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Full Length Research Paper

A tourism demand based method of geosites assessment on geotourism prioritization modeling: The case of Razavi Khorasan Province

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A systematic prioritization model maintains standards based on different levels of categorization to evaluate the sustainability of geosites. This approach makes use of an analytical hierarchical method to manage and prioritize a geotourism system on the base of tourism demand. The research concentrated on the importance of sustainable tourism planning to develop and investigate successful tourism activities using algorithmic hierarchical analysis. Nine indicators were used to integrate, identify and prioritize the potential geosites. They were: Distance from the Geosite Index (DGI); Accessibility of the Geosite Index (AGI); Climate Conditions Index (CCI); Regional Topography Index (RTI); Types of Rocks Formation Index (RFI); Geological History Index (GHI); Geological & Geomorphologic Forms Index (GGFI); Tourist's Infrastructures Index (TII) and Regional Safety Index (RSI). The primary variables used to generate the indices were: rainfall, temperature, moisture, height, formations' type, formations' age, stratigraphy, amount of fossils, intrusions, faults, ripple marks, volcanic shears, weathering forms, caves, lakes, springs, waterfalls, canyons, gullies, mines, tourist's welfare services and safety protections. The significance of the analytical hierarchical process in multi-criterion decision making to solve spatial problems of ranking and prioritizing tourist spots was validated and then verified for a case study in Iran. This proposed modeling technique can be applied to rank geosites around the world and provide criteria to allocate funds for geotourism developments.

Key words: Geotourism, geosite, prioritization, sustainable tourism.

INTRODUCTION

Geotourism is generally defined by its sustainable results: conserving natural areas, educating visitors about sustainability, and benefiting local people (Epler, 2002). It is a holistic approach to sustainable tourism that focuses on all definable points that create an authentic travel experience (Stokes et al., 2003).

Geotourism can be one of the most powerful tools for protecting the environment. Geotourism (as a 'new' tourism) is an improvement over mass or 'old' tourism that provides better sector linkages, reduces leakage of benefits from a country, creates local employment, and fosters sustainable development (Khan, 1997). It has been popularly promoted as a means of reconciling conservation of geologic and geomorphologic phenomena with economic development, particularly in developing countries (Campbell, 2002).

There is a rich literature devoted to geotourism (generally by geologists and geomorphologists) by which the attractiveness of many geotourism objects are assessed. Many attributes such as type and age of geological formations (including geomorphological factors and

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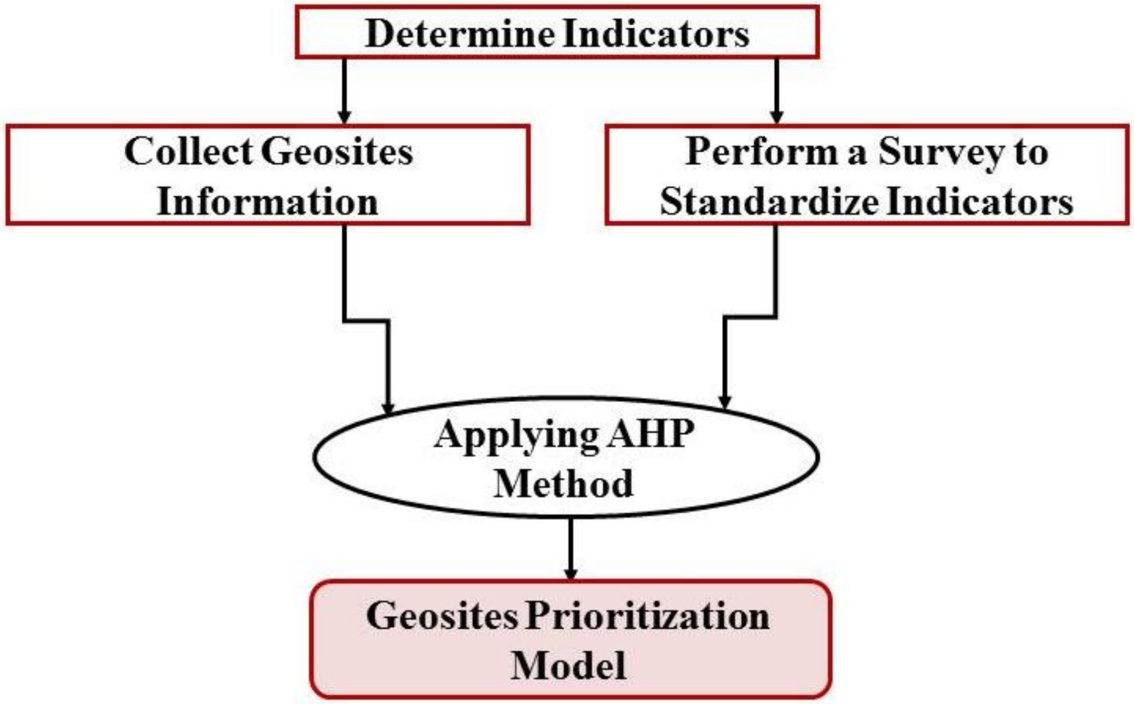


Figure 1. Proposed geosites prioritization modeling procedure.

and nature influenced formations), geographical location, etc are considered in the assessment process as well as transport accessibility, tourism infrastructures, economic and many other factors (Bruschi and Cendrero, 2005; Bruschi et al., 2011; Coratza and Giusti, 2005; Pereira et al., 2007; Reynard et al., 2007).

The related literature allows studying the attractiveness of geosites on the base of "Tourism Supply" and not "Tourism Demand". Due to the lack of enough literature on the base of tourism demand, this research is supposed to be one of the first studies which investigates an adequate modeling tool to establish appropriate priorities on the base of tourism demand.

Since prioritization and adequate resource allocation play vital roles in planning, the success of any geotourism project depends to some extent on the success of adequate prioritization and modeling. The prioritization problem can be modeled on the basis of tourism supply and demand issues. With respect to the insufficient prioritization tools on tourism demand base, in this research the perception of potential geosites and their prioritization are developed and verified according to tourists' interests for the case of Razavi Khorasan Province in Iran.

According to the inventory in the north eastern part of Iran which introduces many geological and geomorphological values (Shahbeyg, 1993; Shahrabi, 1994; Ahmadi, 1998 and Zomorrodian, 2003), Razavi Khorasan Province in Iran is found to be attractive on the base of geotourism points of view.

