Topography of Tel Al-Nasr and its Archaeological Importance Using Geographic Information Systems

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Abstract

The main bed rock units of studied area comprises: Sandstone, siltstone claystone, Limestone, dolostone, dolomitic limestone and marl. While the main topographic features are: hill, plateau, valleys and depression. The isolated hill named; Tel Al-Nasr elevated more than 25 meters over surrounded areas. The main important plateau is Mulussa, which composed of Limestone and dolostone, overlined by Tel Al-Nasr Archaeological Site. Wide Mulussa plateaus dissected by large and deep valleys such as Wadi Hauran, Wadi Ajrumiyat, Wadi Dwekhla, Sahib Al-Agarri, Wadi Njeli, and Wadi Mulussa. The main and important depression in the area is the Ga′ara Depression, about 70 km long and 35 km wide, which far about 10 km from Tel Al- Nasr. This hill got its archaeological importance due to its elevation on a wide plateau, its location between many archaeological sites and on the trade road between Euphrates River and Arabian Peninsula as well as inhabited by ancient human for different time periods. A Visibility analysis was performed with ERDAS Imagine Ver. 9.2, using Digital Elevation Model (DEM) produced from SRTM. Frequently archaeologists are concerned with whether one site is visible from another site.

Key words: Iraq, Tel Al-Nasr, Topography, Archaeology, Visibility, GIS.

طبوغرافية موقع تل النسر وأهميتها الاثارية باستخدام نظم المعلومات الجغرافية

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الخلاصة

تضم المنطقة المدروسة طبقات صخور رملية، وكلسية، ودولوماتية، وكلسية دولوماتية، ومارل، وغرينية، وطينية. والمظاهر الطبوغرافية الرئيسة في المنطقة هي: تل النسر، وهضبة الملصي، وعدة وديان، ومنخفض الكعرة. ويمثل تل النسر المرتفع الطوبوغرافيا الوحيد في المنطقة والذي يزيد ارتفاعه عن 25 متر عن هضبة الملصي التي تقطعها الكثير من الوديان الكبيرة والعميقة مثل وادي حوران، وعجرميات، ودويخلة، والاغري، ونجيلي، وملصي، التي تجري باتجاه الشمال لتصب في منخفض الكعرة، الذي يصل طوله 70 كم وعرضه 35 كم. ويكتسب تل النسر أهميته الاثارية من وجوده بين عدة مواقع اثارية، وعلى طرق مواصلات برية تربط بين نهر الفرات والجزيرة العربية، واستيطانه لفترات زمنية مختلفة. تم أنجاز تحليل مدى الرؤية ضمن برنامج ERDAS ألنسخة 9.2 باستخدام موديل ألارتفاع الرقمي DEM المنتج من SRTM اذ يهتم علماء ألآثار عن امكانية رصد موقع ما من موقع أخر.

الكلمات ألمفتاحيه: العراق, تل النسر, الطبوغرافية، علم ألآثار, مدى الرؤية, و نظم المعلومات الجغرافية.

Introduction

There is interaction between human and surrounded nature (Tilley, 1996) and intrinsic relationship between archaeological site and natural resources particularly with topography. The term "topography" from archaeological point of view, usually means a combination of several different subjects, including: the geography & natural resources of a site and different functional areas within a site or its surrounded such as sanctuaries, civic centers, market places, workshops, private (1). Archaeological sites cannot be understood without taking topography and surrounding landscape into account. Ancient dwelling human chosen places where an optimal protection from destruction natural forces (weather, flooding) and enemy attacks is possible, and the supply of essentials (food, water, kindling) is assured as well (2, 3, 4). Special topographic features are chosen in all religions places of worship or as sites for the location of buildings. The location of all those objects in landscape was a result of practical or metaphysical considerations and rules. The landscape surrounding a cultural heritage object should be considered, studied and documented too. When the present topography is surveyed, mapped and visualized, historical evidence may be used to reconstruct landscape (5). GIS are an ideal means to manage data of archaeological sites and can be uses for documentation. A few archaeological sites are already documented and managed using GIS-techniques (3). A GIS provides tool to store, manage, analyze and visualize spatially related data.

