



Modelling the natural Geotourism Potential of North Sepidan County Using a Multi-Criteria Approach and Kriging-Based GIS Approach

Atefeh Nimrooz

Geological Survey and Mineral Exploration Survey of South Iran, Shiraz- Nasr Blvd., Iran

Corresponding Author's E-mail: atefhnimrooz@gmail.com

Original Article

Abstract

Received:
07-Jul-2025
Revised:
09-Aug-2025
Accepted:
29-Nov-2025
Published Online:
10-Dec-2025

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Geotourism plays a vital role in preserving geological heritage while fostering local economic development, particularly in mountainous regions. Sepidan County in Fars Province, southern Iran, is a promising destination for county-level geotourism for its diverse geological structures, geomorphological features, and distinctive natural phenomena. We applied three assessment models within the MCDM framework—GAM, AHP, and CoBa-LiKoA—to identify and prioritize sites for sustainable development. Results consistently ranked Margoon Waterfall, Barm Firuz Lake, Sheshpir Lake, and the Chellegah karst zone as the top geosites in terms of scientific value, aesthetic appeal, accessibility, and conservation potential. Spatial interpolation using Kriging in ArcGIS revealed that the highest intensities of geotourism potential are concentrated in the northern and northwestern sectors of Sepidan, particularly in areas surrounding lakes, springs, and karst landscapes. The findings highlight the need for participatory planning, sustainable infrastructure development, and geoheritage conservation. By integrating MCDM techniques with geostatistical Kriging in a GIS-based framework, this study addresses a significant gap in comprehensive geotourism assessments and provides a precise and practical strategy for sustainable county-level geotourism development in Sepidan. The interdisciplinary methodology—combining spatial analysis, multi-criteria evaluation, and community engagement—not only distinguishes this study from previous research but also offers a replicable framework for geotourism planning in other mountainous regions of Iran.

Keywords: Geotourism, tourism, Sepidan, Evaluation model, Kriging

Introduction

Geotourism, an interdisciplinary branch of sustainable tourism, focuses on the interpretation, conservation, and promotion of geological, geomorphological, and cultural features. It has emerged as a key approach to appreciating and preserving geological heritage for educational, recreational,

and economic purposes (Dowling & Newsome 2010). According to the National Geographic Society (2005) in Washington, geotourism enhances the “sense of place” by fostering the conservation of a region’s geological, cultural, aesthetic, historical, and environmental identity. Unlike traditional mass tourism, geotourism promotes environmental stewardship and raises public awareness of

earth sciences (Torabi Farsani *et al.* 2011).

Theoretically, geotourism builds upon foundational concepts such as cultural landscape theory, place capital theory, and participatory and sustainable planning. These frameworks emphasize local community engagement, geodiversity conservation, and development anchored in landscape-based values (Dowling 2010; Reynard & Brilha 2018). Within this framework, geosites are seen not only as scientific and natural assets but also as cultural and historical landmarks that contribute to regional identity and heritage.

County-level geotourism (Vergari *et al.* 2022) refers to geotourism initiatives organized at a regional or county scale. This captures broader natural landscapes, geomorphological structures, and local livelihoods within a jurisdiction and creates strong synergies between geoheritage, education, recreation, and rural socio-economic empowerment (Dowling & Newsome 2018). Recent studies across Europe (Hose 2011) and Asia have demonstrated that county-scale geotourism is an effective framework for promoting sustainable regional development while preserving natural and cultural landscapes. For instance, Tufănoiu (2023) analyzed geomorphosites in Vrancea County, Romania, showing how geotourism can stimulate local economies and reinforce community identity through the valorization of geological heritage. Similarly, Marlina and Herawan (2022) highlighted the potential of geotourism in Indonesia as a regional planning tool that integrates environmental sustainability, sociocultural values, and natural science resources. Together, these examples illustrate how county-level geotourism initiatives provide a practical model for linking geoconservation with socio-economic growth across diverse geographic contexts.

Sepidan County, at 51°59' E longitude and 30°16' N latitude (Fig. 1), located in Fars Province, Iran, has a population of around 90,000–91,000 people



Figure 1. Location of the study area shown in the world, Iran, Fars province and in satellite image.

whose livelihoods are primarily based on agriculture, livestock, and nature-based tourism. The city lies at an elevation of about 2,230 m above sea level and experiences a cold and humid mountainous climate, with cool summers (up to 31 °C) and cold winters (down to -5 °C). The average annual rainfall is approximately 600 mm, and the mean temperature is about 12 °C, making Sepidan one of the wetter and cooler regions in southern Iran.

The Digital Elevation Model (DEM) map of Sepidan County (Fig. 2) illustrates the region's complex mountainous topography and elevation variations. The variations in elevation, from high-altitude zones to valleys, reflect the strong influence of tectonic activity in shaping the geomorphological diversity of the area. Geologically, the region lies between the Folded and High Zagros structural zones and contains rock units ranging from the Cretaceous to Quaternary, including thick-bedded limestones, marls, shales, and recent alluvial deposits. Major formations include the

Dariyan, Kazhdumi, Sarvak, Gurpi, Pabdeh, Asmari, Razak, Aghajari, and Bakhtiari (James and Wynd 1965; Carrillo-Hernández et al. 2024).

Sepidan County hosts notable natural attractions, including Margoon Waterfall, Barm-e Firouz Lake, and the Chellegah karst formations. In addition, rural communities, traditional lifestyles, and rich cultural heritage contribute socio-economic value and opportunities for community-based tourism. The geotouristic significance of Sepidan arises from the integration of geological, natural, and cultural elements, creating a multifaceted identity that supports sustainable tourism, geoheritage conservation, environmental education, and local economic empowerment (Ruiz-Pedrosa et al. 2024; Ólafsdóttir 2018; Najwer et al. 2023). Its geological diversity, scenic landscapes, accessibility, and cultural richness make Sepidan an exemplar for regional geotourism planning that balances conservation with sustainable local development.

Literature Review

This study builds on a wide range of previous research addressing the fundamental concepts, theoretical frameworks, and assessment methods of geotourism in both Iranian and international contexts. The rapid growth of geotourism as a research domain has been documented, for example, in a systematic review of two decades, which found that most works focus on geoheritage identification, site assessment, and methodological development, while stakeholder and sustainability aspects remain underexplored (Ólafsdóttir 2018).