METHODOLOGY

Geotourism prioritization modeling approach

The few studies to model geosite prioritization have emphasized and encouraged management as a critical component for sustainable tourism success (Figuera et al., 2005). Sustainable tourism depends largely on the success of logical decision making and resource allocation. The procedure shown in Figure 1 is verified to develop a geotourism prioritization model.

According to the proposed procedure in this research the most important geotourism indicators are determined and standardized as well as the specified characteristics of the geosites in *Razavi Khorasan* Province are collected. Then by applying the analytic hierarchical process (AHP) the geosites are prioritized on the base of tourism interests.

Analytic hierarchical process (AHP) method

Based on the research goals which express the need to develop and interpret indicators for modeling, the Analytical Hierarchical Prioritization method is applied to prioritize the geosites (Figure 2). The analytic hierarchy process (AHP), a formal decision-making methodology developed in the late 1970s is a very attractive basis for forming such a geosites standardization framework (Golden et.al., 1989).

The AHP is based on the experience gained by its developer, Saaty (1980), while directing research projects in the US Arms Control and Disarmament Agency. The AHP provides a means of decomposing the problem into hierarchy of sub-problems which can more easily be comprehended and subjectively evaluated. The subjective evaluations are converted into numerical values and processed to rank each alternative on a numerical scale. The

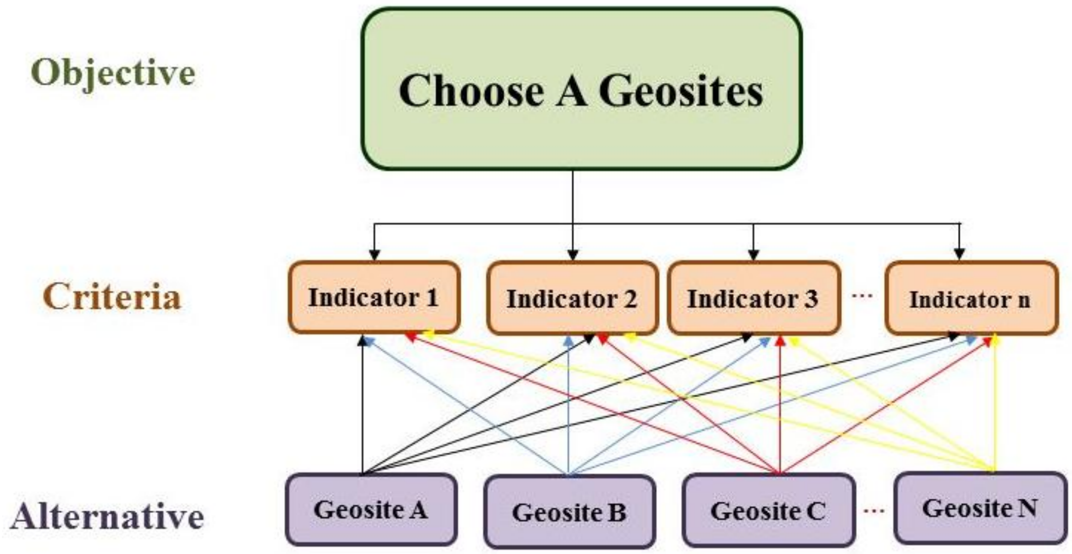


Figure 2. Applying analytical hierarchical method in geotourism prioritization.

Table 1. Socio-economical information of the geotourism interviewees in Iran (number of samples=510).

Province (Iran)	Samples (% from total number of respondents)	Gender (% male among respondents)	Field of study (% geological related respondents)
Razavi Khorasan	32.1	32.5	50.9
Northern Khorasan	9.3	36.2	63.8
Southern Khorasan	10.8	52.7	78.2
Golestan	9.6	26.5	46.9
Hormozgan	9.8	40.0	50.0
Sistan and Baluchestan	10.0	74.5	52.9
Tehran	18.3	41.9	40.9
Total (7 provinces)	100.0	41.1	53.0

methodology of the AHP can be explained in the following steps:

Step 1: Decomposing the problem into a hierarchy of goal, criteria, sub-criteria and alternatives;
Step 2: Collecting data from experts or decision-makers corresponding to the hierarchical structure, in the pair-wise comparison of alternatives on a qualitative scale;
Step 3: organizing the pair-wise comparisons of various criteria generated at step 2 into a square matrix. (The diagonal elements of the matrix are 1. The criterion in the i^{th} row is better than criterion in the j^{th} column if the value of element (*i*, *j*) is more than 1; otherwise the criterion in the j^{th} column is better than that in the i^{th} row. The (*j*, *i*) element of the matrix is the reciprocal of the (*i*, *j*) element);
Step 4: The principal eigen-value and the corresponding normalized right eigenvector of the comparison matrix give the relative importance of the various criteria being compared.
Step 5: The consistency of the matrix of order n is evaluated. Comparisons made by this method are subjective and the AHP tolerates inconsistency through the amount of redundancy in the approach. If this consistency index fails to reach a required level then answers to comparisons may be re-examined.
Step 6: The rating of each alternative is multiplied by the weights of the sub-criteria and aggregated to get local ratings with respect to each criterion. The local ratings are then multiplied by the weights of the criteria and aggregated to get global ratings.

Geotourism indicators integration and standardization

Indicators integration

Knowledge of history provides understanding of the importance of particular geologic and geomorphologic features. To obtain a list of pertinent and operational geotourism indicators, a precise literature survey was conducted as well as the important geological features were studied. Furthermore, 510 geotourists were interviewed about the most important factors in selecting a geosite as shown in Table 1. The interviews were conducted among geological students of universities of seven provinces in Iran (Tehran, Golestan, Razavi Khorasan, Northern Khorasan, Southern Khorasan, Sistan and

