University of Khartoum
Faculty of Graduate Studies

Environmental Archaeology of The Nile Third Cataract Region: A Study of Wadi Farja

Thesis
Submitted for the Degree of
Doctor of Philosophy in Archaeology

By

Yahia Fadl Tahir

Supervisor:
Prof. Ali Osman Moh. Salih
Co-supervisor:
Dr. Moh. Ahmed Osman Kambal

2007

ACKNOWLEDGMENTS

I am greatly indebted to my supervisor Prof. Ali Osman Moh. Salih of Khartoum University, Faculty of Arts, Dept. of Archeology. My thanks are due to Dr. Moh. Ahmed Osman Kambal of Khartoum University, Faculty of Science, Dept. of Zoology for his co-supervision and advice.

My special thanks are due to the Dr. David Edwards, University of Licester, England, for his kind help for providing the sattelite image of the study area and dating the snail materials.

I wish to express my sincere thanks to the Vice Canceller of University of Khartoum for giving the scholarship.

My apperciations are due to Mahas people specially Sadig village people for their hosptality.

I would like to thank my collogues in Department of Archaeology, Dr. Intisar, Dr. Azhari, Dr. Howida, Ust. Ahmed, Ust. Abdelrahman and Ust. Husna for their help and encouragement.

My thanks are extended to Dr. Ali Beshier of Khartoum University, Faculty of Veterinary Medicine Dept. of Anatomy for his assistance in identification and classification of bone materials.

I would like to thank Dr. Laurence Smith, University of Cambridge, MacDonald Laboratory and Miss Anglina Christie, University of London for their editing of chapter four and one respectively.

My last but not least thanks are due to my wife Dr. Saada for her real help and encouragement and also to my daughter Lina and my sons Mohammed and Monieb.

ABSTRACT

In Third Cataract Region, the prominent geological features are the presence of paleaochannels, khors and wadis, indicating a humid nature of the climatic conditions in the past. There are some wadis; the most important one is situated in Masida village and Farja area.

The important cultivated plants are palm, wheat, Sorghum, maize, beans, onion, some fruits and vegetables. So many acacia trees and dome as well bushes, shrubs and grass are recognized in the area. Concerning the fauna, the natives rear goats, sheep, cattle, donkeys, cats, dogs, and hens. The wild animals are Dorcas gazelles, wild rabbits, hyaena and many reptiles as *Uromastyx* Sp, Nile monitor, crocodiles, and snakes. More than 40 species of Nile fish were also reported. There are mosquitoes, sand flies, and Nemitti. Scorpions are very common residents of this area. The area has a large number of animal rock drawings. These drawings include elephants, rhinoceroses, hippopotamuses, giraffes, cows, camels, leopards, and lions. One of rarest drawings is a one of a scorpion.

The important notification from the statistical analysis is the homogeneity of the region from prehistoric times to the present day. Islamic, Christian and Kerma period sites are the most abundant. To the contrary, Napatan and Meroetic sites are rare. The Nubian Groups (A, C, and X) sites are also are rare.

The archaeological sites of this wadi reveal that its highest period of occupation was in Neolithic to Kerma periods. The sites periods are Paleolithic, Neolithic, Pre-Kerma, Kerma, Pharaonic, Napata- Meroe, Medieval and undated sites Another important indication is the concentration of most sites in the middle of the western bank of the wadi, suggesting the presence of a later island.

The bioarchaeological materials collected were *Etheria elliptica*, *Coelatura* sp, *Pila* sp, Nile perch vertebrae, hippopotamus radius bones, cattle bone, different mammalian bone fragments, and

ostrich egg shells. These remains were indicative of the prevalence of savannah conditions at that time.

Surface altitudes of the wadi have been obtained by using GPS. The plotting of readings (130) clearly shows that the there is a possibility of a water flow from the upper stream to downstream.

Fortunately, Nile oyster shells samples from Wadi Farja are dated back to mid-Holocene 7617± 50 BP and the second as7687± 50 BP.

Preliminary analysis of archaeological sites of Wadi Farja reveals that two categories of sites are related directly to the palaeoeconomy of the area. These are settlements and stone wall structures sites. Biological remains collected along the wadi were also related to the economy of the past populations.

The distribution map of the sites reveals the position of the sites on the wadi bank near water resources. Hence, their economy has been dependent on permanent water. Zooarchaeological finds, which relate to human consumption from the sites are fish bone, mollusc shell and other mammalian bone, mainly cattle.

Historically, two distinct changes in the palaeoeconomy of the area are noticed. Firstly, Neolithic (4600 cal. BC) and Pre-Kerma (3000 cal. BC) settlement sites are of the concentred type. Other activity loci such as graves are present but are rare. So it can be concluded that these settlements were seasonal, and for gathering and hunting people. Secondly, it seems that during Kerma the settlement continued in the same area, but, noticeably, the society becomes more settled.

One of most prominent archaeological features of the Wadi is the presence of a large number of long stone wall structures. To me these walls are correlated with past human activity, hence they are indicative of the palaeoeconomy of the area.

The walls can be classified into 3 categories according to their physical position: those present on the top of the bank or on the raised areas, those present in the bed of a channel, and those on the edge and sloping downwards into the bed of the wadi. The possible functional categories of the wall suggested are animal traps or fences; territories and roads; silt precipitation, water storage and irrigation related function. The building of such long walls needs much effort and some form of administration or power, so we can say that the past residents of the Wadi were formed into a well organized and hierarchical society.

INTRODUCTION

The importance of the scientific study of environmental remains from archaeological sites has only been realized in the last three decades. In the past, archaeologists studied artifacts such as pottery, coins, metalwork and large bones. However, more recently it has been realized that plant and animal remains such as fish bones, seeds, snails and even beetles are very important. These are known as ecofacts that can survive in the ground for hundreds of years. From such remains, information can be gained about the past environments and economic activities such as farming which would have otherwise gone unnoticed (Worcestershire County Council, 2004).

1. Hypothesis

Edwards, D.N. and Osman, A. (1994).The Mahas Survey 1990.Repot No. 2 (Interim Report & Site Inventory). Cambridge, wrote:

> *In general, the survey was restricted to areas usually within 1 or 2 km of the river while permanent settlement has been almost entirely restricted to this area for at least the last 3 millennia. It is recognized that many earlier sites, including those of Kerma date may await discovery in areas further away from the river which are now true desert. The project plans to carry out some limited reconnaissance in the desert hinterland in only 2 areas, in the bend of the river east of the Nile north of Tombos and near Sesibi-Gorgod on the west bank. However, as the recent discovery of Kerma period sites in the desert over 17km east of the Nile (Bonnet & Reinold 1993) has demonstrated that it is likely surveys in other areas may be productive.*

Osman (2004) wrote:

Another important Characteristic of the Third Cataract Region is the fact that there are so many Khors which branch out of the Nile or joint it from the hinterlands, both from and to the right and left banks. Most of the khors were palaeochannels which carried running waters as late as the 17th and the 18th centuries. Important among these are Wadi Farja, which connects Semit East, in the south, to Mesaida in the north. This one is said to have had running water as late as the end of 19th century, and there is archaeological proof of this.

A famous spot called by the local people as " Ber Juha" that is, Juha's well, has proved be one of the present days wells dug in the bed of the right channel of the island Arduan, to which Wadi Farja flowed. Archaeological investigation and the style of built compared to those in khor Mesaida (the right channel of the island Arduan). These wells became the only source of fresh water when the khor dried up, during the months from January to August each year.

Therefore, Wadi Farja had running water as a branch of the Nile, like khor Mesaida during the flood season and possibly to the end of January. Then the population living on the wadi would depend on the water from Ber Juha and alike.

As a result of the above assumptions and our continuous visits to the area, it was gradually considered pertinent to test and/or prove such assumptions.

2. Study Area

The study area covers the Mahas Survey Project run by the Dept. of Archaeology, University of Khartoum (1990 to the present). The area of Mahas is situated in northern Sudan at the vicinity of Nile Third

Cataract Region. The project has discovered a tremendous number of archaeological sites, which are situated in a remote area from the Nile. The most important area of these was Wadi Farja. Wadi Farja, suspected to be the most important Nile palaeochannel in the area of the Third Cataract, is rich in both archaeological and palaeoenvironmental aspects. It is situated immediately to the north of the cataract on the eastern bank of the Nile, and its length is estimated to be 12 km, crossing the rocky desert in a northeasterly direction. The Mahas Archaeological Survey Project of University of Khartoum (MASPUK), established in 1990 recorded about 40 sites in the wadi and hinterlands. Another 24 sites were added in 2005. Accordingly**,** there is an increasingly strong hypothesis that Wadi Farja was a branch of the main Nile sometime ago. Osman (2004) pointed out that it was a seasonal stream like neighboring Khor Masida.

3. Objectives of the Work

It is assumed that Wadi Farja was inhabited by humans and it played a considerable role in the area's history during prehistoric, Pre-Kerman and Kerman times. This piece of work aims to illuminate the area's ecology, Palaeoecology and Palaeoeconomy through an interdisciplinary approach of archaeology and related sciences (geology and zoology).

