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An Assessment of Geosites and Geomorphosites in the Lut Desert of Shahdad Region for Potential Geotourism Development

Rasa Raeisi [1], Iulian Dincă [2,*], Seyed Ali Almodaresi [3], Magdalena Petronella (Nellie) Swart [4] and Ali Boloor [3]

[1] Geography Department, Yazd Branch, Islamic Azad University, Yazd 89158 13135, Iran; ma.raeisi@iauyazd.ac.ir
[2] Department of Geography, Tourism and Territorial Planning, University of Oradea, Str. Universitatii nr. 1, 410087 Oradea, Romania
[3] GIS & RS Department, Yazd Branch, Islamic Azad University, Yazd 89158 13135, Iran; almodaresi@iauyazd.ac.ir (S.A.A.); boloor@iauyazd.ac.ir (A.B.)
[4] Department of Applied Management, University of South Africa (UNISA), ZA, Room 5-29, Anton Lembede Building, Pretoria 0003, South Africa; swartmp@unisa.ac.za
* Correspondence: idinca@uoradea.ro or iulian_dinca@yahoo.co.uk

Abstract: In the fields of geology, economics, history, cultural studies, and ecology, tourism can be the basis for proper planning, for sustainable tourism management, and for economic development. The Dasht-e Lut is one of the most significant desert areas in Iran due to its exemplary desert patterns and world-famous landscapes, such as the kaluts and nebkhas landforms. Furthermore, it is the hottest spot in the world and can attract adventurous tourists, amongst others, from around the globe. The purpose of this study was to determine and compare the most suitable geomorphosites for better sustainable tourism planning using three methods of evaluating geotourism as proposed by Pereira et al., Pralong, and Reynard et al. The results show that the geomorphosites of kaluts, nebkhas, and Gandom Beryan had the greatest potential for different reasons. In addition to geosites and geomorphosites, the night sky was also demonstrated to have a high potential to attract tourists. Using the economic criteria of the Reynard method, all geomorphosites had similar scores. The familiarity of officials and tourism planners with the tourist capabilities of this region can lead to economic and cultural capacity building for the Indigenous people and the tourism industry.

Keywords: natural environments; geosites; geomorphosites; geodiversity; landscapes

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1. Introduction

A geomorphosite may be a specific terrestrial shape or a complex landscape. The purpose of such concepts is to identify landforms that are of particular importance in describing and understanding the history of the Earth's surface [1]. Moreover, they have scientific, ecological, cultural, aesthetic, and economic value, which can be used to understand and exploit tourism [2–4].

Geotourism offers a great opportunity to further economic development and, for visitors, to discover new places [5,6]. The relationship between tourism and geological sites and their characteristics (including the diversity of landscapes) can be considered a relatively new phenomenon and a subset of geology and tourism [7,8]. Over the last two decades, this relationship has become an important issue of tourism at the international level [9–12], especially where recreational activities are intertwined with scientific and educational activities. Even with restrictions imposed by the COVID-19 pandemic, Quaid recorded a high number of visitors in 2021 [13]. Unlike ecotourism, which focuses on the attractions of living nature, the geotourism industry uses the identity of geographical diversity and geological heritage associated with non-living world attractions and landscapes with an emphasis on specific locations [3,8,14–16].

Here, geoheritage includes the national, global, and local characteristics of geology, at all scales, which are inherently important sites or culturally important sites that provide information or insights into the evolution of the Earth. These findings are significant to either the history of science, or for research, teaching, or reference purposes. Because geographic heritage focuses on features that are geological, the scope and scale of what constitutes geology are defined as igneous, metamorphic, sedimentary, stratigraphic, structural, geochemical, paleontological, geomorphic, pedological, and hydrological features. This paper will be involved in geographical heritage, with the potential to protect the land. Land conservation is the preservation of the Earth's scientific features for heritage, scientific or educational purposes [17]. Therefore, geomorphosites alone or in combination with geological, cultural, historical, and ecological heritage can offer significant capacity-building opportunities in the development of sustainable tourism in a specific area [17,18], and tourism activities that involve providing such services can attract tourists through the enhanced offering of authentic products, such as local cuisine, to foster local economic development [19]. Tourism revenues can be an alternative to oil revenues, and can stimulate innovative business models through geotourism, especially as the tourism industry from Iran ranks second in terms of revenue potential after oil exports [20].

The United Nations includes geodiversity in the 2030 Sustainable Development Goals (SDG) Agenda as the driving force behind the management and conservation of abiotic patrimony elements as non-renewable environmental assets, to the human benefit, leading to sustainable development [21,22]. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), in 2019, Iran was ranked among the top countries in the world in terms of the number of archeological and historical sites. This includes 22 historic sites, while 57 sites were temporarily inscribed on the World Heritage List, making Iran a world-famous commercial heritage destination [23]. Among the geological features in Iran (geotourism destinations) are arid areas and deserts, which can be considered as geotourist attractions due to the diverse range of geological and geomorphic phenomena which provide a suitable background for the development of geotourism [24]. Deserts include the Lut Desert and the Dasht-e Kavir, and together they cover 25% of Iran's territory [25].

The Lut Desert has the potential for geotourism development based on its geographical location and geodiversity. Iranian and foreign enthusiasts interested in ecotourism and geotourism attractions have easy access to the Lut Desert as it is close to Kerman and has relatively favorable biological facilities in the western suburbs. Despite its extremely arid climate, the Lut Desert has potential capabilities that require coherent and systematic planning to become a tourist attraction [26]. Undoubtedly, the success of this attraction requires a deep understanding of geotourism and adherence to a sustainable and equitable planning and development approach [27,28].

Linking geographic heritage with local socio-economic development, through the promotion of geo-chiefs and geoparks, can assist in raising awareness amongst local communities and decision-makers on the need to evaluate and promote the sustainable use of their geographical heritage [29]. The main purpose of this study is to determine the most suitable geomorphosites of the Shahdad region through an assessment by using three methods of evaluating geotourism as proposed by Pereira and colleagues [4,22,30] (known as the Pereira method), Pralong [31], and Reynard and colleagues [2,8,32] (known as the Reynard method). Insights obtained through this investigation aimed to support the officials of this industry by making constructive decisions related to sustainable tourism planning, how to attract tourists, and stimulate the economic prosperity of this region and Iran.

2. Research Background

Reynard [32] analyzed the relationship between geomorphology and tourism by stating that geomorphology may be the main or primary source of tourism or be used as a secondary source as long as tourism infrastructure, tools (e.g., training booklets), or services (e.g., tour guides) are utilized effectively for the main purpose. In this regard, we can refer to the concept of geomorphotourism [32]. Panizza [33,34] used the term geomorphosite for the first time for landforms that acquire scientific, cultural, historical, aesthetic, and socioeconomic value over time [33]. Ruban [35] reviewed 165 journal articles in the field of geotourism and found that geotourism research was concentrated in East Asia, the Middle East, and South America, and in general, geotourism studies were conducted on all continents (except Antarctica), which shows the global scale of geotourism research [35,36].

The multitude of eco-geographical situations in which the different geosites and geomorphosites around the world are found, as well as the variety of methods related to the study of geotourism, are highlighted in temporal sequence in Table 1.

Table 1. Relevant research on geosites and geomorphosites as a basis for the study and practice of geotourism.

Row	Researcher	Research	Year
1	Serrano and Gonzalez-Trueba	Assessed geomorphosites in natural protected areas such as the Picos de Europa National Park (Spain) [37].	2005
2	Pralong	Introduced and assessed geomorphosites in Chamonix (Switzerland) and studied geotourism in the region by presenting a method for assessing its tourist potential [31].	2005
3	Bruschi and Cendrero	In this study, an approach based on the definition of three groups of criteria is presented, which are related to a) the intrinsic quality of sites, b) potential threats and protection needs, and c) the possibility of using indicators for each criterion. Two applications for case studies for cataloging and evaluation are also introduced [38].	2005
4	Reynard et al.	Discussed the determination of scientific and complementary value in geomorphosites. In their research, they considered the economic value, ecological value, and aesthetic value as independent criteria, and the two main criteria (scientific and cultural value) have their own sub-indicators which resulted in the selection of the main geomorphosites [8].	2007
5	Pereira et al.	Assessed the capability of tourism geomorphosites in Montesinho Natural Park (Portugal) and argued that scientific value, additional value, use-value, protection value, and the criterion of integrity should be considered in tandem [4]	2007
6	Rovere et al.	Designed an assessment model for underwater geomorphosites for the Siri area on Lesvos Island (Greece) [39].	2010
7	Comanescu et al.	Evaluated geomorphosites in the Vistea Valley. Scientific value and complementary value were assessed for selected geomorphosites. The results showed that geomorphosites are similar in terms of geological evolution and are not rich in economic and cultural value [40].	2011
8	Fassoulas et al.	Designed a quantitative assessment method for geomorphosites of Silverits geopark (Greece) based on six main criteria in which the scientific, conservation, and tourism value of each geomorphosite was determined [41].	2011
9	Kubalíková	Examined the relationship between geodiversity, geoheritage (represented by geosites and geomorphosites), and geotourism. Geosites and geomorphosites represent fundamental resources for geotourism. Several assessment methods are utilized as significant tools for geoconservation and geotourism evaluation. The assessment is carried out from several perspectives with an emphasis on the scientific, cultural, and economic parameters of the sites [42].	2013

