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# THE WIND AS AN IMPORTANT ASPECT AND ITS IMPACT ON POPULATION TRENDS AND DEMOGRAPHIC CONDITIONS IN TRIPOLITANIA DURING LATE PLEISTOCENE/EARLY HOLOCENE

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**Abstract:** The vast majority of Tripolitania sites are open surface sites, but after the introduction of paleoclimatology in archaeological research during 1980's, even with the insufficient amount of research, we were given a new vision of the archaeology of the region in regards to technology, adaptation, and behaviourism. The archaeological study of the region has developed within its own right, producing individual characteristics, including the sub-regional parts of Northern Africa. From the 1990's up through today, the archaeology of Tripolitania has benefited from these new developments with the introduction of climatology inclusive of geology, physical anthropology with genetic data, and the new methods of chronology and interpretations of cultural activities. This article will attempt to show the importance of the introduction of climatology and geomorphology in the study of surface sites where systematic excavations for whatever reasons had not been possible, yet certainly preferred. The geographical positioning of the sites in correlation with their surroundings, and the appearance and composition of the sediments in context with the archaeological artefacts, could provide us with valuable information about the connection between the cultures that inhabited this region. With these developments in research, we are now able to trace the cultural evolution of Tripolitania by paying particular attention to periods impacted by climate change (particularly wind), which had caused new geological and geomorphological conditions that forced the individuals of this culture to adapt in order to survive.

**Key words:** Wind, Pleistocene, and Holocene.

## Introduction

The archaeological excavations in North Africa began during the period of European colonialism. The research conducted during the second half of 19th and early 20th centuries were based mainly on the researchers' personal ability to understand and put in the time frame and social context a large variety of stone tools, yet at that time still making positive contributions towards the understanding of development in the human species. Precisely because of the

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lack of appropriate methodology and typology, some artefacts had been interpreted in different ways by different researchers or even by the same researcher during a later period in his research. Until the 1960's, researchers had used the known and accepted methods of that time: therefore, they compared the results of European artefact typology with the African typology, considering it related. This resulted in the ignoring of the specific and individual characteristics of North African archaeological sites, separate from their European counterparts. Also, at that time the Sahara had been considered a physical barrier to the trend and the migration of the populations, however, looking at the geographical feature from the modern perspective proved to be a misinterpretation, and as we know, geomorphology today is certainly not suited to that from the time of the Pleistocene.

Naturally, during the transition from the Pleistocene to the Holocene, the climate was adjusted to a different structure and appearance of the regional floor, and this is the specific problem that this paper intends to address. When scientists talk about climate, they question the average precipitation, temperature, humidity, amount of sunlight, wind velocity, phenomena such as fog, frost, hail storms and other parameters that occur in a particular place over a long period of time. *Weather* is the atmospheric conditions over a short period with regard to its effects on the life and the activities of human populations. When we talk about *climate change* we talk about the changes in the parameters' average for a longer period. For example, by measuring the average amount of precipitation, water level in lakes and rivers, as well as viewing the satellite data, scientists could conclude that in a certain area during the summer the conditions were drier than average. If this situation persists over a period of many summers, this could indicate climate change. The changing of regional climate affects the vegetation across the entire region and the quantity of fresh water, as well as the entire eco-system, and therefore, health and life of humans, plants, and animals. Until the end of the 1970s, non-implementation of climatology in archaeological and anthropological studies had led to a series of confusions, errors, and assumptions without evidence.

Why is it important to include the study of climate and climatic and geomorphological changes in archaeology and anthropology in general? Climatic and geomorphological conditions have always dictated the composition and appearance of the landscape, and thus the living environment of each animal species. Humankind cannot be an exception, especially during Pleistocene when the survival of the human species was entirely dependent on its ability to adapt to the given conditions of life. The amount of precipitation and potable water, tectonic disturbances, winds, drifting sand, and other climatic and geological conditions have influenced smaller or larger movements of human populations to the areas that were better suited to survival. In these temporal and spatial movements of populations, every succeeding generation gained new experiences, leading to more successful adaptive strategies, and in that way culturally developed. Even though the most of the prehistoric studies consider the development of artefacts to have been based on the influence of one culture on another, our opinion is that this kind of development could also be due to the impact of new experiences encountered by the next generation of the same culture (Figure 1).

