Research Paper: Assessing Environmental Capacities of Geoparks for Sustainable Rural Tourism (Case Study: Proposed Dorfak-Deylaman Geoparkin Gilan, North of Iran)

Tahereh Sabouri[1], *Mohammad Reza Servati[2], Jamshid Jedari Eyvazi[3]

1. PhD Graduated, Science and Research Branch, Islamic Azad University, Tehran, Iran.
2. Professor, Department of Natural Geography, Faculty of Earth Sciences, Shahid Beheshti University, Tehran, Iran.
3. Professor, Department of Natural Geography, University of Tehran, Tehran, Iran.

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ABSTRACT

Purpose: Sustainable rural development is a comprehensive, balanced, and endogenous process wherein the capacities and capabilities of rural communities to fulfill primary material and spiritual needs, as well as to exert control over the forces shaping the local settlement system (ecological, social, economic, institutional and territorial), undergo enhancement and advancement. This research aims to identify and assess the geotourism capabilities and their role in the sustainable rural development of the proposed Dorfak and Deylaman Geopark in Gilan Province, the first of its kind in the north of Iran.

Methods: This study employs a descriptive-analytical method. Using field observations and library studies, selected landforms were identified using topographic and geological maps with scales of 1:50,000 and 1:100,000. Subsequently, the Fassoulas model was applied to six main groups (scientific-ecological, protection, cultural, aesthetic, economic, and potential for use criteria) for review and ranking.

Results: The scores for the Dorfak karstic landscape (3.71), Dorfak glacial cave (3.36), Beshkafteh Sang (3), Yarshalman cave (2.91), Darband Rashi cave (2.87), Babu cave (2.125), Espahbadan cave (2.1), and Diarjan cave (1.92) were obtained, ranked in descending order from highest to lowest.

Conclusion: According to UNESCO guidelines, the findings demonstrate the substantial potential for investing in geosites, geomorphosites, and surrounding villages to establish the first geopark, fostering socio-economic-environmental development in this region. Beyond contributing to rural development and tourist attraction, this initiative has the potential to transform the area into a critical hub for geotourism within the country.

*** Corresponding Author:**
Mohammad Reza Servati, PhD
Address: *Department of Natural Geography, Faculty of Earth Sciences, Shahid Beheshti University, Tehran, Iran.*
Tel: *+98 (912) 23353962*
E-mail: *rezasarvati@yahoo.com*

1. Introduction

With its vast expanse, Iran boasts diverse geographical conditions, encompassing eleven of the thirteen recognized climates worldwide. This diversity bestows the country with considerable environmental, ecotourism, recreational, and economic capabilities. This research aims to explore, identify, and introduce the Geotourism capabilities of the proposed Dorfak and Deylaman area using the Fassoulas method. One strategy many development experts emphasize today is the promotion of tourism in areas with potential. Geotourism is a new form of tourism, an interdisciplinary integration of the tourism industry with the conservation and interpretation of abiotic nature attributes, besides considering related cultural issues within the Geosites for the general public (Sadry, 2009: 23). Geotourism is identified as a novel approach to elucidate and comprehend the earth sciences and natural resources unique to each region. In addition to its educational and scientific roles, Geotourism fosters tourist development in the region, offering a method for sustainable development in areas with inherent capabilities (Afifi & Ghanbari, 2009: 31). The study to develop geotourism in an area with potential contributes to social, economic, and environmental development. The Dorfak and Deylaman Geopark have been proposed in previous research (Sabouri et al., 2020). Therefore, the current study aims to assess the existing geological heritage in the villages surrounding Dorfak and Deylaman Geoparks in Gilan province and rank the Geotourism capabilities of the area by the objectives of sustainable rural development (following the global standards established by UNESCO for Geoparks). The studied area, situated in Gilan province, stands out as one of the most picturesque tourist destinations, featuring significant Geosites and Geomorphosites such as karstic formations (Polje et al., well), springs, erosional formations, rock shelters associated with early humans, and numerous distinctive caves. These features are linked to the Iron Age and early human settlements. Additionally, the area boasts multiple cultural and ancient connections, all rooted in naturalist rituals and beliefs (Sabouri, 2008). Despite stunning Geosites and Geomorphosites (geological and geomorphological heritage) in the study area, the surrounding villages still need to achieve the necessary status to attract and promote sustainable tourism. This issue highlights a need for more attention and in-depth study to comprehend the potentials and capabilities of Geotourism in social, scientific, economic, and natural aspects, coupled with insufficient planning and the absence of a harmonious infrastructure compatible with the surrounding environment. Hence, planning Geotourism for this collection of valuable and distinctive phenomena in the study area (Dorfak and Deylaman proposed Geopark) becomes imperative. This research aims to address the question of the feasibility of designating a potential Geopark for this region's economic, social, and environmental development and to propose it to the UNESCO organization.