Table 1. *Cont.*

Row	Researcher	Research	Year
10	Różycka and Migoń	Introduced a new topic for geosite evaluation that addresses the individual needs of visitors with diverse backgrounds, such as geoscience knowledge and interest in geographical heritage, was introduced. Parallel group assessments of 11 geosites in the Pogórze Kaczawskie region, where the Cenozoic volcanoes are located, were compared. Different features led to significant changes in the position of some geosites rankings [43].	2014
11	Kirillova et al.	Relating to environmental psychology, attempted to reveal dimensions of tourist aesthetic judgment in the context of both nature-based and urban tourist destinations. This research posits that tourism allows a unique "appreciator-object" dyad where individuals are fully immersed in a destination in pursuit of a non-routine and often novel experience. The beauty of a tourism destination is uniquely judged, admired, and appreciated, and the assessment of the beauty goes beyond the visual aspects and engages all senses [44].	2014
12	Bollati et al.	Based on scientific value, the Alpine glacial geomorphosites of Italy were evaluated. The results indicate the importance of this method by determining the trails related to geomorphosites and their vulnerability [45].	2015
13	Errami et al.	Their book entitled *From Geoheritage to Geoparks* provides examples of valuable geographical heritage in Africa and the Middle East. Furthermore, international case studies related to geography, geotourism, and geoparks in China, Australia, and Europe are documented. This book mainly includes papers presented at the first International Conference on Geoparks in Africa and the Middle East. The book consists of two parts: the first part deals with the history of geographical heritage, geoparks, and geotourism, while the second part deals with case studies on geographical heritage and geoparks at the global level [29].	2015
14	M. Brocx and Semeniuk	The Geoheritage Toolkit was developed in Western Australia to advance geological and geomorphic heritage disciplines. This was done by systematically compiling an inventory of the diversity of geological and geomorphological features in a given area and assessing these features at all levels. Scientists can use the Geoheritage Toolkit to identify geological sites. These sites are then listed according to their geological requirements to create a database of geographically important locations. The next step is to identify good examples of these features, or feature-related collections, regardless of the review, and then to evaluate them based on the important predetermined criteria. In terms of scope, categories, interrelationships, and level(s) of characterization, scientists can examine the final stage of the features by determining the type and level of protection needed for the land [18].	2015
14	Reynard and Coratza	Due to special physical properties and natural diversity, mountainous areas are introduced as geomorphosites and brought into environmental education. In this regard, they studied Italian dolomite and Swiss alpine areas as case studies [46].	2016
15	El Aref et al.	Studied and evaluated the geomorphosites of the western desert of Egypt using the Pereira method [9].	2017
16	Santangelo, and Valente	By utilizing geoheritage and geotourism resources, an attempt was made to depict the role of geographical heritage and geotourism as potential sources for tourism in a region [47].	2020

Table 1. *Cont.*

Row	Researcher	Research	Year
17	Crofts et al.	This publication describes the "state of the art" of geographical heritage and land conservation with case study in Western Australia. The case study was designed for the application of feature recognition and feature assessment techniques, for example, on how to use geographic heritage tools. Its main goals were (i) to define geographical heritage in the broader context of geology, (ii) to conceptualize the various categories of what constitutes geographical heritage, (iii) to address the issue of scale, and (iv) to define more precisely the levels of geology. The importance of these results provides a foundation for the design classification and evaluation systems to identify geographically significant sites in Western Australia and elsewhere [48].	2020

Based on the literature review conducted on geosites and geomorphosites, its relevance and application to the practice of geotourism are supported (Table 1). While previous researchers [49,50] assessed geosites and geomorphosites using the Pareira and Reynard method, in this study, the application of multiple assessment methods was deemed necessary. In this study, three methods for evaluating geotourism, as proposed by Pereira [4,22,30], Pralong [31], and Reynard [2,8,32], were undertaken for the comparison of the most suitable geomorphosites for better sustainable tourism planning in the Lut Desert.

3. Materials and Methods

3.1. Research Territory

The Lut Desert (Lut Plain) is located in the southeastern part of Iran, in the Kerman Province, and is one of the largest deserts in Iran, with an area of 51,800 km^2 [51]. Shahdad city is located between 57021′ and 59028′ longitude, and 29027′ and 31045′ latitude, in the northeast of the Kerman Province. This part is situated at the confluence of high central mountain ranges and lowlands (Figure 1). This exceptional intersection between the mountainous and desert area has created unique environmental features, which can be seen in small parts of the Iranian plateau [52].

This region has sites of geoheritage significance that are of international significance. This region is known for its spectacular desert landforms and as the Earth's thermal pole. It is one of the hottest places on the planet. Its surface temperature reaches 70.7 °C, which was recorded by satellite in the mid-2000s [51]. Additionally, this attraction is of educational and sporting value, and is of interest to scientific and tourism researchers from around the world. Geomorphosites are evaluated by field observations which include kaluts (yardangs), the nebkha jungle, Gandom Beryan, huge alluvial fans, salt polygons, the Salty River, the night sky, and the badlands (Table 2).

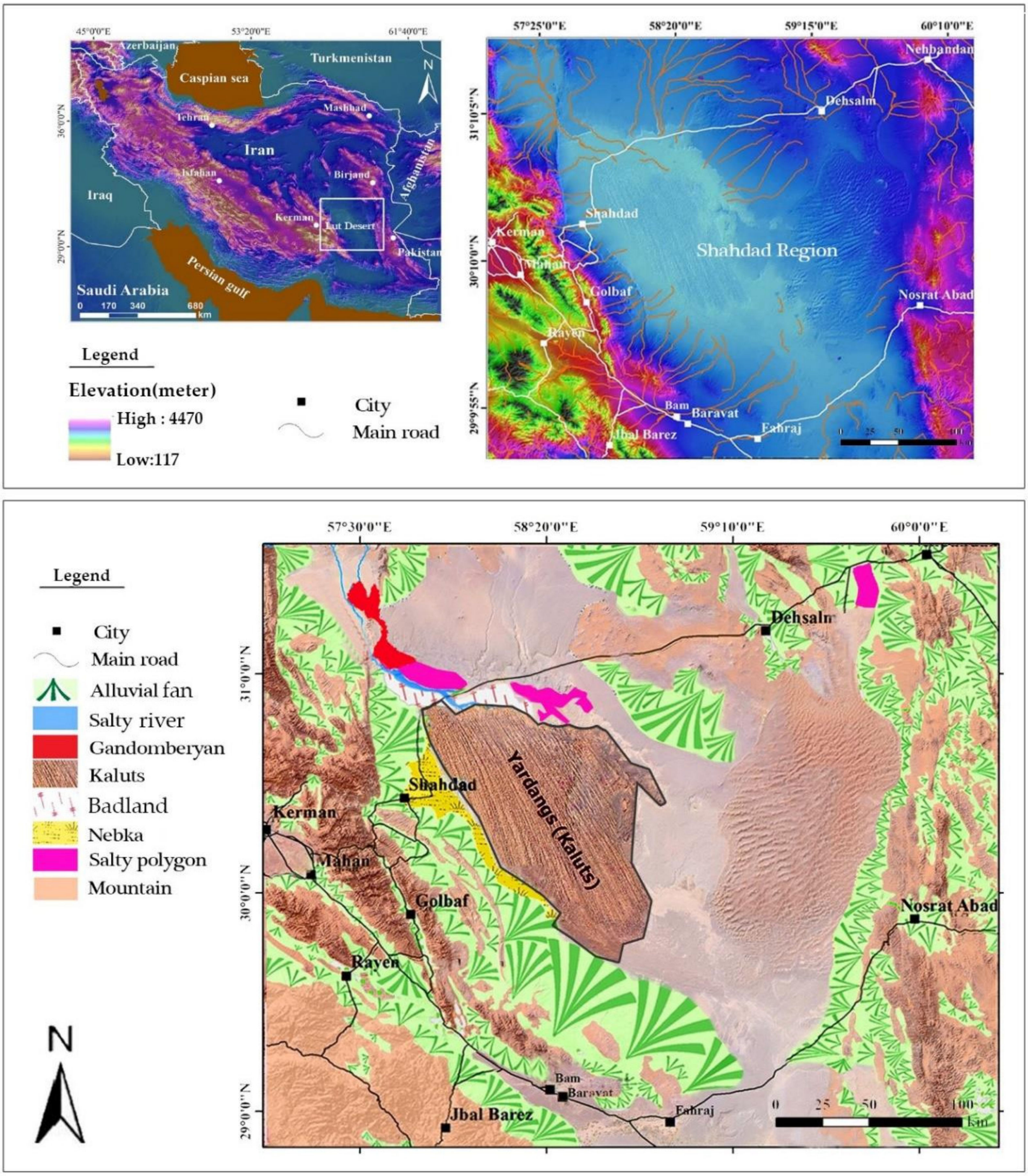
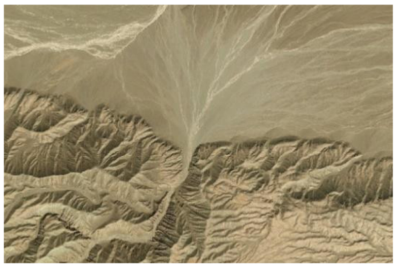


Figure 1. Map showing the position of geosites and geomorphosites in the study of the Shahdad region. In the medallions are satellite images of the position of the Lut Desert in Iran (top left) and the Shahdad region in which the study area is located (top right). (Source: Authors).

