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Inventory and Assessment of the Geomorphosites of Bahariya –Farafra Territory, Western Desert, Egypt

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Abstract

The study area forms the central territory of the Western Desert, Egypt, and encompasses two declared Protected Areas namely, the White Desert National Park and Al Wahat Al Bahariya under the law number 102 /1983 in the framework of protected areas in Egypt. The Ministerial Decrees No. 1220/2002 and No. 2656/2010 declared the White Desert National Park to protect spectacular karst landscapes and associated erosional features and Al Wahat Al Bahariya Protected Area to protect the sites of the Cenomanian Dinasour as a natural heritage and the black duricrusted cone hills. The present study presents an inventory and assessment for the wonderful geosites within the Bahriya- Farafra territory, Western Desert, Egypt, with emphases on the protected areas, using inclusive inventory cards for each selected site. Firstly, up to 52 potential sites are selected representing the remarkable historical geological evolution of the Early Cretaceous to a Recent time span. Later nineteen of them as significant geomorphosites have been subjected to further assessment. The main inventory results revealed that the Bahariya - Farafra territory has a great geodiversity reflecting high scientific, aesthetic and management values for various activities of geotourism and education and research institutions. Protection and conservations of the recorded geosites are available to a certain extent, but still not high enough to regulate the visiting activities. The visitors' awareness is of very low level due to the lack of an adequate infrastructure and qualified administrative and guiding staff.

Keywords: Geoheritage; Geosite; geomorphosites; inventory; assessment; protected area.

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1. Introduction

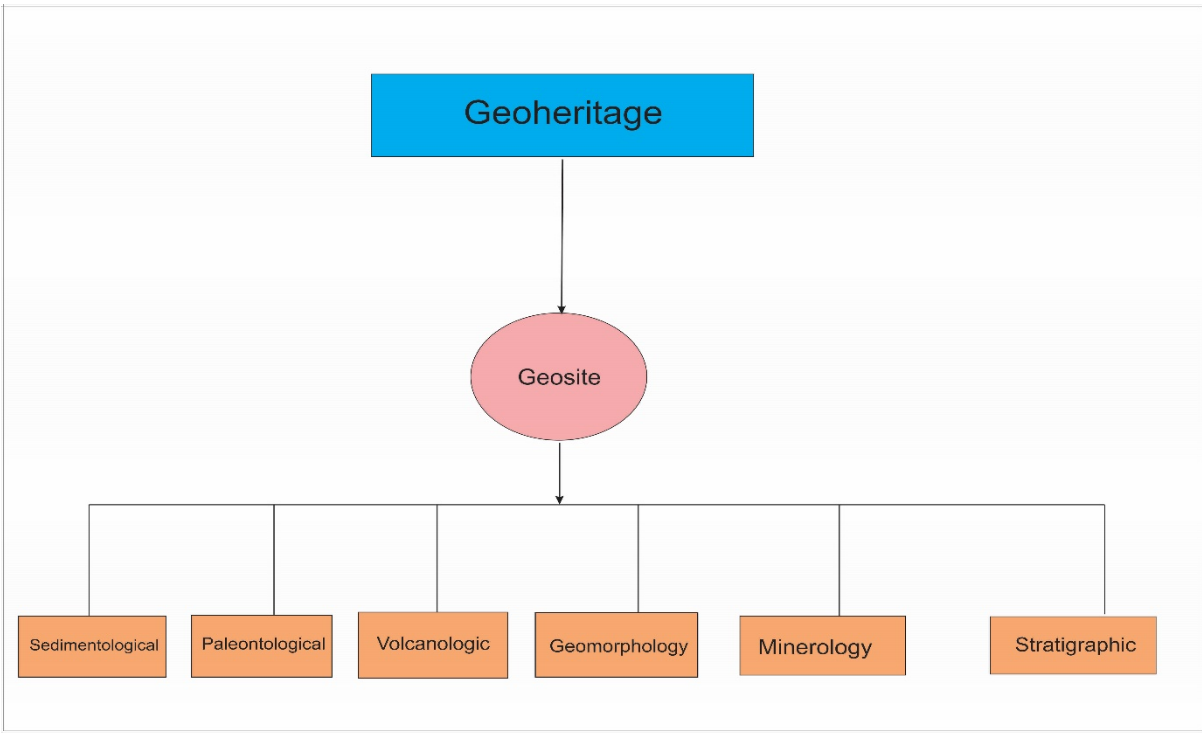

Figure 1: The relationship between Geoheritage and Geosite [1]

The term geoheritage is defined by Dixon [1] as the components elements of natural geodiversity of significant value to humans, including scientific research, education, aesthetics and inspiration, cultural development and a sense of place experienced by communities (Figure.1).

It is a generic term comprising a place where the geomorphological and geological setting makes the landscapes distinctive features, or defined as apportions of the geosphere that present a particular importance for comprehension of earth history, geological or geomorphological objects that have acquires scientific, cultural, aesthetic or essential economic value due to human perception or exploitation [2]. The geosite can be divided into groups, including sedimentological, stratigraphical, volcanic, geomorphological, petrographical and mining. term “Geomorphological” became widely used since the beginning of the 90’s and researchers from all over Europe started discussing the issues of conservation of geological and geomorphologic landforms and landscapes. Different terms have been used in literature to describe geomorphologic landforms such as geomorphological assets[3], geomorphological goods[4] (Carton and his colleagues 1994), geomorphological sites [5], geomorphological geotopes [6], sites of geomorphological interest [7]. The term «geomorphosite» has recently been introduced as an acronym for «geomorphological site» [8]. It is defined as a landform that has acquired a special value due to human perception or exploitation [3]. This value depends on the scientific, ecological, environmental, cultural, aesthetic and/or economic importance [9], (Figure.2). The scientific value must be seen as a fundamental kind of value for that recognition but other types of value like cultural, ecological or aesthetic are often considered in the selection and comparison of geomorphosites, Economic value refers mainly to the tourism potential of sites. Authors [6] and [9] defined the term geomorphosite as any part of the

Earth's surface that is important for the knowledge of Earth, climate and life history.