In the international field, Dowling (2013) emphasizes geotourism as a key instrument for sustainable development, noting that it hinges on the conservation of geological heritage and the responsible use of abiotic natural resources (Aliyev & Suleymanov 2023). His earlier book *Geotourism: Geological Tourism and Landscapes* (2010)

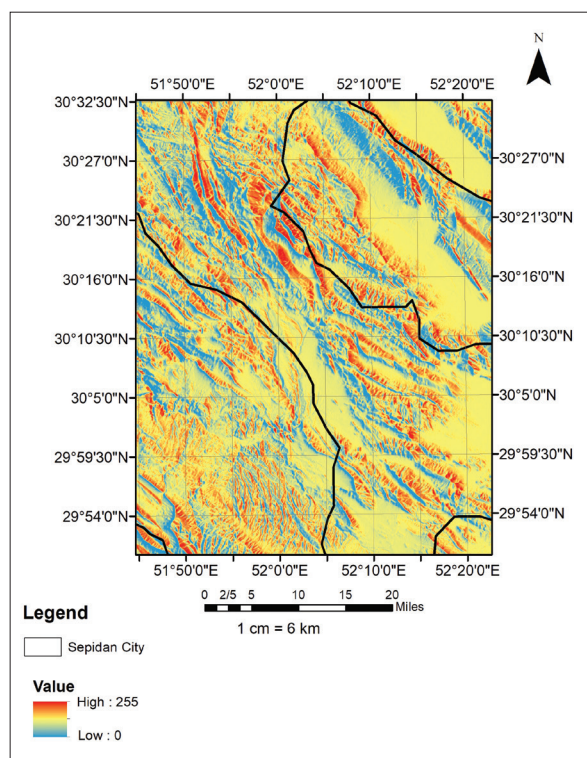


Figure 2. Digital Elevation Model (DEM) map of the Sepidan County.

further elaborates core principles and provides a global framework for best practices in geotourism. Other scholars have advanced theoretical frameworks: for instance, Gray (2019) proposed a conceptual model of geotourism composed of three essential components: geological education, structural interpretation, and geoheritage conservation. The model is frequently referenced in geotourism planning literature.

Methodologically, foundational work by Pierre Pralong (2005) introduced a structured tourist value assessment for geomorphological sites, combining scenic/aesthetic, scientific, cultural/historical and economic values into a unified scoring scheme. Subsequent studies have expanded this line of research by integrating spatial technology: for example, geodiversity assessment methods combined with GIS have been used as a first step to delineate geotourism potential zones (Chrobak-Žuffová *et al.* 2021). Frontiers and geosite/geoheritage assessment models like the Geosite Assessment Model (GAM) coupled with GIS-based isochrone accessibility analyses, have been applied in Serbia (Ivanović *et al.* 2023).

In the Iranian context, geotourism research has gained momentum at the regional and county levels. For instance, the development of the Qeshm Island Geopark illustrates how geoheritage zones can contribute to socio-cultural sustainability and local economies (Amrikazemi *et al.* 2006). Similar community-based approaches have been adopted in counties such as Neyshabur and Firuzeh, where cultural geomorphology is used to interpret local geosites and promote geotourism (Zangeneh asadi *et al.* 2020; Ghoorchi *et al.* 2019). Furthermore, studies in regions like Garmsar and Aradan (Semnan Province) investigate how rural geotourism can enhance rural livelihoods by leveraging natural, social, and economic capitals (Khorasani *et al.* 2025).

Iranian methodological contributions include the

application of the Analytic Hierarchy Process (AHP) in assessing geotourism potential—for example, a study of Mount Alvand using AHP to prioritize criteria such as scientific value, aesthetics and accessibility (Esmaeili 2014). Other investigations evaluated fossilsite tourism in Maragheh for its educational applicability, and in the Fars Province, studies used the Kubalíková (CoBa-LiKoA) model to rank geomorphosites based on combined quantitative and qualitative indicators. A summary of some geotourism studies conducted in county-level research is listed in Table 1.

Methods

Data collection represents one of the most critical and sensitive stages in geotourism research, as the accuracy and credibility of final results depend on it. In this study, both fieldwork and documentary methods were employed to ensure a comprehensive and reliable dataset. Field activities included multiple site visits, systematic photographic documentation, detailed geomorphological observations, GPS-based spatial surveys, and, where necessary, environmental sampling. Alongside field observations, geological maps (1:25,000 scale), high-resolution satellite imagery, long-term climatic records, historical documents, and previous scientific studies were analyzed to establish a robust and multi-source database (Kubalíková & Bajer 2018; Reynard & Brilha 2018; Pereira *et al.* 2020). Data quality control was performed through cross-validation of GPS data with satellite imagery and verification of geological information with official maps from the Geological Survey of Iran (GSI). Since detailed geological surveys by GSI are mainly concentrated in northern Sepidan (Nimroozi 2011), this area—characterized by prominent fold and fault structures, mineral springs, waterfalls, and mountainous landscapes—became the primary focus of analysis. The collected data aimed not only to document the geological and geomorphological features but

Table 1. A summary of some geotourism studies conducted in county environments.

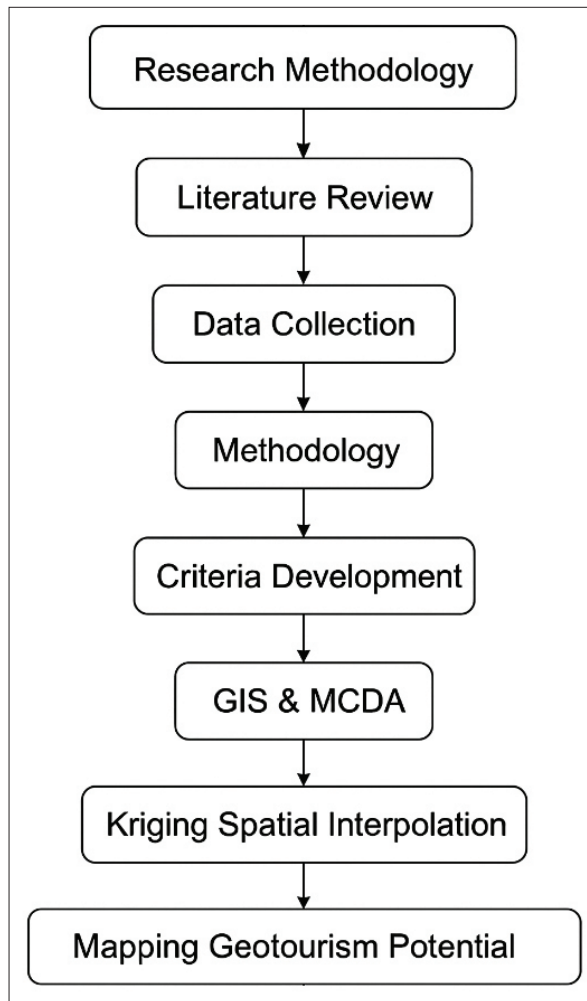
Author / Year	Region / Context	Main Objective / Concept	Method / Tool
Dowling (2010, 2013)	Global	Highlighted geotourism as a tool for sustainable development and geological heritage conservation	Theoretical review, global conceptual framework
Ólafsdóttir & Tverijonaite (2018)	International	Systematic review of 20 years of geotourism research	Literature review
Gray (2019)	International	Proposed a conceptual model of geotourism: geological education, structural interpretation, geoheritage conservation	Conceptual modeling
Pralong (2005)	International	Evaluate geomorphological tourism value	Combined scoring model: scientific, cultural, economic, aesthetic values
Kubalíková & Bajer (2018)	International	Geodiversity and geosite assessment	CoBaLiKoA model, quantitative qualitative indicators
Kubalíková & Kirchner (2016)			
Amrikazemi <i>et al.</i> (2006)	Qeshm Island, Iran	Geopark development and its impact on socio-cultural sustainability and local economy	Geomorphological documentation, geoheritage assessment
Zangeneh asadi <i>et al.</i> (2020), Ghoorchi <i>et al.</i> (2019)	Neyshabur and Firuzeh Counties, Iran	Apply cultural geomorphology for local geosite interpretation and community-based geotourism	Field-based descriptive studies
Khorasani <i>et al.</i> (2025)	Garmsar and Aradan, Iran	Enhance rural livelihoods via geotourism	Social, economic, environmental analysis
Esmaeili (2014)	Mount Alvand, Iran	Assess geotourism potential using criteria prioritization	Analytic Hierarchy Process (AHP)
Zare GR (2024)	Maragheh region, Iran	Educational value of fossil sites for geotourism	CoBaLiKoA model, quantitative qualitative indicators