Table 2. Geosites of Shahdad in Iran: (**a**) kalut; (**b**) nebkha; (**c**) Gandom Beryan; (**d**) Salty River; (**e**) Salt polygons; (**f**) huge alluvial fans; (**g**) badlands; (**h**) night sky.

Figure	Geosites for Geotourism. Morpho-Dynamic Identity Features for Geotourists	Picture
(**a**)	**Kalut.** Many 'kaluts' develop in areas where strong one-way winds occur most of the year. In these areas, one direction of wind seems to be dominant, and opposite winds have less intensity and frequency. A unique example of these features can be found in the form of embankments and parallel corridors in southeastern Iran which cover a large area of the Lut hole with dimensions of 150 by 70 m. Kaluts in the Lut Desert have round and flat peaks and have an average height of 60 to 80 m, and are spread as embankments over a very large area [53].	
(**b**)	**Nebkha.** Nebkhas are created by sediments transported by wind around shrubs [11,54,55]. They are usually formed on flatlands by soil and wind erosion [56].	
(**c**)	**Gandom Beryan**. Gandom Beryan (the hottest place on Earth) is located in the southern part of the Nayband fault, to the northeast of Kerman, and is part of the Lut area [57]. Researchers believe that central Lut represents the Earth's thermal pole and has recorded temperatures of about 70 °C, the highest in the world [51,58]. (Photo: M. Salehi).	
(**d**)	**Salty River.** This river has its headwaters outside the province, and originates from the heights of Khosof and South Khorasan. It enters Kerman Province from the north [51]. Tourists traveling from Shahdad to Nehbandan after seeing the wonders of the kaluts and the beauty of the egg-shaped hills will reach Chaleh shour. The route of the Salty River can be seen in different parts of this area and in some places cross under the road [59]. (Photo: M. Salehi).	
(**e**)	**Salt polygons.** Polygons are created by the evaporation of water on parts of desert soil that have significant salinity. Evaporation makes irregular polygons on the ground by creating deep cracks in the soil [58]. These shapes are the most important features of the lake surface [60]. (Photo: V. Dehyadegari).	

Table 2. *Cont.*

Figure	Geosites for Geotourism. Morpho-Dynamic Identity Features for Geotourists	Picture
(**f**)	**Large alluvial fans.** The alluvial fan of the Derakhtangan catchment basin is one of the largest in Iran and is located in a completely arid region in the north-northeast of Kerman. This alluvial fan was formed from the erosion of materials in the catchment basin of the Derakhtangan River and the deposition of these materials in the last part of the basin, Dasht-e-Lut [61].	
(**g**)	**Badland.** Some of the most destructive processes of water erosion are in the badlands, which prevent agriculture for various reasons, including the lack of suitable vegetation, high slopes, high water density, low depth or absence of soil, and a high rate of erosion [62].	
(**h**)	**Night sky.** Iran's vast deserts can be one of the most important motivations for traveling to Iran for astronomers who are looking for a clear, dark, dust-free sky to observe celestial bodies. Deserts are the best place to observe stars and meteor showers on special nights [63]. In the Lut Desert, the ozone layer is less damaged and thick, the sun's rays are not dangerous, and have healing properties. (Photo: M. Salehi).	

3.2. Methodology

In general, there are two main approaches to evaluate geosites and geomorphosites: the first approach is based on specialized and qualitative procedures, while the second approach is related to the ranking of the sites through numerical evaluation and the identification of its potential value [30]. Evaluation can be divided into several scientific categories including value-added (economic) and risk-taking to determine the potential of geomorphosites. Additionally, for the scientific criterion, the basis and value that are related to the nature of the site are considered [64,65]. For example, rarity or educational value [19], combined with value of the cultural, historical, religious, and aesthetic aspects, increases the sensitivity of the value. This approach is regarded as very necessary [42].

In various studies, the grouping of criteria in different sets of value was associated mainly with the purpose of evaluation. However, the evaluated criteria sometimes overlap [65]. In Lucie Kubalíková's study [42], the best methods for evaluating the geomorphosites those proposed by Peralong and Priya [42]. In this study, three comprehensive geomorphological methods, namely Pereira [4,22,30], Pralong [31], and Reynard [8] were used, as it seems that these three methods have not been used in a combined study before. By comparing the criteria from these three methods, the geomorphosites of the desert region of the Shahdad region could be assessed more comprehensively. Therefore, these three methods were selected and deemed the most suitable in this study.

In support of this approach, and to have an as close as possible inter and multidisciplinary assessment of geotourism, we used the thematic and applicative content of geosites. According to UNESCO, The International Union of Geological Sciences IUGS), the International Union for Conservation of Nature (IUCN), the opinion of researchers both from

Anglo-American countries and from many European countries, the term geosite is related to different categories of phenomena from past and present environments and ecosystems, purely geological, geographical, bioecological, or anthropogenic [49,66,67]. In frequent situations, as in the case of the Shahdad region with its Lut Desert, the subject of our study, it is representative of geological and geomorphological structures of the region, where assemblages appear to be dominant.

The full understanding of the scenic value and the attractiveness of these geomorphosites is based on the representation of the landscape personality and value categories, and the visual design elements [68–70], including, amongst others, aesthetic, affective, ecological, scientific, cultural, and spiritual elements.

We investigated in this way the advantages that the application of tourism of the landscape as a "product" of nature and the anthropomorphized part brings to geotourists as "consumers". These components of the landscape environment are dominated by the rock component and offer geological support. Thus, geoheritage is regarded as a set of landscapes with diverse petrographic, structural, mineralogical, stratigraphic features, where the landscapes are called geo-petrographic landscapes or geological landscapes [5].

As scientists, we asked the question 'What is the fundamental reason for the landscape research of our study?' It is known that when the majority of geoscientists/geotourists get to these geosites, they have little interest in or understanding of the terminology issues such as: "Precambrian, Pleistocene, laminated quartzite, megascale, macroscale, mesoscale, microscale, and leptoscale, metasomatic minerals, and others". They understand what they see, observing, comparing, and sensorily analyzing the elemental or complex identity of landscape features or the scenic value of local geo- and biodiversity. These principles were also applied in this study in answering this question.

Therefore, here we highlighted a simple way for the tourist/geotourist to understand and learn from the intimacy of the geological components and phenomena and other components of physical geography and human geography. Everything was filtered through the established qualifiers, attributes, and emotional states, when the geotourist and ecotourist are exposed to the local/regional anthropo-, bio-and geodiversity landscapes, which we explored through inter and multidisciplinary methods. The results are supported through tourism marketing formulae and solutions. In other words, we started from an eminently theoretical background and we redirected the study towards practical, territorial, and tourism (in this case geotourism) planning.

3.2.1. Pereira Method

Pereira et al. [4] proposed a very detailed assessment procedure based on science, including criteria such as additional use, and protection value. The methodology was then developed by Pereira and Pereira [30,42]. In the Pereira method, geomorphosites are examined through two general aspects and from different viewpoints, such as protection, management, science, infrastructure, and complementary aspects (Table 3). Geomorphological properties are used to assess the value obtained from the sum of the scientific and complementary criteria. In this section, cultural, ecological, beauty and scientific attractiveness, and uniqueness are examined. The highest value in this section is 10, and managerial value is derived from the sum of the value of use and protection. This part deals with infrastructure issues such as access and equipment, acceptance capacity, existing rules, and restrictions. The closer the sum of these two values is to 20, the higher the potential of geomorphosites in tourism development [71].

Table 3. Evaluation of the four geomorphotourism criteria based on the Pereira method.