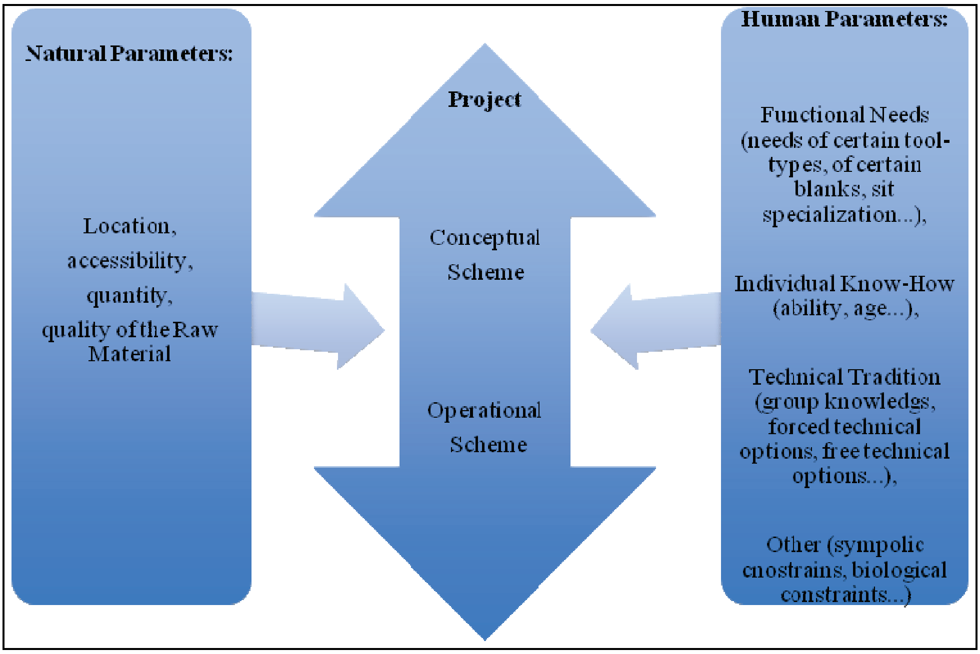


Figure 1. Relationship between the project, conceptual scheme, and operational scheme from the knapper's point of view by Soressi and Geneste (2011)

In support of this claim is a number of Late Pleistocene-Early Holocene sites in the coastal regions of North Africa, where the biological and archaeological continuity can be read in stratigraphic layers (locality of Hau Fteah). In the southern region, for example, in the stratigraphic layers of the Uan Afuda site (24˚51'57.39" N / 10˚29'59.85" E 918 m above sea level), three different temporal phases, and therefore cultural sequences, can be distinguished (Figure 2): the third sequence belongs to the middle Palaeolithic (Aterian culture), with sediments that are less wet and with dry sand, which points to a long period of dry climate and the beginning of the wet period; the second sequence, with colluvium sediments, is indicative of a relatively dry environment at the end of 10th millennium. According to the typology of Cremaschi and Di Lernia (1995) the artefacts that were recovered belonged to the hunting Epipalaeolithic communities; the first sequence that was made of plant and grass remains, as well as a layer of human coprolites, indicates an increase in animal resources for human consumption, but does not necessarily prove their domestication, although it was known in the succeeding phases of this region. In this case, based on current typological findings, the authors placed this sequence in the Mesolithic phase.

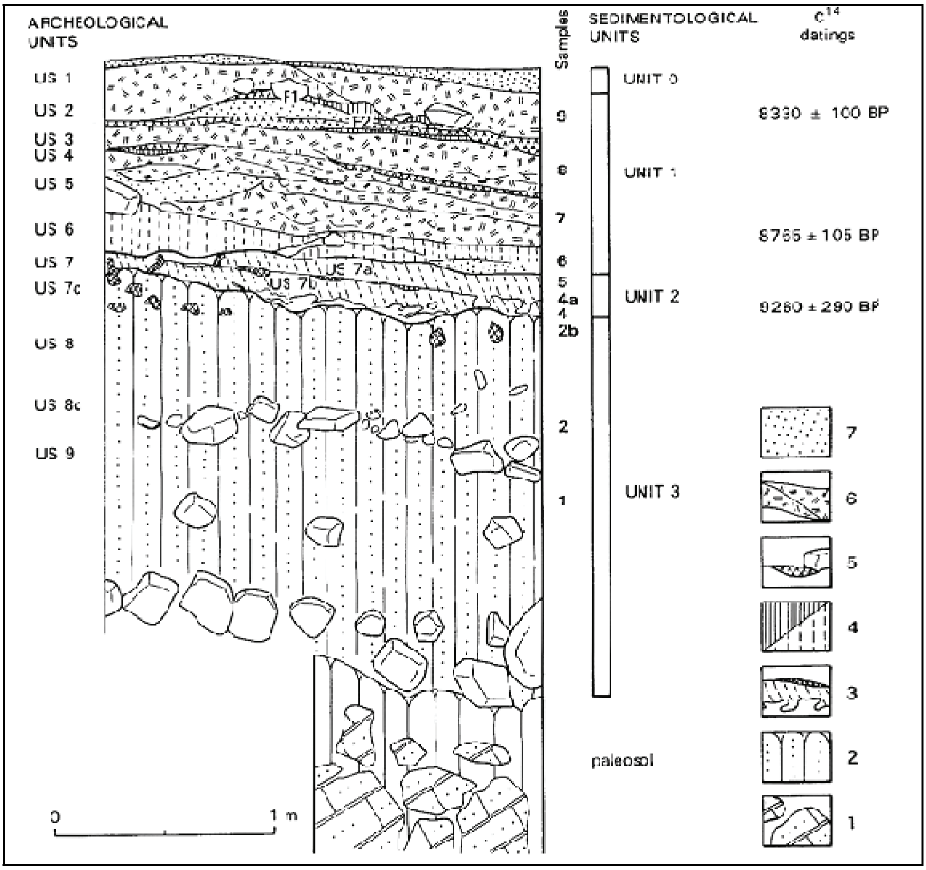


Figure 2. The stratigraphic section of the excavation I at Uan Afuda (southern wall), by Cremaschi & Di Lernia (1995)