4. Theoretical Approaches to Environmental Reconstruction

In this study the interpretation of past human ecology and economy in the study area will be conducted using the following approaches:

a) Observational or descriptive palaeoecology: This is the dominant approach to the study of past environments. It involves the modeling of the past by extending observations about processes within present day ecosystems back in time. These observations build upon previous observations providing data upon which hypotheses can be constructed and later tested.

b) Inferential or deductive palaeoecology: In this case the creation of a hypothesis proceeds observation and sets out the means by which the hypothesis could be tested. This approach lends itself to mathematical modeling.

c) Experimental (experimental palaeoecology)-the experimental approach to the study of palaeoecology has two main expressions. First, the experimental monitoring of modern environmental processes designed to increase the understanding of how these processes operate. The observations produced are then used to test ideas or explanations for particular features in the fossil record. Secondly, the experimental reconstruction of past human activities designed to increase understanding of the possible range of ways in which a particular artifact was used or ecofact was produced.

CHAPTER ONE

1. Geology, Ecology and Archaeology of Third Cataract

1.1. Geology of Third Cataract Region

Introduction

The Mahas region extends 100 km along the Nile between Hannek-Tombos villages, at the south (in beginning of the Third Cataract), and Jebel Dosha-Wawa village in the north. The major component of the region is the Third Cataract Region, which extends over 55km of the Nile (30 15-30 33 N and 20 00- 19 35 E).

Few works on the region's geology have been published. Hume (1934 and 1935) drew a topographic map of the area. Berry and Whiteman (1968) commented on the sandstone jebeles and volcanic rocks in the area, and their aging. Vial (1972) mentioned the trends for the metamorphosed basement gneisses and diagrammatic distribution of dykes. Vial *et a;l*(1973) surveyed the area's physiography. Thurmond *et al;* (2004) studied the paleohydrology of Nubian swell using remotes sensors, and concluded that, the course of the Nile has been strongly affected by the continued uplift of the Nubian Swell as manifested by the youthful geomorphology of the area. SIR-C/X-SAR imagery over a segment of the Nile was studied.

1.1.1. Geological History of the Area

The oldest rock to be seen is gneisses and schist, laid down during pre-Cambrian era. A long period of erosion followed the deposition of Nubian Sandstone Formation probably during the cretaceous era. The Nubian sedimentary rocks were followed in time, by the intrusion of younger volcanic basalt plugs. Berry and Whiteman (1968) aged these rocks to average of 97$\pm$ 17 million years. Thurmond *et al;* (2004), stated that they discovered in Third Cataract stretch an East -Western trending faults of much younger age (<90 million years old). The most recent geological events in the area were the deposition of alluvium and gravel along the Nile as it cut various channels through the basement rocks and the building up of the desert sands during the drier periods. This process of deposition and erosion continues as the deposition of the silt in seasonal stream of Masida (Personal communication: Us. Anwar Masida village, 2005).

1.1.2. Physiography

The Nile River flows northwards across a wide flood plain in the area of Dongola as far as Kerma. About 20 km north of Kerma, however, there is a sudden change in the scenery as the river crosses on to crystalline basement complex rocks. The ground on either side of the river becomes rugged, with numerous small granitic jebels rising up a hundred meters or so above the river water level (Vail *et al:* 1973: 3).

The riverbanks became steeper and rock lined, and the river itself broke into numerous channels passing around many large islands. There is an abrupt change from the northerly flow of the river when it splits around Arduan Island and flows almost due east for some 25 km before resuming its northerly direction in Kajbar- Sabu villages. This flow change was due to an abrupt change in the structure of the gneisses and granite bedrocks (ibid: 3).

1.1.3. Old Channels

The surrounding countryside is still a peneplained surface, but has been dissected by numerous old channels, now marked by deposits of alluvium and sand, indicating humid climatic conditions in the past.

1.1.4. The *Khor*s

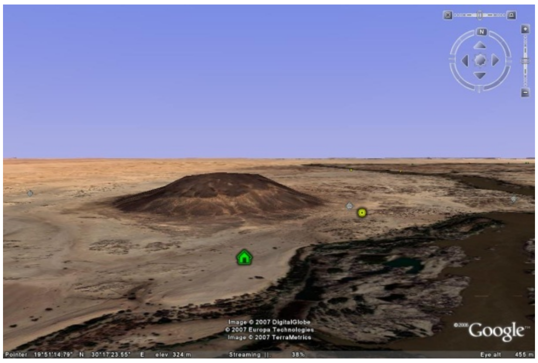
The region is marked by the many *khors* and wadis, which indicate that it is surrounded by mountains. The *khor*s are long, narrow depressions formed as a result of erosion and they are natural drainage for the rare rainfall from the desert to the Nile Valley. They are affected by the continuous erosion of soil material by the flowing water. The length of *Khor*s varies; longer ones extend deep into the Sahara and have small tributaries, which channel rainfall into the larger main *khor*s on the west bank.

The *khor*s are a very common topographic feature of this area. From Ashshaw to Jawgul there are about 15 *khor*s: as for example, "Kessin Ferki", "Seti", and "Ko-Ferki" *khor*s extending into the desert. Long *khor*s are indicative of the presence of open plain and wadis in the desert, while shorter ones are found in areas facing rocky mountains. There are some wadis, the most important one is situated in Masada and Farja areas.

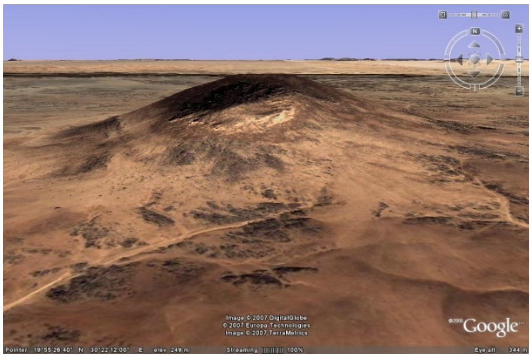
1.1.5. Hills

Several of the larger hills are capped by a thin, horizontal Nubian Sandstone Formation deposit, which rests over the metamorphosed basement rocks (ibid. 4). These hills are well demonstrated at Jebel Ali Barsi (385 m), J. Sadeik (372.4m), J. Dema (322 m), J. Kilgel (319 m) on Arduan Island, and J. Alarambi (409m, highest point in the area). (Satellite Image: 1-1 a, b, c, d and e respectively). River level is around 245m above the sea. At Fareig (303 m) a number of the high hills are composed of basaltic plugs, and the strong hexagonal jointing indicates the pipe-like nature of some of these intrusions.(Satellite Image: 1- 1 f).

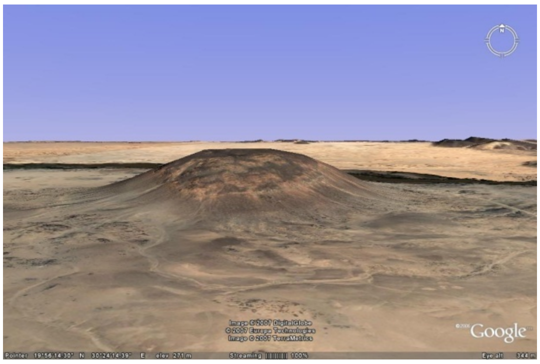
Satellite Image (1-1-a): Jebel Sadeik



Satellite Image (1-1-b): Jebel Ali Barsi

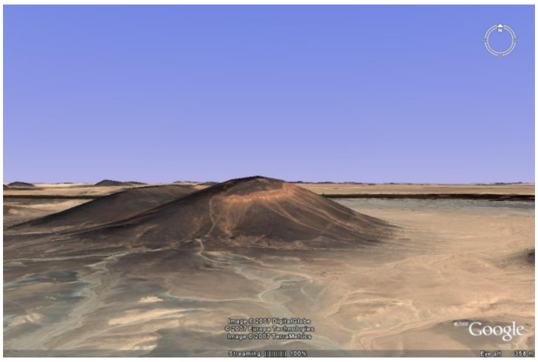


Satellite Image (1-1-c): Sadeik Image of Jebel Dema



Satellite Image (1-1-d): Jebel Kilgel

Satellite Image (1-1-e): Jebel Alarambi



Satellite Image (1-1-f): Jebel Fareig (Igneous)

1.1.6. The Rock Structures of the Area

The geological structure of Nubia shows variation from one area to another, but generally, it is composed of Nubian sandstone and the basement complex. Dykes and volcanic rocks in many areas of the Third Cataract Region (Map 1-1) cut the Nubian sandstone and the basement complex (Whiteman 1971: 42). The main features of the area's geology can be summarized as follows (Vail *et al:* 1973: 17-20):

1.1.6.1. Metamorphosed Sedimentary Rocks

These form the greatest part of the area's rocks. They are metamorphosed, garanitized coarse to median grained, biotite gneeisses and schist. They occur on both Nile banks in the regions of Abu Fatima-Tombos and south of Arduan Island towards Fareig. On the eastern bank, in area of Wadi Farja junction with the Nile there is ferruginous quartzite with mica schists. On the western bank opposite to Musul Island, limestone was reported by Hume (1934).