also to assess the environmental and social context relevant to sustainable geotourism development. (Table 2)

The analytical framework combined Multi-Criteria Decision-Making (MCDM) techniques—namely the Analytical Hierarchy Process (AHP), (Acharya *et al.* 2022), Generic Assessment Model (GAM), and the Czech CoBaLiKoA method (Kubalíková 2013)—with spatial and geostatistical analyses using GIS and Kriging interpolation. Each MCDM model applies distinct weighting schemes to geotourism criteria such as scientific significance, accessibility, conservation status, and aesthetic value (Javadi *et al.* 2018; Tamang *et*

al. 2023). The AHP method, through hierarchical structuring and expert judgment, enables prioritization of key geosite attributes, while the GAM model, efficient in data-scarce environments, classifies geosites according to scientific, complementary, and environmental indices. The CoBaLiKoA approach integrates geomorphological and managerial parameters, refining local and regional evaluations of geomorphotourism potential.

Kriging interpolation, based on semivariogram analysis, was implemented in ArcGIS to generate predictive maps of geotourism potential (Louz *et al.* 2024). Although the ordinal geotourism scores do not fully satisfy Kriging's assumption of con-

Table 2. Stages for geotourism study in Sepidan.

tinuous normal data, they were approximated as continuous variables to identify spatial trends and priority areas. Despite this approximation, Kriging proved to be an effective exploratory tool for mapping and prioritizing potential geosites and routes for future development. The integration of geological, geomorphological, and socio-environmental data with MCDM–GIS–Kriging analyses provides a comprehensive and participatory framework for identifying, classifying, and managing geotourism resources. This methodology enhances spatial accuracy, strengthens heritage conservation, and supports sustainable development policies for Sepidan and other similar mountainous regions of Iran (Carrillo-Hernández *et al.* 2024; Ruiz-Pedrosa *et al.* 2024).

Results

Geomorphological Features and Landforms

In the dynamic mountainous region of Sepidan, geomorphological phenomena play a key role in geotourism development. The diverse topography, folded and fractured structures, Zagros, highlands, and the influence of active faults such as the Dena Fault have produced striking landforms, including narrow deep valleys, overturned synclines, rocky cliffs, tall waterfalls (e.g., Margoon Falls), and permanent and seasonal springs. These features possess high aesthetic, scientific, and educational value, offering unique attractions for tourists interested in nature, geology, and photography. Active processes such as fluvial erosion, landslides, and karst phenomena impart a dynamic character to the region's natural environment, making these geomorphological features essential for sustainable tourism planning, local economic development, and geoscientific awareness. Table 3 represent geographic coordinates of the geosites investigated in this study, which are described briefly as below:

Key Geotourism Units

1. Barm Firuz and Sheshpir Lakes

Barm Firuz Lake (Fig. 3A, B), situated at approximately 3,350 m above sea level on the slopes of Mount Barm Firuz, is a seasonal high-altitude lake fed by melting winter snow. Its ice cover in winter, gradual spring thaw, sediment deposition, and surrounding vegetation changes make it a live classroom for geomorphic processes. Proximity to active Zagros faults and surrounding peaks (up to 3,700 m) enhances its scientific and educational value for tectonics, mountain hydrology, and slope erosion. The lake's sedimentary basin and positioning within folded and faulted structures, particularly the Barm Firuz anticline, indicate a combination of karstic and tectonic processes (tecnokarstic) (Samani 2014).

Table 3. Geographic coordinates of the geosites investigated in this study

Phenomena	X	Y	Phenomena	X	Y
Vertical bedding	593577.21 m E	3350277.35 m N	fault	602148.87 m E	3340544.61 m N
Fault	593224.81 m E	3350772.63 m N	spring	594717.99 m E	3350401.43 m N
Landslide	591386.65 m E	3356606.08 m N	spring	593865.02 m E	3350940.93 m N
Landslide	605578.09 m E	3342464.09	spring	594868.04 m E	3350233.28 m N
Overtun syncline	606655.15 m E	3345510.40 m N	spring	592176.37 m E	3348555.12 m N
River	590761.96 m E	3355816.72 m N	spring	584634.44 m E	3350172.84 m N
Escarpments	595644.43 m E	3358840.79 m N	spring	585796.88 m E	3350023.96 m N
Escarpments	593765.68 m E	3354585.99 m N	fault	602148.87 m E	3340544.61 m N
Fossil	593142.03 m E	3351693.73 m N	spring	594717.99 m E	3350401.43 m N
Fault	588081.61 m E	3360050.05 m N	spring	593865.02 m E	3350940.93 m N
Spring	586182.26 m E	3349369.73 m N	spring	586040.81 m E	3352905.25 m N
Spring	587101.32 m E	3352449.02 m N	river	590160.11 m E	3352913.03 m N
Spring	586247.16 m E	3357303.53 m N	river	594035.66 m E	3356478.52 m N
Barmfirouz	587579.02 m E	3360557.60 m N	river	602461.12 m E	3343576.99 m N
Sheshpir	602688.73 m E	3343779.19 m N	river	600268.72 m E	3339760.13 m
Landslide	588280.08 m E	3358163.67 m N	river	599721.74 m E	3335851.32 m N
Landslide	595480.92 m E	3356662.04 m N	Overtun syncline	590472.47 m E	3353653.02 m N
River	585739.04 m E	3355831.64 m N	Chelehghah karst	589953.72 m E	3352654.73 m N
Spring	587101.32 m E	3352449.02 m N	river	590160.11 m E	3352913.03 m N