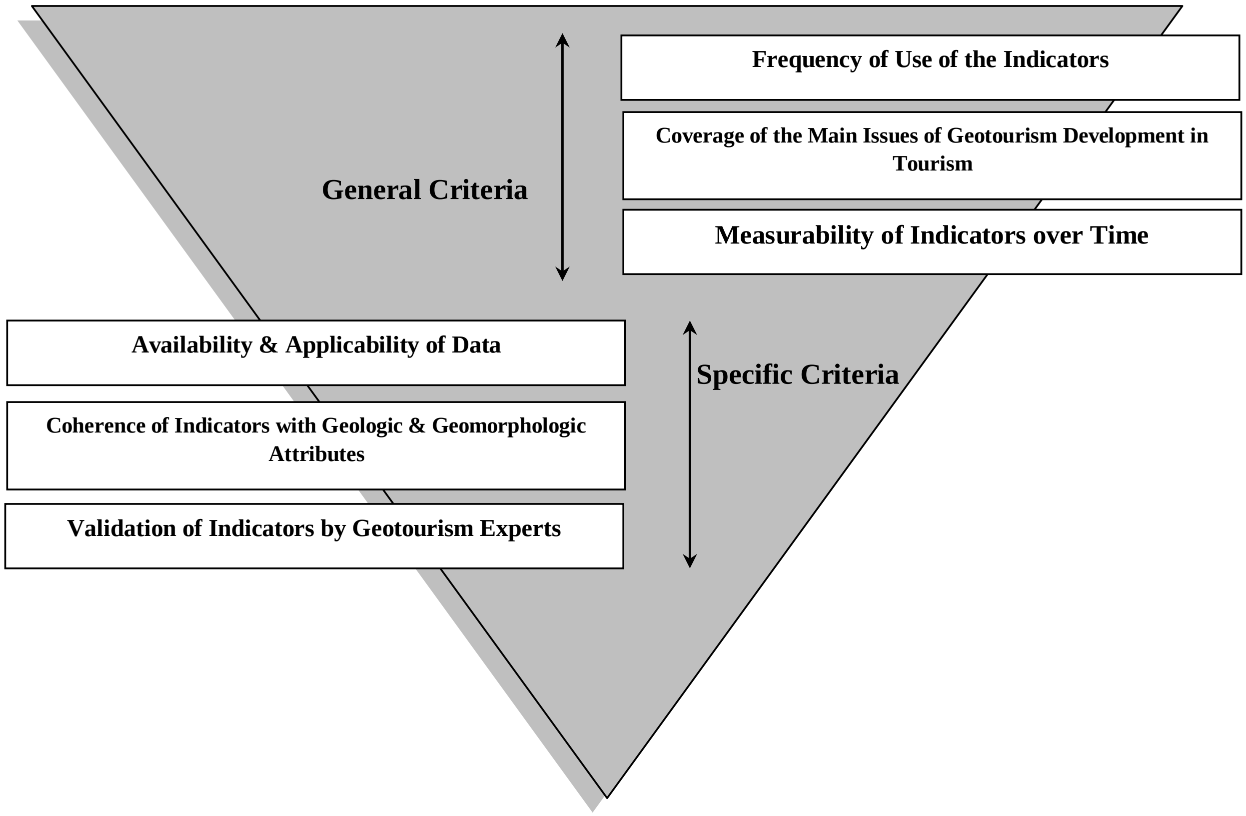


Figure 3. Selection criteria of geotourism indicators.

Table 2. The ranking results of the most famous five Iranian geosites, according to the interviewees.

Rank	Iranian geosite	No. of persons that visited geosite	Priority vector (%)
V1	Alisadr Cave	148	29
V4	Gheshm Island	122	24
V2	Gol-Feshan Spring of Chabahar	97	19
V3	Hormoz Island	74	14.5
V5	Damavand Village	69	13.5
	Total filled questionnaires	510	100%

Baluchestan and Hormozgan) and sought to establish the important individual interests in conducting geotours.

The interviewees were also asked to introduce their selected choice among five famous Iranian geosites as shown in Table 2. The interview data are analyzed using the Cochran formula (Cochran, 1977) and found to have an accuracy of about 86%, which is acceptable.

Nine main indicators are selected on the base of both the general and the specific criteria of geotourism as shown in Figure 3 by processing the interview results: Distance from the Geosite Index (DGI); Accessibility of the Geosite Index (AGI); Climate Conditions Index (CCI); Regional Topography Index (RTI); Types of Rocks Formation Index (RFI); Geological History Index (GHI); Geological and Geomorphologic Forms Index (GGFI); Tourist's Infrastructures Index (TII); and Regional Safety Index (RSI).

Each main indicator also includes related sub-indicators: rainfall, temperature, moisture, height, formations' type, formations' age, stratigraphy, amount of fossils, intrusions, faults, ripple marks, volcanic shears, weathering forms, caves, lakes, springs, waterfalls, canyons, gullies, mines, tourist's welfare services and safety protections.

The recognized indicators clarify the dependent parameters to identify and prioritize the potential geosites. An analytical hierarchical process was used to identify appropriate geosites. Table 3 shows the geosite evaluation indicators and provides a baseline standard to verify the proposed modeling method. Research is needed to establish the importance of each index and the prioritization of potential geosites.

Table 3. Geotourism indicators.

Indicator	First level	Second level
Distance from the Geosite	Long (more than 100 km)	
	Medium (50-100 km)	
	Short (less than 50 km)	
Accessibility of the Geosite	Good road access	
	Poor or limited road access	
	No road access (hiking)	
Climate conditions	Precipitation	Very High
		High
		Medium
		Low
		Very Low
	Temperature	High
		Medium
		Low
	Moisture	Dry
		Moderate
		Humid
Types of rock formation	Sedimentary	
	Igneous	
	Metamorphic	
Geological history	Stratigraphic relations	
	Formation age	
	Fossil content and bio-stratigraphy	
Topography	Highland	Steep, cliffs
	Lowland	Mountainous-rugged terrain
		Rolling hills
Safety	Patrolling	
	Police stations	
	Protection against wild animals	

Table 3. Contd.