Geomorphology Value (GMV = SCV + ADV; maximum 10)		Managerial Value (MGV = Usv + Prv; Maximum 10)	
Scientific Value (SCV = Ra + In + Rp + Dv + Ge + Kn + Rn; Maximum 5.5)		**Use Value (Usv = Ac + Vi + Gu + Ou + Lp + Eq; Maximum 7)**	
Ra	being rare (maximum 1)	**Ac**	access (maximum 1.5)
In	being perfect (maximum 1)	**Vi**	visible (maximum 1.5)
Rp	presentation of geomorphological processes and educational attractions (maximum 1)	**Gu**	current use of geomorphological attractions (maximum 1)
Dv	number of geomorphological forms (maximum 1)	**Ou**	current use of other natural or cultural attractions (maximum 1)
Ge	other geological forms with hereditary value (maximum 0.5)	**Lp**	legal protection and restrictions on use (maximum 1)
Kn	scientific knowledge of geomorphological topics (maximum 0.5)	**Eq**	support equipment and services (maximum 1)
Rn	being rare at the scientific level (maximum 0.5)	**Protection value** (Prv = In + Vu; maximum 3)	
Value-added (ADV = Ecol + Aest + Cult; maximum 4.5)		**In**	being perfect (maximum 1)
Cul	cultural value (maximum 1.5)	**Vu**	vulnerability if used as a geomorphosite (maximum 2)
Ae	beauty value (maximum 1.5)		
Ec	ecological value (maximum 1.5)		

3.2.2. Pralong Method

With the Pralong method [31], the tourism value of every site is determined by the average of the four indicators of apparent beauty, scientific, historical-cultural, and socioeconomic aspects (Table 4), which are scored from five different levels. In this method, the value of the current productivity of the sites is evaluated. In other words, productivity and product quality are used to assess the productivity value of geomorphosites (Table 5) to identify the potential and actual capabilities of sites [61].

Table 4. Evaluation of the four geomorphotourism criteria based on the Pralong method.

Score	0	0.25	0.50	0.75	1
Apparent Beauty of Geomorphosites					
Number of sights	-	1	2–3	4, 5, 6	more than 6
Average distance from places of interest (meters)	-	less than 50	50–200	200–500	more than 500
Area	-	small	average	Large	very large
Altitude	0	low	average	High	very high
Color contrast with the environment	similar color	-	different colors	-	contrasting colors
Scientific value of geomorphosites					
Attractiveness in terms of ancient geography	-	low	average	great	very much
Visual features	0	low	average	great	very much
Area	-	less than 25	25–30	50–90	more than 90
Rarity	more than 7	5–7	3–4	1–2	Unique
Location	ruined	severely destroyed	moderately destroyed	slightly destroyed	without any tampering
Ecological interest	0	low	average	great	very much

Table 4. *Cont.*

Score	0	0.25	0.50	0.75	1
Historical/cultural value of geomorphology					
Cultural-historical aspects	without belonging	weak	Average	intense	very intense
Landscape iconography	0	1–5	5–20	21–50	more than 50
Historical and archaeological aspects	without any buildings	weak	Average	great	very much
Religious and spiritual aspects	0	weak	Average	great	very much
Artistic and cultural events	Never	-	Sometimes	-	at least once a year
Socioeconomic value of geomorphosites					
Accessibility	more than one kilometer of the accessible route	less than one kilometer of the accessible route	accessible via local roads	accessible via regional roads	available via national road
Natural hazards	uncontrollable	uncontrolled	somewhat controlled	optional controls	without risk
Number of visitors per year	less than 100,000 people	between 10 and 100,000 people	100–500,000	500,000–1,000,000	more than 1,000,000
The level of protection measures	perfect	limited	-	unlimited	without protection
Attractiveness	-	local	Regional	national	international

Table 5. Assessing the value of tourism productivity based on the Pralong method.

Criterion	0	0.25	0.50	0.75	1
Productivity rate of the geomorphosites					
Area used (hectare)	0	less than 1	1–5	5–10	more than 10
Number of infrastructures	0	1	2–5	6–10	more than 10
Seasonal accommodation	-	from 1 to 90 days (one season)	from 91 to 180 days (2 seasons)	from 181 to 270 days (3 seasons)	from 271 to 360 days (4 seasons)
Daily accommodation	0	less than 3 h	3–6	6–9	more than 9 h
Quality of productivity					
Use of apparent beauty	without any advertising	a supportive action and the introduction of a product	a supportive action and the introduction of several products	several supportive measures and the introduction of a product	several supportive actions and the introduction of several products
Use of scientific value	without any educational possibility	a supportive action and the introduction of a product	a supportive action and the introduction of several products	several supportive measures and the introduction of a product	several supportive actions and the introduction of several products
Use of cultural value	without any educational possibility	a supportive action and the introduction of a product	a supportive action and the introduction of several products	several supportive measures and the introduction of a product	several supportive actions and the introduction of several products
Use of economic value (people)	no visitors	less than 5000	5000–20,000	20,000–100,000	more than 100,000

3.2.3. Reynard Method

In this method, to identify the geotourism capabilities studied, a questionnaire was used for evaluating geomorphosites, which consisted of two parts: scientific value and value-added. Each part included sub-criteria expressing the spectrum of value. In total, each of the criteria was finally evaluated for less than 4 points for each of the scientific and complementary value in proportion to the obtained value.

a. Scientific value: Criteria used for evaluating evolution, indexing, rarity, and long-standing geographical value.
b. Value-added (complimentary) used environmental, apparent beauty, cultural, and economic dimensions. These dimensions are considered as forms of complementary value in the development of geomorphosite tourism. This section essentially sought to understand the relationship between geomorphological features and other economic, ecological, and cultural dimensions to evaluate geomorphosites.

These values are placed in the related tables and based on the aforementioned indicators, once the scoring was completed. The range of quantitative values of each of the sub-criteria is between 0 (lowest) and 1 (highest) (Table 6) [72].

Table 6. Evaluation of scientific and complementary geomorphic value based on the Reynard method.

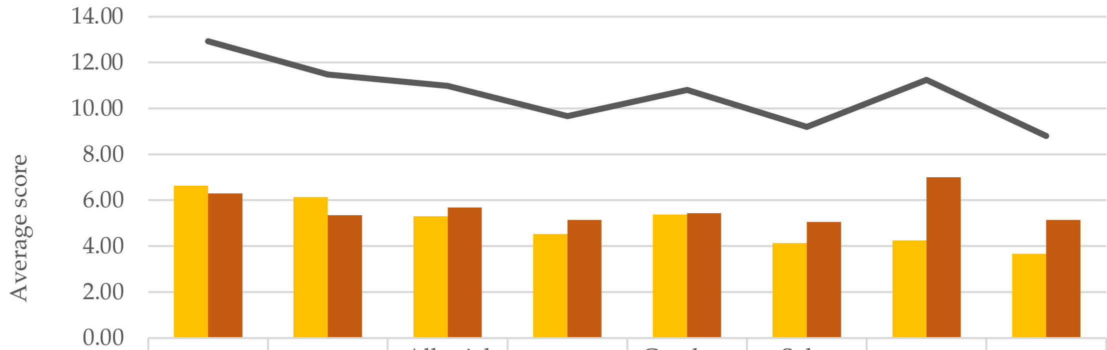
Criteria	Sub-Criteria	Descriptions and Sections
Scientific value	Protection	How to protect the site and the extent of site tampering under the influence of human or natural factors
	Being an indicator	Existence of a special geomorphosite compared to other similar places in the region, country, and province
	Rarity	Existence of a unique phenomenon at the level of an area
	Paleogeography	The importance of the place due to its historical nature from the perspective of climatic and geomorphological conditions
Complementary value	Ecology	Ecological effects Protected places
	Aesthetics	Number of places of interest Structure and features
	Cultural	Religious value Historical value Artistic value Historical land value
	Economic	Paying attention to the products and economic capabilities of the Shahdad region

4. Results

The Use of Geomorphotourist Models in the Study of Geotourism Potential of Lut Desert, Shahdad Region

As mentioned earlier, the purpose of this study was to identify the most suitable geomorphosites of the Lut plain of Shahdad for better sustainable tourism planning, as this region is an excellent area for geomorphology. Tourist use of geological sites is generally through the exploitation of geographical heritage. In this research, potential and existing places were identified through concepts and studied in compliance with the principles and key features of geotourism. As can be seen in Tables 3–5, the Pereira and Peralong methods had a high degree of overlap and provided the most comprehensive evaluation of all the geomorphosites components.

(A) Based on the tourism potential evaluation of geomorphosites in the Shahdad-Lut Desert region, using the Pereira method, the calculations of scientific value, added value, protection, and management resulted in reliable components. In general, using this method, kaluts, nebkhas, and Gandom Beryan provided very high values (12.92, 11.48, and 11.25, respectively), with specific reference to geomorphology in terms of rarity, specific geological forms, and availability (Figure 2). Additionally, at night, due to the very large and biological areas of this region, the light is very low, which enables sky tourism tours to use this phenomenon to increase the number of visitors to the regions.



