

Quantitative Assessment of Five Geosites Locations in Northeast Misan Southeast Iraq by Using Satellite Images and Field Survey

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Abstract: Sentinel satellite images are enhanced using Erdas-2014 and analyzed by GIS techniques to distinguish the main geological features in the study area. Satellite image is processed to select and determine several geological and geomorphological features that are evident through a Sentinel image as a Geopoint. These Geopoints were checked in the field survey to be geosite. Field techniques include photogeological and terrestrial photogrammetry. Quantities' assessment of geological heritage in five geosite in Potential Geopark (Telal AL Band). Scientific, educational, functional, and touristic categories values were calculated for each Geosite. The Results of the quantitative assessment depend on questionnaire data for three types of audiences: university students, Government circles, researchers, tourists then, and previous geoscientific studies. The infrastructures like paved roads, bridges, and security, played a vital role in the scores in different studied sites. The infrastructures of geotourism need to develop through local government funding and community people investments. The area of east Misan required more professional promoting efforts to develop geoeducation and geotourism. The results of the study show the Telal AL Band geopark of geoeducation, geotourism, and economical importance.

Keywords: geosite, geopoint, geopark, geodiversity , geo heritage

1. Introduction

The Geopark includes a several sites (on any scale) or a mosaic of geological systems of special geological significance, Representative of an area and its geological history, Events, or processes. It contributes to the protection and conservation of significant geological features ('geodiversity'), By representing examples of significant rocks, mineral resources, minerals, fossils, and landforms, and it provides information on various geoscientific disciplines such as geology, geomorphology, soil science, glacial geology, hydrology, engineering geology, mineralogy, petrography, paleontology, economic geology and mining, sedimentology, stratigraphy, structural geology and volcanology. It is a well-established practice to consider Geosite assessment according to the four main types of use – scientific, educational, and geotourism/recreational [13]. A Geopark is a generic term ascribed by a nation or region to an area with outstanding geological heritage aimed at both conservation and promoting its use in a sustainable way. Most Geoparks are not protected areas but they may contain protected areas [8]. UNESCO Global Geoparks encourage awareness of the story of the planet as read in the rocks, landscape, and ongoing geological processes.” [11]. According to digital image processing and optical attribution, geomorphic characterize classified the Telal Al- -Band Geopark to five Geosites and determined number of Geopoints. field survey for each Geopoint to Quantitive assessment of geosite .

2. Aim the study

1. Explore and understand the Geoheritage and geodiversity in each geosite in Telal AL Band geopark that has been selected according to the remote sensing technique.
2. Quantitive assessment of geosites.
3. Document the geoheritage of the study area.

3- Location of area study

The study area is located in the northeastern Missan governorate, south of Iraq between ($32^{\circ}03'25.52'' - 32^{\circ}30'30''$) latitudes and ($47^{\circ}05'21.16'' - 47^{\circ}40'53.52''$) longitudes, Fig. (1). It encompasses an area of (1856 km²). Fig(2) show the location of five sites