Indicator	First level	Second level
Geological and geomorphological forms	Batholits, magmatic intrusions	
	Faults	
	Transverse stratification	
	Ripple marks and Color mélange	
	Stratigraphic Layers	Anticline
		Syncline
	Xenoliths, enclaves, veins	
	Volcanic shears	
	Weathering forms	Physical
		Chemical
	Caves	
	Lakes	
	Springs	
	Waterfalls	
	Canyons, ravines etc. (results of river erosion)	
	River terraces	
	Gullies	
	Kavir (Salt desert)	
	Mines	
	Caves	
	Lakes	
Tourist's Infrastructure	Appropriate guide signs	
	Accommodation (hotels, camps, etc.)	
	Drinking water	
	Telephone/ Cell phone antenna	
	Emergency services	
	Restaurants, Bars, etc.	
	Gas station repairing services	
	Shops	
	Sanitary services	
	Tourist protection (stairs, railings, pavements etc.)	
	Electricity	

Indicators standardization

The professors and graduate students in geology and geography in Canada, Iran and Poland were surveyed. They worked in earth and ocean sciences at the University of British Columbia (UBC) and Simon Fraser University (SFU) in Canada; in geography and regional studies at the University of Warsaw in Poland and in geology at Ferdowsi University of Mashhad in Iran.

The respondents profile is shown in Table 4. The Polish and Canadian individuals are enthusiastic advocates of geotourism with professional expertise in identification and maintenance of geosites

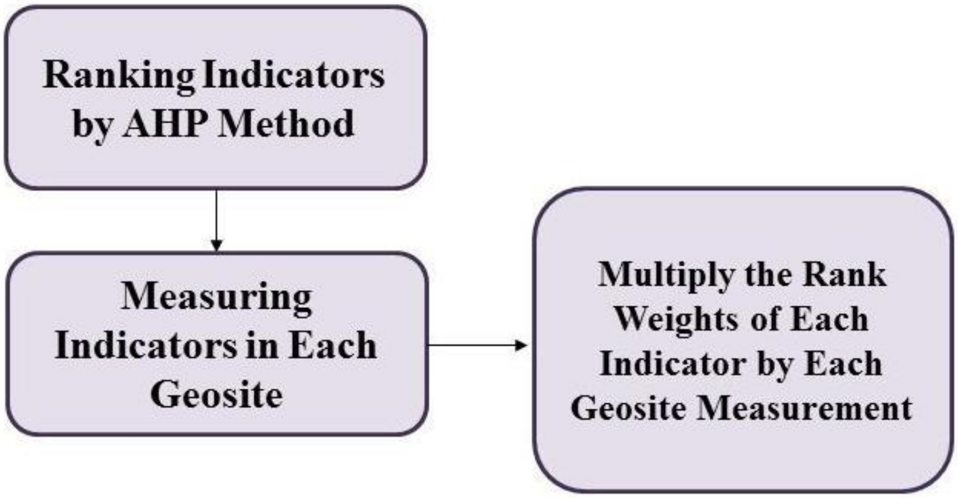


Figure 4. Geotourism prioritization model scheme.

Table 4. Socio-economical information of survey respondents (number of samples=92).

Country	Professors	Students	Related university (Geotourism related fields)
Poland	10	26	Warsaw University
Canada	6	19	UBC, SFU
Iran	4	27	Ferdowsi University of Mashhad
Total (3 countries)	20	72	92 samples

Table 5. Priority vector of global scale indicators.

Indicator	Global priority	Percentage
Accessibility to the geosites	1st	13.5
Tourists' infrastructures	1st	13.5
Distance from the geosite	2nd	12
Geological history	3rd	11
Geological and geomorphologic forms	3rd	11
Safety	3rd	11
Types of rocks formations	4th	10
Topography	5th	9
Climate conditions	5th	9

in their countries. The Iranians were included because *Razavi Khorasan* province, which is home to Ferdowsi University of Mashhad, contains many historically and culturally important sites which made it suitable for the authors to establish the determined case study. The result of these surveys was processed by the analytical hierarchical prioritization (AHP) method to identify the geotourism global scale indicators.

In this approach, a paired comparison is applied to prioritize the determined indicators according to geotourists interests. The global scale of indicators is derived from individual choices from each respondent by geometric mean. It has been proved that the geometric mean, not the frequently used arithmetic mean, is the only way to aggregate individual judgments in a group into a single representative judgment for the entire group (Saaty, 2008). The priority vector of global scale indicators are shown in Table 5.

Geosites selection

Iran has a rich culture and civilization as well as an outstanding natural environment. Its natural and cultural diversity justify its listing as one of the top ten tourist countries in the world (Newsome, 2006). Its archaeological, cultural and natural attractions form an excellent basis for developing geotourism.

Table 6. Prioritization results of five most famous Iranian geosites according to model (%).

Geosite code	Geosite name	Percentage (%)
V1	Alisadr cave	28.52
V4	Gheshm Island	23.26
V2	Gol-Feshan spring of Chabahar	18.55
V3	Hormoz Island	15.06
V5	Damavand village	14.61

Table 7. Comparisons of modeling results with collected data from surveys.

Interview results (Table 2)		Results of proposed prioritization modeling tool (Table 6)		Error (%)
V1	29	V1	28.52	1.68
V4	24	V4	23.26	3.18
V2	19	V2	18.55	2.43
V3	14.5	V3	15.06	3.72
V5	13.5	V5	14.61	7.60
Average error (%)				3.72%

The country has been labeled a “geologists’ and geographers’ paradise” or “the 1.5 million km^2 geological and geographical museum” (Newsome, 2006). While Iran has a great range of geological and geomorphological phenomena, geotourism is just emerging and being developed.

Geosites are selected based on the type of geologic or geomorphologic processes and formations and the level of attraction, rareness and special that exists at each geosite. Each should fit into a set of generic characteristics as dictated by research value. In this research the field study was undertaken at 65 selected geosites in *Razavi Khorasan* province to determine the presence of geotourism features.

Geotourism sites prioritization model

The general scheme of the geotourism prioritization developed model is shown in Figure 4.

Firstly, by applying the analytical hierarchical process method, the recognized indicators are ranked according to the geotourism experts points of view as shown in Table 5. Then the indicators in each geosite are measured according to the collected information in field trips. Finally the prioritizing ranks are multiplied and then added together to obtain the final score for each geosite.

Validation of prioritization model

To validate the accuracy of the developed prioritization model, it is applied to the five most famous Iranian geosites as mentioned in Table 2. Each alternative has to be compared based on the lowest level in the hierarchy of decision criteria. By applying the lowest level of the determined hierarchy, it is ensured that all variations of all options are considered.

It should be mentioned that there can be as many levels of sub-criteria as a final decision should be made. With each level, the total weight always adds to about 1.0 and the overall weight is spread up the hierarchy through each subsequent calculation.