The field of satellite remote sensing, like archaeology, will always advance, becoming broader as satellite technology improves and the general public becomes more aware of its existence. The overall quality of science applied in archaeology improves. The major benefits of remote sensing to archaeology are they provides a regional outlook of archaeological sites and features, relatively rapid procedure, non destructive and multi- spectral (6, 7, 8).

The aim of this Research is to show and interpret the importance of the topography of Tel Al-Nasr on the ancient human dwellings at this site using GIS techniques.

2- Materials and Methods:

2-1- Location: Tel Al-Nasr is located at western desert of Iraq, about 400 km west Baghdad, and about 35 km north of Rutba Town at the coordination:

Long. : 40° 25′ 00″ Lat.: 33° 21′ 00″

Geological setting of the studied area being part of the Rutba Uplift falls within the northeastern edge of the Arabian platform.

2-2- Climate: The meteorological data taken from surrounded meteorological station: Rutba on the south, Qaim on the north west, Ana and Haditha on the north east; as shown in (Table-1), (9). According to the above data, the study area can be classified as arid to semi-arid area.

Torrential rains are characteristic to the studied area, during which, and/ or later, the ephemeral streams become flooded with flash flowing water.

Table-1: Climatic Information of Rutba, Qaim, Ana and Haditha (IGOMI, 2000).

Station	Max. Temp. ˚C	Min. Temp. ˚C	Wind Speed m/ sec.	Annual Precipitation (ml./year)	Annual Evaporation (ml./year)
Rutba	14.6- 38.3	1.9- 22.8	2.3- 4	125.3	2720
Qaim	14.5- 40.5	3.3- 24.3	1.9- 4.1	142.2	2646.3
Ana	14.6- 41.6	2- 32.7	1.8- 5.4	167.4	2716.9
Haditha	15.3- 42.3	4.1- 25.5	2.1- 5.4	141.7	3368.9

2-3- Aim of study: This study attempt to show and interpret the importance of the topography of Tel Al-Nasr on the ancient human dwellings at this site according to visibility analysis-GIS of Tel Al-Nasr region.

2-4- Methodology: The source of the data presented in this study was depend on the field trips of the authors to survey the topographic features of the site and surrounded, in addition to applying visibility analysis on DEM of the study area, interpretation of field survey and compared it with visibility analysis and explanation of the importance of topography on ancient human behaviors. Figure (1) below represent the study area chosen for visibility analysis.