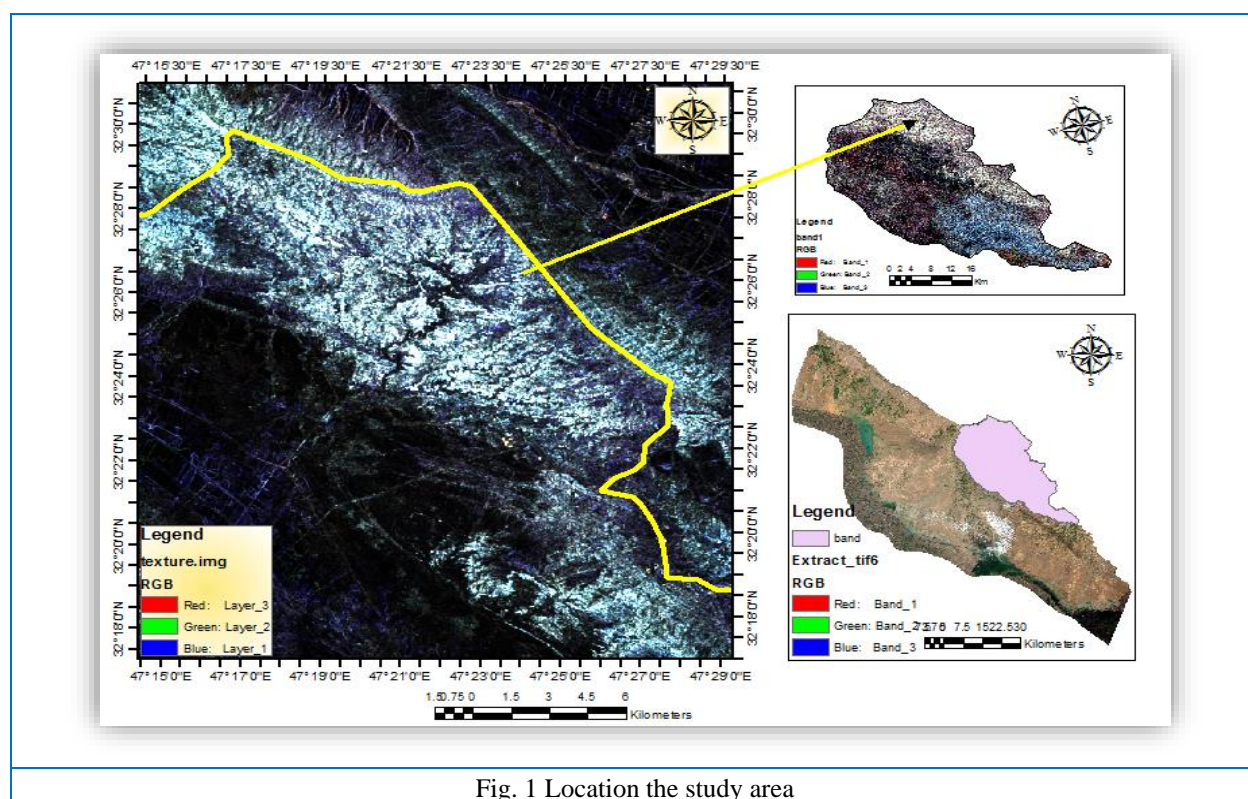


Fig. 1 Location the study area

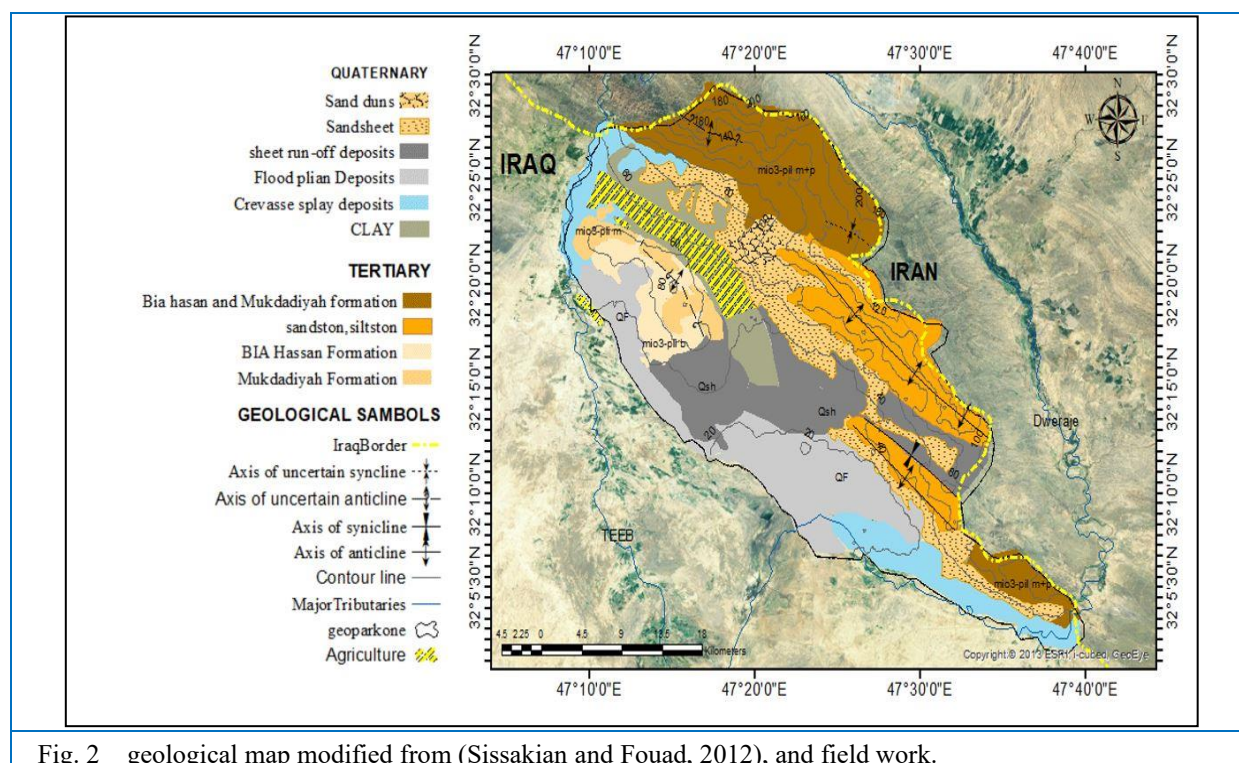
4. Geological condition or Geological setting of study area