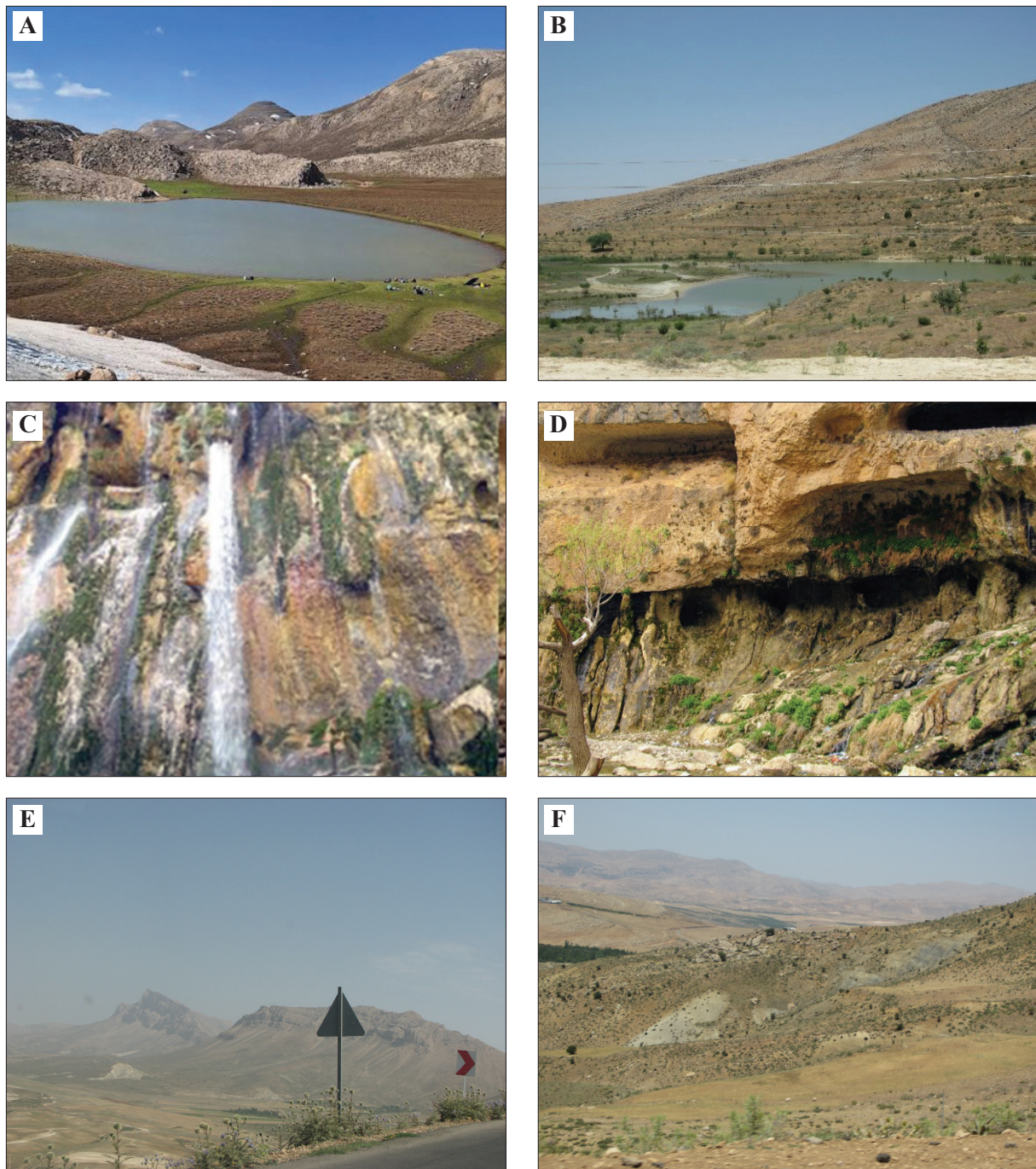


Figure 3. Some of the geotourism features in the Sepidan region: **A)** Barm-e Firuz Lake, **B)** Sheshpir Lake, **C)** Margoon fall **D)** Chellehgah Karst, **E)** Scarpment, **F)** Landslide

Sheshpir Lake (Fig. 3B), located at about 2,500 m in southeastern Sepidan, is primarily fed by karstic springs from the Asmari Formation. Unlike the largely seasonal Barm Firuz, Sheshpir maintains relatively stable water levels due to continuous spring discharge from Sheshpir Spring. Surrounding karstic depressions, lush vegetation, and trav-

ertine deposits make it scientifically valuable for karst hydrology and carbonate sedimentation studies. Its accessible location and cultural significance in local folklore enhance its tourism appeal.

2. Margoon Waterfalls

Margoon Waterfall (Fig. 3C), one of the tallest

waterfalls in Iran (~70 m), emerges directly from the cliff face. Formed through tectonic uplift, karst processes, and unique lithology, it provides both aesthetic enjoyment and geotouristic significance. Scenic landscapes, biodiversity, and cool microclimate make it ideal for sustainable tourism development (Ruiz-Pedrosa *et al.* 2024; Ólafsdóttir 2018; Najwer *et al.* 2023).

3. Folding Structures

Folds, particularly overturned and asymmetric types, reflect tectonic pressures in convergent crustal zones and indicate directions and magnitudes of tectonic forces. They are important for geoscientific education and research-based geotourism (Fossen 2021). In Sepidan, anticlines and synclines, influenced by the Dena Fault, include notable examples such as the overturned syncline in Alvandi Valley.

4. Karst Structures

Karst landforms—dolines, karren, sinkholes, caves, and springs—result from carbonate rock dissolution in humid to semi-humid climates and combine geological, hydrogeological, and aesthetic value. Limestone formations like Sarvak and Asmari support small caves, sinkholes, limestone springs, and dissolution basins (Samani 2014; Ford & Williams 2013; Klimchouk *et al.* 2017; Parise & Gutiérrez 2014; Goldscheider & Drew 2007). Sheshpir Spring is a perennial karst outlet forming downstream rivers. Dissolution cavities in Chellegah (Fig. 3D) further exemplify karst processes.

5. Landslides and Slope Instability Phenomena

Slope failures reflect interactions among gradient, tectonics, lithology, and climate, demonstrating geomorphological dynamism (Niculiță & Mărgărint 2018, Gutiérrez *et al.* 2014, Margottini *et al.* 2013). They provide natural cross-sections for education on geodynamic processes. In Sepi-

dan, active and ancient landslides occur in marl, shale, and softer lithologies (e.g., Gurpi Formation) along steep slopes like Mount Ranj and the new Sepidan–Yasuj road (Morino *et al.* 2025) (Fig. 3E).