1.1.6.2. Metagabbros Rocks

Small gabbroic bodies are emplaced. These rocks are metamorphosed, which resemble the amphibolites but lack schistosity.

1.1.6.3. Granite Intrusions

Two types of granite have been recognized. These were coarser granite porphyry and finer pink granite. They occur at the west end of Arduan Island extending southeast for about 18 km with a width of 5 km. The granite formed in parts of the high boulder jebels and rocky county, through which the Nile has cut a number of narrow channels. This granite intruded into the metasedimentry country rocks giving rise to a wide belt of grandoioties contact rocks.

At Kajbar, gneiss cropped out beneath the Nubian formation that formed the bank and the major cataract. The gneiss rose on both banks from beneath Nubian Sandstone. It is a red variety of a decomposing character, forming rounded masses and sloping steeply to the north-west. The gneiss form along the western bank gave rise to a broad plain, out of which rose low masses of tumbled boulders composed of a light-coloured biotite-granite.

1.1.6.4. Micrograntes Dykes and Sills

Following the main tectonic movements and metamorphic events affecting the basement, a larger number of granitic dykes, and a few sills have been intruded, mainly into the metamorphosed country rocks of the Third Cataract Region, where they form a considerable late-tectonic dyke swarm. They may extend for two or three kilo meter and always follow the main granite instruction. Most of them are micrograntes with a few that are dioritic. These are fine-to-medium grained and pinkish to light grey in colour.

1.1.6.5. Nubian Sandstone Formation

Sandstone cabs most jebels (Dema, Kilgel, Sadeik, Ali Barsi and Alarambi). It also occurs as outcrops (Simit Island). These sediments overlay the granite and gneiesses basement, formed from quartz bebbles and feldspars. They have a white or cream course of sand conglomerates.

1.1.6.6. Cretaceous-tertiary Volcanic Rocks

A few small plugs of basalt have been observed and these correlate to volcanic activities near Fareig. They are fine-grained, dark greenish- blue massive rocks.

1.1.6.7. Unconsolidated Alluvium and Blown Sands

These are the youngest deposits composed of unconsolidated silts and gravels brought down by the Nile or resulting from sand blown across the desert. The banks of the Nile have narrow terraces of rich silt on which is used by the population for agriculture.

Low terraces are seen well away from the present streambed, demonstrating that in previous times the pattern of the river channels was different from those of today. Parts of the western side of the extreme north of the area away from the river south of Jebel Alrambi are masked by a thin, but presenting, cover of blown sands. It obscures the underling geology and through which the higher jebeles and resistant microgranites dykes may protrude.

1.1.7. Soil

The area’s soil can be roughly divided into four main types. These types include *gerif, seluka, sagia* (permanent land) and desert soil (basin land).

1.1.7.1. ***Seluka* land:**

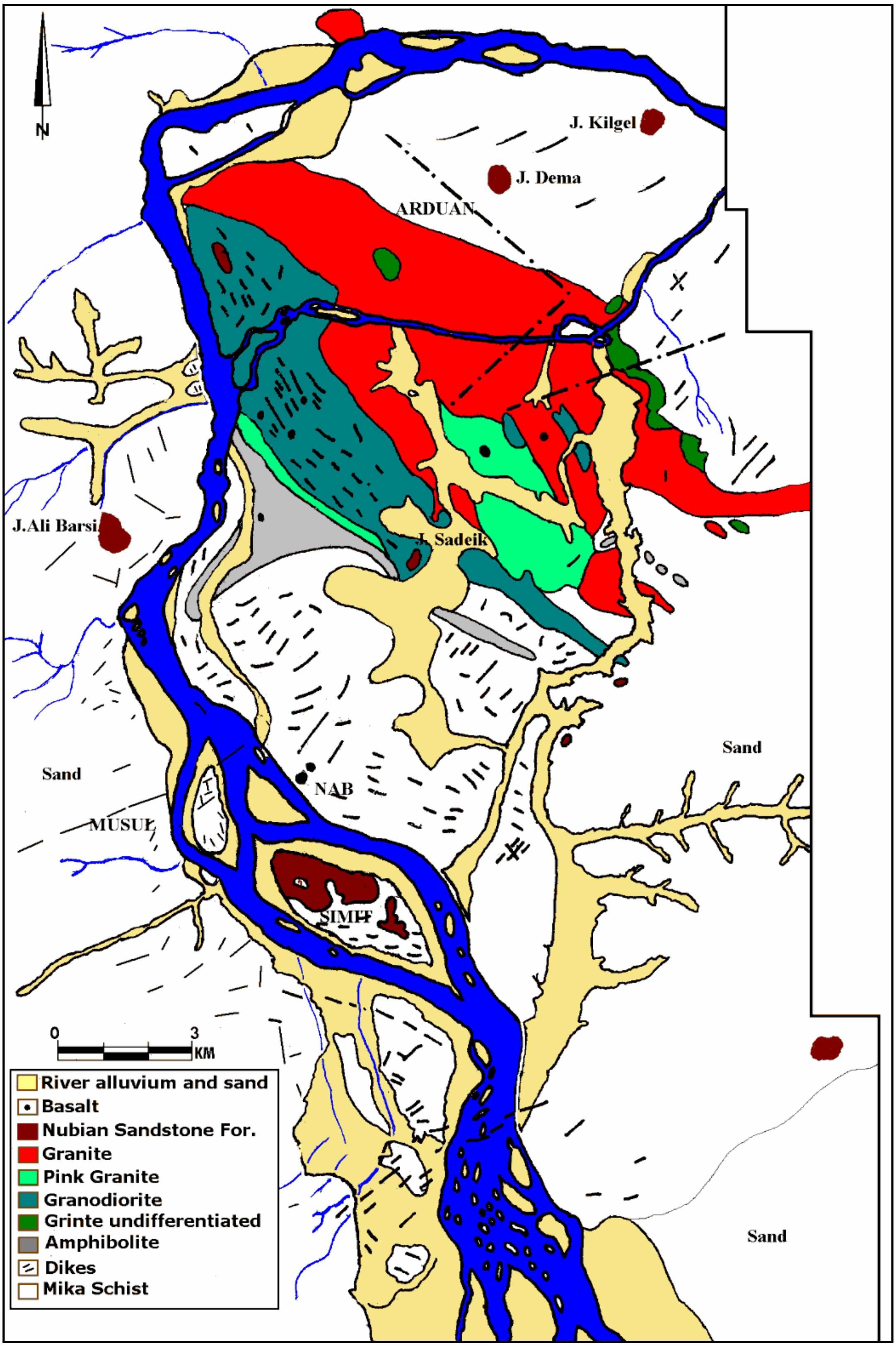
This is the soil covered by the river during the flood season. It contains two types: The *gerif* soil, which is the slope annually flooded by the river; and the *shadoof* -land soil which is included in the *seluka* land, but flooded only during very high Nile flood.

1.1.7.2. ***Gerif*:**

Gerif soil is an alluvial soil with a high content of minerals and humus and a generally fine texture. It is a fertile soil and is annually rejuvenated by river floods, which maintains its fertility.

Shadoof soil is a rich alluvial soil, that has been deposited fairly recently by the river and it may disappear when the river begins eroding the land by *hadam* (water erosion). It has nearly the same characteristics as *gerif* soil, but is not annually rejuvenated. This type of soil is locally termed as *gorier* which means ‘fertile’.

Local people tend to construct small artificial dams to create *seluka* soil with its two types. This type of soil is of great importance to local people for growing early harvested crops and animal fodder with some vegetables.



Map (1-1): Geological Map of the Third Cataract (Adopted from Vail *et al;* 1973) (Illustrated and colored by Sadig, 2004)

1.1.7.3. *Sagia*:

Permanent land soil is the alluvial terrace, which is well above the flood level. It is less fertile than *seluka* soil and has a less coarse texture. In many cases, it fertility has deteriorated because it has been exposed to continuous and may requires the land tiller to use fertilizers.

The third category of soil in the area is the desert soil. It is thin and merely consists of particles of pavement rocks or coarse sand particles. It is the poorest soil of the three categories. It is mostly occupied by settlement and rarely used in agriculture when irrigation is available. Thus, there is variation in soil types, ranging from poor desert soil to fertile soil of *seluka.*

1.1.7.4. Desert Soil:

The prevailing physical conditions of the area are favorable for moving sand dune development. Sand dunes move both steadily and fast over agricultural land in the area where land is dear and valuable. Any loss however small, may affect many families in the area because this land is virtually cases, their only source of livelihood. Dune encroachment is more serious on the western bank of the river.