The study area covered with Zagros foothill deposits like, alluvial fan, dunes, and colluvial deposits derived from the mountains lies to the East North direction across Iraqi Iranian border line. The geological attitude characterized by The Tertiary rocks are formations, as the mukdadiy Formation consists of monotonous sequences of interbedding of claystone and sandstone with some siltstone intercalation. The sandstone beds very often contain pebbles with different shapes, therefore, they are considered typical freshwater mollas [5], and bai hassan Formation is composed of interbedding of conglomerate, claystone, and sandstone [2]. In addition, several major normal and thrust faults are identified in the study area [17], whereas most of the study area is covered by Quaternary sediments of sands, silts, and, silty clay. The Quaternary deposits

represent about 72% while Tertiary sediments extend over 28%. show fig. (3) geological map of Geopark according to fieldwork survey and previous studies. Table (1).

Table 1 The geological setting of the study area [1].

Formation	Age	Lithology
Quaternary Deposits	Recent	Sand dunes, Sand sheets alluvial and colluvial deposits comprised mainly of gravel, pebble, sand, silt and clay. sand dunes and river terraces are formed
		Sand dunes, Sand sheets alluvial and colluvial deposits comprised mainly of gravel, pebble, sand, silt and clay .sand dunes and river terraces are formed
Bai Hassan	Late Pliocene	Mudstone and conglomerates with some sandstone and siltstone
Mukdadiya	Upper Miocene Lower Pliocene	Thick massive sandstone beds changed to pebbly with thin conglomerates. The lithology change in upper part to light brown claystone with few sandstone and lenses of pebbles
Injana	Early to Late Miocene	Marls and siltstone with beds of sandstone. fresh water limestone and lacustrine clay and bentonite are occasionally occurred



5. Methodology

In this study, Remote sensing techniques were used to characterize the surface geological structures. The visual interpretation of the imaging satellite and geomorphological characteristics of the area were used to determine the geo site.

1- the digital image processing and optical Interpretation for Sentinel-2satellite Images to distinguish five Geosites and Geo points, table (2) and fig. (3).

2-prepared the Questionnaire for the study area.

3- fieldwork of each Geosite

3- select criteria for assessments.

4- Quantitive assessment for each Geosite

Selected five Geosite and 15 Geo points and make a questionnaire. it was conducted for several sides, including universities, researchers, governorate departments, and tourists. The questionnaire included four axes (educational, scientific, tourism, and economic) The opinions of those included in the questionnaire emphasized the importance of the scientific, educational, touristic, and economic zone, and the need to develop it.

Table (2) potential Geosites and Geo points

Geosite	Area\KM	Geo point	Notes
Al-Teeb River	208.95	5	The number of points was large because the area is geologically diverse and safer than other sites
Telal - Al-Band fold	374.95	4	The number of points may be more in the future due to the geological diversity and the lack of risks in the region
Al-Bajalia	249.44	1	Difficult access to the area, and the presence of mines. One point was chosen
Al-Fuqi	249.44	3	The area contains many water wells and projects
Al-Zubiadt	275.580	2	The area contains several sites, but access to them is still difficult, as well as containing mines