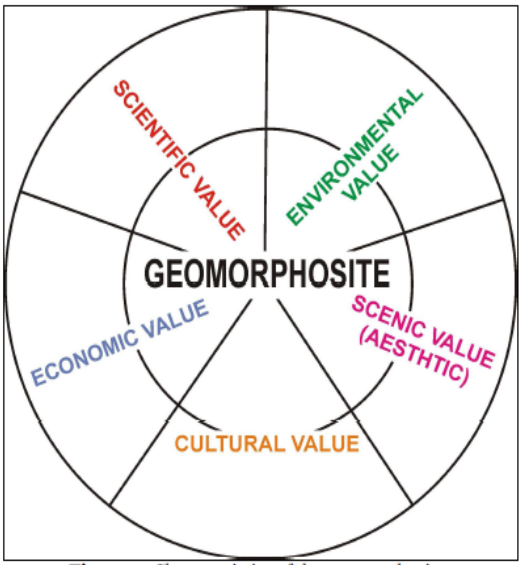

Figure 2: The characteristics of geomorphosites according to [9]

The term inventory means identification of potential geomorphosites. One of the essential aims of the inventory stage is the selection of landforms that can be defined as geomorphosite. The inventory processes involve the detailed analysis of all sites of geomorphological features within a study area.

2. Geology and karst morphology

The study area is located in the central Western Desert of Egypt and encompasses within it El Bahr Valley and two large depression is known respectively as El Bahariya and El Farafra Depressions (Figure.3). The exposed rocks in the study area are of sedimentary nature except for the occurrences of Oligo-Miocene basaltic flows and intrusions. This sedimentary succession ranges in age from Late Cretaceous to Recent. The distribution of carbonate rocks covers an area about 35.000 km2,and characterized by intensive dissolution and karst features, while the non-karst rocks include, sand and clays, sand dunes in El Bahr valley, Cenominean clastic rocks of Bahariya Formation, clastic rocks of Wadi Hennis Formation in the northern part of El Farafra Depression, Dakhla shales, interbedded clays and carbonate layers of Esna Formation and sand dunes covers an area about 20.000 km2 and in the El Farafra Depression hidden under it the karst rocks of Cretaceous and Paleocene age Fig.3. The surface karst landforms and morphology in the study area were classified by [10] in press into sixteen assemblage fields include, El Bahr Valley, Karst depressions, cone karst, Carbonate pavements, rejuvenated karst and Degraded caves, MaqfiUvala, Polygonal doline karst, Tower karst, Mushrooms, karren, Half dome (Chocolate balls), Ripple, Degraded karst, solution basin(pan-like), Karst inselbergs and Grike and Client which used to produce karst map for the first time in Egypt (Figure 4). Each field includes several residual landforms shaped by karstification processes and some geosites produced as a result of volcanic activities. These fields help us to identify the important geological and geomorphological sites within the studied region**.**

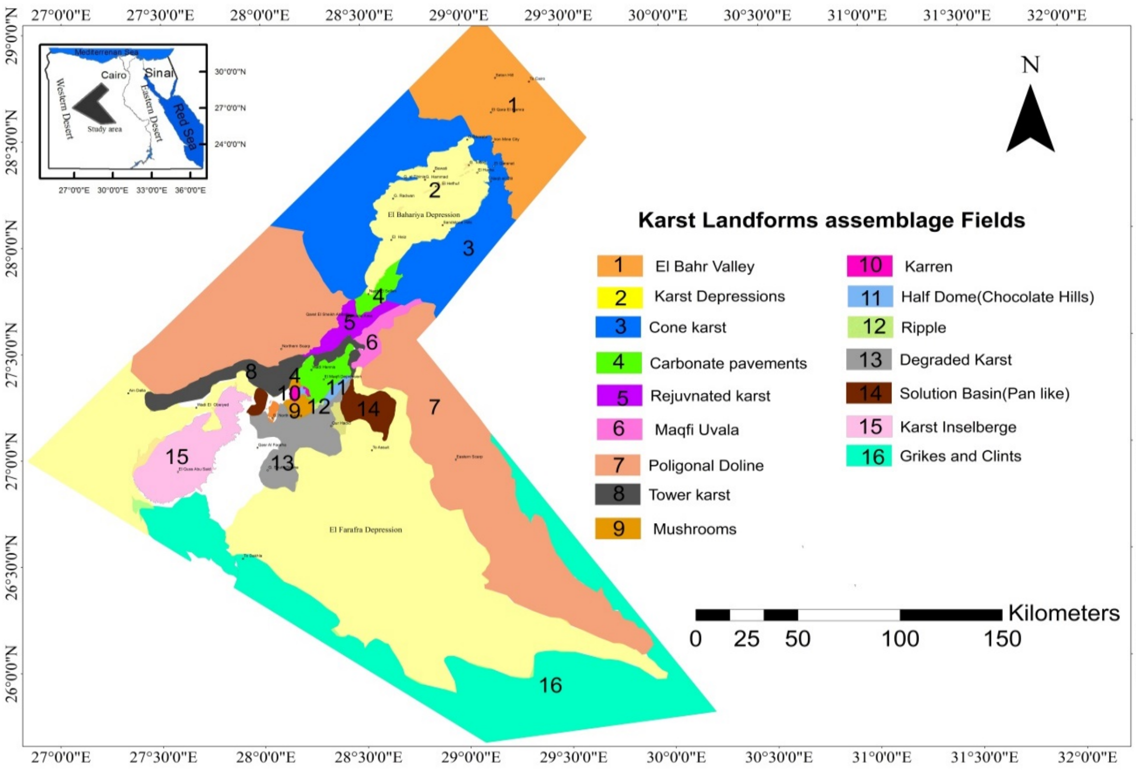

Figure 3: Location map of the study area and encompasses protectorates. Note the distribution of karst and non-karst rocks