1) Collapsed blocks with gypsum concretions; 2) Unite 3, aeolian sand, weathered at the top, including bioturbation pedotubules; 3) Unite 2, colluviated sand including gypsum concretions; 4) Unit 1, loose sand rich in charcoal and organic matter; 5) Unit 1, as lenses and stone of hearth; 6) Unite 1, lenses of undecomposed plant remains; 7) Unit 0, top aeolian loose sand.

Although this site was not found in Tripolitania region, it is of great significance for further archaeological research of North Africa, particularly Libya, because it represents the turning point in the forgoing of the Euro-centrism present in the research, and autochthonous (indigenous) typology of the artefacts is applied with attention paid to regional differences. The importance of the work of those authors was that they were the first in proposing the terminology based on localisms (early and late Acacus), and are related to the regional Holocene, in order to avoid confusion with the use of terms related to Epipalaeolithic and Mesolithic. A similar situation can be observed in the sites in the region that indicate the need for comparing the chronology of the site with the chronology of its surroundings, in order to determine the dynamics of movement and change in the given region due to climatic and geomorphological changes.

## Geographical and topographical characteristics of Tripolitania

The name Tripolitania is derived from the Greek name “Tri-polis”, meaning “three cities”, on the western coast of Libya (Leptis Magna, Sabratha, and Oia). The region belongs to the southern Mediterranean plateau; it stretches for about a 300 km long line, from Leptis Magna (32˚38'N / 14˚17'E) to Pisida (33˚04'N / 11˚44'E) on the western border of Libya, extending approximately 170 km into the coastal part of Tunisia till the city of Gabes (33˚53'N / 10˚06'E), creating a unique sub-regional division. In the continental part it stretches 153 km, to the city of Nalut (31˚52'N / 10˚58'E), connecting the western coastal plateau and Cyrenaica at the eastern border of Maghreb (Figure 3).

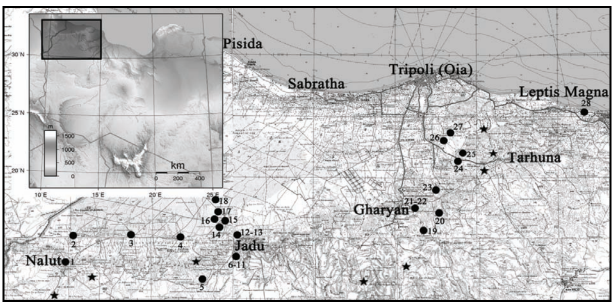


Figure 3. The distribution of Epipalaeolithic localities over Adrar Nafusa in Tripolitania

(•)Epipaleolite sites Iberomaurusian-Capsian type, (★)Cave art

1) Nalut, 2) Wadi Thamat, 3) Tiji, 4) Josh “site SJ-03-72 / SJ-03-75”, i Badr “site SJ-03-83”, 5) Nana Tala “SJ-89-02”, 6-7) Ain Zargha “Ras al Wadi” two cave, 8) SJ-98-26, 9) SJ -98-26A, 10) SJ-98-26B, 11) SJ-90-13, 12) SJ-90-19A, 13) SJ-90-19B “at Ginnaun”,14) SJ-02-68, 15) SJ-00-55 east, 16) SJ-00-56, 17) SJ-00-52, I 18) SJ-90-52, 19) Upper Wadi Ghan or SG-99-41. 20) Middle Wadi Ghan. 21) Gerian site station. 22) Gerian 9 cave. 23) Lower Wadi Ghan, 24) Wadi Mulghah. 25) Ra’s Fam Mullaghah. 26)Wadi Ar-Ribat. 27) Wadi al-Bitir, i 28) Silin-18.