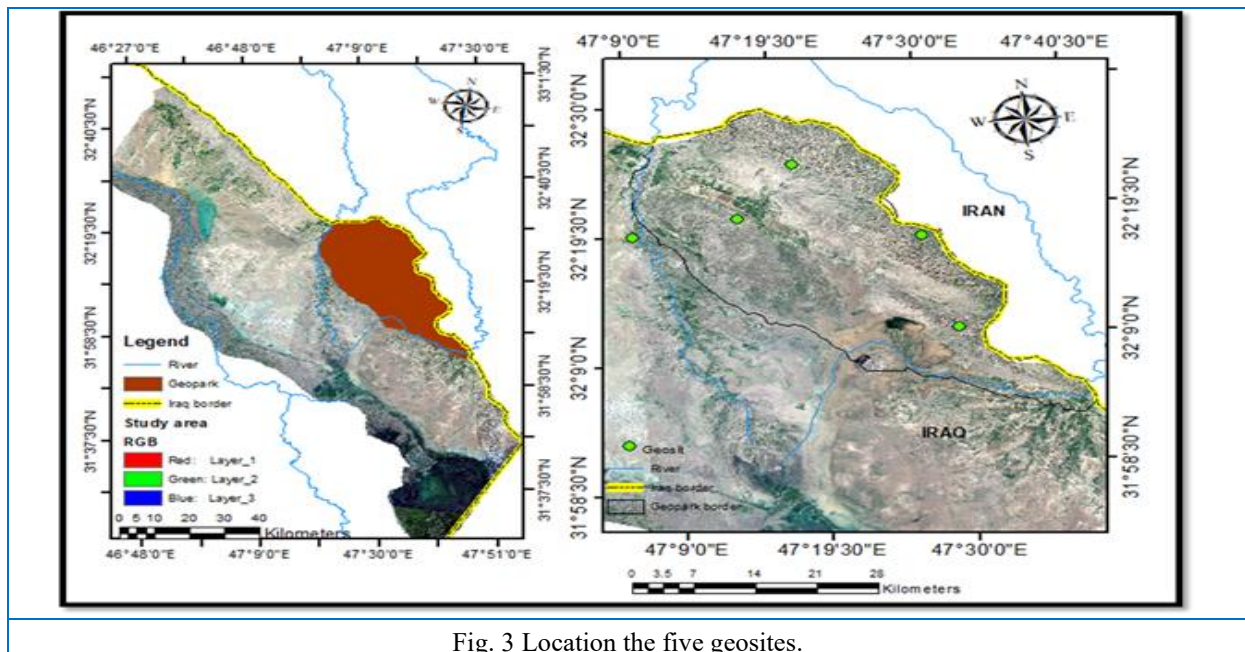


Fig. 3 Location the five geosites.

5.1 Questionnaire

A questionnaire is the main means of collecting quantitative primary data. A questionnaire enables quantitative data to be collected in a standardized way so that data is internally consistent and coherent for analysis. Questionnaires should always have a definite purpose that is related to the objectives of the research, and it needs to be clear from the outset how the findings will be used [16].

5.2 Quantitative assessment of Geosites

The research on numerical assessment of sites has been under development for the last decade, but the geoscientific community has not yet reached a generally accepted method. Usually, quantitative methods are based on several criteria and respective indicators to which different scores or parameters may be assigned [4,6, 7;12. 14; 9,15]. The criteria of assessment choose according to [11,10, 3, and 8] choose four criteria (Scientific value, Education value, tourism value, and functional value).

1-Scientific values include five indicators (Representativeness, Integrate, Rarity, Scientific knowledge, and use limitation) shown in table (3).

2-Education values include five indicators (Didactic potential, Association with other values, Geological diversity, Accessibility, and Safety) as shown in table (4).

3-tourism value includes five indicators (Scenery, Interpretive potential, Density of population, Accessibility, and Safety) shown in table (5).

4-functional values includes five indicators (Capacity, Level economic, Accessibility, distains from a paved roads, Use limitation, and Safety) as shown in table (6)

Table (3) Scientific assessment

	indicator	Question	Score
1	Representativeness	The site can cover more than (4) geological disciplines	100
		The site can cover (4) geological disciplines	80
		The site can cover (3) geological disciplines	60
		The site can cover (2) geological disciplines	40
2	Integrate	There are educational, scientific, tourist, economic, cultural and heritage aspects (5 aspects)	100
		There are educational, scientific, tourist, economic, cultural and heritage aspects (4 aspects)	80
		There are educational, scientific, tourist, economic, cultural and heritage aspects (3 aspects)	60
		There are educational, scientific, tourist, economic, cultural and heritage aspects (2 aspects)	40
3	Rarity	The same conditions were repeated at the sites (2 sites)	100
		The same conditions were repeated at the sites (3 sites)	80
		The same conditions were repeated at the sites (4 sites)	60
		The same conditions were repeated at the sites (5 sites)	40
4	Scientific knowledge	Published and unpublished research and studies are available in addition to scientific theses and dissertations	100
		Unpublished research and studies are available	80
		Researches, theses and studies are available	60
		There are no studies on the area	40
5	Use limitation	The site is easily accessible, there are no Limitation	100
		There are Limitation (2 Limitation)	80
		There are Limitation (3 Limitation)	60
		There are Limitation (4 Limitation)	40