To this extent, for making a comparison of determined geosites according to the defined levels of evaluation criteria, a comparison matrix for each decision criterion of evaluation is created. The final prioritized gesosites based on the developed prioritization method and the evaluated indicators is shown in Table 6.

As it is demonstrated in Table 7, a comparison of the results introduced by geotourism interviewees in indicators integration (Table 2) and the prioritization results of modeling tool (Table 6) shows a compatible adaption.

GEOSITES PRIORITIZATION RESULTS: A CASE STUDY

The final results of geosites ranking of Razavi Khorasan Province are introduced as a case study in this section by applying the developed prioritization model and with respect to the global scale of indicators (Table 5).

As it was discussed in the analytic hierarchical process (AHP) method, the final step is to combine the overall weights, and determine a value for each geosite as an alternative. The value for each geosite is the weighted sum of all rankings that are associated with it. The priority values (PVs) for each criterion have been added to the hierarchy. The priority percentages of 65 geosites of Razavi Khorasan Province resulted from the proposed geotourism priority modeling method is shown in Table 8.

DISCUSSION

As it is shown in Table 8, the geosites’ prioritization results in Razavi Khorasan province are ranked from 4.09 to 0.51%. Rocky Mountains of Mashhad, Ortkand Waterfalls, Vakil Abad, Chelmir Countryside Spring, Iron Ore of Sangan, Chalidareh Dam, Shahan Garmab Spring, Haft Hoz, Jaghargh, Bajestan’s Pelaya, Zavin

Table 8. Final geosites' prioritizing results in Razavi Khorasan Province (%).

Geosite code	Geosite name	Percentage	Geosite code	Geosite name	Percentage
C38	Rocky Mountains of Mashhad	4.09	C22	Bid Cave	1.42
C54	Ortkand Waterfalls	3.32	C15	Neojen Sandstone	1.41
C49	Vakil Abad	3.26	C44	Golmakan Green Spring	1.39
C45	Chelmir Countryside	3	C63	Line River	1.35
C7	Iron Ore of Sangan	2.83	C64	Idelik River	1.35
C50	Chalidareh Dam	2.63	C14	Duck Pool	1.29
C6	Shahan Garmab Spring	2.59	C4	Bazangan Lake	1.28
C37	Haft Hoz	2.4	C20	Bid Waterfalls	1.26
C51	Jaghargh	2.12	C28	Kardeh Cave	1.26
C19	Bajestan's Pelaya	2.09	C21	Bid Spring	1.24
C56	Zavin Dam	2.09	C27	Prismatic Basalt of Bayg	1.13
C42	Akhlamad Waterfalls	2	C24	Balashabad River	1.12
C36	Dehgheibi Granites	1.97	C29	Anderokht Cave	1.08
C8	Chaman Heights	1.95	C34	Moghan Cave	1.08
C52	Kang	1.92	C1	Pelat Khan Cave	1.07
C53	Zoshk	1.92	C2	Handle Abad Cave	1.07
C32	Garmab Spring	1.9	C59	Baba Ramezan river	1.06
C62	Khor River and Syncline	1.86	C58	Jarf River	1.05
C46	Chorlagh Spring	1.78	C30	Rostam Slave Cave	1
C12	Daghestan	1.74	C31	Ableh Cave	1
C35	Khalaj Heights	1.74	C40	Komaystan Dam and Valley	1
C9	Firouz Mine	1.73	C43	Sarab Waterfalls	0.8
C60	Gabris' House	1.72	C39	Shamkhal Valley	0.79
C11	Arghash gold	1.58	C5	Mozduran Cave	0.75
C33	Red village spring	1.57	C18	Khooshab Mill Valley	0.72
C57	Naderi Dam	1.57	C23	Erosion Shapes	0.71
C41	Gilas spring	1.54	C48	Allah Akbar Hot Water	0.69
C55	Gharesou Waterfalls	1.5	C47	Imam Ghanbar Hot Water	0.63
C65	Kalat Syncline	1.5	C13	Majan Waterfalls	0.62
C26	Ophiolite of Sabzevar	1.46	C16	Hot Spring Water	0.62
C25	Baba Afchang region	1.45	C3	Bazangan Cave	0.57
C10	Armadlou Mine	1.44	C17	Ghezlagh Cave	0.51
C61	Hot Water Waterfalls	1.44			

Dam and Akhlamad waterfalls are the first prioritized geosites with an amount of more than 2% of importance in ranking. These 12 geosites are localized in Figure 5 on the base of their ranking number. Figure 6 shows three geosites of 12 top ranked ones in Razavi Khorasan Province.

Rocky Mountains of Mashhad

Rocky Mountains of Mashhad which consists of Khaje Morad batholithic rock masses is a recreational spot in Mashhad. It has turned into a park a long time ago and receives travelers and guests that come to Mashhad.

Rocky Mountains Park is easily accessible and fully equipped (including parking, restaurants, play grounds, camping area, etc.) and because it is inside the city, its maintenance is convenient and low cost. Rocky Mountain is located at the center of the park and is formed around a core which is a geologic phenomenon itself. From geological points of view, Rocky Mountains' area includes G1 and G2 granites that can be observed by pegmatite streaks. G2 granites are younger and injected into G1 granites. Xenoliths are enveloped into these granites due to above mentioned mixture.

CODE	NAME
1	Mashhad Rocky Mountains
2	Ortkand Waterfall
3	Vakilabad Park
4	Sangan Iron Ore
5	Chelmir Countryside
6	Chalidareh Dam
7	Shahan Garmab Spring
8	Haft Hoz (Seven Springs)
9	Jaghargh Village and River
10	Bajestan's Playa
11	Zavin Dam
12	Akhlamad Waterfall