In 1976, a UNEP/UNESCO reconnaissance team reported that sand from the expansive Libyan Desert is being blown southwards on a broad front by the steady northern wind. The team noted that the whole length of the Nile between Delgo and Karima is subject to serious sand encroachment along the north-facing bank.

In many areas, such as the region between the third Cataract and Kokka village, these dunes have reached the river. Some settlements in this area have been abandoned because they have been obliterated by moving sand dunes. Another area threatened by sand dune encroachment is the western facing, northern part of Mahas area.

1.1.7.5.Basin land:

This land includes the lower alluvial areas or depressions that are watered during the annual flood. It has developed recently in Dongola, Kerma region and in the areas of Ashshaw and Hannek.

All these physical conditions promote geomorphic processes like erosion and deposition by both running water and wind. The first is termed locally *hadam*. The *hadam* phenomenon is simply the geomorphic process of erosion, which takes place along the riverbank causing the disappearance of highly fertile strips.

1.2. General Ecological Survey of Third Cataract Region

Introduction

The Third Cataract Region falls in the Sahara region of northern Sudan, in the southern part of the Mahas area (30 15-30 33 N and 20 00- 19 35 E). This region is virginal from the perspective of ecological studies. The area is inviting to such studies because it has amongst others, a unique geology, geography, history and archaeology. The only known literature about this region's ecology was written by Admes (1977), in his book on the ecology of Nubia.

Within this desert environment, there are many habitats ranging from riverine fresh water and closed islands to bare rocky and sandy desert.

1.2.1. Field work periods

A survey of the area was carried out in March 2002 and this was repeated in August 2003, March 2004 and June 2005. Each survey lasted 2 weeks.

1.2.2. Material and Methods

1.2.2.1. Physical Environment

1.2.2.2.1.1. Climatic Factors

Temperature and wind speed and direction were obtained from Dongola Climatological Station, which is closest centre (70 kilometers south).

1.2.2.1.1.2. Soil and topography were reviewed from previous studies.

1.2.3. Biotic Environment

1.2.2.1. Flora

Samples of plants or their leaves were pressed between two sheets of papers for later identification in the Dept. of Botany, University of Khartoum.

The relative abundance of every species was calculated as a percentage of the total population.

1.2.3.1.1. Fauna

1.2.3.1.1. Insects: Butterfly nets, sucking tubes and oiled paper sheets were used to capture insects. These insects were preserved in boxes after labeling.

1.2.3.1.2. Reptiles: Some reptiles were identified in the field by binoculars, while others were caught using traps. The small reptiles were skinned and dried under the sun for later identification.

1.2.3.1.3. Birds: species were identified using binoculars and field guidebooks.

The relative abundance of every species was calculated as a percentage of the total population.

1.2.3.1.4. Domestic animals: Domestic animal species in the area were recorded.

1.2.4. Ecosystem of the Third Cataract Region

The area receives on the average less than O.1 mm of rain fall per year, so twelve dry months are the norm in the area. Complete dry years can occur. The scarcity of water is the limiting factor in the area. The Nile contains most of the life and the seasonal flood plays a vital role in refreshing the valley.

1.2.4.1. Climatic Factors of the Area

Five climatic parameters were obtained from Dongola Station. They are summarized in Table 1-1 and 1-2 and are plotted in Graph 1-1 and 1-2. (Ministry of Science and Technology, Metrological Authority, Administration of Data Service, Sudan, 2006).

Table (1-1): Weather Summery in Dongola Station -1984.

(Source: Ministry of Science and Technology - Metrological Authority)

Element	Mean Temperature C		Relative Humidity %	Total Rainfall (Mm)	Wind		Mean Station Level Pressure (HPA)
Month	Max.	Min.			Direction	Speed (Knots)	
January	26.0	7.3	33	0.0	N	8	989.2
February	31.9	11.6	23	0.0	N	9	985.3
March	36.0	16.5	19	0.0	N	7	982.9
April	39.6	18.9	16	0.0	N	10	982.3
May	43.8	23.2	13	0.0	NE	8	979.8
June	41.1	23.4	16	0.8	N	10	980.7
July	41.4	23.4	16	0.0	NW	9	980.1
August	40.6	22.7	18	0.0	NW	8	981.2
September	41.7	25.1	17	Trace	N	6	981.0
October	39.2	22.4	22	Trace	N	9	983.0
November	31.2	13.8	30	Trace	N	10	986.9
December	28.7	10.9	41	0.0	N	8	987.3
Total				Trace			

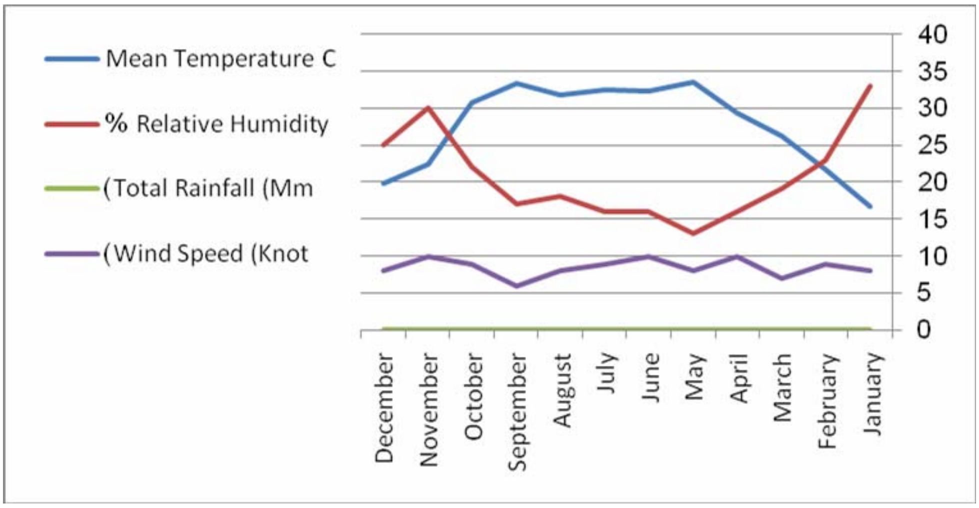
Note: 1 Knot(1.85 km/hr), HPA(Hetco Pascal pressure units)

Table (1-2): Weather Summery in Dongola Station -2006.

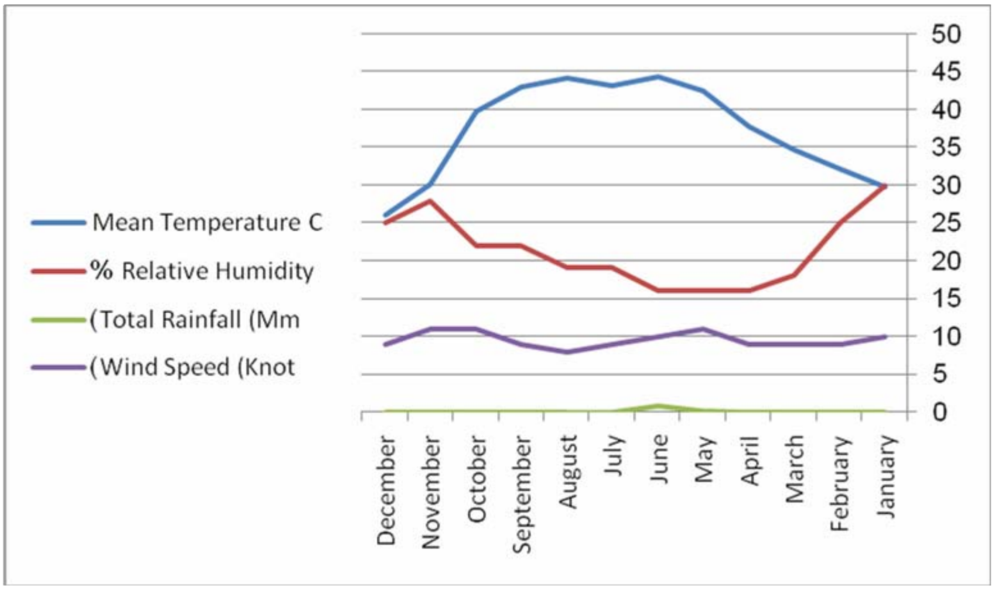
(Source: Ministry of Science and Technology - Metrological Authority)

Element	Mean Temperature C		Relative Humidity %	Total Rainfall (Mm)	Wind	
Month	Max.	Min.			Dir.	Speed (Knot)
January	29.7	11.9	30	0.0	N	10
February	32.2	13.3	25	0.0	N	9
March	34.7	15.3	18	0.0	N	9
April	37.7	18.5	16	0.0	NNW	9
May	42.5	25.0	16	Trace	N	11
June	44.4	26.7	16	0.8	NNW	10
July	43.2	26.1	19	0.0	N	9
August	44.2	28.2	19	0.0	NNW	8
September	43.0	27.4	22	0.0	N	9
October	39.8	23.4	22	0.0	N	11
November	30.1	13.8	28	0.0	NNW	11
December	26.0	9.0	25	0.0	NNW	9
Total				0.8		

Graph (1-1): Showing Climatic Data in 2006 - Dongola Station



Graph (1-2): Showing Climatic Data in 1984 - Dongola Station



1.2.4.2. The Ecological Zones of the Area

1.2.4.2.1. Fresh Water

There is no major difference in the flora and fauna of the Nile collected in this area compared to other parts of the Nile valley. The most important feature of the area is the presence of the 2 cataracts at Abu Fatima -Hannik in the south and at Kajbar-Sabo in the north. In addition, there are a scattered islands and rocks with a large concentration of islands in the southern part. General observation reveals that southern part, of the Nile harbors more aquatic life (specially the fishes) than the northern shallow and wide Nile water.