Table (4) Education assessment

indicator	Question	Score
1 Didactic potential	The site represents geological elements that can be easily understood by students of different levels (Primary, Secondary, Bachelor, and Studies (5 elements)	100
	The site represents geological elements that can be easily understood by students of different levels (Primary, Secondary, Bachelor, and Studies (4 items)	80
	The site represents geological elements that can be easily understood by students of different levels (Primary, Secondary, Bachelor, and Studies (3 items)	60
	The site represents geological elements that can be easily understood by students of different levels (Primary, Secondary, Bachelor, and Studies (5 elements)	40
2 Association with other value	The site contains tourist, educational, scientific, functional, cultural, aesthetic, and heritage values (5 values)	100
	The site contains tourist, educational, scientific, functional, cultural, aesthetic, and heritage values (4 values)	80
	The site contains tourist, educational, scientific, functional, cultural, aesthetic, and heritage values (3 values)	60
	The site contains tourist, educational, scientific, functional, cultural, aesthetic, and heritage values (2 values)	40
3 Geological diversity	There are educational elements, natural processes (5 appearances)	100
	There are educational elements, natural processes (4 appearances)	80
	There are educational elements, natural processes (3 appearances)	60
	There are educational elements, natural processes (2 appearances)	40
4 Accessibility	Asphalted roads and transportation (all types of cars) are available.	100
	Paved but damaged roads (high types of cars, tire size greater than 15 inch)	80
	Dirt roads and transportation modes (four-wheel-drive vehicles)	60
	Access only by tractors	40
5 Safety	Availability of protection elements (5 items)	100
	Availability of protection elements (4 items)	80
	Availability of protection elements (3 items)	60
	Availability of protection elements (2 items)	40

Table (5) Tourism assessment

indicator	Question	Score
1 <i>Scenery</i>	The site contains attractive and aesthetic natural appearances (5 items)	100
	The site contains attractive and aesthetic natural appearances (4 items)	80
	The site contains attractive and aesthetic natural appearances (3 items)	60
	The site contains attractive and aesthetic natural appearances (2 items)	40
2 <i>Interpretive potential</i>	There are items that can be easily understood by non-professionals (5 items)	100
	There are items that can be easily understood by non-professionals (4 items)	80
	There are items that can be easily understood by non-professionals (3 items)	60
	There are items that can be easily understood by non-professionals (2 items)	40
3 <i>Density of population</i>	Numbers that the site can accommodate (200-100)	100
	Numbers that the site can accommodate (100-50)	80
	The numbers that the site can accommodate (25-25)	60
	The numbers that the site can accommodate is less than 25	40
4 <i>Accessibility</i>	Asphalted roads and transportation (all types of cars) are available.	100
	Paved but damaged roads (high types of cars, tire size greater than 15 inch)	80
	Dirt roads and transportation modes (four-wheel-drive vehicles)	60
	Access only by tractors	40
5 <i>Safety</i>	Availability of protection elements (5 items)	100
	Availability of protection elements (4 items)	80
	Availability of protection elements (3 items)	60
	Availability of protection elements (2 items)	40

Table (6) Functional assessment

indicator	Question	score
1 Capacity	Number of people accommodated by the site (200-100)	100
	Number of people accommodated by the site (50-100)	80
	Number of people accommodated by the site (25-25)	60
	The number of people that the site can accommodate is less than 25	40
2 Level economic	There are economic elements on or near the site (5 elements)	100
	There are economic elements in the site or close to it (4 elements)	80
	There are economic elements on or near the site (3 elements)	60
	There are economic elements on or near the site (2 elements)	40
3 Accessibility distains from paved road	The distance of the site from the main road (less than 5 km)	100
	The distance of the site from the main road (5-10) km	80
	The distance of the site from the main road (10-20) km	60
	Distance of the site from the main road (20-50) km	40
4 Use limitation	The site is easily accessible, there are no Limitation	100
	There are Limitation (2 Limitation)	80
	There are Limitation (3 Limitation)	60
	There are Limitation (4 Limitation)	40
5 Safety	Availability of protection elements (5 items)	100
	Availability of protection elements (4 items)	80
	Availability of protection elements (3 items)	60
	Availability of protection elements (2 items)	40