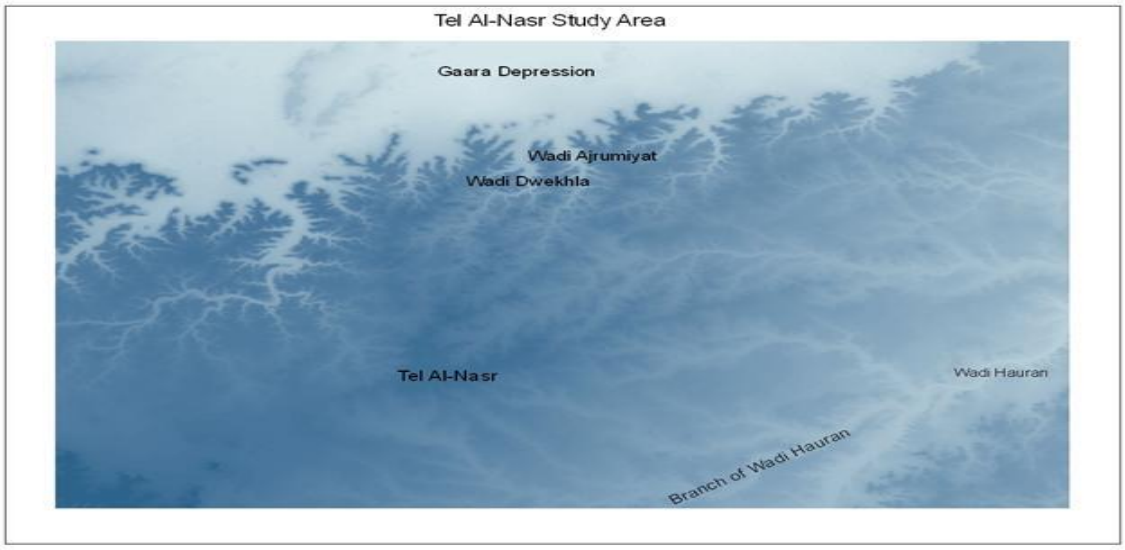

Figure (1) the study area.

The SRTM (Shuttle Radar Topography Mission) provides 3D global elevation data without charge to any user. Flown on the Space Shuttle Endeavor during an 11- day mission in February of 2000, NASA collected the data through a specialized radar system onboard the shuttle (10, 11). SRTM data is employed in many archaeological projects due to its cost and applications to a wide range of archaeological questions. Archaeologists can import the data into either a remote sensing program or a GIS, and then layer additional satellite data on top of it. Good digital elevation models (DEMs) also have numerous military and civilian applications, in addition to archaeological applications, as they all rely greatly on landscape reconstruction and visualization (12, 13). Archaeological teams have used SRTM data to model past landscapes (12). Any past landscape reconstruction studies would benefit from SRTM data, considering the cost of the imagery and the terrain detail it can provide. Radar imagery has many advantages and disadvantages for archaeological use (14). Visibility analysis did not really become popular in archaeology until the late 1980's. There are a number of ways that visibility analysis could be applied to archaeological problems (15, 8).

3- Results and Discussion:

3-1: Topography: Topography of studied area reflects arid and semi-arid conditions, and resulted from erosion and sedimentation on the structural elements, although the former is more effective (18). Topographic feature related to rock bed units (formations) (table-2).

(Table-2): rock bed units (formations), thickness, age, and lithology of the studied area according to (16, 17).

Formation	Thickness (m)	Age	Litho logy
Msad	65	L- Cretaceous	Limestone, marls, sandy marl and sand.
Rutba	54	L- Cretaceous	Cross bedded, medium to coarse grained sandstone, composed mainly of quartz (> 95%)
Mulussa	100 (Ajrumiyat valley)	L- Triassic	Limestone, dolostone, dolomitic limestone and marl.
Gaara	140 exposed	E-L Permian	Sandstone, siltstone and claystone.

Field survey of the studied area and surrounded shows diverse type of topographic features such as: hills, plateaus, valleys and depression.

Hills: hills are common in the western desert of Iraq, but the more important one is the Tel Al-Nasr, that lying on wide plateau called mulussa plateau (Fig. 2- a,b). This hill surrounded by semi flat area that its radius may be reach to 20 km. The elevation hill range between 660 and 685 meters above mean sea level. Topographically, Tel Al-Nasr can be subdivides into three levels: 1st level on the plateau about 660 meter and below in the vallies. 2nd level, about 685 meter on the intermediate zone of the hill. 3rd level, more than 685 meter, that represent the top of hill. Lithologically, this hill comprises white to varicolored cross-bedded, medium to large pebbly sandstone (18).

Plateaus: many plateaus present at studied area and surrounded, but the main important one is Mulussa plateau (Fig. 2- b), which composed of Limestone and dolostone, and over lined by Tel Al-Nasr Archaeological Site. This plateau can be considered as one simple plateau, where the dolomite forms a single cliff of dominantly dolostone beds (16).

Valleys: The mulussa plateau is deeply dissected by long ramifying wadi systems with gentle valley- side slope (Fig. 2- c) and steep valley-side slopes (Fig. 2- d) up to 100 meters in high, near Gaara Depression. The major valleys are filled by imprecated gravels of different sizes which composed mostly of carbonates with some cherts and subordinate amount of coarse sand, silt and clay materials. On the valley slopes soils may be deposited between rock fragments. Some of mentioned valleys formed ephemeral streams, such as: Ajrumiyat, Dwekhla, Agarri, Njili, and Mulussa.