This area is characterized by interesting landscape morphology; the crescent feature of the area is bordered with a coastal line on one side, and on the other with the mountain range of Adrar Nafusah, with its highest peak at 750 m above sea level. The name “Adrar Nafusah” comes from the Libyan aboriginal language, and the name “Al-Jabal Al-Garbi” is of Arabic origin. Between these borders exist segments with different characteristics, and also the sand dunes intersected by river beds from the mountain peaks to the coast, forming seats for a seasonal water storage area of 21,000 $m^2$ (the plain of Jefara). This region is one of the most important agricultural areas in the whole of Libya, from the first communities up through modern times. It represents 44% of the total human population, and 50% of all agriculture originates from this region, along with more than 70% of fruit and vegetables (Kruseman & Floeghel, 1980; Al Farrah, Martens, & Walraevens, 2011). The region today is characterized by a semi dry Mediterranean climate, with an average rainfall of 250–100 mm annually in the western part, and 400 mm in the eastern, mostly during December and January, and with constant winds. The summers are dry and hot with an average temperature of 28˚ to 38˚C, but can reach up to 49˚C. Winters are cold and humid with an average temperature of 11˚ to 17˚C, while the temperature in the western area of “Nalut” reaches up to -5˚C. The highest temperature ever recorded in the world was in 1922 in Al-Azizi, just 80 km southwest from the city of Tripoli, and had reached up to 58˚C (Barich, Giraudi, Conati-Barbaro, & Capezza, 1995; El-Fadli, et al., 2013). The flora and fauna of this region are typical for the Mediterranean region, but are less restricted by the river flows and their tributaries that cut through this mountain range in different directions.

## Geological and geomorphological features of Adrar Nafusah

The geomorphological features of the area were formed as the result of tectonic activity during the Triassic and Cretaceous eras, forcing displacement and elevation of the seafloor to the southwest course, while its present typical crescent form was defined during the Pleistocene under the influence of various climatic factors (such as wind and tsunami) (Figure. 4). The changing of the landscape has led to a climate change and thus created a specific habitat for plant and animal diversity. The evidence for these changes can be found in the sediments. Almost the entire surface of the Nafusah geographical formations contains sandy-clay layers that separate the Miocene from the Pliocene, and the Pliocene from the Quaternary complex on the top. At a depth of 30–150 m an accumulation of water with a depth of 20–60 m can be found (Fatmi, Eliagoubi & Hammuda, 1980; Megerisi & Mamgain, 1980; El-Zouki, 1980; Kruseman & Floeghel, 1980; Al Farrah, Martens, & Walraevens, 2011).

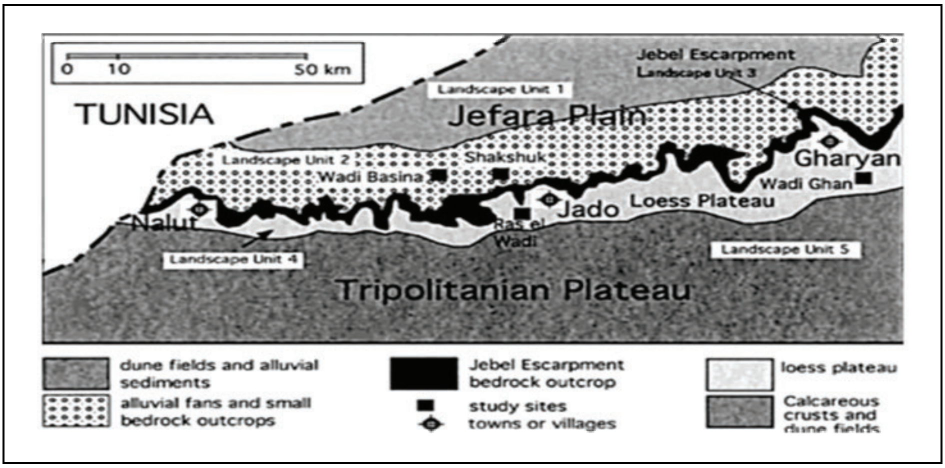

Figure 4. Adrar Nafusah landscape unites by Barich, Garcea, and Giraudi (2006)

The results of the Palaeoclimatic research showed how the climate changes have influenced the development of biodiversity in the area, which had been confirmed by recent archaeological excavations and by the research of development of artefact typology and function, as well as distribution with sub-regional specificities of the area (Close, 1978; Nicholson & Flohn, 1980; Lubell, Sheppard, & Jackes, 1984).

## The link between climate and ecological conditions with the sites and their archaeological material

### *Silin site*

The site of Silin-18 is located on the west coast of the ancient city Leptis Magna, around 500 m from coastline (32˚42'37.54"N / 14˚08'38.76"E; 18 m above sea level). The most important characteristics of this site are its topographic feature, which is located in the centre of two seasonal rivers (wadi) with a length of 3.5 km: wadi Tour/Fani in the East and wadi Jabron in the West. On the landscape the hilly formations from the Miocene are visible, and over them the quaternary sand layer that indicates the northwest and southeast wind activities by its direction of stretching and deformation.