1.2.4.2.2. Riverine Ecosystem and Island

Almost all the Third Cataract falls on a granite zone, so the flood plain (gref) is very narrow, fertile, steep-walled – and is formed by silt deposition on the bottom rock. The water content of the soil and its type and distance from the water's edge determines the abundance of plant and animal species. Every year the flood almost cleaned up all the life on such soil. The *gref* can be divided into three strips

1.2.4.2.2.1. The Strip Adjacent to the Water (Amangar):

This is a wet soil with a width of 3-5 meters. The plant community in this strip consists mostly of fleshy grasses and shrubs, interspersed with some areas with no plant cover. Some species of reptiles, birds and insects be resident in this strip.

1.2.4.2.2.2. The Basin Strip_(Farry):

This is a flooded soil with a width of 10-500 meters. It is a cultivable area, used mostly for domestic animals green fodder, or cultivation of some cereals or vegetables. When the flood water has retreated. Wild grasses, insects, small reptiles and insect-eating birds are also resident in this area.

1.2.4.2.2.3. The Strip at the Top Edge of the Gref (aery):

The water content of this strip is low because it is rarely flooded. Its width ranges from 10- 30 meters in Fogo and Arduan villages in the south to 500 meters in Difoi, Mashakela and Kajbar villages in the north. The strip adjacent to the Nile valley edge is naturally colonized by trees like *Acacia* sp and grasses such as Halfa. After the soil dries up, the strip is cultivated by mechanically pumped water. Cereals and/or date palm and fruits are normally cultivated here.

1.2.4.2.3. Islands (Arties):

There are more than 65 islands in this region, and they can be classified intoe are two types:

1.2.4.2.3.1. Main Land Islands:

This is formed by the water of the water surrounding to a part of the main land. It can be a large island like Arduan (13X6.3 km); Simit (6X 2.4 km); a moderate island like Musul (3X1 km); a small island like Nab (1.8X0.8 km) or it can be a series of very small scattered uninhabited rocky islands. Land ecosystems prevail on this type of island, which is a phenomenon in the southern part of the area.

1.2.4.2.3.2. Precipitated Islands:

These are not part of the main land. They are formed by deposition and precipitations of the silt carried by the water in the flood season. They are normally relatively large, for example Mamoon-arti (3X1 km) and Defoi-narti (0.93X0.36 km). In the north, the islands of Narnarti (2X0.7 km), Mogan-arti (1. 3X0.7 km) and Arti-merry (3. 3X0. 6

km) also fall under this category. These islands have very fertile soil, which is very rich in plant cover and animals. *Tamarix* is the dominant tree, in addition to some grasses. These islands are also inhabited by many species of birds and serve as nesting sites for them. The land is normally very high, and stood even against the high floods of 1946, 1988 and.1998. Other categories of these islands are used just for cultivation like the basin strip (*Farry*). For example, Sabnarti (0.6X0.31 km) and Omdan-arti (1.2X0.22 km), facing Difoi and Jedi villages respectively. These seasonal islands can degenerate and reform. This type of island is a phenomenon of the northern part of the area, where there is a sandstone zone in which the rocks disappear and the Nile water was dispersed in a wide basin (averages are in Table 1-3). This contrasts with the southern part of the area, where the basin is restricted by rocky land. Seasonal small islands, with dense vegetation serve as a shelter for many birds, foxes, wild cats and dogs, as well as numerous reptile species.

1.2.4.2.4. Cultivated land or the Top Ridge of the Nile valley

This strip of land is narrow and scattered as general feature of the granite zone in the southern part of the region. However, the land in the northern part becomes sandstone and is clearly demonstrateed in vicinity of Difoi village. The strip ranges from between 1-2 kilometers in Mashakela, Fareig, Kajbar, and Difoi villages to three or more kilometers in Kokka- Shada villages, situated to the north of the region. This land lies between the date palm strip and human settlements, and can almost be flooded during very high floods. It is cultivated, irrigated by mechanical irrigation. The largest agricultural schemes are at Kajbar, Mashakela and Fareig range from 500 – 1000 Fedans. In the winter, wheat and bean are grown as *dura, zae maize, lobia and weka*. Other minor crops are *kerkedi* and watermelons. Many birds and insects are known as pest of these crops.

1.2.4.2.5. Human Settlements Strip (Houses)

Commonly this area lies between the cultivation strip and the open desert**.** Ordinarily, houses are built of mud (Jalos). Recently a few houses have been constructed from red brick, and some of the mud walls have been covered by a cement coloured layer. Adjacent to old houses there is usually an animal fence. Domestic animals that are bred include sheep, goats, donkeys and cattle. Some local Arabs breed camels. Pigeon towers are present near houses and are most common in the southern part of the region. Chickens and rarely duks are kept inside the houses. Doge and cats are the carnivore animals kept by Nubians.

Wild animals like rats (*Ratus ratus*), spotted gecko and housefly are common dwellers in the houses. Some birds like house sparrows and doves also nest in houses. Ants, mosquitoes and sand flies commonly visit at night and the latter two can transmit malaria and cutaneous leishmaniasis respectively.

1.2.4.2.6. Khors (Farkies)

In terms of the presence of plants and animals, the Khors are richer than the Sahara wadis. Khors are very long depressions formed by water erosion of soil when the water is drained from the desert to the Nile valley. They could be short or long with tributaries. Khors are common topographic features of the area, mainly on southern part of the western bank. From Ashshaw to Jawgul villages there are about 15 khors. The longest are Kessin Farki, Marakol, Difoi and Sabu, all of which extend deeply in the desert. This indicated the presence of wadis beyond the khor, as shorter ones often indicate the presence of the facing rocky mountains. Khors are indicators of the ecological changes as rainfall has decreased.

In the western banks of the Nile, there are many khors and wadis including Wadi Farja, and the Khors of Mashakela, Asmakool, Jedi and Sabu.

As parts of the khors are always flooded, their ecosystem is similar to that of *Gref*. In the parts of the Khors closest to the desert, their ecosystem is similar to that of the desert, with a relative richness in flora and fauna.

Trees like *Acacia ehrenbergiana* (Ar., Nu., selem), *Tribulus longiptalus* (Direase) grass and animals as Dorcas gazelle, rabbit, jerboa, snakes and wasps are resident in these area.

1.2.4.2.7. Open Desert

On both banks at a distance of approximately 500 meter extends the open lifeless desert. In some khor's bed there may be very sporadic desert vegetation and very few animals.

Table (1-3): Summaried the Nile Width in Different Localities in Third Cataract Region

Villages	Nile width in meters
South to Simit Island	**330**
North to Simit Island	**330**
Fogo- Sadeik	**410**
Habarab- Taajab	**271**
Jawgul- Arduan	**310**
Joran- Melejab	**300**
Kossinknja- Amnnein	**220**
Shofein- Nauri	**340**
Hafirnog – Mashakela	**471**
Difoi –Fareig	**680**
Haleba- Jedi	**512**
Kajbar-Sabu	**480**

1.2.4.2.8. Palaeochannels of Third Cataract Region

In this region, there are many palaeochannels and possible palaeolakes. No geophysical or satellite imagery studies have been conducted. Osman and Edward (1992-1994) detected many palaeochannels through the distribution of archaeological sites and biological material collected. Google satellite images of normal quality, also reveal some others. On the eastern bank of the Nile, there is the Wadi Farja, which is in our study area. Another possible palaeochannel extends from Kerma area at the south to the end of the cataract in Sabu village and may be connected with Wadi Farja. By using the normal images, it is difficult to detect and our archaeological survey was cut short on two occasions (in July 2004 and February 2007) because special vehicles were required to pass through the area.

On the other bank, there is a palaeochannel in vicinity of Ashshaw and Hannik villages called Gaamuffa,, at which many settlement sites have been reported by Edwards and Osman (1990, 1991) Osman and Edwards (2000). Three other possible palaeochannels in Fogo, Jawgul and Difoi villages have been reported**.**

1.2.3. Flora

1.2.3.1. Cultivated Plants

Nowadays the old water lifting devices of ancients have changed from *shaduf* and *saqia* to water pumping machines. These machines irrigate 2-5 Feddans if bought privately. Alternatively, it may be owned by a single hamlet of people, which is more common. There are some comparatively larger agricultural schemes (50-150 Feddans).

