. Eco-cultural tourism serves

as a mechanism for the preservation of natural and cultural heritage by enhancing creativity, a vital element of a knowledge-based economy that fosters growth and significantly influences cultural identity while encouraging cultural diversity. In addition to preserving a wealth of folklore, including the legends of the poisonous well, the *kopong* stone, the *kopong* land, and the magical cardinal direction stone, the Batu Bedil Geosite area boasts attractions such as mangrove forests, shellfish conservation, sand islands, and underwater parks. Using natural heritage, an area or natural feature with exceptional value for the current and future generations in Batu Bedil Geosite, can be a source of income and jobs through tourism, inspiration for creative industries, and recreation, and a source to raise awareness of heritage preservation. Natural heritage in the Batu Bedil Geosite area is an essential element for the existence and development of the community; in the context of applying sustainable development, preservation is becoming increasingly important in protecting, developing, and utilizing natural resources. Preserving valuable natural heritage, which can guarantee economic, social, historical, and cultural processes, will benefit society.

On the other hand, the creative use of cultural heritage involves packaging the traditional environment, the daily lifestyle of the local community, and historical sites into attractions that offer new experiences and in-depth knowledge, thereby educating and entertaining visitors while generating income for the local community. The existence of material and intangible cultural heritage in the Batu Bedil Geosite area reflects the characteristics and traditions of the people in this region. According to the previous description, cultural heritage represents the community's strategies for adapting to environmental limitations in the Batu Bedil Geosite area. We can transform information on the use of environmental resources and the community's interaction with their environment into tourism products. Utilising this material and intangible cultural heritage through eco-culture tourism can enhance sustainable tourism development as a responsible tourism practice that aims to minimise the negative impact on the environment and local communities and maximise positive socio-economic impacts. Eco-culture tourism also generates many activities related to cultural heritage preservation that can create local employment and encourage economic growth, especially in areas with limited economic diversification.

Eco-culture tourism relies on sustainable tourism as its foundation, shifting from mass, standardised, and organised activities to a focus on flexibility, segmentation, and diagonal integration. This approach has facilitated the growth of community participation, enhancing the sustainability of environmental, socio-cultural, and historical assets for future generations. We can prioritise sustainable development policies to support the preservation of natural and cultural resources. This includes developing sustainable tourism that is culturally appropriate, socially accepted, people-centred, indiscriminative, and environmentally sound. This approach aims to reduce environmental degradation, strengthen community involvement, and improve the welfare of local communities. Thus, if professionally managed, ecoculture tourism has the potential to provide a consistent and long-term source of revenue for local communities [70]. The following diagram illustrates the development model of the Batu Bedil Geosite (Figure 8).

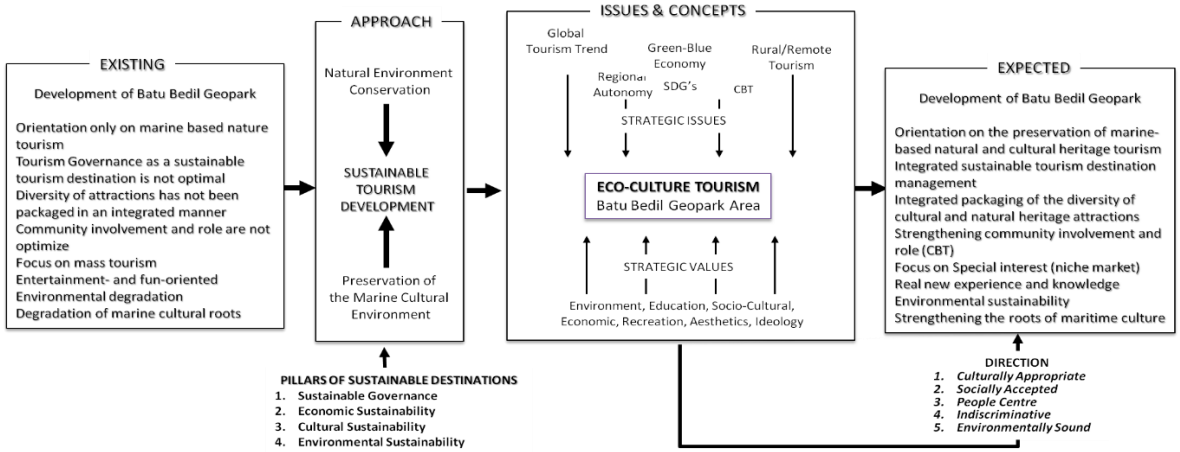

Figure 8. Natural and cultural heritage management framework in the Belitung Global Geopark Area through a sustainable eco-culture tourism approach (Source: Results of the study, 2024)

Using natural and cultural heritage in the Batu Bedil Geosite area provides information about how the people of Sungaipadang village adapt to their environment. The maritime tradition of the Batu Bedil Geosite reflects the Sungaipadang Village community's adaptation to its environment as an attraction of eco-culture tourism; marine biodiversity and tradition can attract visitors by offering a unique and authentic new experience of the cultural and natural heritage in coastal areas [70], [71]. Maritime tradition in Sungaipadang Village is one of the tourism potentials that supports sustainable eco-culture tourism and enriches the repertoire of both natural and cultural diversity in the Batu Bedil Geosite area [72]. Visitors not only enjoy the natural beauty and unique landscapes and ecosystems in the geosite area but can also understand and preserve the culture of the Belitung Malay community by utilizing maritime traditions, such as fishing practices and boat-building techniques.