2. Literature Review

Geotourism, as defined by (Sadry, 2009), is a knowledge-based tourism, an interdisciplinary integration of the tourism industry with the conservation and interpretation of abiotic nature attributes, besides considering related cultural issues within the Geosites for the general public. Geomorphosites and Geosites (geological heritage) are recognized as valuable locations in terms of Geomorphology (Reynard, 2009). The term 'Geosite' specifically refers to the location of geological heritage (Sadry, 2021). Geomorphosites are a type of Geosites (Sadry, 2021). Geomorphosites (synonymous with Geosites or Geotopes in German; locations associated with geological and earth sciences) can be ascribed to five distinct values: scientific, ecological, aesthetic, cultural, and economic. Furthermore, Geosites can be regarded as integral components of the geosphere, holding particular significance in comprehending the Earth's history (Reynard, 2009). This research involved the identification of Geosites in the Takht-e Soleyman region, employing geological heritage evaluation methods commonly used in Europe. The diverse landscapes and geological formations worldwide, coupled with extensive knowledge of Earth's history and geological processes, contribute to the expansive scope of Geotourism in terms of content and territory (Dowling & Newsome, 2010).

Geomorphological forms and their manifestation in Geomorphological locations are fundamental components of Geotourism knowledge. This study identifies and integrates distinctive tourism landforms with cultural, historical, and ecological heritage to promote sustainable development. Geomorphic places are thus defined as formations and processes that, considering human understanding of geological, geomorphological, historical, and social factors, hold aesthetic, scientific, cultural-historical, or socio-economic value. Geotourism, a relatively recent concept in geography and tourism literature, underscores the identification of unique tourism destinations through a geological and geomorphological lens. The central goal of research in this field is to pinpoint these fantastic locations and interlink them with cultural, historical, and ecological heritage, thereby

fostering the sustainable development of tourism (Sabouri et al., 2020).

Geoparks are protected areas encompassing a wealth of Geosites, locations featuring historical and cultural monuments, and a diversity of living ecosystems (ecosites). With efficient management and appropriate resident training, these areas aim to attract tourists, focusing on recreational and educational activities. By presenting geological and environmental concepts to the public, Geoparks strives to offer compelling interpretations of all attractions, enriching tourists' free time. These actions can contribute to the sustainable improvement of local and national residents' economic and social well-being (Hajalilo & Sadry, 2011).

According to UNESCO's latest definition in 2016, UNESCO Global Geoparks are single, unified geographical areas where sites and landscapes of international geological significance are managed with a holistic concept of protection, education, and sustainable development. Geoparks play a significant role in developing the regional and local economy, fostering meaningful connections with the local population. However, geoparks are not just about rocks but also about people and helping communities understand their Earth's heritage and benefit from it (UNESCO Global Geoparks, 2023).

Economic activities within a Geopark can only be successful if carried out in cooperation with local communities. According to the charter governing the establishment of global geoparks, the region's indigenous people must participate actively in the construction and management of geoparks. There are 127 registered global Geoparks (UNESCO Global Geoparks, 2023). Some of these Geoparks are situated in rural areas, away from urban centers, where natural environments are less disturbed. Directing tourists to these areas can significantly contribute to narrowing the income gap between rural and urban areas. The development of rural Geotourism, a novel branch of rural tourism, serves as a generalization strategy of earth sciences. Rural Geotourism aims to revive cultural components by integrating them with geological attractions. Additionally, it integrates recreational and tourism activities with geological sciences. The expansion of this tourism branch involves the villagers' education and the transfer of geological knowledge to visitors. Rural geotourism, as a form of knowledge-based tourism, involves initiatives such as organizing Geotours, constructing stone restaurants, cave restaurants, stone hotels, geological museums, stone therapy, hydrotherapy centers, geological residences, and ecolodges. These initiatives are locally managed, focusing on resource conservation, respect for local traditions and culture, participation, and enhancing tourists' and local communities' knowledge. The overarching goal is to alleviate poverty in villages and reduce the unemployment rate in Geotourism destinations (Robinson, 2008). As Sadry (2009) defined, Geotourism is a knowledge-based tourism, an interdisciplinary integration of the tourism industry with the conservation and interpretation of abiotic nature attributes, besides considering related cultural issues within the Geosites for the general public (Wendt, 2020).

Fassoulas et al. (2011) designed a quantitative model to assess the Geomorphosites of Silvertis Geopark, Greece, based on six main criteria, and the scientific, protection, and tourism values of each Geomorphosite were evaluated separately. This method was applied to multiple distinct regions to ensure its reliability. It is a valuable quantitative approach, mitigating subjectivity and eliminating personal opinions.

Pralong (2005) introduced and evaluated Geomorphosites in the Chamonix-Mont-Blanc area of Switzerland. He investigated Geotourism by developing an assessment model and establishing standard criteria for Geotourism.