Razavi Khorasan Province Border Line

MASHHAD Capital of Razavi Khorasan Province

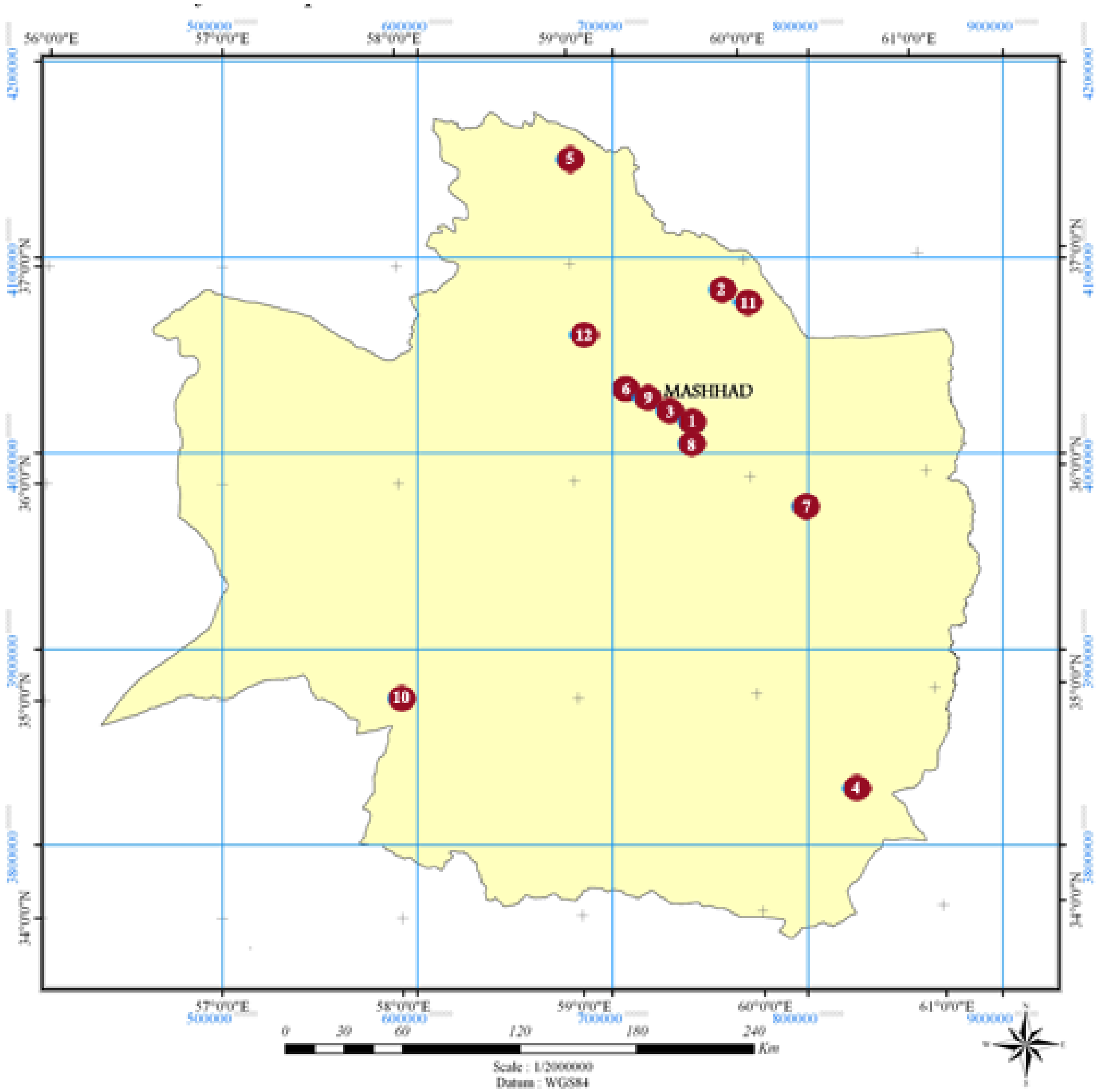
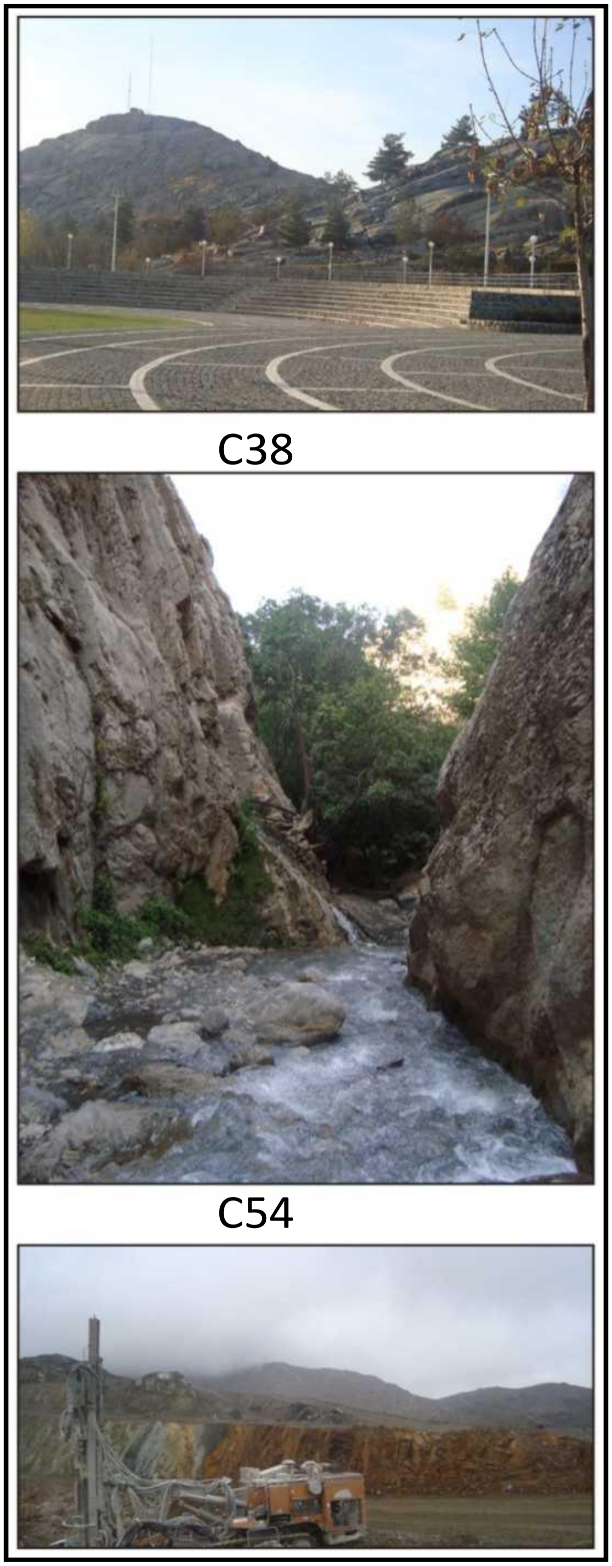


Figure 5. Localization of 12 top ranked geosites in Razavi Khorasan Province.



C7

Figure 6. Three Geosites in Razavi Khorasan Province. Mashhad Rocky Mountains (C38), Ortkand Waterfalls (C54), Sangan (C7).

Ortkand waterfall

This is another top ranked geosite in *Razavi Khorasan* province. On the way towards *Kalat*, there is the beautiful and the unique *Ortkand* waterfall which is one of the pure country sides in *Kalat* that attract tourists as well as climbers to the waterfall, enormous mountain and the mysterious cave. There is a little facility around *Ortkand* waterfall. Two restaurants, renting houses for accommodation and street parking can be reached in a close distance in *Kalat*. From geomorphologic aspects, *Ortkand* waterfall is about 1400 m above sea level with a mean annual precipitation of 247 mm.

Geomorphologically, *Ortkand* is similar to *Gharesou* Waterfall. Stiff carbonated formations such as Mozdura ,Tirgan and also the Shoorijeh classic formation along *Kopehdagh* mountains are the main factors in development of this natural phenomenon. In fact, the waterfall is Karstic type and is a result of Karstification activities, according to the folding in above formations and also the lithology. Strong streams in the past have transversely split these mountains antecedently and formed numerous gaps and causes.

According to geologic similarities to *Gharesou* waterfalls, *Ortkand* consists of sediments from Mozduran formation, including limestone with shale of upper-Jurassic age, Shoorijeh formation of lower-Cretaceous age including red and brown shale, gypsum and sandstone, and finally the Tirgan formation of lower-Cretaceous age including limestone and sub-ordinate marl. Tirgan lays in a conformable and sometimes inter-fingering manner above Shoorijeh.

Vakil Abad park

This is one of the city's attractions that receive lots of tourists each year. One of the characteristics of this park is the seasonal river accompanied by Granite rock masses. The park also includes playgrounds and other facilities. Geologically, the park is located in G2 unit which consists of loco-granite. Another unit which could be observed is C2 which consists of sandstones, Slate, crystallized lime and sequences of slate and Ultra-basic rocks.

Another major formation in Mashhad plain is the Quaternary units that are mainly composed of alluvial fan sediments, Conglomerate and sandstones. Geomorphologically, Vakil Abad includes a seasonal river with a granite bed. The area is located in Mashhad suburbs and its granites follow those of Khaje Morad.

The area is topographically bottomlands and high grounds. The park is planted all over. This park includes many facilities, such as camping area, special parking, close accommodation places, restaurants and coffee shops. Because it is located in the city, it is easily accessible and all the facilities are available.

Sangan iron ore

Geologically looking, Sangan mine forms a part of Talib Mountains East-West strike. From geomorphologic aspects, the area is 1650 m above sea level. It is located in hot and arid desert and semi desert climate. The annual precipitation varies from 140 to 200 mm and the average annual precipitation is 150 mm.

The average annual relative humidity is 40% and the RH varies from 12% in June to 76% in December. The least amounts of monthly humidity are measured for June to August which is around 25 to 35%. There are severe and strong winds in the summers, the most important of which is named Harat which blows from Hindukosh Mountains in Afghanistan.

The average wind velocity is 5 km/hr. The area has a desert type climate and no important water streams are observed. There are quite infrastructures in Sangan, such as two hotels, several restaurants, coffee shops, enough parking places and accessible road to the place.

Chelmir countryside

This is located in north-east of Quchan. On the way from Quchan to Dargaz, a quite sharp boundary between quaternary sedimentary units and Tirgan formations can be observed which is partially distinctive with faults. Tirgan formation which is nearly 600 m thick in this area is also considered the main formation due to its vast spread.

Major strata in this area are old terraces, Pliocene to Quaternary conglomerates and Tirgan formation. Among the geological phenomena along Quchan to Dargaz road, the water stream sources can be called local faults and dissolution of lime layers. There are quite infrastructures in this area, such as two hotels, several restaurants, enough parking places and accessible road to the place.

Chalidareh dam

Chalidareh Dam is another attractive geosite. From geologic points of view, it includes rocks which cover older rocks tectonically. These sediments are mainly in the form of dark metamorphic sandstones in southern parts of Binaloud while in the north it consists of metamorphic sandstones and shale including great amounts of intrusions of sandstones.

The complex is about 2000 m thick. The upper part of the formation is located in the south of Golmakan. In this area, shale rocks and sandstones have covered sediments. Quality standard sediments are located in neighboring layers.

Mount Siah Mansoor is composed of shale and metamorphic sandstones and several veins of milky quartz (St Unit). The significant point in this unit is the existence of chlorite following tectonic faulted thrusts. Quaternary sediments consist of alluvial thrusts which are mainly composed of conglomerate, sandstones and weak river sediments. They usually include sedimentary structures such as diagonal stratigraphy and gradual classification.

Alluvial thrusts are usually laid on older formations horizontally and unconformable. From geomorphologic aspects, the area is topographically high grounds with thorn bushes flora. The Quaternary units of sandstones and slates have formed a gentle slope. This area includes many facilities, such as camping area, special parking, close accommodation places and even close five stars hotels, restaurants and coffee shops. Because it is located quite close to Mashhad, it is easily accessible and all the facilities are available.

Shahan Garmab spring

This is a kind of hot spring, odorless and colorless, with a temperature of 48° and is free of sulphur and ammonia. It has numerous therapeutic properties due to its silicates. Quantitatively, it doesn’t contain much salts and therefore drinking the water is harmless.

Geologically, the route to the hot spring is located in a complex (Color mélange) and there are also various units such as pelagic lime mudstones, rocks, pillow and spilt lava, gabbros, and strongly crushed serpentines. There are adequate infrastructures including hotels, restaurants and parking places.

Haft Hoz (Seven springs)

This is a geosite located in Razavi Khorasan Province; it is potentially an attractive tourism place due to its distinctive landscapes and geology. It is located in suburbs of Mashhad, on the way to Moghan cave. The municipality is attempting to construct the *Haft Hoz* Park at the entrance to the area which will be quite a visiting place for citizens and tourists when facilitated.