	Kalut	Nebkha	Alluvial fan	Salty river	Gandom Beryan	Salty polygon	Night sky	Badland
Geomorphology	6.63	6.13	5.31	4.53	5.37	4.13	4.25	3.66
Management	6.29	5.35	5.68	5.14	5.43	5.06	7.0	5.14
SUM	12.92	11.48	10.99	9.67	10.81	9.18	11.25	8.81

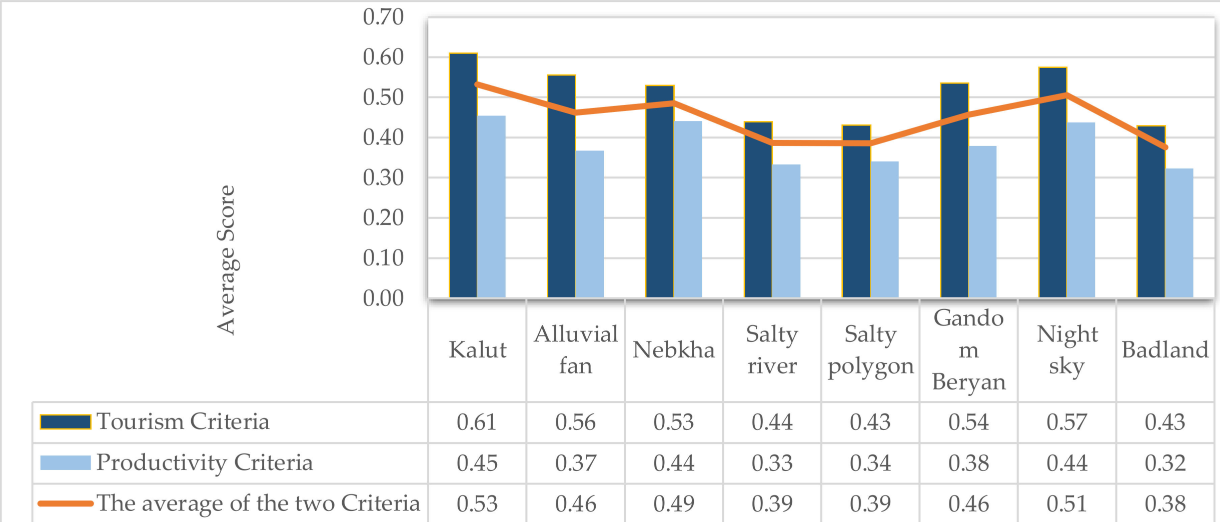
Figure 2. Final results of the evaluation of the studied sites using the Pereira method.

(B) The evaluation of the ability of geomorphosites in the Lut Desert of the Shahdad region was based on the Pralong method.

The results obtained in this study of geomorphosites of the Shahdad region using the Pralong method are divided into two categories: tourism value and productivity. As can be seen in Figure 3, in terms of tourism value, kaluts, nebkhas, and the night sky had the highest score (0.45 and 0.44). In terms of beauty, productivity, and tourism; these three geomorphosites also scored the highest. This high score was due to the number of sights and appearance, the average distance from the sights, color contrast in the beauty component, the efficiency of geomorphotourism, a high area of residence, and protection measures in productivity. The badlands, salt polygons, and Salty River had the lowest scores.

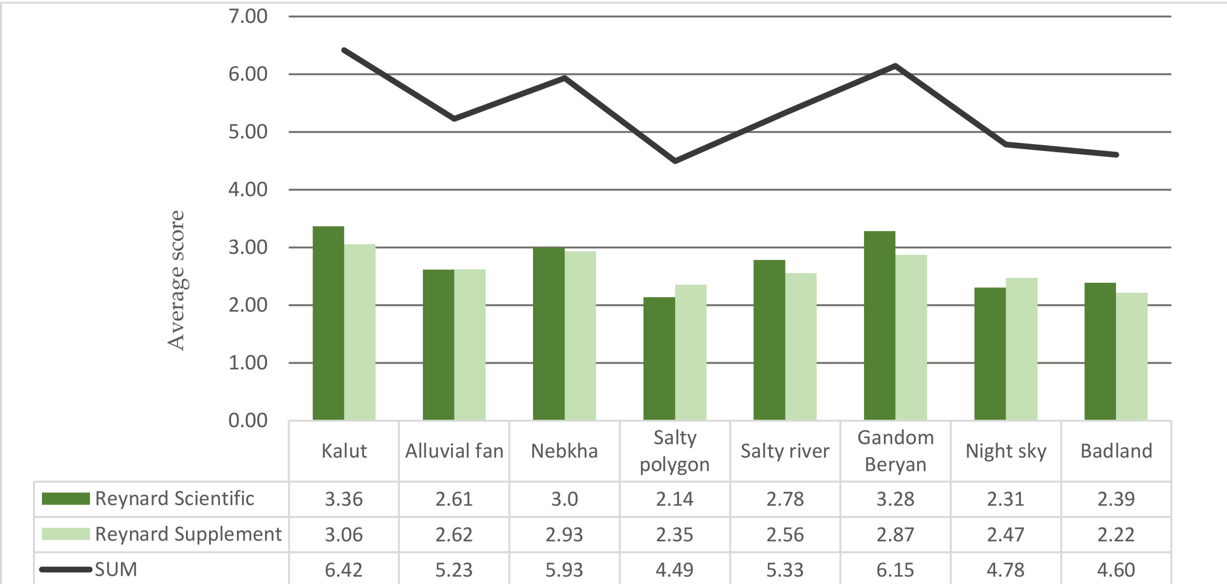
(C) The evaluation of the capabilities of the geomorphosites in the Lut Desert's Shahdad region was also carried out using the Reynard method.

In the Reynard method, the scientific and economic value was studied as indicated in Figure 4. Kaluts, Gandom Beryan, and nebkhas had the highest scores (3.36, 3.28, and 3, respectively) in the scientific component, and kaluts, nebkhas, and Gandom Beryan had the highest scores in the economic component, with scores of 3.06, 2.93, and 2.87, respectively. Furthermore, these regions were assigned the highest priority for tourism planning. It seems that due to the global registration of kaluts and nebkhas in this region, it has been less affected by human factors and has a high level of protection. Another reason for the high value for tourism, using this method, is the rarity and uniqueness of many geomorphosites in the province and the country. These areas are also historically very important. Other geomorphosites may also play an important role in the economic development of the region, but with less intensity, or for criteria other than those that were evaluated in this method in terms of the two scientific and complementary criteria.



	Kalut	Alluvial fan	Nebkha	Salty river	Salty polygon	Gandom Beryan	Night sky	Badland
Tourism Criteria	0.61	0.56	0.53	0.44	0.43	0.54	0.57	0.43
Productivity Criteria	0.45	0.37	0.44	0.33	0.34	0.38	0.44	0.32
The average of the two Criteria	0.53	0.46	0.49	0.39	0.39	0.46	0.51	0.38

Figure 3. Final results of the evaluation of the studied sites using the Pralong method.



	Kalut	Alluvial fan	Nebkha	Salty polygon	Salty river	Gandom Beryan	Night sky	Badland
Reynard Scientific	3.36	2.61	3.0	2.14	2.78	3.28	2.31	2.39
Reynard Supplement	3.06	2.62	2.93	2.35	2.56	2.87	2.47	2.22
SUM	6.42	5.23	5.93	4.49	5.33	6.15	4.78	4.60

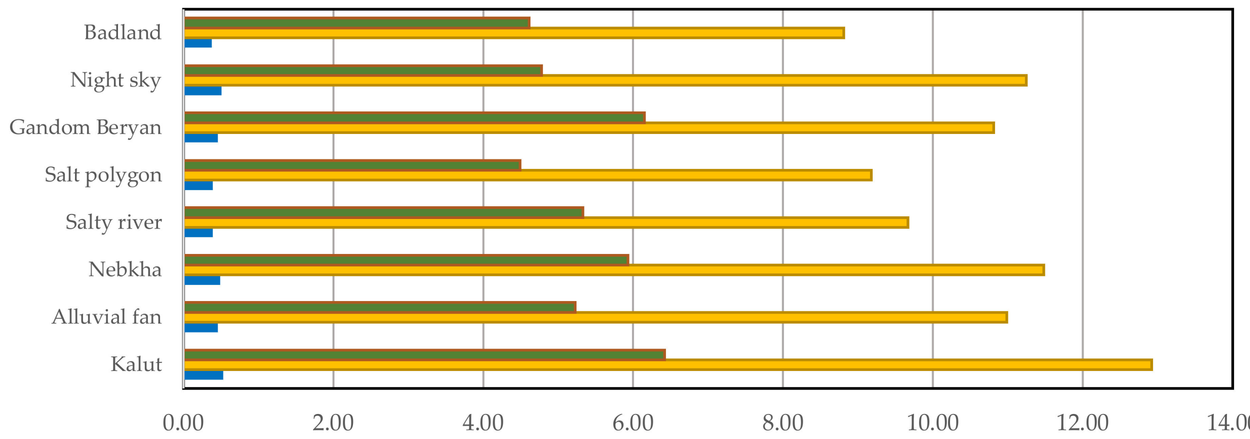
Figure 4. Final results of the evaluation of the studied sites using the Reynard method.