Pereira et al. (2007) examined 154 Geomorphosites in the Montesinho National Park in Portugal from the point of view of investment potential, of which only 26 were selected for investment in the tourism sector. Pereira has identified this method as a means to eliminate subjectivity.

The study of geotourism should encompass examining all natural and human values and aspects (Bruno & Perrotta, 2010). Geoconservation is a critical element of Geotourism (Wang et al., 2014). This conservation rationale underpins the Geotourism concept as developed in Europe that also promotes tourism for both urban and, especially relevant to the model herein presented, rural destinations while promoting conservation (Vujic et al., 2011: 4). In recent decades, the rise of urbanization and environmental pollution has led to an increased focus on ecotourism. However, inadequate development practices, insufficient consideration of nature's capacity, and a lack of adherence to geoconservation principles (Sai-Leung et al., 2010), coupled with the impact of intense human activities, have resulted in widespread destruction of many ecotourism resources, particularly in the realm of Geotourism. The first step is knowledge and awareness: the geomorphological sciences are a power-

ful tool to reach and share a "sense of natural identity" (Lugeri et al., 2011: 221). In recent years, earth heritage planning and management assumed a growing importance, leading to a place for Geodiversity concepts alongside biodiversity. There has been a channeling of efforts to protect biological assemblages, their physical environments, and geomorphological features through identifying Geosites or Geomorphosites. In particular, relatively young studies related to the assessment of Geoheritage are fast-growing and include quantitative methods (Burlando et al., 2011: 63-64). At the international level, most Geotourism studies have focused on assessing Geotourism and preparing Geotourism maps (Reynard et al., 2011). Assessment methods typically encompass both conservation and tourism scientific values. These values are interconnected and mutually influence each other, with the scientific value representing the distinctive and intrinsic characteristics of a Geomorphosite. Such value underscores the imperative to preserve Geomorphosites, as a high scientific value, coupled with tourist attention and services, can threaten these sites. By reinforcing both scientific and conservation values, there is a need to enhance the tourism values of Geomorphosites. In turn, strengthened tourism values contribute to fortifying scientific and conservation values, as regional tourism development aligns with the demand for scientific knowledge and the imperative to protect Geomorphosites (Oroji, 2012: 29). Iran exhibits diversity in the features of landscapes and Geomorphological sites, showcasing a high potential in this field (Karami, 2006: 117).

Zouros (2007) designed a model for protected areas in Greece, focusing specifically on the Lesvos Petrified Forest. The model emphasized administrative and formal protection, the impact of cultural issues, potential use, and separate studies on large-scale and small-scale Geomorphosites.

Reynard (2009) introduced a new geotourism assessment method based on central and added values. The method includes separate criteria for ecological, aesthetic, and economic values. Feuillet and Sourp (2011) also designed a new assessment method for national parks. Eventually, the author suggests that organizations and institutions should intensify efforts to protect and promote the national park. He also advocates for comprehensive studies on the non-refrigerated side effects. Vujicic et al. (2011) also developed the Geomorphosite Assessment Method (GAM) in Serbia, emphasizing tourism values more. Their research concluded that the Geomorphosites in this mountain exhibit significant scientific value. However, the condition is unsatisfactory concerning functional values, indicating a need for further work to promote sustainable development. In the same year, Costa (2011) presented a method for assessing volcanic Geomorphosites, combining previous methods with different values. Furthermore, Rovere et al. (2011) suggested a new assessment method for underwater Geomorphosites. In the studies on assessing Geomorphosites at the domestic level, the methods designed at international levels were generally used to evaluate Geotourist areas. Mokhtari (2008) assessed the geotourism potential of Asiab Kharabeh using the Pralong method. The study highlights the importance of focusing on ecotourism, pointing out that the insufficient tourism development in Asiab Kharabeh is attributed to a lack of infrastructure. In their research, Maghsoudi et al. (2012) investigated and assessed the geotourism of the Kavir National Park using Pereira's method. The research identified scientific values as the foundation of geotourism in the region. However, limitations in tourism infrastructure and services were acknowledged as significant factors impeding the development of geotourism in the area. Oroji (2012) explored the potential of geotourism in Tabas City in his thesis. This study employed four assessment methods: Fassoulas, Paola Coratza, Sourp, and the GAM assessment method. The results revealed the significant scientific value of geomorphosites, highlighting the limited awareness among people regarding geotourist attractions. Additionally, the findings underscored the need for enhanced conservation efforts. Furthermore, the study identified challenges such as a lack of tourist influx, limited public awareness about tourism, and undiscovered Geomorphosites in the Tabas region. Moghimi et al. (2012) evaluated the open Geomorphosites along the Qom-Kashan freeway in the same year. The results revealed deficiencies in facilities and shortcomings in tourism and conservation services. Several other studies in the country focusing on assessment are available, such as Yamani et al. (2013).