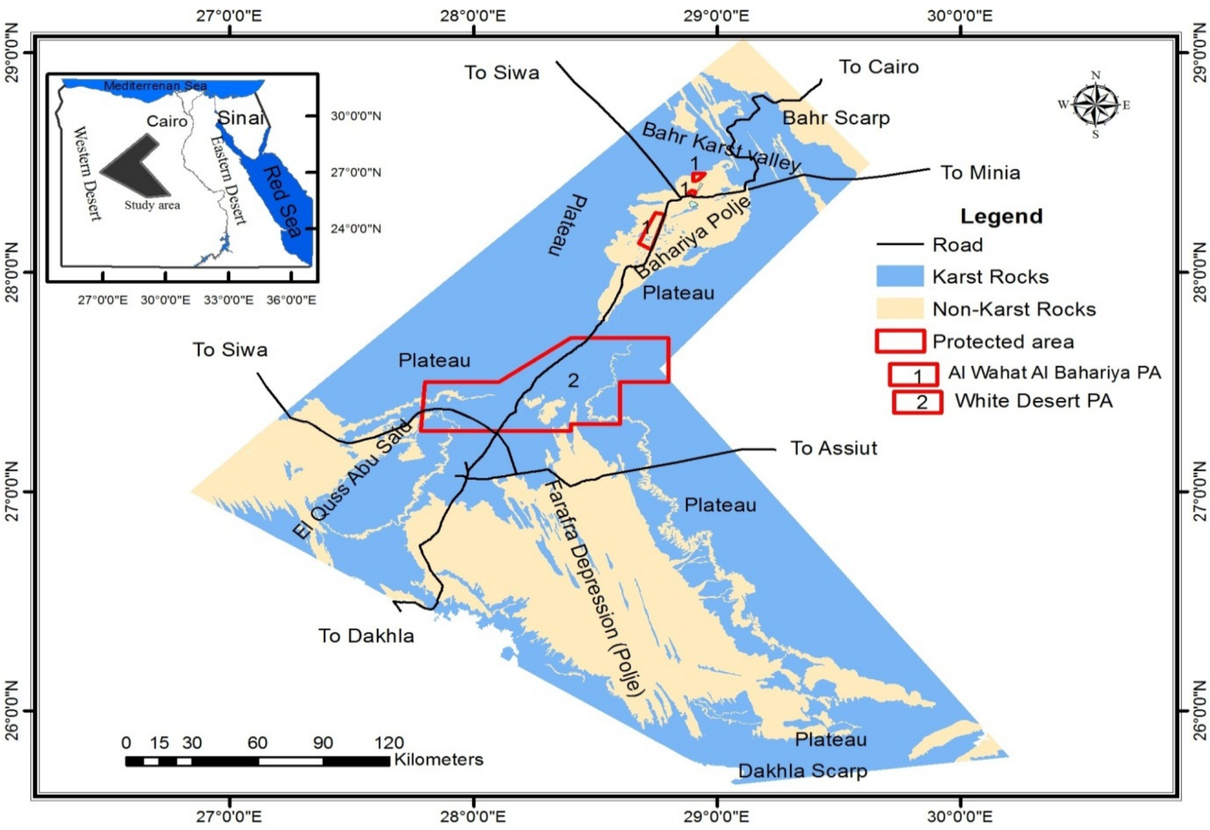

Figure 4: Karst Map shows different karst landform fields in the study area after El Aref and his colleagues [10]

3. Methodology

Since 1990s various inventory and assessment methods for geosite and geomorphosite were introduced by several authors (e.g., [3,11,12,13,14,15,16,17,18]. The present study followed the methodology of [19] and the reputable methodological guidelines of [20] , shown in (Figure 5). stage, of the important geomorphosites are collected, depending on the detailed field observations and documentation on the entire surface of the study area. During the quantification stage, the importance of each site is determined by numerical assessment of criteria, allowing the comparison of sites. The approach is based on the previous definition of three types of geomorphosites according to the observation scale including single places, areas and panoramic viewpoints.

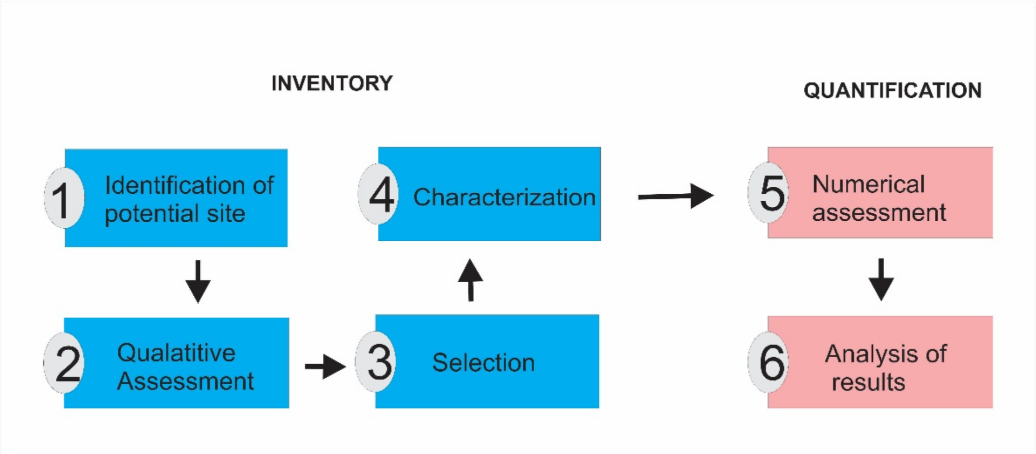

Figure 5: The main stages and sub-stages used in geomorphosite assessment after [20].