Depressions: The Gaara Depression (Fig. 2- e, f) represents the main and important depression in the area, which far about 10 km from Tel Al- Nasr. It is suboval Shape, about 70 km long and 35 km wide and running in an E-W direction and located about 50 km north of Rutba Town. It is about 2000 km^2 and confined between the following coordinates (16):

Longitudes: 40° 00′ 00″ – 40° 50′ 00″ Latitudes: 33° 20′ 00″ – 33° 45′ 00″

Figure -2 : Topographic map and some topographic features of studied area, a- Topographic map of Tel Al- Nasr. b- Tel Al- Nasr and Mulussa wide plateau. c- valley- side gentle slope. d- valley- side steep slope. e- Gaara Depression. f- Southern rim of Gaara Depression.

The elevation ranges from 460 meters above sea level, on the floor of the depression to about 660 meters above sea level, on its southern rim (Fig. 2- f). The depression comprises sand, silt, clay and gravel deposited as fluvial sediments, within flood plain, valley fill and alluvial fan that produce by ephemeral streams.

3-2- Archaeology:

Tel Al- Nasr: In this Hill many archaeological indicators were present (Table- 3) and got a great archeological importance for several reasons as follows: The high of Tel Al-Nasr more than 25 meters, enabling over lined ancient human to control and observe surrounded plane areas and monitoring caravan that moving toward and outward the hill, and / or it is a home of local leaders because it seem to be as a fortified defensive positions, and it has important geographic location between many archaeological sites such as: Muhaiwer Palace on the east, Bir Al-Rah on the north, Basalt Belt on the west, and Araal on the south west; as well as on the trade road between Euphrates River and Arabian Peninsula (17). Based on the archaeological evidences, the site was inhabitants by different nation for different time periods (table-3).

Table- 3: rock type founded near Tel Al-Nasr and Formations, description, uses and archaeological ages (17).

	Rock type	Formation	Description	Uses	Archaeological time periods
1-	chert	Mulussa	Less than 6 cm length, angular artifacts.	Stone tools	Stone ages
2-	sandstone	Rutba	More than 1^3 m blocks covered by desert varnish.	Animal inscription	Stone age
3-	carbonate	Mulussa, Zor hauran	Stony circles (hawat).	Building stones	4^{th}-2^{th} mellinium BC.
4-	carbonate dolostone	Mulussa	Stony column 2 m high, inscript on the base.	Defence site, astronomical	4^{th}-2^{th} mellinium BC.
5-	Basalt	Syria, Jordan, Saudi Arabia basalt belt	Part of disc, d= 14 cm, open center d= 4 cm.	Grinding	
6-	sandstone	Rutba	Blocks of rocks With desert varnish.	Rock inscription	Nabatian, Tadmurian, yrian

Plateau: Wide Mulussa plateau that surrounded Tel Al- Nasr is covered large flat area and dissected some time by shallow valleys. This plateau provides easy roads for land caravans when transfer from Arabian Peninsula to the Euphrates River and vise versa.

Valleys: some valleys are dissected Mulussa plateau and flows from south to north toward Gaara Depression, such as: Mulussa, Agarri, Nejili, Dwekhla, and Ajrumiyat. Mentioned valleys can be used for travelling from plateau toward the Gaara Depression, then after to the Euphrates River. Divers plant grows inside and on both slopes.

Depression: during rainy seasons plants are growing on the fluvial sediments and on the undulated hills, such as ….. some of plants eaten by recent bedwin till now, and other useful food for domestic animals grazing, in addition to some seed useful food for birds.

3-3- GIS- Visibility analysis:

The principle behind GIS visibility analysis is a simple one: the extents of an area visible from one point or a set of points are defined over a digital elevation model. The resulting grid presents the cells where a straight unhindered line-of-sight (LOS) exists between observation and target points. The heights of observation points, target points and cells between them determine if a cell can be seen from the point. Cells are considered "visible" if no elevation between is higher than either observation or target points. The input data is DEM (Digital Elevation Model), observer site and parameters of visibility (e.g. the direction of the viewshed and the search distance). The field of view (FOV) with 360 degrees represented by red circle in which the observer lies at its center at height 1.5 (fig. 3-a) and 10 meters (Fig. 3-b). FOV shows wide visibility areas like to be that the observer lies on the tower for example.

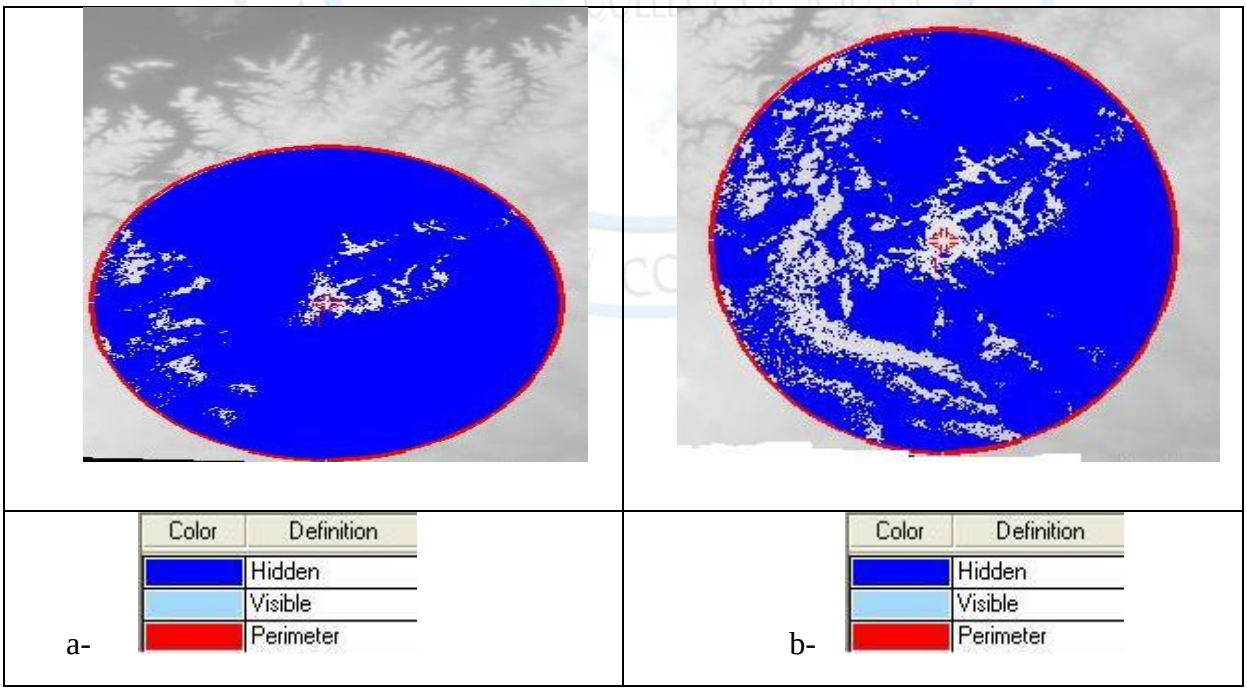

Fig. 3- Visibility results for the observer on Tel Al- Nasr at high: a- 1.5 and 10 meters.

Defensive village locations are in places where there is a commanding view, so that dwellers have time to prepare defenses against an attack in addition to observing arrival and leaving land caravan, and it may be has religious importance. On a generally flat terrain, past peoples were more likely to settle on a raised area to give them a defensive position in times of conflict. Each culture will have varying relationships with their landscapes. Understanding how past peoples interacted with their topographies allows better archaeological analyses to take place. Frequently archaeologists are concerned with whether one site is visible from another site. Figures (4, a, b, c) depict the variation of height beginning from Tel Al-Nasr toward different directions.