The scheme illustrates a framework emphasizing the integration of geodiversity, biodiversity, and cultural diversity—essential components of the geopark's value and significance. Combining these three aspects will make the community's social development in the geosite area sustainable. It can improve the community's welfare by creating geopark management that benefits the environment, supports local communities, and promotes local cultural heritage [73].

An evaluation of the existing conditions related to the supporting pillars at Batu Bedil Geosite reveals several critical observations. The pillar of cultural heritage preservation is partially implemented, with local initiatives focusing on community-based storytelling and the safeguarding of traditional maritime practices; however, systematic documentation and conservation of tangible artifacts remain limited. In terms of community empowerment, although there are informal networks supporting traditional livelihoods, formal programs that enhance local capacity building and economic resilience are still underdeveloped. Regarding ecotourism development, the site has not yet fully established structured tourism programs or visitor management systems, resulting in an untapped potential for sustainable tourism growth. Finally, the environmental conservation pillar shows some positive signs through local fishing practices that emphasize coral reef preservation, but broader ecosystem protection strategies are largely absent. This evaluation indicates that while the conceptual framework is relevant, substantial efforts are required to translate these pillars into concrete, operational actions at the site level.

This study advances a novel eco-culture tourism framework for the Batu Bedil Geosite that holistically integrates environmental, cultural, educational, and economic dimensions. By emphasizing community participation, conservation, and sustainable tourism practices, the framework offers a transformative model for the responsible development of geoparks. The Batu Bedil Geosite is a natural and cultural heritage repository and a living laboratory for achieving sustainability. Its innovative eco-culture tourism model can provide a global benchmark for balancing environmental conservation, cultural revitalization, and community-driven economic growth—ensuring heritage preservation for future generations while fostering meaningful tourist experiences. Novelty is also seen in the engagement of the local community and tourists in the preservation of the local ecosystem.

The involvement of the local community in the management of geosites and environmental and cultural education programs has not been fully realized, so their participation needs to be increased. In addition, it is necessary to enhance educational programs about the environment and culture for geosite visitors. By applying appropriate ecocultural practices, Batu Bedil Geosite can become a tourist destination that is attractive to visitors and brings significant benefits to the local community, natural environment, and culture.

4. Conclusions

Utilizing natural and cultural heritage within geoparks, such as Batu Bedil Geosite, offers transformative opportunities to achieve sustainable development, foster economic growth, preserve cultural heritage, and promote cross-cultural understanding. However, the novelty of this study lies in positioning ecoculture tourism not merely as a tourism model but as a strategic tool for resource conservation, community empowerment, and

knowledge dissemination. This approach reflects a change in basic assumptions: tourism becomes a mechanism for balancing the protection, development, and use of tangible and intangible heritage.

UGGp has designated the Batu Bedil Geosite as part of the Belitong Global Geopark, reflecting its growing prominence and potential to serve as a cornerstone for the strategic development of Belitung Regency. By leveraging ecoculture tourism, the government can move beyond conventional tourism programming toward an integrated framework that positions the geopark as a dynamic platform for environmental conservation, scientific inquiry, and cultural revitalization. This framework elevates Batu Bedil as a quality, unique tourism destination of interest and a center of excellence for ecology, geology, history, and cultural studies.

Critically, the success of sustainable development in the Batu Bedil Geosite hinges on three interdependent factors:

1. Balancing Preservation and Utilisation: Ensuring the ecological and cultural integrity of the geopark while allowing for responsible tourism and economic opportunities.
2. The community, as the primary stakeholder, must shift from being passive beneficiaries to active custodians of their heritage, taking on central roles in governance, resource management, and tourism development. Their active involvement ensures cultural continuity and socio-economic inclusivity.
3. Multi-Stakeholder Collaboration: Effective partnerships between governments, local communities, researchers, and private sectors are essential to implementing holistic management strategies that align tourism development with long-term sustainability goals.

The Batu Bedil Geosite is more than a tourist destination—it is a living, evolving laboratory that embodies the intersection of natural processes, human adaptation, and cultural narratives. By adopting a sustainable ecotourism framework, stakeholders can transform the geopark into a global model for balancing tourism, conservation, and community welfare. This innovative approach safeguards heritage for future generations. It elevates the region's identity, strengthens environmental stewardship, and drives inclusive economic growth, ensuring the geopark's enduring significance in a rapidly changing world.

Declaration of competing interest

The authors declare that they have no known financial or non-financial competing interests in any material discussed in this paper

Funding information

No funding was received from any financial organization to conduct this research.

Author contribution

The contribution to the paper is as follows: DH Purnama: study conception, data analysis, interpretation of results, and final manuscript; A Novita: study conception, data collection, data analysis, interpretation of results, drat preparation, and final manuscript; R Ardiwidjaja: study conception, data analysis, interpretation of results, and final manuscript; N Laili: data collection, data analysis, interpretation of results, draft preparation, and final manuscript; E Widyastuti: data collection, data analysis, interpretation of results, draft preparation, and final manuscript. All authors approved the final version of the manuscript.”

Ethical approval statement

Our institution does not require research ethics approval for reporting individual cases or case series.

Informed consent

Informed consent for the publication of personal data in this article was obtained from the participants.

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