Bahram Nekouie Sadry (2009) proposed the theoretical framework for Geotourism science in Iran for the first time through a book titled "Fundamentals of Geotourism with Special Emphasis on Iran" (Yamani et al., 2013; Maghsoudi et al., 2012; Saeidi-Shahri & Zarandian, 2014).

Shayan et al. (2007), in an article titled "Investigating the obstacles and problems of geotourism in Iran with an emphasis on the situation of geotourism in Lut desert," argues that geotourism, a branch of both tourism and ecotourism, aims to showcase geological attractions, offering tourists the opportunity to access desired natural attractions in the shortest possible time directly and

without significant expenditure of money and time. This industry encompasses economic, ecological, geological, and socio-cultural dimensions, offering employment opportunities for a diverse range of professionals, including environmental scholars, geographers, geologists, zoologists, and others who may serve as guides in geotourism and ecotourism.

Tahereh Sabouri (2008), in an article titled "Geotourism: A New Approach towards Resource Development and Environmental Management in Iran," declared that studies and statistical analyses indicate that there is still a lack of understanding among our people regarding the actual value of the country's natural resources. They do not hold a correct perspective on a future without plants and forests. Moreover, societal growth and awareness have not yet reached a point where the nation can fully leverage other areas under the country's management, including a significant portion of deserts. All of these factors necessitate the initiation of a new way of thinking.

Ghorbani et al. (2009), in an article titled "Geotourism: using of mountainous valleys geomorphic and geological attractions (Case study: Simin Valley in the south of Hamadan)," proposed that due to its abundant natural attractions, proximity to the historical city of Hamadan, the presence of rural-nomadic life patterns, and a well-established access network, the study area holds significant potential for ecotourism. Furthermore, the region's active tectonics make it a natural laboratory for studying various geological phenomena, including folds, faults, magmatism, dykes, pegmatites, and batholith. It is also an ideal setting for lithology, mineralogy, and metamorphic and igneous processes, making it an attractive destination for earth sciences researchers and geotourists.

Nikpoor Ghanvati et al. (2012) conducted a comprehensive review of the evolution of geotourism and its associated models in Iran. Through a comparative and descriptive analysis, it was concluded that, among the ten examined models, the prolong and ecological models are the most prevalent in geomorphic studies in Iran. Conversely, the fuzzy model has shown limited utilization in the context of Iran's geotourism. Furthermore, the survey of the evolution of geotourism in Iran revealed that between 2010 and 2012, a notable increase in research efforts was observed, particularly in the application of models for discussing geotourism. This trend underscores the growing prominence of geotourism studies in the country, emphasizing the importance of familiarizing oneself with these models for a comprehensive understanding of geotourism.

Asadollah Divsalar (2013), in a study titled "Investigating the role of geotourism in the sustainable cultural development of coastal cities," concluded that considering the capabilities and potentials in the studied area, these cities can be regarded as geotourism poles in the country, aligning with the principles of sustainable cultural development.

Zarabi and Safarabadi (2013), in their study titled "Evaluating Ecotourism Sustainability in Kermanshah," concluded that the region's most important strengths are its pristine nature and high ecotourism potential, earning a weighted score of 0.45, along with diverse weather, receiving a weighted score of 0.32. The study identified the most crucial weakness as the lack of proper attraction introduction, with a weighted score of 0.32. Opportunities highlighted include employment creation, with a weighted score of 0.36, and the organization of visit management, with a weighted score of 0.28. Conversely, the most significant threat to the sustainable development of ecotourism in the region is the lack of pre-studied basic plans, which received a weighted score of 0.40.

Azani et al. (2015), in a study titled "Geotourism and its relationship with the sustainable development of tourism in Iran (case study: Mud Volcano)," claim that the findings of this research highlight the contributions of geotourism in fostering the appeal of the ecotourism industry, particularly in connection with the mud volcano phenomenon. Geotourism has enabled researchers and operators to enhance the environment and improve the quality of visits, resulting in a distinctive and renewed emphasis on nature as human intervention in the earth takes on a special significance.

Arbabi Sabzevari (2013), in a study titled "Assessment of Geotourism Capabilities and Potentials in Sustainable Development (Case study: Darband Pond in Sahneh City)," asserts that DarbandPond, in its current state, exhibits favorable qualities for the development of geotourism and sustainable development. The region maintains a stable condition due to the harmonious alignment of scientific, conservation, and tourism values, although it is not yet considered a high-level geotourism area. Nevertheless, the area holds the potential to influence Sahneh City's sustainable development positively. Therefore, planning for the geotourism development of this region should prioritize a marketing and economical approach, focusing on the gradual promotion of geotourism values to ensure its sustainability in the future.