5. Discussion

Sites suitable for geotourism development were assessed using three methods, i.e., Pralong, Pereira, and Reynard. The results show that the western part of Lut and the northeastern part are very suitable for the development of geotourism. Both the scientific and complementary value from the Reynard model, the geomorphological value from the Pereira model, and the tourism value from the Pralong model correspond to the nature of geomorphosites and managerial value in the Pereira model and productivity value. In the Pralong model, sites are set within the functional dimensions [73]. According to the results of the study, the kaluts have a very high degree of protection and tourism potential due to the global registration of this geomorphosite, which is considered as the most valuable geomorphosite using all three methods. The night sky, based on the Pereira model, earned the highest score and ranked second in the Pralong method based on managerial value. This ranking is supported by the high potential for attracting star-gazing tourists and teaching astronomy due to the distance of the area from the urban environment and low light in the Shahdad region. Gandom Beryan is an attractive destination as it holds the record for the highest temperature recorded in satellite images, and tourists desire to have this experience.

The economic standard of Reynard's method shows us that due to the small differences in geomorphosites, all of them have the potential to generate income and economic profit, and with careful planning, the cultural and economic potential of the region can be improved.

Based on the results of this study, it can be seen that all three models use similar quantitative and qualitative methods (Figure 5). Evaluation tools in the Pereira model are based on field observations and numerical indicators as well as parameters such as the geomorphological and the managerial value of areas [60]. The Pereira method is a more recent method than the other two. All three methods take into account scientific criteria and emphasize the protection of geomorphosites. Based on these methods, it is inferred that the selection criteria of geomorphosites do not differ much in evaluation outcomes but offer different views. However, the most important advantage of these three methods is that despite the similarity in the evaluation of geomorphotourist value, each of them considered several different variables in their evaluation. Therefore, to plan and achieve geotourism and development in geomorphosites, all variables must be considered. Otherwise, the growth of one of the variables may have adverse consequences in the future. For example, increasing productivity and use value, regardless of the quality of productivity and protection, destroys sites. Therefore, these models need a comprehensive vision for tourism planning and development.



	Kalut	Alluvial fan	Nebkha	Salty river	Salt polygon	Gandom Beryan	Night sky	Badland
Reynard	6.42	5.23	5.93	5.33	4.49	6.15	4.78	4.61
Pereira	12.92	10.99	11.48	9.67	9.18	10.81	11.25	8.81
Pralong	0.53	0.46	0.49	0.39	0.39	0.46	0.51	0.38

Figure 5. The results of the three methods.

The results of this study are based on visits to the region by the authors, expert comments, as well as scientific and educational criteria. The results show that the Shahdad region has high geomorphic tourism potential in attracting geotourists (Figure 5). If attention is paid to maintaining the quality of the environment and principled planning is executed, it can play a sustainable role in local tourism development in the region. However, traditional communities have a low capacity to identify these new aspects of life. In other words, local communities are not open to tourism and change, as they fear the misuse of cultural value or the misleading and damaging misuse of local communities. Hostility also leads to the issue of a lack of awareness and education about tourism and its positive contribution to the development of geotourism in the region [74].

Since there is no comprehensive monitoring plan for the development of tourism in the region, in some cases, a lack of careful planning and management can lead to the region being endangered through damage to the environment and economic resources for the next generation. Additionally, pollution may cause inconvenience to local people due to overcrowding, noise pollution, refuse waste, and traffic. If ecotourism is properly managed and planned, it can also provide economic resources for the government, the private sector, as well as local communities and change the quality of life of local people. Therefore, the goal is to identify areas with tourism potential, make predictions for the development of tourism that will prevent the destruction of these spaces, and develop the tourism of world geoheritage sites for this region in a sustainable way and for future generations to enjoy [50].

Many benefits could be achieved through tourism development, such as job creation, partnerships between the host communities, and cooperation between different sectors. This can be carried out through the use of handicrafts and local products to maintain the region's culture. This can further support a sustainable and strong economy, raise awareness of the area, stimulate education, and ultimately preserve the environment.

In many countries, there is only one average geotourism research community or just a handful of experts. However, there are four countries with relatively large geotourism research communities, such as Italy, Brazil, China, and Poland, where there are dozens of experts who publish journal articles on geotourism, and a relatively large number of specialists are available in the United States, Australia, the United Kingdom, Portugal, Spain, Iran, and Serbia. It should be noted that these countries are located in very different parts of the world [35].

The inventory of geological sites based on comprehensive and clear criteria is the first step for any land conservation strategy [74]. Pérez-Umaña et al. [50] conducted a study on volcanoes in Costa Rica, including the Paricutin volcano in Mexico, and Teide-Pico Viejo volcanoes in Spain, and compared the geomorphosites of these volcanoes. They showed that places with geomorphological features have geological and cultural importance to attract people in the field of tourism, and support the development of tourism [75].

Mauerhofer et al. [76] studied 21 geomorphosites at the Simien National Park in Ethiopia and found that knowledge of geomorphological and geological heritage can be effective in the development of the country by formulating a management and protection program with the approach of increasing awareness and sustainable use of geomorphological heritage. Safarabadi et al. [77] examined the potential of geomorphosites and special geomorphic landscapes in combination with the cultural, historical, and environmental heritage of Ali Sadr Cave. They concluded that sustainable tourism planning can have a great impact on stimulating people's aesthetic sense and attracting visitors.

Kim and colleagues [78] pointed to the impact of tourists' use of food in tourist areas, and the far-reaching implications of designing a food experience as an emerging tourist attraction. This can have a significant impact on the economic growth for the residents of those areas.

Lastly, Newsome et al. [3] emphasized that geotourism can be a powerful tool for sustainable development, but if left unmanaged, it can be a direct threat to geo-heritage resources, especially to achieving sustainable use for visitors to these sites is crucial. Due to its unsustainable nature, tourism can become a challenging industry without any specific management program or strategy, and environmental and social problems can have a negative impact on the host community [22,79–81].

Tourism in Iran is a new and emerging industry that can contribute to the country's economic independence and the growth of the region's indigenous people through local economic development. Among the geological features in Iran (geotourism destinations) arid areas such as deserts with a diverse range of geological and geomorphic phenomena can be considered as geomorphotouristic attractions. Furthermore, this can provide a good basis for the development of geotourism in the area [26]. Geomorphotouristic and geotouristic attractions constitute 25% from the total land area in Iran, consists of desert, loot, and desert plain [27]. Although the Lut plain has an arid and ultra-arid climate, this plain has potential tourism capabilities that require coherent and systematic planning to develop them [57].

Geotourism in the Shahdad region has greater tourism potential, as the area can accommodate higher visitor volumes with more attractions for tourists to spend money. Opportunities include a higher concentration of geosite and geomorphosite attractions in this part (as seen from Figure 1) with easier access to the sites through a number of road networks and trails. Furthermore, physiognomy, typological and structural diversity, the dynamic and dimensional relationships amongst the vertical display of erosion at geosites and geomorphosites, are attractive attributes for geotourism. The identification, personalization, and unique characteristics of attractions can support the development of geotourism and other activities for the flourishing tourism industry in Iran.

Here, we have included the aesthetic status of geographical heritage and land conservation, using a comprehensive case study to showcase techniques and evaluation tools from a geotourism perspective. What constitutes geographical heritage and the importance of these results are the basic foundations for designing classification and evaluation systems to identify sites of geographical importance in the Shahdad region. In all the study areas mentioned, the components of a single geographical heritage assessment should not be viewed in isolation. These geotourism sites represent the "best example of a particular feature", as an integrated system of products and processes for geological and non-geological products to form a "geopark". Due to the importance and unique characteristics of these areas, they are eligible to be classified as national or state geoparks (with features of international importance). Furthermore, the combination of different geological and geomorphological scales into one land conservation unit supports further the development of a geopark in Iran. The results from Table 6 highlight a large number of "geological heritage sites of special scientific importance" and significance for nature conservation, in support of this notion.

The results of the three methods applied (Figures 2–5) only highlight the functional and organizational complexity of all the geosites, environments, and landscapes that make up the geosites and geomorphosites of the Shahdad region and the Lut Desert. At the same time, we can also infer from the cipher information the beauty of the details of the geosites that can be captured and "deciphered" from any visiting experience by geoscientists and geotourists (Table 7).

Table 7. Information and geomorphic, geologic, and cultural details concerning the geodiversity of the Shahdad region, which make the geosites attractive through landscapes for geotourism and the development of geoparks.

Figure	Types of Geosites. Landscape Personality and Value Categories Based on Elements of Visual Design
Table 2a: Kalut	*Geomorphologically relevant geosites (geomorphosites).* Landscape assembly of very large spatial openings, veined or with basins of obvious depth. Viewing axes are often limited to a few tens or hundreds of meters, due to the existence of a huge number of inselberg erosion markers and eolian entrainment of sand within shallow deposits. The landforms range from widely prismatic to low-altitude sharp ridges. The structural axes are thick and marked by the vertical edges of erosion markers. The esthetic value is determined by the enormous diversity and density of these erosion forms, in a monotonous pink-grey chromatic ensemble with an overall diffuse and lacteal appearance; broad panoramas over the erosion markers, over the large and varying sandy deposits of the dunes, over the desert pavement and the flat parts of the desert. Geotourists may develop affective reactions such as the recognition of the strength of local nature in association with feelings of 'negotiating' with solitude. Ecological and scientific value is given by the harshness of the environmental conditions (dryness, high thermal amplitudes of 60–70 °C, occasionally even higher, in the summer season, lack of soil and difficulty in the thriving of flora and fauna), reflecting an active but "troubled" shaping in geological time. There is no recognized cultural value, as there is no information and no tradition that makes special reference to history, religion, art, symbolism concerning the kaluts. These are unexplored tourism gems that afford local communities to repackage these geotourism features in adventurous tourism packages.
Table 2b: Nebkha	*Geosites of mixed relevance: geomorphological and botanical.* Scenes in which geosites are mistaken for real landscape units, whose identity is revealed by two fundamental components that are also identified as dominant elements of attraction (sand dunes and vegetation in the form of groups of dwarf or several-meter-high bushes). The unitary volumes of the sand-tamarisk bush accumulation type are non-uniform, from elongated to semi-spherical, ranging in size from small and medium up to towards 6–10 m high. The aesthetic value is given by the succession of a texture ranging from small volumetric to slightly striated at the base (small sand waves generated by the wind). It adds mixed neutral-to-cool chromatics and transitions from the clear blue of the sky to the green of the bushes and ochre to grey for the sand deposits. Other image elements are supported by elevation angles (the geotourist's gaze directed towards these formations) and small numbers of landscape layers. The affective reactions that can be aroused by these geosites are of the type of "uncontrolled", but positive, including the identification of man with a restrictive environment, a touching beauty, an invitation to calmness, and the search for "self". The ecological and scientific value is given by the result of the perfect adaptation of the tamarisk formations to the obvious harshness of the local environmental conditions. The only cultural value, as there are no traditions arising from this mixed geosite, refers in particular to the settlements on the edge of the desert, to the idea of desertification, the alteration of the quality of the soil as a productive agricultural environment, and the adaptation of the few people and wildlife to this hostile environment. This affords opportunities for agritourism and hunting where tourists can learn how to live from the land sustainably.
Table 2c: Gandom Beryan	*Geosites evoke a geodiversity based on geological relevance and geomorphosites, with reference to past and present climatic and atmospheric phenomena* [66]. This predominantly mineral assemblage presents itself as a basaltic plateau with pavements of multi-edged rocks, displaying the iconic character of very hot desert landscapes. Physico-mechanical fragmentation truncates the bedrock and towards the edges of the plateaus losing mass and installing structural steepness. The visual design features: maximum aperture angles (120 degrees) and viewing axes that measure distances in the range of kilometers. The texture is coarse and the dominant color is black (from the sandy stripped stones) as opposed to the blue of the sky. The pleasing, uncomplicated morphological character of the ensemble is the basic aesthetic feature. The affective response developed based on contact and socialization with these geosites, despite presenting the highest temperatures on the globe, include the acceptance of solitude, individual integration into the intricate equation of local nature, and a heightened spirit. The ecological and scientific value of these geosites is a formative-informative one, due to the fact that geosites develop an appetite for information, the discovery of climate-shaping effects, and the development of personal and companion cognitive acquisitions. The cultural, archaeological, and historical value of the landscapes of this type of geosite relates particularly to the anthropized part of the western edge of the Lut Desert, with much archaeological evidence speaking of civilization over 7000 years old across the Near East. Tourists interested in the evolution theory can be tantalized by geographical sites where they can co-exist in peace and harmony with nature.

Table 7. *Cont.*

Figure	Types of Geosites. Landscape Personality and Value Categories Based on Elements of Visual Design
Table 2d: Salty River	*Geosites of mixed geomorphological and hydrological relevance.* The Shur River is flanked by the elongated, dome-shaped hills near the springs, and the lost vegetation along the river due to salinity is a fundamental component of the geosystem of which these geosites are part. The iconographic image elements are as follows: the position of the main attraction of the salt water of the river and the hills creating the wide valley; the corridor effect of the valley-river pair; simple, undulated structuring axes depicted by the minor riverbed, the banks and the line of the surrounding chaotic interfluvial; an environment with a texture ranging from fine-medium (salty crusts) to rough (for alluvial deposits); a color register from neutral to cold, frequently even ranging to slightly warm colors. The esthetic value is dominated by the pleasing interplay between volumes, lines, texture, and colors. The affective reactions that can be developed by the geotourists here range from reverie disposition to attachment towards an ensemble that seems simple yet complex in its evolution. Ecological and scientific value highlights the particularity, diversity, and dynamics in time and space of what is the substratum, modeling, and chemistry, including water. Historical, cultural, and spiritual value can be part of what is now proposed and spoken of as "water rights and human rights" [81]—water rights because we are witnessing an unfolding of forces and energy of geological origin that gives rise to salt water that must be conserved as an environment and resource, and "human rights" because local people or others, such as ecotourists and geotourists, must make use of a tourism resource that can offer so many rewards: ways of understanding, engaging, and reproducing our knowledge, values, and beliefs. Educational tourism packages can be designed to capture an understanding of water and human rights in a complex world.
Table 2e: Salt polygons	*Mixed geomorphological and hydrological geosites.* These geosites have landscapes that are dominated by salt precipitation products in the form of polygons or ridges. The morphological detail of white crystal efflorescences and evaporite crusts in the bed creates conditions and falls into a typology of the following image elements: large to maximal viewing angles and axes; fine to the coarse texture of the structures; simplicity of the 2 landscape planes (polygonal surface and sky). As aesthetic value, the geometry of the terrain in shapes resembling pentagons and the horizontalization to the perfection of the crystallization base stand out. The primitive, sometimes chaotic, amalgamated beauty of the morphology of the impoverished and mineral crusts of this geosite captures the visitor's gaze and produces strong emotional reactions. These are of pleasant amazement at the salt polygons, frequently of astonishing geometric regularity and verging on perfection. The ecological and scientific value of these geosites derives from the distinct, particular natural features of the local environmental reality, focused on the mineralization–water evaporation–crystallization mix. Intrinsic knowledge through direct contact with locals and geoscientists alike of the elemental geoheritage, from the micro to macroscale, of great functional complexity is useful information and a geo-educational tool for the development of an environmental awareness [67]. The historical, spiritual, cultural, and economic value of the geometry of the geomorphological detail forms in these geosites is a reason for artistic concerns and the perpetuation of traditions, a real economic resource for the locals. Such is the case of the textiles and tapestries made in the villages, but also the craft workshops in the towns of Shahdad and Kerman. These take into their work strip patterns, regular polygons, repetitive polygons, and emblematic animal motifs from the historical past of the Iranian imperial period, as well as parts of the local vegetation. Cultural tourism and handicraft activities can provide richness in authentic experiences when geotourists visit this area.
Table 2f: Large alluvial fans	*Geomorphologically relevant geosites (geomorphosites).* The dominant features (including their quality as a fundamental component) are the suite of sediment deposits in the form of alluvial cones, ridges, and valleys in the mountainous area. In terms of esthetic value, the basic feature is the unity and contrast of masses and volumes (debris cones vs. sediment supplying the mountain sector). Visiting such geosites, the geotourists may manifest affective reactions referring both to the rugged beauty of the desert and the fan-like shape of the sediment deposits at the mouths of the rivers coming down from the mountains, and then a real sense of invitation to adventure from the nearby mountains. The ecological and scientific value is supported by the knowledge of a particular morphology in these geosites, a consequence of the causal relationship between the production of large amounts of debris by weathering processes, then the production of occasional floods that swell the mountain streams with high waters, the hollowing out of the catchment basins lacking protective plant cover, and finally the deployment of sediments in the form of alluvial fans and well-built river terraces [82]. No cultural value is recognized, as there is no information and no tradition that makes special reference to history, religion, art, or symbolism concerning these geosites. Therefore, local communities can design short hiking trails for adventure tourists to explore when the streams are not in flood.