6. Peaks and Rocky Ridges

Steep peaks and serrated ridges, such as Mount Ranj, exhibit differential erosion of limestone, fracture patterns, and cliffs, creating visual and geotouristic appeal. These formations support adventure tourism activities including rock climbing (Melelli 2023) and ridge traversing, combining recreation with geological interpretation (Anonymous 2013; Hose & Vasiljević 2012, Hose 2016; Dowling 2011) (Fig. 3F).

7. Erosional Valleys and River Terraces

Valleys and terraces formed by fluvial erosion indicate climatic, tectonic, and base-level fluctuations (Hu *et al.* 2024; Wasson 2002). Features like bedding cuts and stepped terraces create scenic educational trails (Antić *et al.* 2019). Main rivers, such as Ardekan and Sheshpir, form deep V-shaped valleys upstream and stepped alluvial terraces downstream (Fig. 4A, D).

8. Springs

Natural springs, including Sheshpir, Margoon, Mordraz, and Kamar, offer aesthetic, recreational, and therapeutic value. Proper management ensures sustainable geotourism and environmental protection (Loghmannia 2024).

9. Fossils

Macro- and trace fossils enhance geotourism by illustrating geological history (Willman *et al.* 2011). Fossil parks (Clary 2021) serve as important geotourism destinations by preserving paleontological heritage, allowing visitors to observe ancient life forms (Gordon 2018), learn about Earth's history, and promote scientific education

and conservation awareness. In Sepidan, fossils are reported as follows: rudist macrofossils from the Sarvak Formation (Fig. 4C); *Nummulites* from the Asmari Formation; bivalves and gastropods from the Kazhdumi Formation; and trace fossils from the Asmari Formation (Fig. 3E). These features support educational and conservation objec-

tives (Barroso-Barcenilla *et al.* 2022; Dowling 2013; Martínez-Graña *et al.* 2021; Singh 2021) (Fig. 4C, D).

10. Faults

Active faults, especially the Dena Fault, produce tilted stratigraphy, fracture systems, springs, and

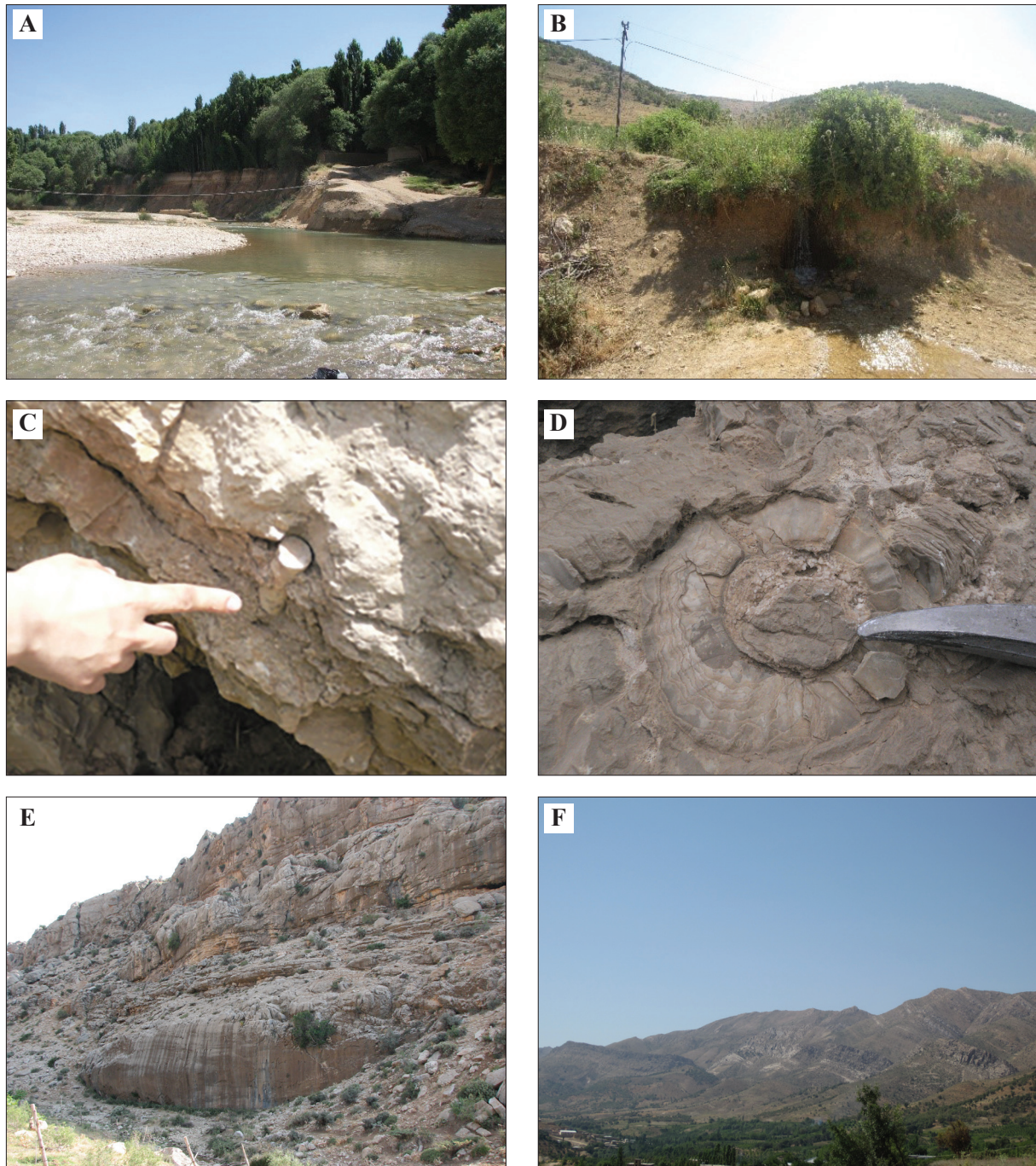


Figure 4. Some geotourism features of the Sepidan region: **A)** Rivers **B)** Spring **C)** Fossil traces, **D)** Rudist macrofossil **E)** Fault-related features, **F)** Fault-related features

waterfalls, representing ongoing tectonic activity and providing geoscience education opportunities (Berberian 1995; Migoń & Pijet- Migoń 2019, 2020) (Fig. 4D, E).

Geotourism Assessment

Geotourism evaluation of features based on AHP, GAM, MCDM, and Kubalíková models are represented in Table 4. based on these calculations, sites with the highest scores for geotourism potential included Margoon Waterfall, Barm Firuz Lake, Sheshpir Lake, and the Chellegah karst zone, based on scientific, aesthetic, accessibility, and conservation criteria. Fossil sites and springs also ranked highly, whereas landslides and vertical strata scored lower due to hazards or access limitations. The geotourism potential map, generated in ArcGIS using Kriging interpolation, shows the northern and southern sectors—around lakes, karst zones, springs, and river valleys—as having the highest development potential. Field interviews confirmed the importance of these sites and the need for conservation and infrastructure development.