4. Inventory of the Geomorphosites

Step 1: Selection of potential geosites

Up to 52 important sites are selected and identified (Figure.6 and Table 1) based on various criteria including:

i. the scientific value (adopted from the results of the present work),
ii. The value of landform aesthetics and characteristics in relation to sites in the same type or of other areas,
iii. The relationship between landforms and cultural elements, such as archaeological features and,
iv. links between landforms and ecological issues, such as fauna and flora populations. The result of the inventory stage shows that most sites are of karst type (Table 1).

Step 2: Qualitative Assessment

After identification of sites, use is made of a qualitative evaluation process to determine geomorphological intrinsic value, potential use, and required protection. The assessment is based on the basis of knowledge and existing detailed inventory of the potential geosites and geomorphosites. The geomorphological value is defined by comparison of sites against their scientific, ecological, cultural and aesthetic performance, with scores being given from nil (0) to very high (5) for each of the criteria. Potential use is defined on the basis of three main criteria: accessibility, visibility, and evidence of importance in other areas (e.g. biological, archaeological). The latter aspect thus also takes a current promotion and use of a site in other fields into account. Required protection includes assessment of the level of intactness (deterioration) and vulnerability, with scores ranging from high (3) to low (1). Although the qualitative assessment may be brief, subjective and strongly influenced by the assessor's understanding of geomorphology and geo-conservation, it is a fundamental step in the overall assessment. The results serve as a basis for the further stages in the inventory phase (Table. 2).

Step 3: Geomorphosite selection.

Only 19 landforms from the ones listed above could truly be classified as geomorphosites (Figure.1) based on their rank performance during the qualitative assessment, those sites that scored overall highest being selected for further characterization.

Step 4: Geomorphosite Characterization

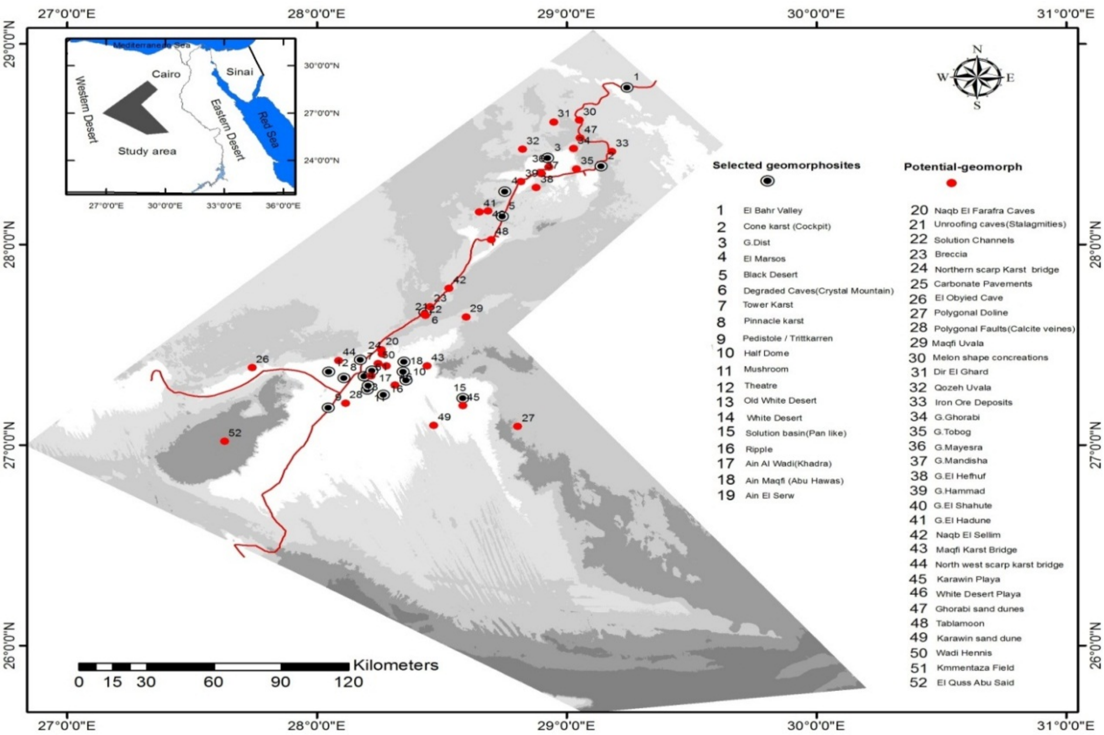

Figure 6: Geomorphosite location map of the potential and selected geomorphosites.

In this step the characterization of Geomorphosites aims to collect a set of wide-ranging data, including name of the site, location, coordinates, owner (public or private) of the land, cartographic data, description, accessibility, Legal protection, genesis, chronology, state of conservation, current use, impact of threats and contribution of the area in job opportunities. The present results are compiled and arranged (Table .3), using the guidelines of Pereira and Periera [20] and Serrano and Trueba [21].