Table 7. *Cont.*

Figure	Types of Geosites. Landscape Personality and Value Categories Based on Elements of Visual Design
Table 2g: Badland	*Geomorphologically relevant geosites (geomorphosites).* The fundamental component shaping these geosites is the relief produced by dissolution and erosion. The visual design of the Badlands is marked by volumes ranging from conical to elongated ridges and structural platforms on harder deposits. Multiple secondary landscape planes (wave or step-like succession of erosional forms) and the multitude of structural axes generated by the huge number of dissolution scales are also displayed. The esthetic value generates a great diversity and density to the microscale of the forms sculpted by erosion, yet in a disposition that reflects the unity of the group. The affective reactions of visitors range from curiosity to amazement at the majesty of nature. Also important is the chroma of the mineral assemblages which change from pale grey-green to reddish ochre. The ecological and scientific value is marked by the educational and informational relevance of the temporal condition in which the platform-type relief was so actively shaped, as it has been produced an erosion-dissolution orientation, on distinct packages from mineralogically petrographically perspectives. The cultural value of the areas marked by these geosites is particularly highlighted archaeologically by some fossil sites and palaeo-lacustrine terraces. Geologists and tourists interested in fossil sites can explore the secrets of this ancient world.
Table 2h: Night sky	*Geomorphologically (geomorphosites) and climate-astronomically relevant geosites.* The iconic features of nocturnal landscapes belonging to these geosites are both the sandy-stony surfaces, the prismatic erosion markers, and the nocturnal atmospheric environment marked by particular weather conditions. It is the very clean air that creates a clear atmosphere and perfect visibility for observing celestial bodies. The esthetic value provided by the pleasant dispute between the mineral masses and the sky, between the horizon line belonging to the interfluves and the sky delicately illuminated by the night stars; the dominance of cold tones, without speaking of an anguish atmosphere; the participation of pale light and wispy clouds in the spectacle given by nature.> Starting from the tangible and intangible "offer" of these geosites, their value must be judged through the prism of the educational, cultural, and scientific acquisitions made by geo-tourists, eco-tourists, photographers, and amateur and professional astronomers. This is the right context for sustainable management and awareness-raising projects, to promote the desert environment, such as the "Heritage of the Sky" project [83]. The affective reactions developed by such a mixed ensemble drive the eye and spirit of the geotourist towards the enchantment of an "ocean of eternal silence", the feeling of being lost in infinity, where freedom and imaginative solitude happily combine under the starry sky and the unreal expanse of the desert.

6. Conclusions

Our study starts with the evaluation of geosites for geotourismand in particular of geomorphotourism, both of which are undoubtedly related to the endeavor of "tourism". Today's tourism (including geotourism) is an eminently trans-, inter-, and multidisciplinary field/science, not only of geology and not only of geography (it includes geomorphology, hydrology, biogeography, population, and human settlements, territorial planning), and so on. Here, we are referring to the benefits that landscape science offers for tourism in general, and geotourism and ecotourism in particular.

Today, geotourism is influencing tourism markets, as most tourists are looking for attractions with a unique natural nature. In general, the results obtained from all three methods of evaluation used in this study are similar in content and all three methods use quantitative and qualitative techniques. One of them is enough to evaluate the areas. The Lut Desert in the Shahdad region is one of the areas that has great potential for attracting tourists because of its special climatic, geological, and geomorphological conditions. However, not all the geotourism potential of this part of the country has been utilized. One of the areas with high potential in terms of geological heritage for attracting tourists is the regions in Central Iran, as this is a phenomenal area due to the geomorphological features (Figure 6).

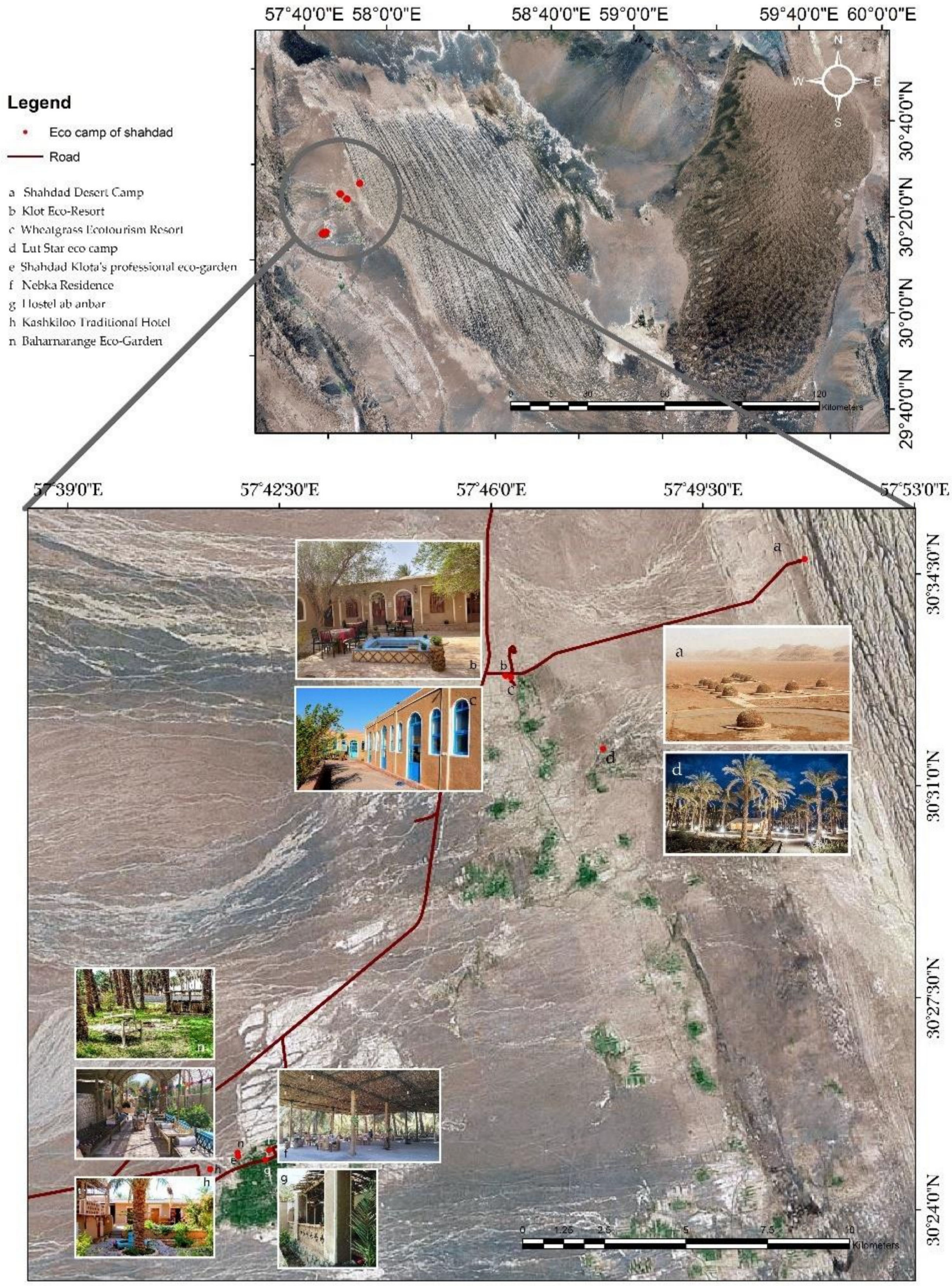


Figure 6. The potential for geotourism is insufficiently exploited through limited visitor reception infrastructure. Eco-camp network and capacities to serve geotourists and ecotourists in the Shahdad region.

This region thus has numerous capabilities in the field of biological and animal species, special surface forms, and climatic conditions that are rare in the world. Areas such as Gandom Beryan, which is the hottest place on Earth, the dune fields of nebkhas, and the rocky formations of kaluts as UNESCO World Heritage Sites, should be given more attention. Proper monitoring and management of resources for planning and sustainable development seems to be a necessity in the field of tourism to prevent improper planning and possible future damage.

Strategies for the development of geotourism in the Lut Plain include:

- creating infrastructure for tourism development, such as access routes to geotourist sites;
- growing the interest in geoeducation among the general public by establishing geotourism centers in the related provinces, where the training of tourist guides is possible, information-guidance boards and brochures are available, new trails are developed, and old routes are replanned by using geotourism trails correctly;
- introducing the unique attractions of Shahdad through advertising and cooperation with organizations such as the Cultural Heritage and Tourism Organization;
- initiating attractive activities for visitors by organizing themed competitions;
- holding Shahdad night plans to observe the stars through clean air, low humidity, and observing celestial constellations for astronomy researchers [84];
- car racing and car-related entertainment;
- skiing on the sand;
- stimulating visits to the nearest villages where culinary and craft products are produced specifically to the region and with a geoheritage theme; and finally
- increasing security in geotouristic areas.

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