Taghilo et al. (2017), in a study titled "Analysis and Evaluation of the geotouristic Potentials of Zarivar Lake,

“ concluded that Zarivar Lake possesses a favorable geotourism capacity, earning high expert scores. Experts suggest that the lake has the potential for reassessment regarding tourism development, facilitating dynamic and efficient planning. According to experts, the value of this sub-index is 0.45, positioning it at an average level in the qualitative spectrum of the model. The lake’s uniqueness at both regional and national levels garnered significant praise from experts, assessing it as above-average and of good quality. The score of this sub-index is 0.61, placing it in the excellent quality spectrum. Strengthening the protection measures and implementing balanced planning that fosters positive interactions between tourists and locals could transform this region into an active and capable tourism site.

Mokhtari (2017), in an article titled “Geotourism: The Master Key to Protect and Improve the Capabilities of Local Communities with Examples from Northwest Iran,” declared that investigating the dependencies of local communities in the surveyed areas on environmental changes, and assessing the impact of the reliability or destruction of geotourism capital from these changes, revealed the inherent characteristics of geotourism, such as ecological orientation, productivity, resource conservation, respect for local traditions and culture, a quality perspective, synergy, participation, awareness, sectoral economic benefits, preservation of integrity, and ultimately satisfaction. All these aspects suggest the central importance of protecting and responsibly exploiting geotourism in conjunction with sustainable development.

Shayan Yeganeh et al. (2020), in research entitled “The quantitative assessment of geodiversity of proposed geopark of West Khorasan Razavi to protect its geological heritage,” employed a geodiversity index evaluation alongside the assessment of geomorphosites.

Nekouie Sadry & Tavazo (2022), in an article titled “Introducing and assessing the tectonic geoheritage in the Sahne-Harsin region of Kermanshah on the West of Iran,” using the qualitative model proposed by Canillo et al.,2005 and other Italian methods, identified the area as a potential future geopark for the preservation of its geological heritage.

3. Methodology

The study is descriptive-analytical research describing and explaining the area through a blend of library research and field visits. Afterward, the selected geosites were identified on 1:50,000 topographic maps. The lithology of various landforms was determined using 1:100,000 geological maps of the region (Table 2). After identifying the landforms, the Fassoulas model, a common and comprehensive geotourism framework, was utilized. Fassoulas et al.’s method (2011) was designed for large and mountainous areas. It was applied to Psiloritis geopark on Crete Island and Lasithi Mountain in Greece. Hence, the researchers of this study opted for this method due to the immense vastness of the Dorfak and Deylaman mountains. Some researchers, including Mohammadi Aragh et al. (2016), also employed this method due to the vast expanse of the Takht-e Soleyman region in northwest Iran. The criteria and values defined in this method are categorized into six main groups: scientific, ecological, protection, cultural, aesthetic, economic, and potential for use values in various tourism applications (Fassoulas et al., 2011).

Each value is associated with several sub-criteria, determined using the standard scoring system ranging from 9 to 93 for each group. Table 1 presents the values obtained using the Fassoulas method:

Gilan province, located in northern Iran with its center in the metropolis of Rasht, is bordered to the north by the Caspian Sea and Azerbaijan, where it shares an international border through Astara. To the west, it is adjacent to Ardabil province, to the south to Zanjan and Qazvin provinces, and the east to Mazandaran province. The area of Gilan province is 14,044 square kilometers. Despite its lush and diverse plant cover with dense forests, the region exhibits significant lithological diversity, featuring rocks of varying ages and extents. The study area of Deylaman and Dorfak is situated on the northern slope of the Alborz mountains, on the foot of the Dorfak mountain, between latitudes 37° 51’ 36” to 58° 02’ 37” and longitudes 44° 35’ 49” to 30° 58’ 49”. It is located 70 kilometers southeast of Rasht. Following the method employed in this research, which involved identifying selected geomorphological landforms and scoring them using the Fassoulas model, the results were presented in several Tables as follows:

Table 1. Fassoulas Method Values

Scientific Values					
Index	0	25	5	75	1
Geological history	Single type history	Combination of at least two types	Combination of most types	Local story	Tells the whole region's geological story
Representativeness	No	Low	Moderate	High	Very high
Geodiversity	<5%	25%	50%	75%	>75%
Rarity	>7	>5 <7	>3 <4	Between 1-3	Unique
Integrity	Almost destroyed	Strongly deteriorated	Moderately deteriorated	Weakly deteriorated	Intact
Ecological Value					
Ecological impact	No	Low	Moderate	High	Very high
Protection status	No protection	Limited	In spots	In large parts	Complete
Cultural Value					
Ethics	No	Low	Moderate	High	Very High
History	No	Low	Moderate	High	Very High
Religious	No	Low	Moderate	High	Very High
Art & Culture	No	Low	Moderate	High	Very High
Aesthetic Value					
Viewpoints	No	One viewpoint	Two viewpoints	Three viewpoints	More than four viewpoints
Landscape difference	No	Low	Moderate	High	Very High
Economic Value					
Visitors	<5000	>5000	>20,000	>50,000	>75,000
Attraction	No	Local	Regional	Zonal	International
Official protection	No	Local	Regional	Zonal	International
Potential for Use Value					
Intensity of use	Very intense	Intense	Moderate	Weak	No
Impacts	Very high	High	Moderate	Low	
Fragility	No	Low	Moderate	High	Very high
Accessibility	Close to hiking trail	Close to road	Close to the local paved road	Close to regional road	Close to highway or town
Acceptable changes	No	Low	Moderate	High	Very high