5. Quantification of Geomphosites In Bahariya - Farafra Region

- ***Numerical Assessment***

According to Pereira and Periera [20], the framework for numerical assessment uses the criteria introduced in the previous stages but divides them up into different classes in order to create two levels, principal, and secondary indicators. The division of criteria takes into account the possible objectives of the assessment, i.e. the protection or promotion of geomorphosites. For this reason, the principal indicator geomorphological value includes the secondary indicators scientific value and additional values, while management value, as a second principal indicator, integrates the secondary indicators use value and protection value for a detailed description of each indicator. Regarding the weighting of results, the geomorphological value and management value are treated the same with a maximum of 10 points each (Table.4). The sum of all indicators determines the total value of the geomorphosite.

Table 1: The main Geological and Geomorphological landforms inventoried in the Bahariya- Farafra region

No.	Name of landform	Potential	selected	Type
1	El Bahr Valley		√	Ful/ karst
2	Cone karst(cockpit)		√	karst
3	G. Dist		√	stratigraphy/paleontology
4	G.Radwan(El Marsos)		√	volcanolgy
5	Black Desert		√	karst
6	Degraded Caves(Crystal mountain)		√	karst
7	Tower karst		√	karst
8	pinnacle karst		√	karst
9	pedistole/Trittekarren		√	karst
10	Half domeome		√	karst
11	Mushroom		√	karst
12	Theatre		√	karst
13	0ld White Desert		√	karst
14	White Desertst		√	karst
15	Solution basin (pan like)		√	karst/geomorphology
16	Ripple		√	karst/geomorphology
17	Ain El Wadi (Ain Khadra)		√	karst
18	Ain Abu Hawas (Ain Maqfi)		√	karst
19	Ain El Serw(Ain Maqfi)		√	karst
20	Naqb El Farafra Caves	√		geomorpholgy
21	Unroofing caves (stalagmites)	√		karst
22	solution channels			karst
23	Breccia			
24	karst bridges	√		karst
25	Carbonate pavements	√		karst
26	El Obyied Cave	√		karst
27	Polygonal Doline	√		karst
28	Polygonal FaultsCalcite vein)	√		karst
29	Maqfi Uvala	√		karst
30	Melon shape concretions	√		karst
31	Dir El Ghard Uvala	√		karst/structure
32	Qozeh Uvala	√		struct/karst
33	Iron ore Deposits	√		karst
34	Gebal Ghorabi	√		karst
35	G.Tobag			karst/struct
36	G.Mayesra	√		valcnoligy
37	G.Mandisha	√		
38	G.El Hefhuf	√		struc/ karst/basalt
39	G.Hammad	√		struc/ karst
40	EI Shalute syncline	√		struct/karst
41	EI Hadune syncline	√		struct/karst
42	Naqb Sellim	√		stratigraphic/palentology
43	Maqfi karst bridge	√		kasrt
44	North west karst bridge	√		kasrt
45	playa Karawin	√		geom
46	playa of White Desert	√		geom
47	Wadi Hennis	√		karst
48	kmmentaz	√		karst
49	Ghorabi Dunes	√		
50	Karawin dune	√		geomorphology
51	Tablomoon playa	√		geomorphology
52	El Quss Abu Said	√		geomorphology

Table 2: Criteria used in the Qualitative assessment of potential geomorphosites (after [20]

Criteria		Assessment
Geomorphological Value	Scientfic value(Sc)	2- Low 3-Medium 4- High 5- very high
	Additional Value(Adv.) Cultural(Cult.) Aesthetic(Aest.) Ecological(Ecol.)	0 - nile 1- very low 2- Low 3-Medium 4- High 5- very high
Use Value(Usv.)	Accessibility(Ac) Visibility (Vi) Other natural and cultural features	1- Very difficult 2- diffiicult 3- medium 4- easy / good 5-very easy/ very good
protection status	Integrity / intactness(In) Vulnerability(Vu)	1- Low 2-Medium 3- High

- ***Geomorphosite Ranking***

In this sub-stage, the results of the numerical assessment are recorded in a quantification table. All criteria are assessed for each of the geomorphosites. As all data are recorded on the same table, a direct comparison of site ranks is possible (Table.5). Whereas the sum of all principal and secondary indicators is expressed as a total value, the sum of rank positions according to an indicator (primary and secondary) are taken into account under final ranking. Consequently, the sites with lowest final ranking scores may be considered to be of greatest value in an assessed area.

The advantage of emphasizing rank averages in geomorphosite assessment is the greater attention given to overall relative value or homogeneity of criteria results. Thus, geomorphosites that score well over the full spectrum of indicators will also be amongst the best place in final ranking.

The final ranking is consequently felt to be particularly useful for supporting site management decisions with regards prioritization of measures for the protection, education (e.g. setting up trails, installation of descriptive panels) and promotion of geomorphosites (Pereira and Periera, 2010).

Table 3: Example of the description of geomorphosite characterization (inventory card), after [20] and [21].