The site was discovered in 1997/98, but was observed only on the surface without any excavation. The artefacts that have been found were collected from the surface area of 300x100 m, and among them a large number of different types of shells were collected, as well as a large area of burned land known as

"*Escargotiéres ili Ramadiia*"[3] on the eastern side of the site. At this site, other archaeological material from various periods was found (pottery fragments from the Roman and Islamic periods) and the fragments of grinding artefacts made of volcanic stone were found in the area of 50x30 m. The prehistoric artefacts that were found at the site Silin 18 were classified according to the classical typology (Tixier, 1963), and complemented by the method of lithic artefact analysis (Close, 1978). The material that the artefacts were made of is silicate stone of different colours. The collections of 2 cores, 20 pieces of debris, 14 pieces of processed tools, and 2 Neolithic artefacts, show a high degree of physical and chemical changes with a whitish occurrence on the surface, and no artefacts made of quartz had been found (Munzi et al., 2004).

According to established typology and chronology, the artefacts belong to the Upper Capsian culture (Munzi et al., 2004), but due to a lack of excavation we cannot determine with certainty the relationship of climate and Capsian culture on the coast area. Nevertheless, this site is of great archaeological importance because it indicates that the Capsian culture that was thought to be typical only for the interior area of North Africa had arrived at the coast (*e.g., Silin, and Hau Fteah*) and adapted to and developed under the new conditions. Additionally, the site indicates that in this part of the area the climate had been stable and provided the ideal conditions for life. The continuity of settlements and population activity from the Neolithic with a Capsian tradition from the ancient period to present day presents very strong evidence for this assumption (Mattingly, 2005; Lucarini, 2013).

### *Tarhuna sites*

The hilly area of Tarhuna is about 40 km long from East to West, and 20 km wide from North to South, with the highest part reaching 450 m above the sea level (Brehony, 1961). The East and West ends of the hill border with the seasonal rivers, and almost vertical slopes facing the plains of Jefara, while the southern edge cannot be clearly defined because it expands about 80 km into the rocky desert. From the geological aspect, the hill/mountain is composed of limestone, which is clearly visible in some parts while a fertile sandy dust covers most of the surfaces of the formations. Below the surface layer of the limestone there is a layer of fertile silt that is very visible on the source of Sharshara (32˚27'58.68"N / 13˚37'15.32"E; 340 m above sea level). Since the classical period, this region had been characterized by ceramic products. There are several sites in this area that are named for the wadies by which the sites are located.

[3] An artificial mound or kitchen madden made up primarily of snail shells but containing artifacts (as found Capsian sites in Algeria and Tunisia).

Given the fact that they have the same or similar characteristics, they will be treated as a single site.

The sites of Tarhuna (32˚24'24.71"N / 13˚38'36.63"E) are located on the western side of Tarhuna landscape, about 33 km west from the main town, mainly at the foot of the mountain Nafusah between 3 wadies: Bitir, Fam Mullagh, and Ribat. The Ribat site was detected in relatively early 1947, but the material was not researched until 1968, under the leadership of the Italian archaeological school named after the archaeologist "Del Fabbro". The material now resides in the Museum of Tripoli Antiquity in Libya, consisting of 266 different pieces, 108-polished blades, and thousands of fragments, which were typologically studied by Del Fabbro (1968). A particular characteristic of the artefacts from this site is that a large percentage are a narrow blade with a pointed tip, which is quite different from artefacts found at other sites that are attributed to the Epipalaeolithic Caspian culture. As suggested by Del Fabbro, here we see evidence for typologies which alternate in size over time, pointing to shifts in the available fauna due to the period's climatic transitions; i.e. large capri to smaller rodent and back to larger capri. The landscape of the site is indicative of having been influenced by the strong winds, resulting in the reshaping of the cliffs of the Tarhuna region from an angular shape to a more rounded slope. The southwestern slopes became a desirable habitation for the human population due to the rich water resources and the protection the slopes provided from the wind and the sand. The area around the watercourses was overgrown with vegetation, which had ensured the existence of a relatively rich fauna, and thus hunting activities, as indicated by the aforementioned artefacts (elongated blade with a pointed tip), which suggests the tools may have been used for cutting and utilizing larger and more diverse animal and plant resources, with this typology being specific to the culture that existed in the Tarhuna region at this time.

The only primary excavation carried out in this area was in a cave, Abiar Miggi (32˚24'10.71"N/13˚32'25.96"E; 400 m above sea level), known for its art and petroglyphs. Although systematic excavations have not been conducted, the site clearly indicates that in the early Neolithic period, the surface of the cliff has been suitable for life; the activity of the winds was significantly reduced, climatic conditions were much more suitable for habitation, which is further confirmed by traces of the rich biodiversity (Barich et al., 1995; Lucarini, 2013).

*Gharyan sites*

The area of Gharyan is also comprised of hilly and mountainous formations, with cliffs on both sides. Unlike the western side, which is very steep, the eastern side is entirely covered by wadi Ghan. The length of this terrain is about 40 km from North to South, and the width is 20 km from West to East, where it borders with Ghan (upper Wadi Ghan 32˚04'59.83"N / 13˚05'57.54'E; 570 m above sea level and bottom Ghan 32˚14'26.68"N / 13˚08'16.89'E; 318 m above sea level). From the geological and geomorphological point of view this area is very complex, characterized by Mesozoic raised formations, which occurred as a result of major tectonic movements (south / north) (El-Zouki, 1980; Kruseman & Floeghel, 1980; Singh, 1980). On the eastern side there are traces of the existence of once active volcanic networks. Between the north-eastern border of the Gharyan area and south-western border of Tarhūna exist large formations which are covered with sand dunes.

The Gharyan site (32˚09'45.74 "N / 13˚02'22.52 "E; 630 m above sea level) is located just 1 km East from the city of Gharyan. The site is of a surface type; the material was collected from an 800x300 m surface, and on the northeast side of the site there are 9 small caves with two streams of fresh water. Average size of the cave is 8x7 m and the height is 3.5 m. The entrance to the cave is positioned facing West-Southwest, and the direction of the stronger winds moves from Southwest to the Northeast. Due to this strong wind activity, the resulting degradation of the interior of the cave, and subsequent fallen rock, would make excavation difficult, yet may have worked to preserve any cultural or natural features within. At this site so far, no systematic excavations have been conducted. Wadi Ghan is rich in archaeological finds representing all phases of Palaeolithic industry, especially Aterian and Epipalaeolithic culture. Going deeper in more geomorphological details of the upper and lower valleys of wadi Ghan, there are visible terraced sequences located at different levels, each with specific biodiversity (Barich et al., 2006; Giraudi, Mercuri & Esu, 2012). Beside the tectonic and volcanic activity, the greatest role in creating these sequences was the wind, which separated the sequences by introducing sand drifting in from the desert, suggesting the need for additional research of the wind activities' impact on the regional geomorphology. The collection of archaeological surface material from this locality is comprised of 1,791 pieces of artefacts processed after the selection by Del Fabro and associates, and 949 pieces of them were analysed in detail with typological characteristics. The artefacts indicate Epipalaeolithic (Capsian blade) and early Neolithic (fragments of pottery and arrowheads) time periods (Fabbri & Winorath-Scott, 1965), which also indicates the continuity of settlement. It seems that this site was selected by the early population for settlement not only because of the large deposits of water, but also for the protection from the very strong winds from the south-east/north direction.

*Jadu sites*

The Jadu division is the central area of the whole of Nafusah, with the V shape form covering a network of deep valleys all the way to plains of Jefara (Figure 5). Two-thirds of valley's length was devoid of any fluvial sediment, but on its end, where the valley makes contact with the plain of Jefara, there are a series of terraces. Terraced formations with colluvium deposits often occur on the slopes of the valley and on the edges of the Nafusah plateau.

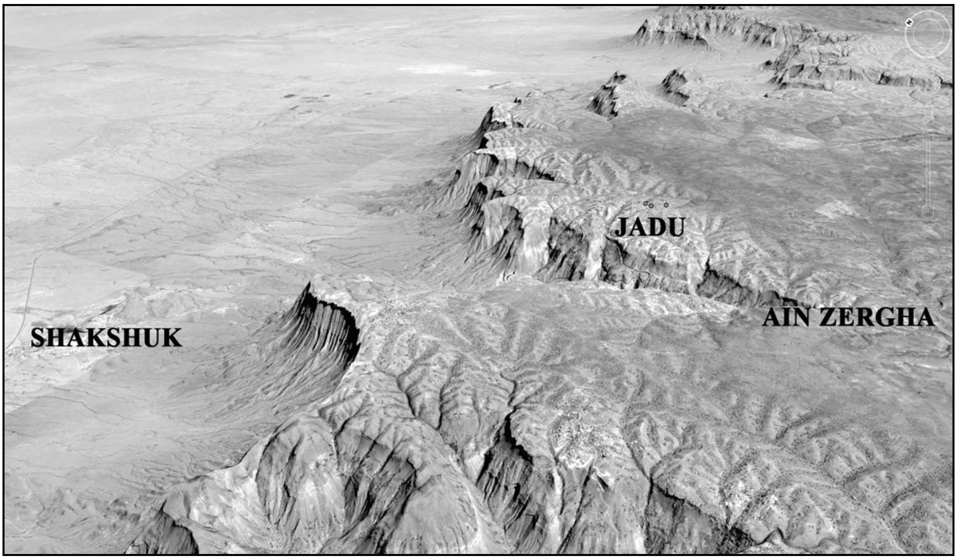


Figure 5. The canyon of Ain Zargha "Ras el Wadi" — Shakshuk (Google Earth, 2016)

***The upper part of Jadu field:*** Ain Zarga (Ras Al Wadi) is the highest part of the deep cut through the rock, and in some places it can be compared with the real canyon. The bottom of the riverbed is covered with different vegetation, and on both sides many shelters can be seen at various heights. Above the Ain Zarga valley, at the top of the left bank there is a large number of temporary Epipalaeolithic sites in the area of 500 m² (31˚55'N / 12˚00'E; 625 m above sea level), where 3,300 stone artefacts were found; according to the typology and dating using the radioactive isotope C14, it has been determined that the artefacts belong to the Upper Stone Age, i.e. Iberomaurusian-Capsian culture (Barich & Conati-Barbaro, 2003). At the northeast part, the plain branches out into several small wadis. Near the old town of Jadu, located on the right side towards the West at the length of 4.5 km, two caves (31˚57'N / 12˚00'E) were discovered and explored. Deposits indicate that one cave has been almost completely eroded by the wind activity, while the deposit of other cave's stratigraphy has clearly been modified by layers of sand and ash, indicating the existence of several fireplaces (Barich et al., 1995). On the central and eastern side of the canyon there are sequences of four alluvial terraces formed during different climatic phases. Basis on archaeological material, the oldest terrace can be dated back to the middle and upper Pleistocene and Holocene. Existing palaeo-soil in the deposit at the bottom of the slope indicates the good development of flora and morphological stability.

Nana Tala, a similar site located southwest of Ain Zarga, SJ-89-02 (31˚49'N / 11˚48'E; 550 m above sea level), presented during excavations sequences of stratigraphy and artefacts indicating that these were not permanent settlements, but temporary. Sites like this were used only in periods of stable climatic conditions, usually during hunting season or as a source of stone for tools, as evidenced by a large number of residues from production found at these sites (Barich et al., 1995).

***The lower part of Jadu field:*** The valley of Shakshūk is located between the plains and the alluvial zone Jefara, near perennial streams which still provide water resources to the local vegetation. Because of the geological configuration of the terrain, it is suggested that these streams are associated with underground water sources, which are located 200 km south of Adrar Nafusah (Mutri & Lucarini, 2008). These streams played a large role in the settlement of this region, even during the driest periods of the Pleistocene and Holocene. At the most important site in this area, SJ-00-56 (32˚01'N / 11˚57'E), 20,733 stone artefacts were found, and according to radioactive isotope C14 dating, belong to Upper Stone Age. Artefacts were different in size, shape and function, indicating the development of production due to the needs of the population (cutting meat, leather, and early species of plants) that inhabited this area, along with rich flora and fauna (Barich et al., 1995; Mutri & Lucarini, 2008; Lucarini & Mutri, 2010).

The sites in the Josh area (31˚59'N / 11˚40'E; 230 m above sea level) and the Badr area (32˚02'N / 11˚32'E; 230 m above sea level), located west of Shakshuk, show the same stratigraphic characteristics and similar artefacts and features, including a large amount of fireplaces, particularly in the Badr sites (Barich, Garcea, Mutri, Lucarini, & Giraudi, 2010), indicating that these parts of the valleys had been inhabited continuously during the Late Pleistocene and Early Holocene, not only because of the large biodiversity, but also due to the protection provided against strong winds and subsequent sand drifts, which created specific environmental conditions.

In addition to these, there are other sites on the plateau and in the valleys, which have not been explored, but indicate a large stone exploitation, including the sites: Nalut (31˚52'N / 10˚58'E; 613 m above sea level), wadi Thamat (32˚02'N / 11˚03'E; 225 m above sea level) and Tiji (32°00'N / 11°20'E; 196 m above sea level).

## The Climate of Tripolitania

Data suggest that during the late Pleistocene and early Holocene, the entire territory of Tripolitania, as well as the whole coastal plateau of North Africa, had suffered significant changes in climate that strongly influenced the local ecosystems and distribution of human settlements. Recorded changes indicate the beginning of a Mediterranean-type climate zone in the north, and a Saharan-type in the south. The whole south eastern part of the Nafusah plateau, according to its geomorphology, biodiversity, hydrology, and even archaeological distribution, shows characteristics of both these climate types, however geographically it does not belong to any of them, so we can safely say that it is located in a Sub-Saharan geo-climatic zone.

Plants characteristic of forested areas are similar to the alluvial plains and bush vegetation of the wadis. Open space is characterized by the dominance of grasses and sedge. Pollen deposits on the surface as well as in some of the deeper parts of the tested terrain indicate a predominantly dry environment and arid climatic phase (Barich et al., 2010). Samples contain the remains of a very well preserved local type of pollen, and a high percentage of pollen that had been distributed from larger distances by the wind activity. The distribution of a Palestrina deposit indicates that the moor, even during the wettest period, was present only in the parts near the stream, and in the periods during which ponds and streams appeared in the area, whose water levels were higher than today. Enlargement of water flow and number of ponds were probably caused by an increase in groundwater level, due to increased rainfall in the alluvial zone of Adrar Nafusah. Localities in this region contain large chunks of coal, and traces of a large amount of fireplaces may indicate greater human activity (e.g. Shakshuk, and Badr). However, the studied Holocene sediments showed evidence of discontinuity due to deflation caused by strong winds and erosion as the result of seasonal water flows. Pollen, which travelled from distant areas of the northern region and can be regarded as indicative of the windy period, presupposes an increase in water level and an increase in volume of permanent water supply, and therefore an increase in the number and variation of floral and faunal species, as well as human settlement populations (Barich et al, 1995; Van der Ven, 1995; Lucarini, 2013).