Source: Fassoulas et al., 2011

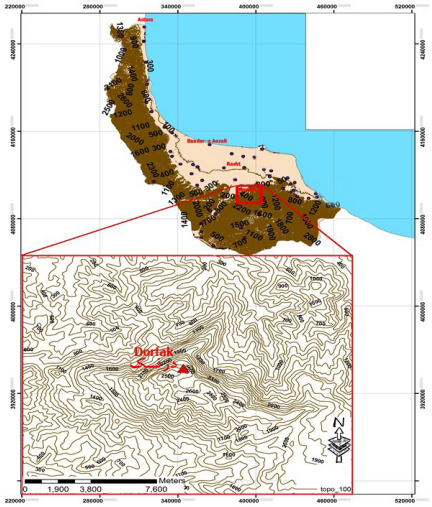

Figure 1. Geographical location of the studied area in Gilan province

Table 2. Selected geosites within the study area were evaluated using the Fassoulas model

Row	Geosites / Villages	1	2	3	4	5	6	Total
1	Dorfak country, Vanehbon, Chichal, Defraz and Rajeon	Polje	Lapies	Glacier Cave	Marine animals' fossils	Well	Doline	6
2	Rashi (Rahmatabad and Boloukat County, Rudbar)	Darband Rashi cave	60-meter-long Koylgar cave	30-meter-long Jokoyleh cave	Darband valley (Hirkani jungles)	Animals' fossils (Paleolithic bear)		4
3	Shah-e Shahidan (Khorgam County)	Espahbadan cave						1
4	Sidasht	Babu cave	Abdar cave					2
5	Pirkooh of Deylaman	Yarshalman cave	Rock shelter					2
6	Diarjan (Siahkal, Deylaman)	Diarjan cave A	Diarjan cave B					2
7	Khalvasht (Amarloo, Rudbar)	Rock shelter						1
8	Malumeh (Deylaman)	Beshkafteh Sang						1
			Sum Total					19

Source: Authors

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4. Findings

To Reynard's (2009) conceptual framework on geomorphological landscapes, mainly focusing on the prevalence of karstic phenomena within the studied area (Figure 1) (as evidenced by detailed field visits and observations documented in Table 2), the landforms of karstic, including Polje, Lapies, well, gopher, avon, and doline, were collectively assessed and scored as part of a unified landscape (Tables 3-6). Dorfak Glacial Cave and its associated complications were evaluated and scored within the karst landscape to achieve this objective. A separate Table was designated for this assessment, considering the non-surface nature of this geomorphological heritage and its high significance.

Table 3. Geosites Scoring (1. Dorfak, 2. Shah-e Shahidan, 3. Sidasht, and 4. Pirkooh Deylaman Country villages)

	1. Dorfak Karstic Landscape		2. Espahbadan Cave		3. Babu Cave and Abdar Cave		4. Yarshalman Cave and Rock Shelter	
Scientific Value								
Criteria/Value	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**
Geological history	Combination of most types	5	Combination of at least two types	25	Combination of at least two types	25	Combination of most types	5
Representativeness	Very high	1	High	75	Moderate	5	High	75
Geodiversity	>75%	1	50	5	25%	25	50	5
Rarity	Unique	1	National	5	More than 1 to 3 samples	75	Unique	1
Integrity	Moderately deteriorated	5	Weakly deteriorated	75	Weakly deteriorated	75	Intact	1
Ecological Value								
Criteria/Value	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**
Ecological impact	High	75	High	75	Moderate	5	High	75
Protection status	In large parts	75	No protection	0	No protection	0	No protection	0

Table 3. Geosites Scoring (1. Dorfak, 2. Shah-e Shahidan, 3. Sidasht, and 4. Pirkooh Deylaman Country villages)