GEOMORPHOSITE DESCRIPTION CARD			
Identification Site Name	Crystal Mountain (Degraded Caves)	No. 6	Photo
Comments	The term Mountain is invalid because the site cannot follow the criteria of the mountain from the elevation point of view.		
Place:	Qaret El Sheikh Abdalla(north Farafra oasis)		
Governorate:	New Valley		
Coordinates	N 27 39 40.84 E 28 25 50.34		
Altitude (a.s.l)	220 m		
landowner	public		
Type	Singular place		
Landforms description	Remnants of infilled caves are widely distributed in this karst terrain. Ultimate denudation led to the complete removal of the roofs and consequently exposing the internal cave sediments including variable forms of crystal calcite clusters, flowstones, dripstones and fructified calcite layers.		
Genesis	Degraded caves related to Karst processes		
Chronology	The original caves and cave sediments are of Cretaceous-Paleocene time span originated during multi-cycles of humid karstification and exposed to the surface during tectonically uplifting phase followed by younger paleo-karst denudation.		
Cultural content	Not present in the site		
Accessibility	√ Easy close to road ☐ Difficult far away from road ☐ Very difficult		
Level of interest	Very high due to its exceptional location within the WDNP.		
State of conservation	☐ Very good √ Good ☐ bad		
Current uses	The site is one of the most popular places for visitors come to the White Desert National Park		
Impacts or threats	Natural threats: does not exist Anthropogenic threats: does not exist (may exist due to the collection and damage of the calcite crystals)		

The area contributes to job opportunities	√ very High ☐ High ☐ Medium ☐ Low The area is very important to local communities accompanying the tourists to recreation and ecotourism activities.
Legal Status	Crystal mountain is a part of the White Desert protected area which declared by The prime Minister decree No.1220/2002 and protected by the law No.102/1983.
References	El Aref and his colleagues (1987); Present Work (2017).

Table 4: Criteria and indicators used in geomorphosite numerical assessment based on the methodology applied by [18,20].

Geomorphological Value (GmV., SCV +AdV) Maxiumum score (10)		
Scientfic value ScV = (Ra+In+Rp+Div+Ge+Kn+I Maxiumum(5.5)		**Max.Score**
Ra	Rareness in relation to the area	1
In	Integrity	1
Rp	Representativeness of geomorphological processes	1
Div	Divesity of (conetent) site (stratigraphical, geomorphological, etc	1
Ge	Other geological features with heritage value	0.5
Kn	Scientfic Knowledge on geomorphological issues	0.5
Rn	Rareness at national level	0.5
	Additional Value(Adv)=(Cult+Aest+ecol) Maxiumum(4.5)	
Cult.	Cultural value	1.5
Aest	Aesthetic value	1.5
Ecol.	Ecological value	1.5
Management Value (MgV.,UsV+prV) Maxiumum score (10)		
	Use value Usv = (Ac+Vi+Gu+Ou+Lp+Eq) Maxiumum(7.0)	
Ac	Accessibility	1.5
Vi	Visibility	1.5
Gu	present use of the geomorphological interest	1
Ou	present use of other natural and cultural interests	1
Lp	legal protection and use limitation	1
Eq	Equipemt and support services	1
	Protection Value (Vpr) = (In+Vu) Maxiumum (3.0)	
In	Integrity / intactness	1
Vu	Vulnerability of use as geomorphosite	2

	ScV. (5.5)	AdV.(4.5)	GmV.	UsV.(7)	PrV.(3)	MgV.	TV(20)	Rk
1 st	TK (5.5)	As (2.98)	Tk (7.75)	Dc (6.25)	TK (2.9)	Wd (8.74)	Tk (16.14)	Tk (17)
2 nd	Dc (5.25)	Am (2.68)	Di (7.28)	Wd (6.24)	Di (2.8)	Od (8.64)	Wd (15.6)	Di (29)
3 rd	Bd (5.3)	Tk (2.25)	wd (7.28)	Od (6.24)	CO (2.8)	Dc (8.5)	Di (15.44)	Wd (32)
4 th	Di (5.08)	Bh (2.21)	Bd (6.71)	Bd (6.17)	Ma (2.8)	Tk (8.39)	Dc (15.15)	Dc (32.4)
5 th	Wd (5)	Di (2.2)	Dc (6.65)	Mu (5.82)	Ah (2.75)	Bd (8.39)	Bd (15.1)	Bd (50)
6th	Sb (4.91)	Aw (2.08)	Mu (6.65)	Pe (5.54)	Th (2.7)	Mu (8.22)	Bd (15.1)	Od (52)
7th	Co (4.81)	Od (1.88)	Bh (6.54)	Tk (5.49)	As (2.7)	Di (8.16)	Mu (14.77)	Mu (54)
8 th	Mu (4.67)	Mu (1.88)	ow (6.46)	Hf (5.41)	pk (2.67)	As (7.89)	Hd (14.07)	Hd (77)
9th	Rp (4.66)	Wd (1.86)	Hd (6.46)	Di (5.36)	Rp (2.65)	Pk (7.83)	Sb (13.99)	Sb (78)
10 th	Hf (4.66)	Pe (1.85)	Sb (6.35)	As (5.19)	Bh (2.6)	Th (7.73)	Pe (13.9)	Pk (79)
11th	Od (4.58)	Hd (1.80)	pe (6.26)	Pk (5.16)	Ma (2.5)	Pe (7.64)	Pk (13.87)	As (82)
12 th	pk (4.49)	PK (1.55)	Co (6.23)	Aw (5.09)	Ak (2.5)	Sb (7.64)	Th (13.76)	Th (82)
13 th	Th (4.5)	Th (1.53)	Re (6.12)	Th (5.03)	WD (2.5)	Hd (7.61)	As (13.32)	Pe (86)
14 th	Ma (4.42)	Ma (1.5)	Pk (6.04)	Sb (4.84)	Mu (2.4)	Aw (7.59)	Re (13.32)	Ah (87)
15 th	pe (4.41)	Rp (1.46)	Th (6.03)	Ah (4.76)	Od (2.4)	Ah (7.51)	Co (13.04)	Co (90)
16 th	Bh (4.33)	Sb (1.44)	Ma (5.92)	Rp (4.55)	Dc (2.25)	Rp (7.2)	Ah (12.99)	Bh (92)
17 th	Ah (2.8)	Bd (1.41)	As (5.58)	Ma (4.09)	Bd (2.22)	Co (6.81)	Bh (12.77)	Rp (92)
18th	Aw (2.7)	Cr (1.42)	Ah (5.58)	Co (4.01)	Hd (2.2)	Ma (6.59)	Ma (12.51)	Aw (100)
19 th	As (2.6)	dc (1.4)	Aw (4.78)	Bh (3.63)	pe (2.1)	Bh (6.23)	Aw (12.37)	Ma (101)