Conclusion

This study comprehensively evaluated the geotourism potential of Sepidan County using advanced Multi-Criteria Decision-Making (MCDM) techniques—including the Analytical Hierarchy Process (AHP), Generic Assessment Model (GAM), and CoBaLiKoA —integrated with GIS-based spatial analyses and Kriging interpolation (Fig.5). The results reveal that Sepidan possesses exceptional geological diversity, distinctive geomorphological features, and outstanding natural attractions such as Margoon Waterfall, Barm-e Firuz Lake, karst formations, active faults, and mineral springs, all of which highlight its strong potential for sustainable geotourism development.

The integrated MCDM–Kriging–GIS framework provided a robust scientific basis for identifying and prioritizing high-potential geosites based on scientific significance, aesthetic value, accessibility, and environmental resilience. This data-driven approach enhances precision in spatial evaluation and supports evidence-based decision-making for regional planning.

Table 4. Geotourism evaluation of features based on AHP, GAM, MCDM, and Kubalíková models.

GEOMORPHOLOGICAL phenomenon	MCDM	GAM	AHP
Waterfalls (Margoon)	4.50	2	4.5
Barm Firuz Lake	4.45	2	4.38
Sheshpir Lake	4.45	2	4.38
Chellegah Karst	4.25	1.90	4.25
River	4.25	1.70	4.10
Fossil	3.70	1.60	3.94
Spring	3.50	1.50	3.68
Overtuned syncline	3.50	1.50	3.56
Scarpment	3.10	1.20	3.42
Fault	3.30	1.50	3.68
Landslide	2.50	1	2.79
Vertical bedding	2.25	0.8	2.61

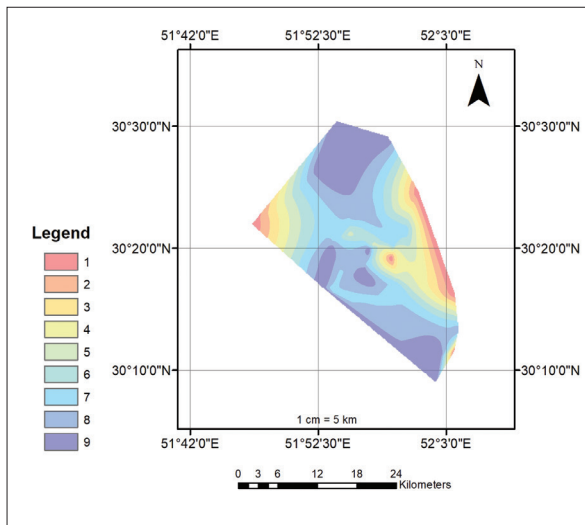


Figure 5. Kriging-style interpolation map of geotourism scores based on the MCDM model.

Geotourism can serve as an environmentally responsible and economically viable development strategy for Sepidan, promoting local empowerment and environmental awareness. The proposed framework offers a transferable model applicable to other mountainous regions of Iran, contributing to national geotourism planning and sustainable management of geoheritage resources.

Recommendations

In this study, it is recommended to conduct more comprehensive and interdisciplinary investigations on the geological and geomorphological characteristics of the Sepidan region to more accurately identify its geotourism capacities. Enhancing education and awareness among local communities regarding the importance of preserving geological heritage is also essential. Collaboration between universities, geological organizations, and tourism authorities is necessary to improve the planning and management of geotourism activities. Moreover, employing modern technologies (Kuleta 2018) such as GIS (Gorai *et al.* 2020), multi-criteria decision-making models, and geostatistical methods like Kriging for data analysis and design of geotourism routes is highly encouraged. Developing coherent conservation and

management policies, expanding environmentally compatible tourism infrastructure, and improving visitor facilities are other important measures. Implementing field projects, training experts and local communities, establishing interpretive trails with environmental protection principles, and planning continuous monitoring of tourism impacts are key actions toward sustainable geotourism development in the Sepidan region.

Acknowledgments

The authors gratefully acknowledge the Geological Survey and Mineral Exploration of Iran (GSI) for providing detailed geological maps and scientific data essential for this research. The invaluable support and expertise of GSI specialists during field data collection and geological analyses greatly contributed to the scientific quality of this study. We sincerely hope that such scientific collaborations will continue and further advance geoscience research in Iran.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

References

- Acharya A, Mondal, BK, Bhadra T, Abdelrahman K, Mishra PK, Tiwari A, Das R (2022). Geospatial analysis of geo-ecotourism site suitability using AHP and GIS for sustainable and resilient tourism planning in West Bengal, India. *Sustainability*. 14(4): 2422. <https://doi.org/10.3390/su14042422>
- Aliyev V, Suleymanov F (2023). The protection