Haft Hoz phenomenon which is placed in *Mashhad* Granites, is around 2 km from the park. Such a long distance should be walked and no transportation facilities are yet available. It is spread in the south and from the south to the west of Mashhad in the form of a strip with a width of 10 km and length of 40 km. Of course if aggregated with other intrusive rock masses in the south to the west of Mashhad, such as Vakil *Abad* and Golestan, it will be as long as 70 km.

The age is determined to be about 126 to145 million years with potassium-argon method on Mashhad Granite Micas. Geomorphologically, Haft Hoz includes granites of the south and from the south to West *Mashhad*, where erosions and also conjugate joint systems are observed. This area includes adequate infrastructures containing hotels, restaurants and parking places.

Jaghargh Village and River

This is located in Torghabeh City, one of the tourism areas around south west of Mashhad. This area is attended by many tourists, because of its suitable climate and existence of a river in a green valley. One of the most attractive aspects of this region is the special beautiful valley including sand stones units. Jaghargh is potentially capable to be mentioned as a geosite and geotourism center, because of its geological unit features with special layers and stratigraphy besides the river. From geomorphologic points of view, this region includes young "V" shape valleys with sharp slopes, angled layers of geological units and a river in the valley.

This region includes many facilities, such as camping area, special parking, close accommodation places, many restaurants and coffee shops. Because it is located in a tourism attractive city and also due to its closing distance to Mashhad, it is easily accessible and all the facilities are available.

Bajestan's Playa

Tectonic activities have caused the formation of a huge bow shaped depression that spreads from east to Torbat Heydarieh and from west to Boshruyeh. This depression is called Playa. The sediments have the same texture as the clay pan but laid in a lower elevation and contain minerals such as salt and gypsum, since the water level is higher than that of clay pan, the clay is wet. The wet zone covers 260 sq-km or 7% of the Playa.

Salt zone or crust, is a hard, smooth and humid surface in which evaporative sediments are formed due to severe evaporation and drying of shallow saline lake. The fractures in salty surface produce pastures through which the saline underground waters reach the surface and again evaporate and leave the salt. These pores are 20 to 200 cm wide and 100 to 200 m long.

Salty zone of Bajestan playa covers an area of 558 sq-km which is around 15% of the playa area. Geologically, quaternary deposits are widely spread in the area and are inconsistently laid on older units. These deposits are the youngest sediments in the area and include young sedimentary deposits and fans, old sedimentary deposits and fans, river bed sediments, clay zones and salty zones containing clay, marl, silt and light colored gypsum.

Geomorphologically in the most inferior parts of some watersheds, flat plains with special characteristics are developed which are called desert or playa, the majority of which are located in warm and low precipitation places and are mainly covered by contemporary lake deposits (clay, silt and salt sequences). Composition of saline waters in the playa usually reflects the composition of the surface. Crusts of the most of the playas consist of sodium carbonates and sulfates which are extracted by local people. The absence of adequate infrastructures is obviously clear in this area.

Zavin Dam

This is a concrete gravity dam that can potentially act as a tourist attraction as well as the water for the downstream areas. Geologically, it contains the following rock units:

Abtalkh (Bitter waters) shale formation

It consists of bluish grey shale limestone and a little marl. It is divided into two parts and is 900 m thick. There are thin layers of clay-sand and sand-lime limestone near the upper surface which are presumed to include basal pelagic zone in their depositional environment.

Sandstone formation

Sandstone formation, which is outcrop in the central core of an anticline located in north-east of *Qale-zoo* Village, is so resistant to erosions and is actually the main contribution to Mont *Kalat* structure.

It consists of fine-to-medium-sized glauconitic thick layer sandstones as well as shale with layers of sandy limestone in upper part. Glauconitic can be found occasionally in this structure. The absence of adequate infrastructures is obviously clear in this area.

Akhlamad Waterfall

This is located 2 km from *Akhlamad* Village. Due to its elevation and high precipitation, it has a high water level in the early months of the year. Geologically, it contains Quaternary sediments which are the youngest units in the area which can be observed on the plain surface and along river routes and lack any kind of classification.

Sediments of alluvial fans, plain surface sediments, alluvial terraces and new alluvial sediments are parts of this formation. Also it includes Chaman Bid formations containing grey marls and grey to brown Argillite limestones. The thickness of the formation is very small in the north-east and gets even thinner towards the south. Chaman Bid formation lies conformably on Kashaf River formations. Originally, this waterfall is a Karstic type. Very high crags which are the result of Karstification along with the collapse of the roof of old mines have made possible for the water to fall down and form numerous waterfalls which are so typical and more even magnificent. Lime lithology has caused deep round pores beneath the waterfall.

The valley includes rocky walls 200 to 300 m high which are a major rock climbing spot in the country. Among the most famous ones are Sefid (white), Allaho Akbar and Oghab (eagle) walls. The valley contains several waterfalls, four of which are permanent while the others are seasonal. Akhlamad main waterfall is 40 m high. Other geomorpholagical features include physical weathering, dissolution and collapse of large slabs. This area includes adequate infrastructures containing hotels, restaurants and parking places.

Conclusions

Studies on geotourism indicators and developing the prioritization model are discussed and many academics agree that there are many critical components for adequate geotourism prioritization modeling. It is also said that the success of geotourism prioritization modeling depends largely on the accuracy of chosen indicators.

The complexity of the geotourism indicators' characteristics with the individual needs of geotourists and motives usually resulted in various perceptions of priority. Therefore this research has come up with two research issues. The first issue for this research is interpreting and developing the indicators which are effective in geotourism sites. The second research issue is introducing and developing the prioritization modeling method of geosites.

This research has come up with a number of geotourism indicators which are effective in ranking process of each geosite. The data collected from the field have suggested nine main indicators related to geotourism and also related to the ranking of geotourism sites.

To this extent, it can be concluded that the developed prioritization modeling tool is an accurate and trustable one to be applied to prioritize any kind of geosites. According to the validated method and developed global scale indicators, a case study on *Razavi Khorasan* was performed in which the included geosites were prioritized by applying the proposed method.

All of these findings hope to contribute to the greater understanding of geotourism development and a more straight forward way of planning and management. It also helps the authorities, from responsible in charge to researchers, to evaluate and monitor the process with greater understanding. Geotourism experts may benefit from the knowledge to establish and operate priorities for geotourism projects and researches.

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