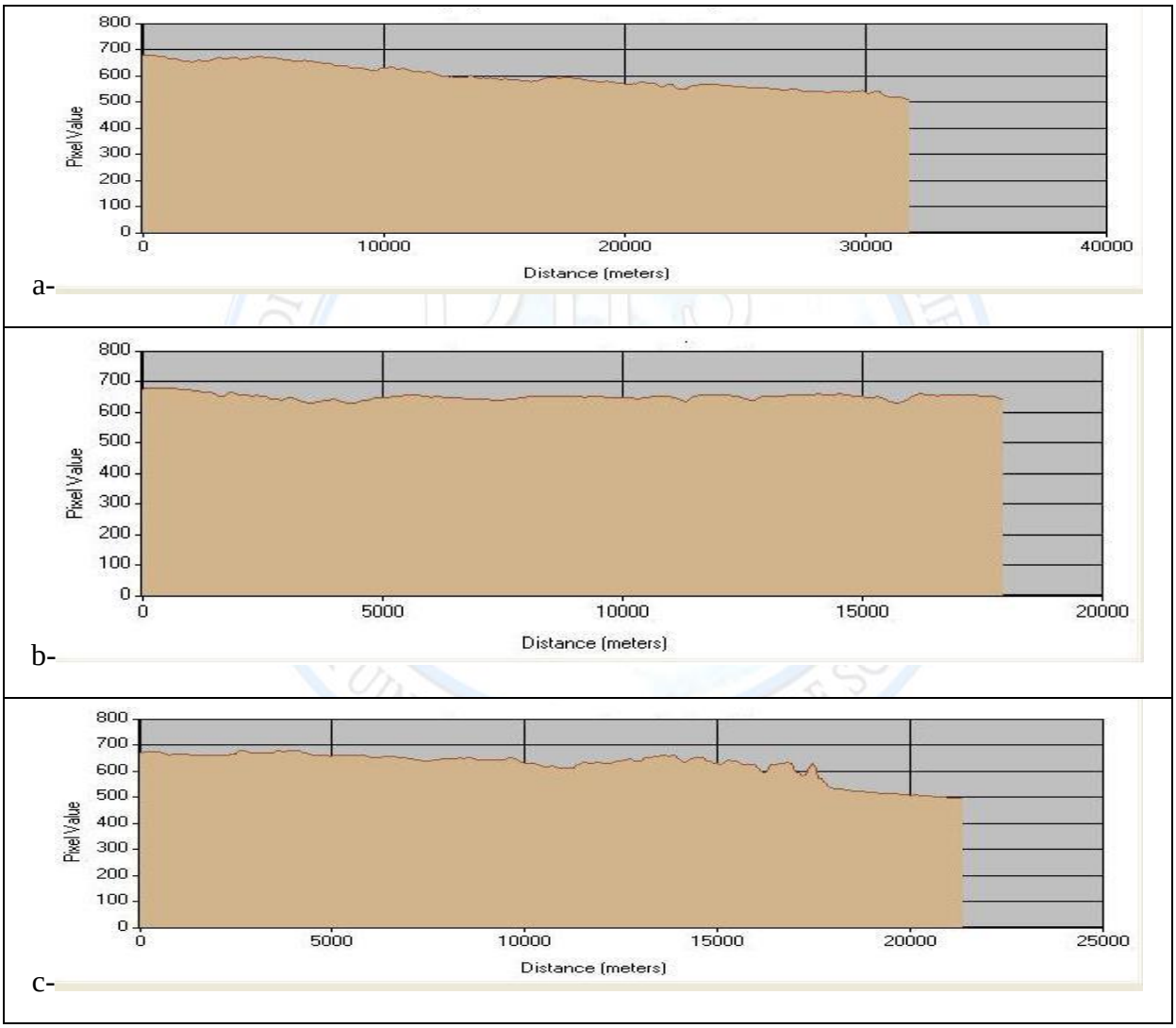

Fig. 4: Profile from Tel Al-Nasr (0- 0) toward: a- east, b- west, c- north.