	1. Dorfak Karstic Landscape		2. Espahbadan Cave		3. Babu Cave and Abdar Cave		4. Yarshalman Cave and Rock Shelter	
Cultural Value								
Criteria/Value	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**
Ethics	Moderate	5	No	0	No	0	High	75
History	Very high	1	Very high	75	Very high	75	Very high	1
Religious	Low	25	Low	25	Low	25	Low	25
Art & Culture	Moderate	5	Moderate	5	Very High	1	High	75
Aesthetic Value								
Criteria/Value	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**
Viewpoints	>4	1	1	25	2	5	1	25
Landscape difference	Very High	1	Low	25	Low	25	Low	25
Economic Value								
Criteria/Value	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**
Visitors	<5000	0	<5000	0	<5000	0	<5000	0
Attraction	Zonal	75	Zonal	75	Zonal	75	Zonal	75
Official Protection	National	25	No	0	No	0	No	0
Potential for Use Value								
Criteria/Value	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**
Intensity of use	Moderate	5	Moderate	5	Moderate	5	Weak	75
Impacts	High	25	Low	25	Low	25	Low	25
Fragility	Moderate	5	Moderate	5	Moderate	5	Moderate	5
Accessibility	Close to hiking trail	0	Close to hiking trail	0	Close to hiking trail	0	Close to hiking trail	0
Acceptable changes	Moderate	5	Low	25	No	0	Low	25

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Table 4. Geosites Scoring (5. Diarjan, Deylaman, 6. Molumeh, Deylaman, 7. Dorfak Country, and 8. Rashi villages)

	5. Diarjan Cave A & Diarjan Cave B		6. Beshkafteh Sang		7. Dorfak Glacial Cave		8. Darband Rashi Cave	
Scientific Value								
Criteria/Value	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**
Geological history	Single type history	0	Combination of at least two types	25	Single type history	0	Combination of at least two types	25
Representativeness	Low	25	High	75	High	75	High	75
Geodiversity	25%	25	50%	5	25%	25	50	5
Rarity	Between 1 to 3 samples	75	>3 <4	5	Unique	1	>3 <4	75
Integrity	Weakly deteriorated	75	Weakly deteriorated	75	Weakly deteriorated	75	Weakly deteriorated	75
Ecological Value								
Criteria/Value	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**
Ecological impact	Moderate	5	Moderate	5	High	75	High	75
Protection status	No protection	0	No protection	0	No protection	1	In spots	5

Table 4. Geosites Scoring (5. Diarjan, Deylaman, 6. Molumeh, Deylaman, 7. Dorfak Country, and 8. Rashi villages)

	5. Diarjan Cave A & Diarjan Cave B		6. Beshkafteh Sang		7. Dorfak Glacial Cave		8. Darband Rashi Cave	
Cultural Value								
Criteria/Value	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**
Ethics	No	0	No	0	Moderate	5	No	0
History	High	75	High	75	Very High	1	Very High	1
Religious	Low	25	Low	25	Low	25	Low	25
Art & Culture	Low	25	Low	25	Low	5	Very High	75
Aesthetic Value								
Criteria/Value	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**
Viewpoints	One viewpoint	25	>4 viewpoints	1	>4 viewpoints	1	Three viewpoints	75
Landscape difference	Low	25	High	75	Moderate	5	Low	25
Economic Value								
Criteria/Value	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**
Visitors	<5000	0	<5000	0	<5000	0	<5000	0
Attraction	Regional	5	Regional	5	Zonal	75	Zonal	75
Official Protection	No	0	No	0	No	0	No	0
Potential for Use Value								
Criteria/Value	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**	**Status**	**Value**
Intensity of use	Moderate	5	Moderate	5	Intense	25	Intense	25
Impacts	Low	25	Low	25	Moderate	5	Intense	75
Fragility	Moderate	5	Moderate	5	High	25	Low	5
Accessibility	Close to hiking trail	0	Close to hiking trail		Moderate	5	Moderate	25
Acceptable changes	Low	25	No	0	Close to hiking trail		Close to road	25

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Table 5. Total and Average of Fassoulas Values

	Darband Rashi Cave		Dorfak Karstic Landscape		Espahbadan Cave		Babu Cave & Abdar Cave	
Values	**Total Values**	**Values Average**	**Total Values**	**Values Average**	**Total Values**	**Values Average**	**Total Values**	**Values Average**
Scientific	3	6	4	8	75.2	55	5.2	5
Ecological	25.1	625	5.1	75	75	375	5	25
Cultural	2	5	25/2	5625	5.1	375	2	5
Aesthetic	1	5	2	1	5	25	75	375
Economic	75	25	1	25	75	25	75	25
Potential for Use	2	4/0	75.1	35	5.1	3	25.1	25

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Table 6. Total and Average of Fassoulas Values

Values	Yarshalman Cave and Rock Shelter		Diarjan Cave A & Diarjan Cave B		Beshkafteh Sang		Dorfak Glacial Cave	
	Total Values	Values Average	Total Values	Values Average	Total Values	Values Average	Total Values	Values Average
Scientific	75.3	75	2	5	3	6	75.2	55
Ecological	75	375	5	25	25/1	75	75.1	875
Cultural	75.2	6875	5.1	375	2	5	75.1	5833
Aesthetic	5	25	5	25	1	5	5.1	75
Economic	75	25	75	25	75	25	75	25
Potential for Use	75.1	35	5.1	3	2	4	75.1	35