Table 5 : Quantified results of 19 selected Geomorphosites in the study area based on the guidelines of Pereira and his colleagues *(*2007)[18] and Pereira and Pereira (2010).[20]

	Geomorphosite Name	ScV. (5.5)	AdV.(4.5)	GmV.	UsV.(7)	PrV.(3)	MgV.	TV(20)
1	El Bahr Valley (Bh-1)	4.33	2.21	6.54	3.63	2.6	6.23	12.8
2	Cone karst(Co)	4.81	1.42	6.23	4.01	2.8	6.81	13.0
3	G. Dist (Di)	5.08	2.2	7.28	5.36	2.8	8.16	15.4
4	G.El Marsos (Ma)	4.42	1.5	5.92	4.09	2.5	6.59	12.5
5	Black Desert (Bd)	5.3	1.41	6.71	6.17	2.22	8.39	15.1
6	Degraded Caves(Crystal mounta	5.25	1.4	6.65	6.25	2.25	8.5	15.2
7	Tower karst (TK)	5.5	2.25	7.75	5.49	2.9	8.39	16.1
8	pinnacle karst(Pk)	4.49	1.55	6.04	5.16	2.67	7.83	13.9
9	pedistole/Trittekarren(pe)	4.41	1.85	6.26	5.54	2.1	7.64	13.9
10	Half dome(Hd)	4.66	1.8	6.46	5.41	2.2	7.61	14.1
11	Mushroom Chicken Mu)	4.67	1.88	6.55	5.82	2.4	8.22	14.8
12	Theatre(Th)	4.5	1.53	6.03	5.03	2.7	7.73	13.8
13	old White Deset(Od)	4.58	1.88	6.46	6.24	2.4	8.64	15.1
14	White Desert(Wd)	5	1.86	6.86	6.24	2.5	8.74	15.6
15	Solution basin pan like(Sb)	4.91	1.44	6.35	4.84	2.8	7.64	14.0
16	Ripple (RP)	4.66	1.46	6.12	4.55	2.65	7.2	13.3
17	Ain El Wadi (Ain Khadra)(Aw)	2.7	2.08	4.78	5.09	2.5	7.59	12.4
18	Ain El Serw(Ain Maqfi) (As)	2.6	2.98	5.58	5.19	2.7	7.89	13.5
19	Ain Abu Hawas (Ain Maqfi)(Ar	2.8	2.68	5.48	4.76	2.75	7.51	13.0

6. Results and Conclusion

The inventory stage revealed that 52 potential sites represent the evolution stage of the earth history of the study area from Early Cretaceous to Recent. Nineteen important geomorphosites were selected for further assessment (Figure.6, Table 6.). These sites are located within two protected areas; Al Wahat Al Bahariya protected Area and White Desert National Park. The single places are all landforms with high natural geomorphological value, whereas a large number of panoramic viewpoints reflects a touch of pragmatism, as from these points a great variety of landforms can easily be observed and recognized. Most of the selected morphosites are of karst origin controlled mainly by the structural geometry and lithology of the host rocks as well as with the climatic conditions.

The results of the numerical assessment and ranking of geomorphosites are presented in Table 6. the analysis revealed that the sites often have a height scientific value. As shown in Tables (6 and 7), Tower

karst (Tk) in Farafra area appears to be the most valuable geomorphosite in the White Desert National Park, scoring highest in total value and final ranking, despite coming first in both geomorphological and management value (1st order). These back to the site representative of good processes, with high geodiversity and have good habitat for endangered bird species (Sooty Falcon) in addition to the

importance of the site for tourist attraction. The sites G. Dist (Di), White Desert (Wd), are equals in geomorphological values. G. Dist (Di) is the second higher rank (2nd order), as it includes Dinosaur bone fragments and traces. While the white desert (Wd) came the third in the final ranking (3rd order), this back to has a higher management value (tourist attraction). Old White Desert (Od), Degraded Caves (Dc), Black Desert (Bd), Mushroom (Mu) and Half Dome (Hd), are the strongest in terms of management value (8.64), (8.5), (8.39), (8.22) and (7.61), respectively. In spite of Od has high value in management value it was the 6th in the final ranking value due to a low geomorphological value as the site not supported by biological diversity. The other geomorphosites have higher values in both geomorphological and management values. Figure 7.