Table (7) Quantitive assessment of study area

Geosite name	Scientific value	Educational value	Tourist value	Functional value
Al-Teeb River	76.1	86.2	69	63.6
Telal - Al-Band fold	77.8	70	59.2	86.2
Al-Bajalia fold	76	67	59	65.4
Al-Fauqi fold	72.3	64.7	69.3	78.87
Al-Zubeidat	74	69.5	86	78.5

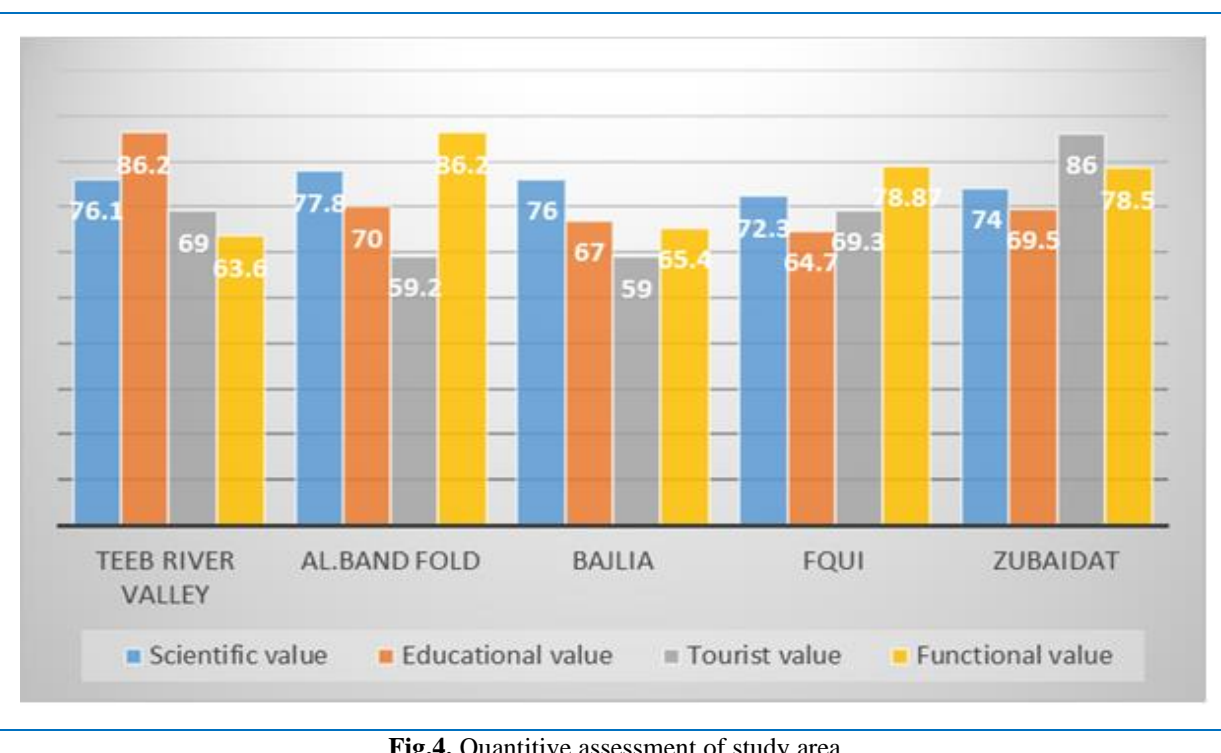


Fig.4. Quantitive assessment of study area

6. Results and Discussion

I- The results of the questionnaire showed the following: -

1- The highest average value for the offices that have projects in the area is about 70%, as the employees of these offices, are always in the region's locations and are knowing about the geological, economic, and environmental processes.

2- The lowest average value was for students and researchers due to their suffering from lack of services and poor infrastructure in the study areas (rest stations, paved roads, transportation services).

3- Weakness in field visits (the fieldwork of the geological departments in Iraq reached 35% of the total departments covered by the questionnaire).

4- Families and visitor's questioner, it was 60%, where the rate decreases due to the lack of mobile coverage, rest areas, and transportation

5- The question related to geological diversity and the nature of the region, was supported by 90% of all groups.