- of water resources for sustainable tourism under climate change in South Caucasus: in the context of Azerbaijan. *GeoJournal of Tourism and Geosites*. 47(2): 515522. <https://doi.org/10.30892/gtg.47219-1051>
- Amrikazemi A, Mehrpooya A (2006). Geotourism resources of Iran. In *Geotourism* (pp. 78–92). <https://doi.org/10.1016/B978-0-7506-6215-4.50013-0>.
- Antić A, Tomić N, Marković V (2019). Karst geoheritage and geotourism potential in the Pek River lower basin (Eastern Serbia). *Geographica Pannonica*. 23(4): 115-124. <https://doi.org/10.5937/gp23-20463>
- Anonymous (2013). *Adventure Tourism Market Study 2013*. The George Washington University and the Adventure Travel Trade Association, Washington.
- Barroso-Barcenilla F, Alcalde-Fuentes M del R, Audije-Gil J, Berrocal-Casero M, Callapez PM, Ozkaya de Juanas S, Pérez-Valera, JA, Faria dos Santos V, Segura M (2022). Discovering a project for the development of geotourism in rural areas: The Paleontological and Archaeological Interpretation Centre of Tamajón (CIPAT, Guadalajara, Spain). *Land*. 11(3): 444. <https://doi.org/10.3390/land11030444>
- Berberian M (1995). Master “blind” thrust faults hidden under the Zagros folds: Active basement tectonics and surface morphotectonics. *Tectonophysics*. 241(3–4): 193–224.
- Carrillo-Hernández LM, Pérez-Martínez JA, Díaz LF (2024). Geotourism and geoeducation: A holistic approach for socioeconomic development in rural areas of Los Santos Municipality, Santander, Colombia. *Geoheritage*. 16(4): 94. <https://doi.org/10.1007/s12371-024-00974-6>
- Chrobak-Žuffová A, Novotný J, Strus P (2021). Geodiversity Assessment as a First Step in Designating Areas of Geotourism Potential: Case Study of the Western Carpathians. *Frontiers in Earth Science*. 9: 752669. <https://doi.org/10.3389/feart.2021.752669>
- Clary RM (2021). A critical review of Texas, USA fossil park sites and implications for global geoheritage sites. *International Journal of Geoheritage and Parks*. 9: 82–92. <https://doi.org/10.1016/j.ijgeop.2020.12.009>
- Dowling RK (2010). Geotourism’s global growth. *Geoheritage*. 3(1): 1–13. <https://doi.org/10.1007/s12371-010-0024-7>
- Dowling RK, Newsome D (2010). *Geotourism: The tourism of geology and landscape*. Goodfellow Publishers.
- Dowling R K (2011). Geotourism’s global growth. In *Proceedings of the 1st International Conference on Geotourism* (pp. 45–56). <https://doi.org/10.2478/cjot-2013-0004>
- Dowling RK (2013). Global geotourism – An emerging form of sustainable tourism. *Czech Journal of Tourism*. 2(2): 59–79. <https://doi.org/10.2478/cjot-2013-0004>
- Dowling RK, Newsome D (2018). *Handbook of Geotourism*. Edward Elgar Publishing.
- Esmaeili A (2014). Assessment of the effective variables in sustainable geotourism development using GIS and AHP method (Case study: Northern slopes of Alvand). *Proceedings of the First National Conference on New Horizons in Empowerment and Sustainable Development of Architecture, Civil Engineering, Tourism, Energy, and Urban & Rural Environment, Iran* (In Persian)
- Fossen H (2021). *Structural Geology* (3rd ed.). Cambridge University Press.
- Ford DC, Williams PW (2013). *Karst Hydrogeology and Geomorphology*. Wiley-Blackwell, Oxford.
- Ghoorchi M, Saadat S (2019). Mining Geotourism and the Empowerment of Rural Women:

- A Case Study of Villages near the Neyshabur Turquoise Mine Proceedings of the Conference on Women and Rural Tourism Development, Kashmar, Iran, October 2019 (in Persian).
- Goldscheider N, Drew D (Eds.). (2007). *Methods in Karst Hydrogeology*. Taylor Francis/Balkema, London
- Gorai T, Yadav P, Kumar A (2020). Geographic information system (GIS) and geostatistics for natural resource mapping. In *Agriculture Letters – Newsletter*. 1(7): 5–9. Agriculture Letters Online.
- Gordon JE (2018). Geoheritage, geotourism and the cultural landscape: Enhancing the visitor experience and promoting geoconservation. *Geosciences*. 8(4): 136. <https://doi.org/10.3390/geosciences8040136>
- Gray M (2019). Geodiversity, geoheritage and geoconservation for society. *International Journal of Geoheritage and Parks*. 7(4):226–236. <https://doi.org/10.1016/j.ijgeop.2019.11.001>
- Gutiérrez F, Parise M, De Waele J, Jourde H (2014). A review on natural and human-induced geohazards and impacts in karst. *Earth-Science Reviews*. 138: 61–88. <https://doi.org/10.1016/j.earscirev.2014.08.002>
- Hose TA (2011). The English origins of geotourism (as a vehicle for geoconservation) and their relevance to current studies. *Acta Geographica Slovenica*. 51(2): 343–359. <https://doi.org/10.3986/AGS51302>
- Hose TA, Vasiljevic D (2012). Defining the nature and purpose of modern geotourism with particular reference to the United Kingdom and South-East Europe. *Geoheritage*. 4(1): 25–43. <https://doi.org/10.1007/s12371-011-0050-0>
- Hose TA (2016). *Re-cycling and geotourism: An adventure approach to appreciating physical landscapes*. School of Earth Sciences, University of Bristol, UK.
- Hu X, Lei J, Wang W, Wang Y, Li Y, Zhang P, Lin K, Zheng W, Liu Q, Liu F, Liang H (2024). Unraveling the tectonic and climatic influences on River Erosion: A late Quaternary case from the Dongda River, northeast Tibet. *Journal of Asian Earth Sciences*. 275: 106297. <https://doi.org/10.1016/j.jseaes.2024.106297>
- Ivanović M, Lukić T, Milentijević NM, Bojović V (2023). Assessment of geosites as a basis for geotourism development: A case study of the Toplica District, Serbia. *Open Geosciences*, 15(1). <https://doi.org/10.1515/geo-2022-0589>
- James GA, Wynd JG (1965). Stratigraphic Nomenclature of Iranian Oil Consortium, Agreement Area. *American Association of Petroleum Geologists Bulletin*. 49: 2182-2245.
- Javadi M, Jalili S, Hasanpouri Gazani P, Ahmadi P (2018, October 2–7). Evaluation of geotouristic potential of Tabriz' Eynali for sustainable tourism development by emphasis on Comănescu method. The 6th Interdisciplinary Tourism Research Conference, Avanos, Turkey.
- Khorasani MA, Vakili Kh, Heydari Kh (2025). Rural Geotourism: A Path Toward Livelihood Sustainability (Case Study: Garmsar and Aradan Counties). *Journal of Geography and Regional Development*. 23(1): 32
- Klimchouk A, Palmer AN, De Waeghele J, Auler A, Audra P (Eds.). (2017). *Hypogene Karst Regions and Caves of the World*. Springer, Cham.
- Kubalíková L, Kirchner K (2016). Geosite and geomorphosite assessment as a tool for geoconservation and geotourism purposes: A case study from Vizovická vrchovina Highland (Eastern part of the Czech Republic). *Geoheritage*. 8(1):5–14. <https://doi.org/10.1007/s12371-015-0143-2>
- Kubalíková L, Bajer A (2018). Geotourism within urban areas: new ways of promotion of natural and cultural heritage (case study from Brno city). *Proceedings of the 25th Central-European*