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UNESCO Global Geoparks are regions where local communities implement programs to promote geological diversity, contributing to sustainable regional development. There are 195 UNESCO Global Geoparks in 48 countries (UNESCO Global Geoparks Network 2023). Geoparks offer numerous advantages for the villages within them, contributing to various aspects of sustainable development. For instance, from the economic point of view, in China, where the highest number of national and global Geopark registrations exists, some villages have experienced an increase in weekly income from $2 to $16 as a result of the establishment of Geoparks (Dowling & Newsome, 2010). Furthermore, from an environmental perspective, in adherence to UNESCO's stringent rules and regulations that emphasize preserving both inanimate and living nature and cultural heritage, these areas have been transformed into environmentally secure zones worldwide. From a social perspective, the advancement of tourism (especially geotourism) fosters social enlightenment, cultural exchange, heightened awareness, and the widespread dissemination of earth sciences. Therefore, addressing the initial query—can a potential Geopark be identified and proposed to the UNESCO organization for the studied area's economic, social, and environmental development? According to UNESCO standards, a minimum of 15 Geosites is required to establish a Geopark in a proposed area (Sadry, 2023). Fortunately, more than 20 Geosites were identified and introduced in the study area, as evidenced by the research findings in Tables 2-6.

5. Discussion

More comprehensive studies in geomorphosite capability assessment and considering aspects of sustainable rural development management and planning are needed. Hence, studying, assessing, and presenting practical methods for developing scientific, cultural, and economic values to foster sustainable tourism in a given area is imperative. According to UNESCO standards and the criteria for registering global Geoparks, the studied area in Gilan province is recognized as an appealing and suitable location for planning and developing Geotourism. Moreover, its natural attractions and country villages attract numerous tourists annually. Given the geological diversity and its significance at the international, national, and regional levels, various methods are typically considered for protection. In this research, following a thorough study and field investigations, 20 Geosites were selected and assessed using the Fassoulas model. In this study, the Dorfak karstic landscape scored (3.71), Dorfak glacial cave scored (3.36), Beshkafteh Sang scored (3), Yarshalman Cave scored (2.91), Darband Rashi Cave scored (2.87), Babu Cave scored (2.125), Espahbadan Cave scored (2.2.1) and Diarjan Cave socred (1.92).In this study, the Dorfak karstic landscape attained the highest score (3.71), followed by the Dorfak glacial cave with a score of (3.36). These areas showcase a range of attractive and spectacular landforms, including polje, lapies, and doline, and hold significant conservation values, as evidenced by their registration as national natural monuments. Furthermore, these sites have proven to be valuable for tourism. Other Geosites were ranked in the subsequent positions. In the literature review of this article, all research conducted on the Fassoulas model and other models employed for the evaluation of Geosites is presented. The area of this study, however, is limited to Tahereh Sabouri's doctoral thesis (2010) titled "Review and Studies of Geomorphology for Establishing Dorfak and Deylaman Geopark in Gilan Province" (Sadry, 2023; Sadry et al., 2023). Based on the assessment conducted in this research and the introduction of environmental capabilities, the establishment of the proposed Dorfak-Deylaman Geopark in Gilan, as the first in the northern region of Iran, could lead to sustainable rural tourism with the support of relevant organiza-

tions and the development of necessary infrastructure. According to UNESCO standards, the establishment of a Geopark in a proposed area requires a minimum of 15 geosites, encompassing both geological and geomorphological heritage, as well as the involvement of the local community, whether it be villages, cities, or country-nomadic settlements (Sadry, 2022). In this research, the identification of 10 villages and 20 unique Geosites indicates that the studied area is highly suitable for inclusion in the UNESCO Global Geopark network. On the other hand, in the 21st century, the establishment of Geoparks plays a significant role in the socio-economic development in and around the Geopark (Farsani et al., 2012; Sadry, 2021). Therefore, the establishment of the first Geopark proposed in Gilan province (Dorfak and Deylaman) is crucial for the economic, social, cultural, and environmental development of Rashi, Pirkooh, Diarjan, and Khalvasht villages, as well as countries (Dorfak et al.), and surrounding areas. In addition to preserving the valuable geological heritage, the geopark will highlight other aspects of the cultural and natural heritage (Dorfak et al. Cave, all registered as national natural monuments). This initiative aims to increase community awareness and understanding of critical issues such as the sustainable use of land resources and the reduction of environmental hazards. Hence, with strategic planning, integrated management of relevant organizations, and official support, the province's branding can be established at national and global levels.

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Conflict of Interest

The authors declared no conflicts of interest.

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