Conclusions

SRTM data is employed in many archaeological projects due to its cost and applications to a wide range of archaeological questions. Archaeologists can import the data into either a remote sensing program or a GIS, and then layer additional satellite data on top of it. Having a good understanding of the Earth's topography is important to the geosciences, especially geology and hydrology, and is an essential part of cartography. Past peoples were more likely to settle on elevated area to give them a defensive position in times of conflict. Each culture will have varying relationships with their landscapes. Defensive village locations are in places where there is a commanding view, so that dwellers have time to prepare defenses against an attack. The results of the research showed the extents of an area visible from one point, i.e. observer on Tel Al-Nasr to the targets points surrounding him, also we proved that increasing the height of the observer reveal a large area visible from the center

point where the observer is located. Figures 5, 6 and 7 represent the profile, i.e. height variation from Tel-Al-Nasr towards different directions around, and reveal that this position gives them a commanding view.

References

1. Glowacki, K. T., 2004. The Ancient City of Athens. creative commons. org. http://www/stoa.org/athens.

2. UNESCO, 2007, Global Geoparks Network: Guidelines and Criteria for National Geoparks Seeking UNESCOs Assistance to Join the Global Geoparks Network, 10 p.

3. Eder, F. W. and Patzac, M., 2004. Geopark- geological attraction: A Tool for public education, recreation and sustainable economic development. Episodes, 27, 3: 162-164.

4. Roessler, M., 2000, World Heritage Cultural Landscapes. Identification, Conservation, Monitoring. ISPRS Proceedings, UNESCO-ICOMOS-CIPA- ISPRS World Heritage Session. Amsterdam.

5. Boehler,W., Heinz, G., Scherer, Y., and Siebold, 2002. Topographic information in cultural and natural heritage visualization and animation. University of Applied Sciences, Mainz, Germany.

6. Lillesand, T. M., and Kiefer R. W., 1994. Remote Sensing and Image Interpretation. 3rd ed. John Wiley ,& Sons, New York.

7. Hunderson, F.M., A.J. Lewis, ed., 1998. Principles and Applications of Imaging Radar, Manual of Remote Sensing, v. 2, Wiley, NY, 866 p.

8. Ali, H. Z., 2012, Visibility Analysis In Archaeology Using Digital Elevation Model Produced From SRTM, Iraqi Journal of Science and Technology, Vol. 3, No. 3.

9. IGOMI, 2000. Iraqi General Organization for Meteorological Information, Climatic Atlas for years (1980- 2000).

10. Bamler R., Rabus B., Eineder M., Roth A., 2003. The shuttle radar topography mission—a new class of digital elevation models acquired by space borne radar, ISPRS Journal of Photogrammetry & Remote Sensing. 57: 241–262.

11. Rabus, B., Eineder, M., Roth, A., Bamler R., 2003. The shuttle radar topography mission-a new class of digital elevation models acquired by space borne radar, J. Photogramm. Rem. Sens. 57: 241-262.

12. Adams, R.E.W., Brown, W.E. and Culbert, J.P. 1981. Radar mapping, archaeology, and ancient Maya land use," Science. 213: 1457–63.

13. ERDAS, Inc. 1994. Erdas Imagine Field Guide. 3rd ed. Erdas, Inc., Atlanta.

14. Elachi, C., 1982. Radar images of earth from space. Scientific American. 247: 46- 53.

15. Kim, Y-H., Rana, S., Wise, S., 2004. Exploring multiple viewshed analysis using terrain features and optimization techniques. Computer &Geosciences,30: 1019-1032.

16. Tamar-Agha, M.Y. 1996, Landforms of the Ga'ara Depression- Western Desert of Iraq- as related to Deposition and Denudation. Dirasat, Natural and Engineering Science. 23, 3: 374-383.

17. Al-Zubaidi, A. A., 2012. Natural stones and its archaeological importance at Tel Al-Nasr site- Iraqi Western Desert. Al- Adab Jour. 99: 523-541.

18. Al- Zubaidi, A. A., 1988. Sedimentary Basin Analysis of Rutba Sandstone Formation, from Rutba- sw Gaara. Unpub, Thesis, Department of Geology, University of Baghdad, 107 p.