- Geographical Conference: Useful Geography, July 2018. Czech Academy of Sciences, Institute of Geonics, Mendel University in Brno.
- Kubalíková L (2013). Geomorphosite assessment for geotourism: A hybrid approach. *Czech Journal of Tourism*. 2(2). <https://10.2478/cjot-2013-0005>
- Kuleta M (2018). Geodiversity Research Methods in Geotourism. *Geosciences*. 8(6): 197. <https://doi.org/10.3390/geosciences8060197>
- Louz E, Rais J, Barakat A, El Baghdadi M (2024). Identification of potential areas for the development of geotourism in the northern part of the M'goun Geopark (Morocco) using multi-criteria analysis and SIG. *Geoheritage*. 17(1). <https://doi.org/10.1007/s12371-024-01054-5>
- Loghmannia K, Hosseinzadeh M, Karami F (2024). Evaluation of geotourism potential of Top Tapan karst spring by comparing Kubalíkova and Serrano Gonzalez-Truba methods. *Geography and Human Research (In Persian)*, <https://doi.org/10.22034/gahr.2024.444229.2055>
- Martínez-Graña A, Legoinha P, Goy JL, González-Delgado JA, Armenteros I, Dabrio C, Zazo C (2021). Geological-geomorphological and paleontological heritage in the Algarve (Portugal) applied to geotourism and geoeducation. *Land*. 10(9): 918. <https://doi.org/10.3390/land10090918>.
- Margottini C, Canuti P, Sassa K (Eds.). (2013). *Landslide Science and Practice: Vol. 2: Early Warning, Instrumentation and Monitoring*. Springer. <https://doi.org/10.1007/978-3-642-31445-2>
- Marlina E, Herawan T (2022). Geotourism concept development in the basis of environment sustainability, socioculture, and natural science wealth: A case study in Indonesia. *Journal of Environmental Management and Tourism*. 11(1): 17–30.
- Melelli L, Bianchini G, Fanò L (2023). HUSH (Hiking in Urban Scientific Heritage): The augmented reality for enhancing the geological and naturalistic heritage in urban areas. *Applied Sciences*. 13(15):8857. <https://doi.org/10.3390/app13158857>
- Migoñ P, PijetMigoñ E (2019). Natural disasters, geotourism, and geointerpretation. *Geoheritage*. 11(4): 629640. <https://doi.org/10.1007/s12371-018-0316-x>
- Migoñ P, PijetMigoñ E (2020). Late Palaeozoic Volcanism in Central Europe – Geoheritage Significance and Use in Geotourism. *Geoheritage*. 12: 43. <https://doi.org/10.1007/s12371-020-00464-5>
- Morino C, Coratza P, Ghirotti M, Pasuto A, Soldati M (2025). Landslide-geomorphosite assessment in the Dolomites (Italy): Application of a newly implemented method. *Geomorphology*. 485: 109844. <https://doi.org/10.1016/j.geomorph.2025.109844>
- Najwer A, Klimczak M, Słowik M (2023). Geodiversity assessment for geomorphosites management: Case study and method development. *Geological Society, London, Special Publications*. 530: 122. <https://doi.org/10.1144/SP530-2022-122>
- National Geographic Society (2005). *Geotourism Charter*. Washington, DC: National Geographic Society
- Niculiță M, Mărgărint MC (2018). Landslides and Fortified Settlements as Valuable Cultural Geomorphosites and Geoheritage Sites in the Moldavian Plateau, North-Eastern Romania. *Geoheritage*. 10: 613–634. <https://doi.org/10.1007/s12371-017-0261-0>
- Nimroozi A (2011). Geological Map of Sepidan Sheet, 1:25,000. Geological Survey Mineral Explorations of Iran.
- Ólafsdóttir R, Tverijonaite E (2018). Geotourism: A systematic literature review. *Geosciences*. 8(7): 234. <https://doi.org/10.3390/geosciences8070234>

es8070234

- Pralong J-P (2005). A method for assessing tourist potential and use of geomorphological sites. *Géomorphologie: Relief, Processus, Environnement*. 3(3): 189-196. <https://doi.org/10.4000/geomorphologie.350>
- Parise M, Gutiérrez F (Eds.). (2018). *Engineering and Environmental Aspects of Karst*. Springer, Cham.
- Pereira PJDS (2007). *Património geomorfológico: conceptualização, avaliação e divulgação. Aplicação ao Parque Natural de Montesinho*. PhD thesis, Departamento de Ciências da Terra, universidade do Minho.
- Pereira E, Mascarenhas M, Flores A, Chalip L, Pires G (2020). Strategic leveraging: Evidences of small-scale sport events. *International Journal of Event and Festival Management*. 11(1): 69–88. <https://doi.org/10.1108/IJEFM-07-2018-0046>
- Reynard E, Brilha J (Eds.). (2018). *Geoheritage: Assessment, Protection, and Management*. Elsevier: Amsterdam.
- Ruiz-Pedrosa RM, González-Amuchástegui, MJ, Serrano E (2024). Geomorphosites as geotouristic resources: Assessment of geomorphological heritage for local development in the Río Lobos Natural Park. *Land*. 13(2): 128. <https://doi.org/10.3390/land13020128>
- Samani B (2014). Tectonic Setting of the Barm Firuz Lake, Zagros Mountains, Iran: Inferred from Structural and Karstic Evidence. *Journal of Earth Science*. 25(5): 932–938. <https://doi.org/10.1007/s12583-014-0474-y>
- Singh RB, Wei D, Anand S (Eds.). (2021). *Global Geographical Heritage, Geoparks and Geotourism*. Springer Singapore.
- Tamang L, Mandal UK, Karmakar M, Banerjee M, Ghosh D (2023). Geomorphosite evaluation for geotourism development using geosite assessment model (GAM): A study from a Proterozoic terrain in eastern India. *International Journal of Geoheritage and Parks*. 11(1):82–99. <https://doi.org/10.1016/j.ijgeop.2022.12.001>
- Torabi Farsani N, Coelho C, Costa C (2011). Geotourism and Geoparks as Novel Strategies for Socio-economic Development in Rural Areas. *International Journal of Tourism Research*. 13(1): 68–81. <https://doi.org/10.1002/jtr.800>
- Tufănoiu I (2023). The role of geomorphosites in the local economy development of the Carpathian and Sub-Carpathian area of Vrancea County, Romania. *Quaestiones Geographicae*. 42(1): 107–122. <https://doi.org/10.14746/qua-geo-2023-0008>
- Vergari F, Pica A, Brandolini P, Melelli L (2022). Geomorphological classification of the landscape in urban areas: Hints from some study cases in Italy. *Rendiconti Online della Società Geologica Italiana*. 56: 1–7. <https://doi.org/10.3301/ROL.2022.09>
- Wasson R (2002). Sediment budgets, dynamics, and variability: New approaches and techniques. In *Advances in Sedimentology* (pp. 4578). Springer.
- Willman S, Meidla T, Budd G (2011). *Fossils Rocks: Geotourism in the Central Baltic*. Uppsala, Sweden: Uppsala University Press.
- Zangeneh Asadi M, Saadatifar R., Goli Mokhtari L (2020). Effects of Geomorphosites in Mountainous Area on Tourism Development (The Case of: Northwest of Neishabour-Firoozeh City). *Journal of the Geographical Studies of Mountainous Areas*. 1(4): 69–87.
- Zare GR (2024). Introducing the geopark potentials of Maragheh County with a special focus on the Maragheh fossil site. *Stratigraphy and Paleontology*. 1(2): 112–125(In Persian). <https://doi.org/10.30470/zpaleo.2024.2023243.1016>