Table 6 : Ranking results of 19 selected Geomorphosites in the study area

	ScV. (5.5)	**AdV.(4.5)**	**GmV.**	**UsV.(7)**	**PrV.(3)**	**MgV.**	**TV(20)**	**Rk**
1 st	TK (5.5)	As (2.98)	Tk (7.75)	Dc (6.25)	TK (2.9)	Wd (8.74)	Tk (16.14)	Tk (17)
2 nd	Dc (5.25)	Am (2.68)	Di (7.28)	Wd (6.24)	Di (2.8)	Od (8.64)	Wd (15.6)	Di (29)
3 rd	Bd (5.3)	Tk (2.25)	wd (7.28)	Od (6.24)	CO (2.8)	Dc (8.5)	Di (15.44)	Wd (32)
4 th	Di (5.08)	Bh (2.21)	Bd (6.71)	Bd (6.17)	Ma (2.8)	Tk (8.39)	Dc (15.15)	Dc (32.4)
5 th	Wd (5)	Di (2.2)	Dc (6.65)	Mu (5.82)	Ah (2.75)	Bd (8.39)	Bd (15.1)	Bd (50)
6th	Sb (4.91)	Aw (2.08)	Mu (6.65)	Pe (5.54)	Th (2.7)	Mu (8.22)	Bd (15.1)	Od (52)
7th	Co (4.81)	Od (1.88)	Bh (6.54)	Tk (5.49)	As (2.7)	Di (8.16)	Mu (14.77)	Mu (54)
8 th	Mu (4.67)	Mu (1.88)	ow (6.46)	Hf (5.41)	pk (2.67)	As (7.89)	Hd (14.07)	Hd (77)
9th	Rp (4.66)	Wd (1.86)	Hd (6.46)	Di (5.36)	Rp (2.65)	Pk (7.83)	Sb (13.99)	Sb (78)
10 th	Hf (4.66)	Pe (1.85)	Sb (6.35)	As (5.19)	Bh (2.6)	Th (7.73)	Pe (13.9)	Pk (79)
11th	Od (4.58)	Hd (1.80)	pe (6.26)	Pk (5.16)	Ma (2.5)	Pe (7.64)	Pk (13.87)	As (82)
12 th	pk (4.49)	PK (1.55)	Co (6.23)	Aw (5.09)	Ak (2.5)	Sb (7.64)	Th (13.76)	Th (82)
13 th	Th (4.5)	Th (1.53)	Re (6.12)	Th (5.03)	WD (2.5)	Hd (7.61)	As (13.32)	Pe (86)
14 th	Ma (4.42)	Ma (1.5)	Pk (6.04)	Sb (4.84)	Mu (2.4)	Aw (7.59)	Re (13.32)	Ah (87)
15 th	pe (4.41)	Rp (1.46)	Th (6.03)	Ah (4.76)	Od (2.4)	Ah (7.51)	Co (13.04)	Co (90)
16 th	Bh (4.33)	Sb (1.44)	Ma (5.92)	Rp (4.55)	Dc (2.25)	Rp (7.2)	Ah (12.99)	Bh (92)
17 th	Ah (2.8)	Bd (1.41)	As (5.58)	Ma (4.09)	Bd (2.22)	Co (6.81)	Bh (12.77)	Rp (92)
18th	Aw (2.7)	Cr (1.42)	Ah (5.58)	Co (4.01)	Hd (2.2)	Ma (6.59)	Ma (12.51)	Aw (100)
19 th	As (2.6)	dc (1.4)	Aw (4.78)	Bh (3.63)	pe (2.1)	Bh (6.23)	Aw (12.37)	Ma (101)

Finally, we can conclude that the Bahariya - Farafra region has a great geodiversity reflecting high scientific, aesthetic and management values very much attractive for various types of geotourism and educational and research institutions. All the activities of desert safari are based on marketing the geomorphosites or landscape in the study area and represent the main generate income for the local communities in both Bahariya and Farafra Depressions. The protection and conservation of the area is present to a certain extent, but still not high enough to regulate visits to each area. The education of visitors is also on a very low level due to the lack of adequate infrastructure and qualified staff who should be engaged in education and interpretation**.**

Table 7 : Types of the selected geomophosites.

Type	N0.	Name
panoramic viewpoints	8	Old White Desert, White Desert, Theatre, Ain Abu Hawas (Ain Maqfi. Ah), Ain El Serw (As), Ain El Wadi (Ain Khadra. Aw) Springs, El Bahr Valley, Black Desert
Areas	7	Crystal Mountain (Degraded Caves), Solution Basins (Pan Like), Ripple Cuesta-Like Forms, Cone Karst, Pedestal/Trittekarren, Marsos and Half Dome Forms.
single places	4	Pinnacle, Tower, Mushrooms and G. Dist,

Figure 7: Selected important gemorphosites

a) Tower karst in the Farafra Depression; b) Panoramic view of G.El Magraph at El Bahariya Depression, the dinosaur site c) Panoramic view of the White Desert; d) Remains of unroofed cave fills (crustified calcite like octopus shape e) Panoramic view showing conical hills of the black desert; f) Panoramic view showing ruins for remains of old lakes in White Desert. g) Panoramic view of Mushrooms karst zone (Cheiken) in White Desert, Farafra Depression; h) Panoramic view of Al Masrah; i) Columnar joint of Basalt at G.El Marsos one of attractive point for tourists in Al Wahat Al Bahariya Protected area; j) Pinnacle karst in White Desert Protected area k) Al serw karst spring in White Desert National Park;l) Remains of chalk (Pedistole) with conspicuous trittkarren.

7. Recommendations

1. So far in Egypt, the inventory and assessment of the various geosites are completely missed and the present work represents the first milestone for future processes of geomorphosites identification and inventory.
2. It is highly recommended to use the recorded data in the structure and design of the guide and geotour maps.
3. Implementation of the obtained results in another area to evaluate the geomorphosite in Protected Areas in Egypt as a step to create geoparks.
4. Focusing should be done in the interplay between the humid paleokarst features and the arid recent abrasion and sedimentation.
5. The present inventory and assessment data of the study area should be re-evaluating and re-assist with the other comparable features of national and international worldwide scale.
6. It constitutes the base for the preparation of various geotourist products (educational trails, panels, and leaflets).
7. Increase the public awareness of local guides and tourist guides by the importance of geological and geomorphological heritage to preserve it for future generations.

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