6- the evaluation of hospitality and reception by the people of the area, it was highly rated (90%), as all groups praised the good reception by the people of the area to the visitors.

II- Assessment of geological sites according to the main types of use in the area (scientific, educational, touristic, Functional).as fellow: -

1- The educational value of the Al-Teeb River valley site is very high.

2- The functional value of Al- Band fold site is very high.

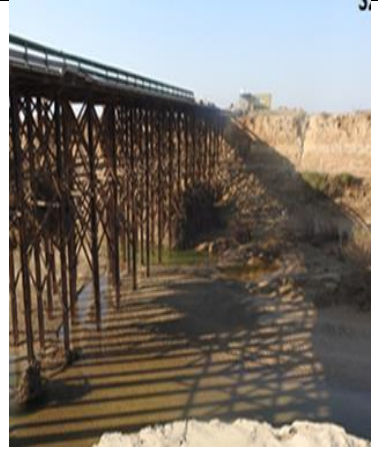
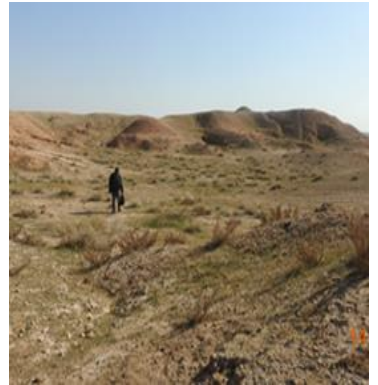
3- The scientific value of Al-Bajalia site is very high.


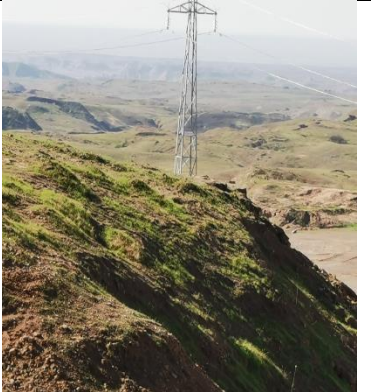

4- The functional value of Al-Fqui site is very high.

5- The tourist value of Al-Zubiadt site is very high.

III- All these sites need to be developed and improved infrastructure and services for the benefit of visitors, researchers, and workers such as (improving roads, providing mobile coverage, providing resting places, and means of transportation).

Table (8) A list of the geological heritage sites and the most important geopointes they contain

Geosite name	GPS Location	Geo points	Cod name	Geomorphological characterizes	Accessibility	Heritage Value	Safety	photo
Teeb river	32°24'26.75"N 47° 2'23.20"E	Teeb River Erosion valley White Sand dunes Old Quarries Playa Swamp	GP1T GP2T GP3T GP4T GP5T	river terraces, braided, meandering variants, sand dunes and Lake Outcrops	Easy access to the site due to the presence of paved roads Possible means of transportation such as cars	Scientific, education And Geotruism	No mobile phone coverage. Flooding and Torrents natural risk in this site more than human risk such as Waste, garbage and pollutants	
Band fold	32°19'20.37"N 47°14'5.09"E	Erosions valley Um syl (Quarries) Archology City SUR Archeological hill	GP1b GP2b GP3b GP4b	Small alluvial fans, Bajada plain Cuesta And hills	presence of paved roads, and There are no guide points on the way	Scientific, Education And Geotourism	No mobile phone coverage. Natural risk	

Bajlia	32°17'10.19"N 47°26'13.45"E	Bajlia out croup Sahein out croup	GP1BJ GP2BJ	Valley	No paved road and no point road guide	Education ,and scientific	No mobile phone coverage. Natural risk And Mine hazards	
Fuqi	32° 7'16.10"N 47°30'30.72"E	Dwerige Dam FUQI mountain out croup Bazurgan Marsh	GP1F GP2F GP3F	river terraces, braided, meandering variants Lake Valleys	paved road and unpaved road or damage no point road guide	Scientific ,and Geotourism	No mobile phone coverage. Natural risk	
Zubiadt	32°25'59.55"N 47°21'40.59"E	Sulphated well Fresh water well Zubiadt Valleys Abu garabe area	GP1z GP2z GP3z GP4z	Valleys Land scape Lake Spring Hills	No paved road and no point road guide	Scientific ,and Tourism	No mobile phone coverage. Natural risk	

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