The greater part of northern Algeria, Tunisia, and northwest Libya consist of the dunes' chain lying north / south, with slopes facing east, which indicates the eastern winds during the forming of dunes. This area (Grand Erge Oriental Desert; 30˚30'N / 6˚33'E) is comprised of sand layers, which in some places present southwestern linear characteristics, assuming the dominance of southwestern winds. The Jafara plains and plateau of Tripolitania were partially covered by dunes and sandy layers (Barich et. al, 2005). In the event that the activity of the dunes and wood deposits were synchronized, it would mean that the periods of drought and periods of rainfall alternated at regular intervals at distances of less than several tens of kilometres. The difference between fine and coarse grains is very important because rough, coarse grain could be transported by wind over short distances (<300 km), while the fine grain could migrate over longer distances (Crouvi, Amit, Enzel, & Gillespie, 2010).

Sand dust observed over the coastal and inner part of the region indicates a suppressing mechanism for the intake of dust and impact of the winds activity on the region, as well as the climatic relationship between higher and lower geographical levels during Pleistocene-Holocene transition. The sediment of Saharan dust on the eastern part of the Mediterranean Sea indicates the penetration of Western African monsoons in the north-eastern Sahara (between Egypt and Libya), creating differences in the deposition of dust which caused the expansion and retreat of the savannahs across the north-eastern Sahara. This would be one of the main elements that influenced the movement of human populations during the climate change through its effect on the composition and appearance of the terrain.

## Conclusion

All archaeological excavations and Palaeo-anthropologic study of early human populations conducted in North Africa until today have shown the necessity of implementation of climatology, particularly wind activity, and geomorphology in the study of modern Homo Sapiens, however not merely as an ancillary discipline, but as a basic one. Man is heavily dependent on his environment, both in terms of survival and in terms of development as a species. Human populations have shown to be more highly capable of adapting to certain environmental factors while remaining in one location, such as temperature and the exploitation of natural resources; however, the size, position, and pattern of Epipalaeolithic human movement show the influence of wind activity on the decision making process when it came to choosing locations for permanent and temporary settlements. In other words, the sites themselves show that locations which did not provide the protection from heavy seasonal wind activity necessary for secure settlements due to their climatic characteristics ended up directing the movement of human populations to better and safer places with only one goal in mind: survival. Wind was the overwhelming factor that influenced the dynamics of the human populations' movement in the region of Tripolitania. Following the prevalence and positions of the sites, we can see that in the late Pleistocene and early Holocene, populations moved from the top plateau to the lowlands, seeking protection from the wind and sand sediment, coming in particularly from the southwest to the north.

Coming in the contact with the plateau, the wind shifted direction towards the east, changing the appearance of the land formation, which can be seen along the entire Nafusah plateau, whose southern steep cliff are littered with large sand dunes, marking this area as Sub-Saharan. The northern side of the plateau provided protection from strong wind and sand, allowing the preservation of pastures, and thus remained rich in flora and fauna. Early populations had to adapt to a combination of Mediterranean and Saharan climates as a result of the movement of the winds.

The correlation of the influence the southwestern and northeastern winds had on the dynamics and trends of the human population may be determined by the geographical position of key sites. The line connecting these sites along Adrar Nafusah indicates a distance of about 50–100 km between the groups of sites from west to east and from about 10–20 km from the highest point of the plateau to the site in the valley in the same area; all the main sites are located on the northwest side of the mountain. In addition, the artefacts' typology as well as the chronology of the sites over Jadu area confirms the fact that these sites are the oldest of the Upper Palaeolithic, followed by Iberomaurusian and Capsian settlements (16000–11000 BP), followed by Neolithic with Capsian tradition and strictly Neolithic. Some of these sites are clearly connected to each other, forming a network of sites (e.g. Ain Zargh, Shakshuk and Badr), while the others show a great similarity to the sites on the north-eastern coastline (e.g. Hua Ftah). The mere connectivity between these sites clearly indicates a correlation between the geographical positioning of the sites and the direction that the African monsoons blow. Site density, artefact typology, and favourable environmental and climatic conditions are providing the opportunity for natural resources, including animals, to flourish, together indicating an increase in the human population of the area, as well as the local populations' contact with neighbouring groups.

All of the sites with favourable climatic conditions for life show not only the cultural continuity of populations, but also the adaptations and developments from one generation to the next within these cultures as the result of changes in the climate. These regions did not only provide sufficient access to food and drinking water, but also enabled the development of stone art, a greater range of tool production, ceramics, and other activities that have contributed to the evolution of modern man.

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