There are two growing seasons - winter (*shittwi*) and summer (*seafi*). The winter growing season is more important than the summer, which is mainly used to grow animal's green fodder. Cultivated plants are summarized in the Table (1-4).

Map (1-2): Palaeochannels of Third Cataract Region

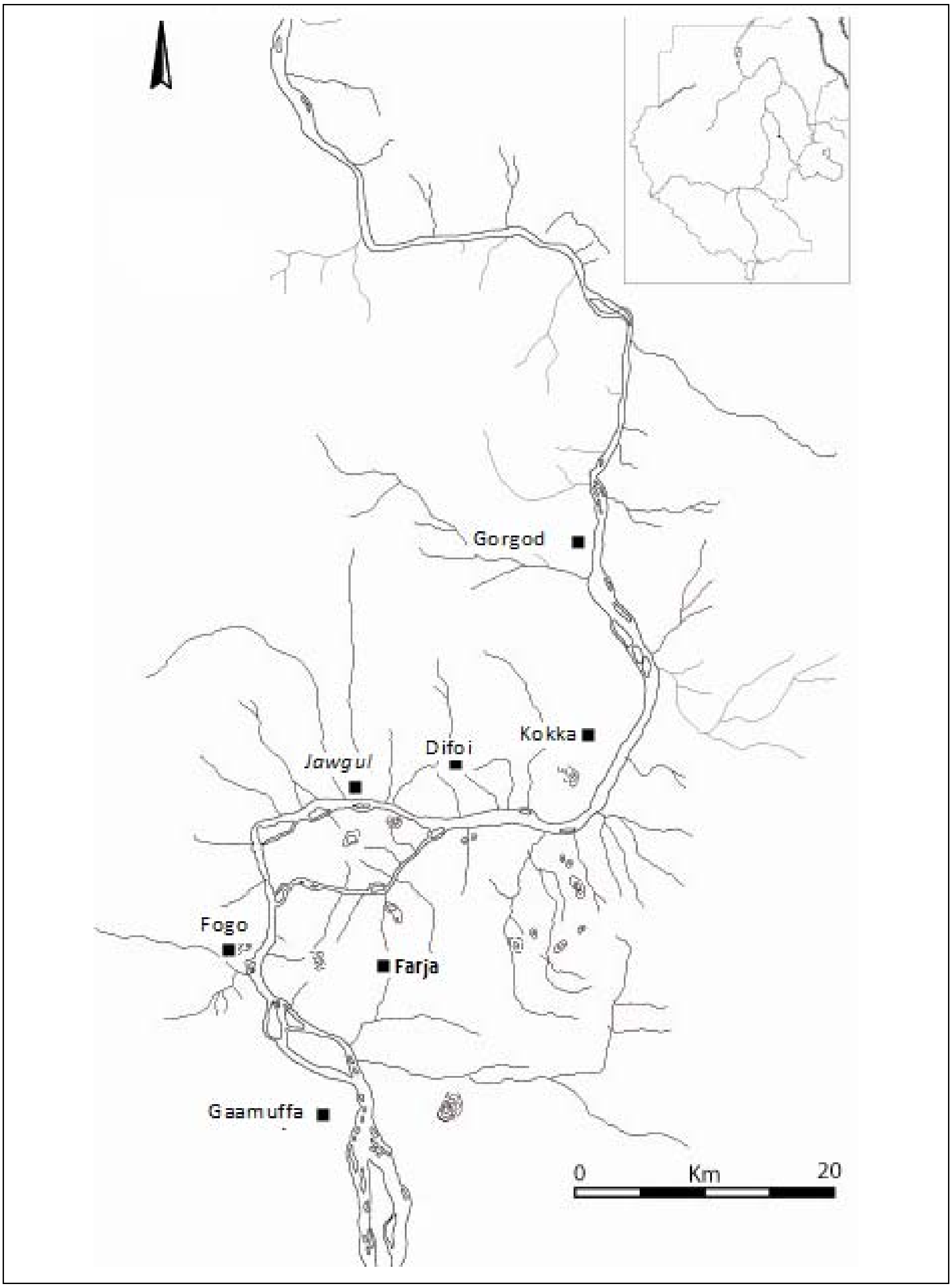


Table (1-4). Cultivated Flora in Third Cataract Region

English	Latin	Nubian	Arabic	Season
Grains				
Wheat		*Ellee*	Gemih	Winter
Durra	*Sorghum sp.*	*Mare*	Dura	Summer
Maize	*Zea mays*	*Makadae*	Dura Shami	Multi-seasons
			Dokhon	
Beans				
Fenugreek	*Trigonella foenum-graecum*	*Karim*	Hilba	Winter
cow pea	*Vigna unguiculata*	*Dignitee*	Lobia	Multi-seasons
Lablab	*Dolichos lablab*	*Ashrangee*	Lobia Afin	Multi-seasons
Haricot	*Phaseolus vulgaris*		*Fasuulia*	Winter
Lupin	*Lupinus sp.*	*Akindee*		Winter
Tick beans	*Vicia faba*	*Ful*	*ful musri*	Winter
Beans	*Lathyrus sativus?*	*Guuruu*	Besila	Winter
Vegetables				
Onion	*Allium cepa*	*Felee*	Basal	Winter
Okra	*Hibiscus esculentus*	*Wee*	Bamia	Multi-seasons
rocket grass	*Eruca sativa*	*Muuginuur*	*Jarjiir*	Multi-seasons
Melon	*Citrullus lanatus*	*Magad*	*Batikh*	Multi-seasons

		Ajoor/ Tibesh	*Ajoor*	
			Molohkia	Summer
			Regla	Summer
Carrot		*Gezir*	*Gezir*	Summer
		Banjar	*Banjar*	Summer
Fruits				
Date	*Phoenix dactylifera*	*Fenti*	Tamur	Perennial
Lemon				Perennial
Grape fruit				Perennial
Orange				Perennial
Mango				Perennial
Dom palm	*Hyphaena Thebaica*	*Hambo, Sabae*	Dom	Wild Perennial
Zizyphus	*Ziziphus spins-christi*	Nabak	Nabak	Wild Perennial
Shades and Ornamentals				
Azarida	*Azaridachata indica*	*Neem*	*Neem*	Perennial
Others				
Safflower	*Carthamus tinctorius*	*Kushee*		Summer
castor bean	*Ricinus communis*	*Akkonj*	*Khirwa*	Winter

1.2.3.3. Natural Flora

Biologically two environments can be distinguished, the river banks and the desert. Vegetation along the Nile is hardly affected by the latitude. The desert supports vegetation where it receives some rainfall especially in low laying land. In the north of the region up to Dongola the desert bears very little vegetation.

This thesis tries to list out plant species identified during the survey with a short comment on each species. To calculate the relative abundance of each plant needs time and team work, thus this thesis documents the area flora and fauna.

1.2.3.3.1.1 . Trees:

1.2.3.3.1.1. Date palm

The date palm *Phoenix dactylifera*, (Nu; Fenti, Ar. Nahkal) is a common tree of the Nile valley north of Khartoum. Mostly part of natural vegetation it has become a cash crop for native Nubians. The palm is found along the Nile bank and the width varies from area to area. In the central region of the Third Cataract Region, the date palms are frequent compared to other parts of the region. The date palms density reaches its peak in Kajbar village. (Photo: 1-1-a).

1.2.3.3.1.2. Dom Palm

The dome palm *Hyphaena thebacia*, (Nu; Humbo or Sabae, Ar. Dom) is a rare tree in the area. A few Dome palms were noticed in the southern part of the region stretching northwards until the Nile bends at Arduan area. From Jawgul village eastwards these trees are scattered and grow as big shrubs rather than the common long trunked palms. (Photo: 1-1-b).

1.2.3.3.1.3. *Acacia* Species

About six species of *Acacia* were recorded, they are scattered in *Gref* and open sand along the flood plains, where land has not been cleared for cultivation. Before, 1970 the sunut wood of *Acacia nilotica* was used in the manufacture of boats and doors. Other types have been used for house roofing, and firing. The acacia fruit has many folk medicine usages. The species are listed below:

Species	Local Nubian and Arabic Names
Acacia nilotica (Photo: 1-2-a)	Ar. sunut , Nu Senti, Jortae
Acacia seyal (Photo: 1-2-b)	Ar. Talh , Nu Sallae
Acacia nubica	Ar. La'oat , Nu Jollae
Fadherbia albida (Photo: 1-2-c)	Ar. Haraz , Nu Khoroj, haroof
Acacia senegal	Ar. Hashab , Nu Gundae
Acacia ehrenbergiana (Photo: 1-2-d)	Ar., Selem , Nu. Selem

1.2.3.3.1.4. Other Tree Species

Species	Local Nubian and Arabic Names
Thamrix articulate (Photo: 1-2-e)	Nu. Moor, Ar. Tarfa, forms dense coverage along the steep sloping river banks specially on islands. It is used as fire wood only. (Photo)
Cappris decidua (Forsk.) (Photo: 1- 2-f)	Nu. Garae Gamy, Ar. Tundob, it is scattered in the strip of houses and the desert specially along the banks of Khors.
Ziziphus spins-christi (L.) Wild	*Ziziphus spins-christi* (Nu. *nabag,* Ar.*sidir* or *nabag*) is rare and found in gardens and houses.
Azaridachata indica	*Azaridachata indica (N*u. *Neem,* Ar.*Neem*) is also scattered and planted by natives for shade and ornamental purpose.

Photos: Trees

Photo: (1-1-a) Date palm *Phoenix dactylifera*

Photo: (1-1-b) Dom palm *Hyphaena thebacia*

Photo (1-2-a): *Acacia nilotica* – Sunut

Photo (1-2-b): *Acacia seyal*

Photo (1-2-c): ***Fadherbia albida***

Photo (1-2-d): ***Acacia ehrenbergiana***

Photo (1-2-e): ***Thamrix articulate***

Photo (1-2-f): ***Capparis sp***

1.2.3.4. Bushes, Shrubs and Grasses

Species	Local Nubian and Arabic Names	Description
Solanum incarum Photo:(1-3 -a)	Nu. Kadran-bus	it is scattered bush in Gerf and cultivates land. It is used locally in treatment of sores abdominal pain relievers.
Abutidlen panosum	Nu .Gergdan	it is scattered bush in edges of the river bank and margin of field. It is used for traditional medicine.
Hibiscus sabdriffa	Ar. & Nu. Krekedae	It is cultivated bush in the margin of field.
Amprosia martima Photo:(		Nu. Tenoom, Ar. Tenoom; Demsisa, Aromatic bushes scattered in the

1-3 -b)		Geref. Very often used for treatment of abdominal pains.
Cassia senna	Nu. Seenmisk	It is Aromatic bushes and it is found in the Gerf and used for treatment of abdominal pains.
Panicum turgidum Photo:(1-3 –d)	Toshae (Nu) Ar.& Nu.Temam	is scattered in the desert specially banks of Khors.
Cyndon dactylon Photo:(1-3 –e)	Nu. *Hambartea,* Ar. Halfa	it is perennial long grass and grows along the steep-cut banks of the river and whenever else it can find moisture as fields. It is used as green fodder or for grazing and also used in manufacturing of robs.
Nub. *Safsaf* Photo:(1-3 –f)		Long grass grows in the gref close to water. It used in vessels (Boats) and fencing sometimes
Calotropis procera Photo:(3 –g)	Nu.,Habad, Ar. Oshar	Big shrub, very common everywhere even in the desert, toxic, domestic animals do not eat it.

Shrubs and Bushes

Photo (1-4-f): *Portulaca sp*

Photo (1-3 -b): *Amprosia martima*

Photo (1-3 -c): *Cassia senna* L

Photo (1-3 -d): *Panicum turgidum*

Photo (1-3 -e): *Desmostachya cynosuroiddes*

Photo (1-3 -f): Nub., *Safsaf*

Photo (1-3 –g): *Calotropis procera* Ar. Oshar, Nub.,Habad

1.2.3.5. Grasses

Species	**Local Nubian and Arabic Names**
Cynoclon dactylon Bermuda grass	Nu. *Bunddi* or Goore, Ar, *Nagiila*
Cypris istandus	Nu., Goran Bungesire, Ar, *Seada*: it's roots are used for medicinal purposes

1.2.3.5.6. Seasonal Herbs

The area has a very rich grass biodiversity, specially in the Gerf after the flood, and in the wheat and bean fields in winter season.

Species	Local Nubian and Arabic Names
Tribulus longiptalus Photo:(1- 4-a)	Nu*. direasl*, Ar, *direase*
Ipomea sp	(Nu*. Tabar*) This is winter growing seasonal herb found in wheat and bean fields. It is used as green fodder for animals.
Medicago sativa Photo:(1-4-b)	Nu., Hadra, it is toxic and fatal to livestock
Photo:(1-4-c)	Nu. Tatur, Ar. Handl
Photo:(1-4-d)	Nu. Khoshe
Hibiscus sp	Nu. Sarmontong
Cenchrus biflorus	Nu. *keniskole*, Ar. *Haskanit*
Pulicaria sp. Photo:(1-4-e)	
Portulaca Photo:(1- 4-f)	
Sonchus oleraceus (Photo: 1-3-g)	
Leptodenia (Photo: 1-3-g)	
Comositae lacuca taraxifola	
Truticum spp	
Chenopoduim murale	
Orrbanche sp	
Datura sp	
Heterophyta	

Photos: Seasonal Grasses

Photo (1-4-a)*: Tribulus longiptalus*

Photo (1-4-b): *Medicago sativa*

Photo (1-4-c): Nu., Tatur, Ar. Handl

Photo (1-4-d): Nu., Khoshe

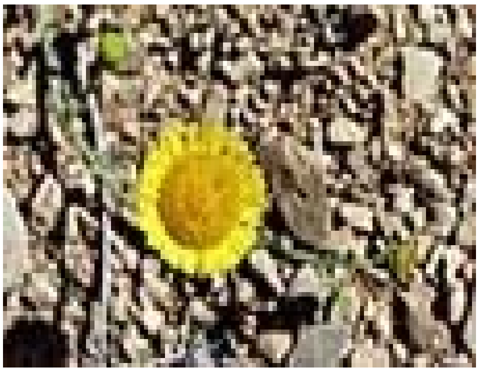


Photo (1-4-e): *Pulicaria sp*

Photo (1-4-f): *Portulaca sp*

Photo (1-3-g) : *Sonchus oleraceus*

Photo (1-3-h): *Ipomea sp*

Some Agricultural Plants

Photo (1-5-a) : Nub.,Akendae Ar.,Tormos

Photo (5-b): Nub.,Degintae,Ar.,Loba

Photo (1-5-c): Nub.,Aromae , Ar.,Gara

Photo (1-5-d): Ar.,Barseem

Photo (1-5-e):Nu., Ashrange

Photo (1-5-f): Ar.,Fool Musrai (Beans)

1.2.4. Fauna

The area is rich in animal biodiversity especially insects, birds, fishes and reptiles. In the coming paragraphs we will list the animals which have been recorded.

1.2.4.1. Large Animals

1.2.4.1.1. Domestic Animals

Animal husbandry is a very important component of the economy of Nubian life. Sheep and goats are the most abundant domesticated animals. They are kept in fence enclosures and are fed on green fodder cultivated at *Gerf* or at small water pump schemes. They are occasionally fed in farms after the cultivation of wheat or beans. Cattle are also kept for milk production and plowing of fields. Donkeys are very common in the Mahas area and every family may own one or more donkeys that are used for transport and for carrying green fodder. There are also horses in this area. Camels are rare and are reared by Arabs for carrying baggage. Sometimes, rabbits also are reared inside houses. Dogs and cats are common.

On the islands the domestic animals are relatively abundant; this is attributed to abundance of green natural and cultivated green fodder.

1.2.4.1.2. Mammals

Goats *Capra hircus* (Nu:Fag). (Photo: 1-6-a).
Sheep *Ovis aries* (Nu:Eged). (Photo: 1-6-b).
Cattle *Bos taurus* (Nu:Tea). (Photo: 1-6-c).
Donkey *Equus asinus* (Nu:Kaj) (Photo: 1-6-d).

Horse *Equus caballus*: very rare

Camel *Camelus dromedarius* (Nu:Kam)

Rabbit *Oryctolagus cuniculus*(Nu:Donj).

Dog *Canis familiaris* (Nu:Mog)

Cat *Felis catus*Nu:Kadis)

Photo: Some Mammals

Photo (1-6-a) :*Capra hircus* (Nu:Fag)

Photo (1-6-b) : Sheep *Ovis aries* (Nu:Eged)

Photo (1-6-c) : *Bos taurus* (Nu:Tea)

Photo (6-d) : *Equus asinus*(Nu:Kaj)

Photo:(1-7) *Crocuta crocuta*

1.2.4.1.3. Wild Mammals

The only known antelope is Dorcas gazelle, normally solitary individuals are seen in the desert wadis. Wild rabbits can also be seen. Fox (jackal) are abundant in the desert nearby human settlement.

Fox *Vulpes* sp. (Nu:Okol)
Gazelle *Gazella thompsonii* (Nu:Kejad). Solitary individuals of this animals are found in the desert wadis up to 30 miles from the Nile. (Adms, 1982:39).
Hyena (Ar.,Nu: Adea or Deep), Photo:(7).

1.2.4.1.4. Domestic Birds

Chicken (Nu: Dirbad) and Pigeon (Nu: Minae): Chicken and pigeons are the most common domesticated bird found in every Nubian house. However, in the southern part of the region, such as in Habarab village and southwards pigeon small towers (*Boroj*) are a very common feature in front of the houses.

Duck (Nu: Butta): not very commonly domesticated in the area.

1.2.4.1.5. Wild Birds

Family	**Species**
Ardeidae (Egrets)	*Egretta alba* (Great White Egert)
	Egretta grazetta (Little Egert)
	Egretta intermedia (Yellow billed Egert)
Ciconiidae (Stork)	*Ciconia abdimii* (Abdim's Stork), *Ar., Simbria*
Anatidae (Ducks and Geese)	*Aythya sp* (African Pochard)
Accipteridaeidae (Vullues Eagle Hawaks and Allies)	*Neoplhron percnoptenus* (Nu: Koog- nollow, Ar., Nissr)
	Torog fracheliotus (Nubian vulture, Nub.,Arabgorda
(Photo: 1-8-a)	*Milvus migrans* (Black kite, Nu: Sirryou)
	Unidentified 2 species of eagle
Phasianidae (Game birds)	Francolinus sephaena (Crested francolin Nu: Gack-gago)
	Other Francoline sp. (Nu., Fock-fogae) is present mainly in wheat field , greenish in color, flies very swiftly causing clapping noise from its wing.
Rallidae (Crakes, Rails and Coots)	*Limnocorax flavirosta*
Charadriidae (Plovers)	*Vanellus spinosus* (Nu: Kiglang)
Collumbidae (Doves and Pigeons)	*Oeva capensis* (Ar.,Balaom)
.(Photo: 1-8-b).	*Streptopelia decipiens*
	Streptopelia senitoraquta (Nu: Duka Dogae)

	Streptopelia capicola (Nu: Habad Dogae)
	Streptopelia lungens (Nu: Wisa wisa)
	Unidentified Small Dove (Dogae kodod)
	Domestic pigeon (more abundant in southern Mahas)
Cllumba levia (Photo: 1-8-c).	*Upupa epops africana* (African Hoopoe, Nu: Shok-shoky)
Strinidae (Owls)	*Tyto alba* (African Barn Owl, Nu: Tele-pongae)
……………………..	*Cypsiurus parvus* (Palm Swift)
Alcedinidae (King Fisher)	*Ceryle maxima* (Giant King Fisher, Nu:Konja-dokeal)
	Ceryle rudis (Nu:Eisa-mosa)
Meropidae (Bee Eater)	*Meropus boehmi* (Nu: Food-Doki)
Hirundinidae (swallow and Martins)	*Psalidoprocne albiceps* (White Headed Roughwing Swallow)
Motacillidae (Wagtail and Pipits) (Photo:1-8-d).	*Motacilla aguimp* (African Pied Wagtail) Nub.,Geldon
Pycnonoyidae (Bulbuls)	*Pyconotus barabatus* (Yellow- vented Bulbul,Nub., Galo-cup
	Argya nubiginosa (Rufous Chatter, Local Name: Gamae-jur)
	Turdoiodes melanops (Black-lored Babber, Nu: Osor-gala)
Polceidae (Photo: 1-8-e).	*Passer domsticus* (House Sparrow) (Nu: Foga or Karti). Most abundant birds 75% approximately.

	Passer griseus (Grey Headed Sparrow)
	Vidua fischeri (Straw-tail Hydah)
Unidentified?	Unidentified Very greenish small sparrow, with long tail, wings rosen over the rump on Tarfa tree
Turdidae (Thrushes, Wheatears, Chats and Allies)	Very dark colored bird with white color undertail coverts, one of the sexes has white-cap-like crown. Similar to *Myrmecochichla sp.*(Antaeterchat)
Nectariniidae (Sunbirds)	*Anthreptes platura* (Pygmy Long-tailed Sunbird), on *Acacia seyal* tree.

1.2.4.1.6. Reptiles

- Spotted Gecko (Nu. Korrey): House hold
- *Mobaya quinqutenioto* (lizard, Ar., Sehlia,Nu. Jendalisae): Date palm plantation
- Lizard: (Nu. Nellae) dwells in the date palm plantation
- Chamelion *Chameleo spp* (Nu. Fanan Desso)
- Nile Crocodiles (Ar., Tomsah, Nu. Olum). (Photo:1- 9-a).
- Nile Aquatic Monitor (Nu. Ashag, Ar. Waral). (Photo: 1-9-b).
- *Uromastyx* Sp.: Spiny Tailed Lizard (Ar., Dab, Nu. Naje- Ashag, Naje- Korri). This is a plant eating reptile that is relatively abundant on Arduan Island and in the Fogo village vicinity. (Photo: 1- 9-c).
- Nile Turtle

Snakes: the area is rich in snakes but unfortunately no work has been carried out to record the species that live there. Adms (1977:40) mentioned two species cobra (*Naja* sp.) and horned viper, Nu. Abdigell (*Cerastes* sp).

Photo: Some Birds

Photo:(1-8-a) ***Milvus migrans*** **(Black kite, Nu: Sirryou)**

Photo:(1-8-b) ***Streptopelia*** **(Nu: Duka Dogae)**

Photo:(1-8-c) ***Upupa epops africana*** **(African Hoopoe, Nu: Shok-shoky)**

Photo:(1-8-d) ***Motacilla alba*** **(African Pied Wagtail) ,Nub.,Geldon**

Photo:(1-8-e) Male ***Passer Passer domsticus*** **(Nu: Foga or Karti)**

Photo: Some Reptiles

Photo (1-9-a):Nile Crocodile

Photo (1-9-b): Nile Monitor

Photo (1-9-c):*Uromastyx* Sp.

1.2.4.1.7. Fishes

The available literature counts more than 40 species of Nile fishes (AbuGiderri, 1984). Fishing is a very important subsistence activity especially in the northern part of the Mahas area, specifically in the Fogo and Kabaja villages. In these villages there are cages in which the fish are kept for transport to Dongola market every Sunday. The list below of species was identified from these fisheries. Photo (1-10-a-d)

Family	Species Name	Arabic and Nubian Names
Osteglossidae	*Mormyrus cashive*	Kashmelbanat, Bushi
Tetradontoidei	*Tetraodon fahka lineatus?*	Tambera, Kako-berro
Cybrinadae	*Lebeo nilotca*	Dabs, Dabs
Clariidae	*Clarias lezara*	Garmut, Dushko
Mochodidae	*Synodontis schall*	Gergur, Kirr-kigi
Malapterusus	*Malapterus electricae*	Barada, Tonngi
Centropomidae	*Lates nilotica*	Igil, Gobir
Cichidae	*Oreochromis niloticus*	Bulti, Ferri
Schilbidae	*Schilbe uranoscopus*	Shilbya, aglung?

Photo: Fish

Photo (1-10-a):*Lates nilotica*

Photo (1-10-b):*Oreochromis niloticus*

Photo (1-10-c):*Clarias lezara*

Photo (1-10-d):*Tetraodon fahka lineatus*

Photo (1-10-e): ***Leiurus quinquestriatus***

1.2.4.2. Small Animals

1.2.4.2.1. Insects:

Family	**Species**
Muscidae	*Musca domestica* Linnaeus(Nu.Kotti)
Curculindae:	*Baristorata spp*
Buprestidae	*Julodis caillaudi*
Hemiptera	*Aphis spp*
Hymenoptera	*Monomorium spp(Pharaoh's ant)*
Lepidoptera	*Sesamia cretica*
	Anopheles gambi (Mosquito)
	Phleobotomas papatasi (Sand fly)
	Simulium damnasum (Black Nemitti), Adms (1977: 40)
	Simulium griseicollis (Green Nemitti), Adms (1977: 40)

In addition, there are many unidentified bugs and Odonata species**.** Mosquito and sand fly are responsible for transmitting malaria and cutaneous leishmaniasis in the area while the Nemitti causes the matic reactions in human back ear and around eyes.

1.2.4.2.2. Archinids - Scorpion (Nub. name Seged):

Leiurus quinquestriatu is a very common scorpion this area especially in the summer months. It becomes less common in the winter. Its sting is fatal, especially to children and old peoples (Photo (1-10-e).

1.2.4.2.3. Snails:

Bulinus and Biomphalaria (Biharsia snail).

Nile oyster

1.2.5. Animals in Rock Drawings

The area has a large number of animal rock drawings, which may date to Neolithic times.. Many of the drawn animals now are now extinct in the area and this is attributed to climatic change. The drawings are more concentrated in the southern part of the region, and in Sabu village. These drawings include, rhinoceros, hippopotamus, giraffe, cow, camel, leopard, and lion. One rare drawing was that of a scorpion.

1.3. Archaeology of Third Cataract Region

1.3.1. Previous Archaeological Work

1.3.2. Classic Writers and Visitors

Archaeologically, the Third Cataract Region is fairly well known. Of the many travelers who passed through the area in the 19th century, these are account of Linant de Bellefonds(1821-22), Cailliaud (1826-27) and Waddington and Hanbury (1822) and Burckhardt, 1819 provide particularly useful descriptions of the region together with relatively accurate maps. Their numerous observations on a wide variety of ancient sites are invaluable. Most of these accounts were supported by many Pharonic and Nubian inscriptions (dating to Medieval periods).

1.3.3. Official Works Research

The works of Blackman (1910-1937), