

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

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(Received 25 Aug, Revised 16 Oct, Accepted 22 Oct)

**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

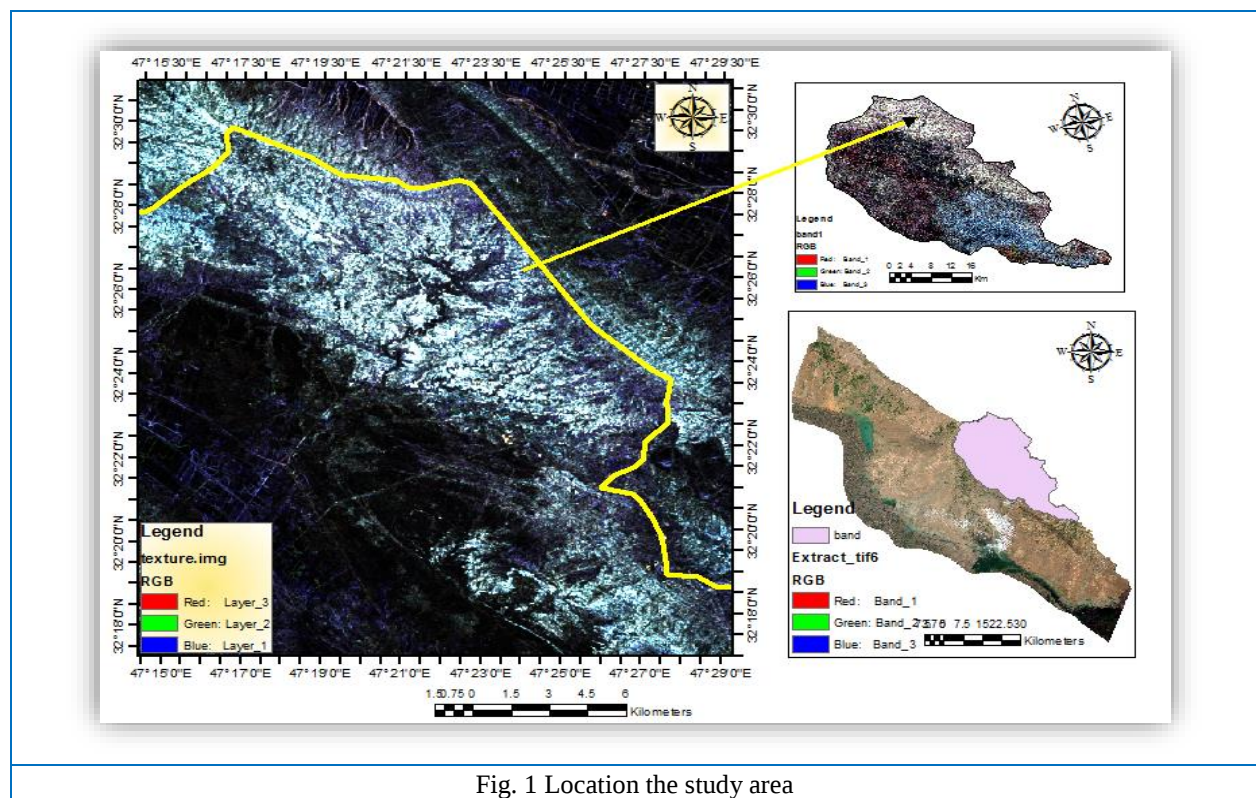
The Geopark includes a several sites (on any scale) or a mosaic of geological systems of special geological significance, Representative of an area and its geological history, Events, or processes. It contributes to the protection and conservation of significant geological features ('geodiversity'), 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 km<sup>2</sup>). Fig(2) show the location of five sites



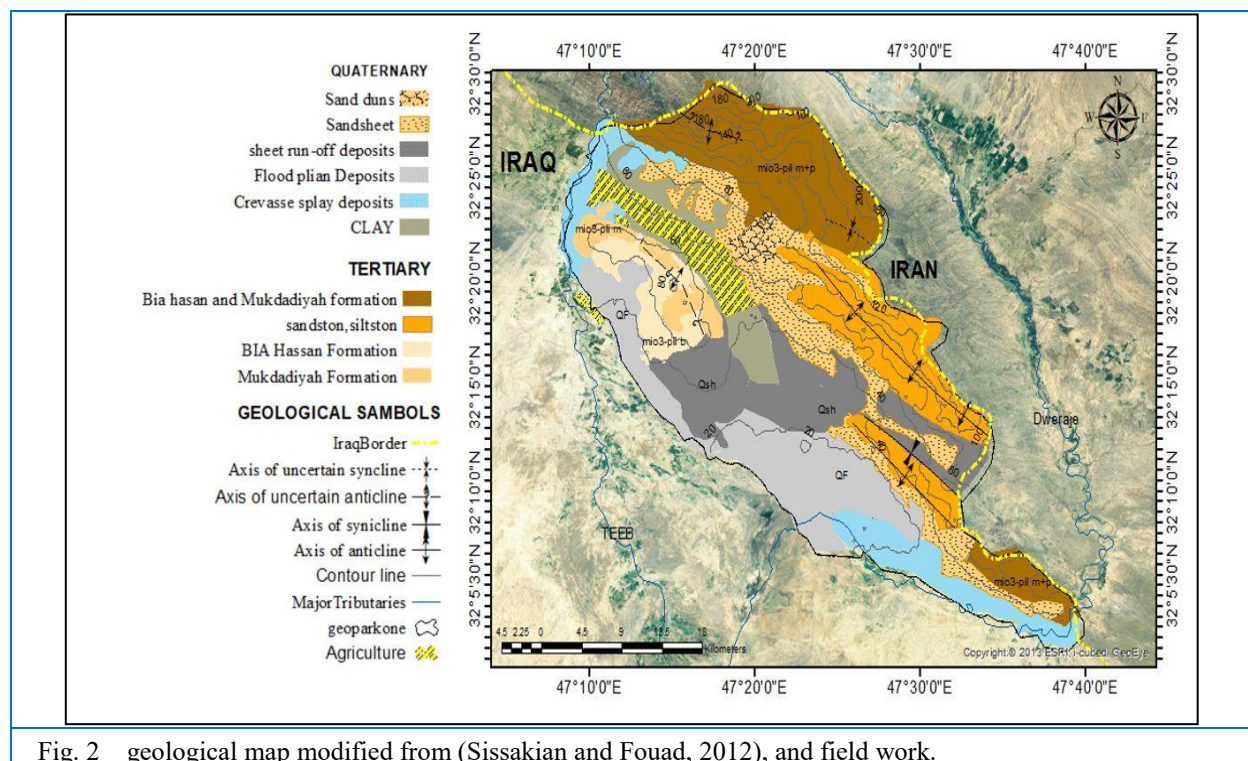
## 4. Geological condition or Geological setting of study area

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<br>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                |

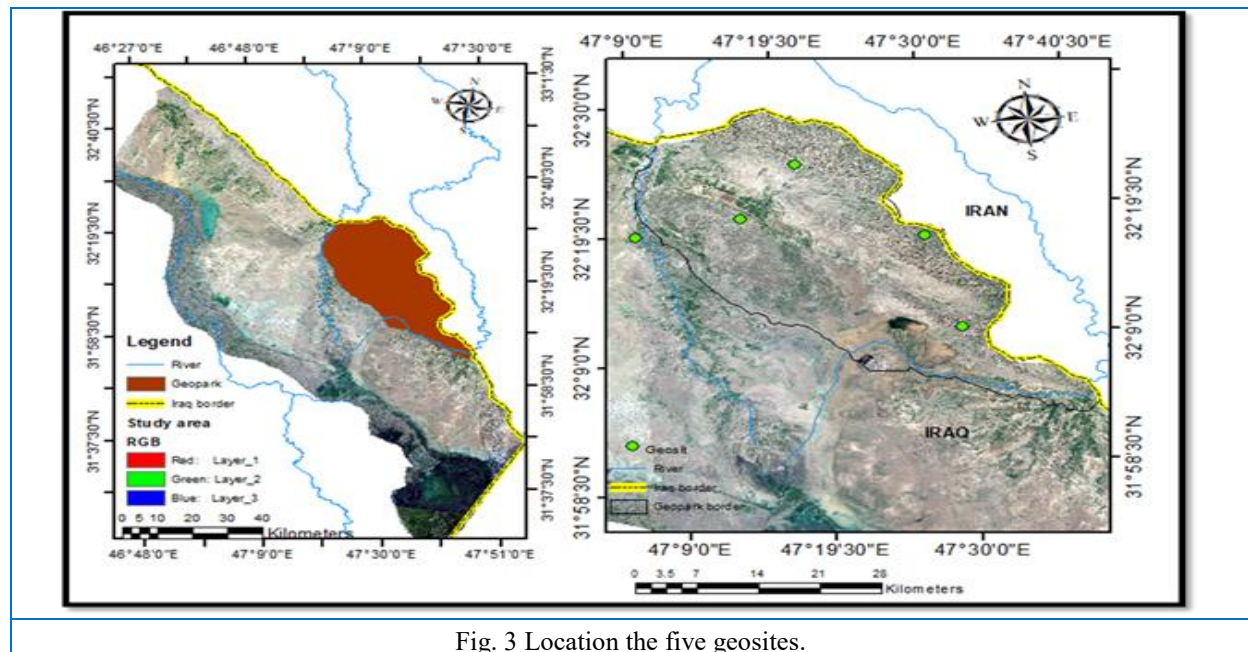


Fig. 3 Location the five geosites.

### 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 |
|----------|----------------------|-----------------------------------------------------------------------------------------------------------------|-------|
| <b>1</b> | 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    |
| <b>2</b> | 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    |
| <b>3</b> | 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    |
| <b>4</b> | 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    |
| <b>5</b> | 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 |
|----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| <b>1</b><br><br>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    |
|                                              |                                                                                                                                                               |       |
| <b>2</b><br><br>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    |
|                                              |                                                                                                                                                               |       |
| <b>3</b><br><br>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    |
| <b>4</b><br><br>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    |
|                                              |                                                                                                                                                               |       |
| <b>5</b><br><br>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

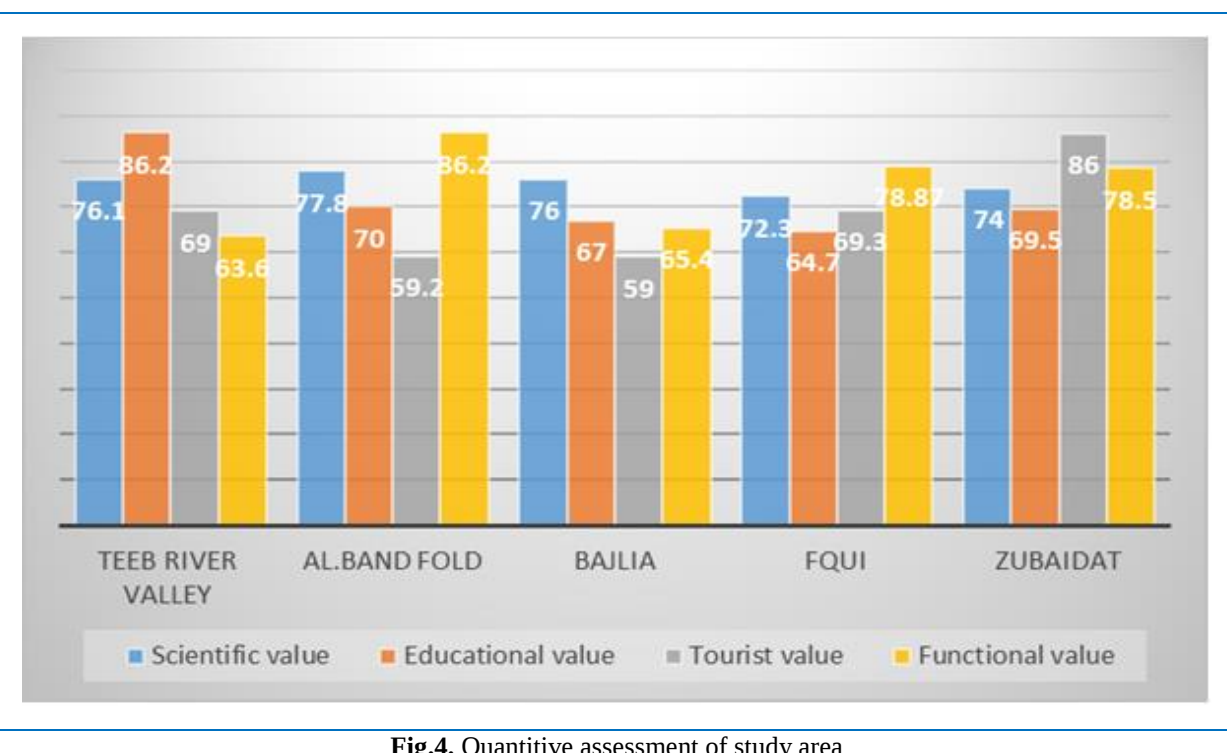
| indicator                                 | Question                                                                     | Score |
|-------------------------------------------|------------------------------------------------------------------------------|-------|
| <b>1</b><br><i>Scenery</i>                | 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    |
| <b>2</b><br><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    |
| <b>3</b><br><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    |
| <b>4</b><br><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    |
| <b>5</b><br><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 |
|----------------------------------------------------|---------------------------------------------------------------------|-------|
| <b>1</b><br>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    |
| <b>2</b><br>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    |
| <b>3</b><br>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    |
| <b>4</b><br>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    |
| <b>5</b><br>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.

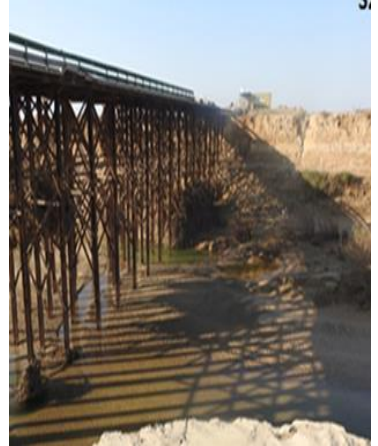
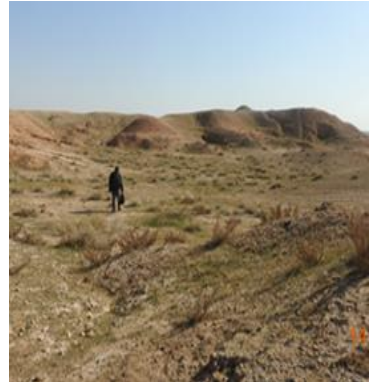
3- The scientific value of Al-Bajalia site is very high.

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

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

**Acknowledgments:** The researcher would like to thank everyone who has helped us and convey their sincere gratitude.

**Author Contributions:** The authors contributed to all parts of the current study.

**Funding:** This study received no external funding.

**Conflicts of Interest:** The authors declare no conflict of interest.

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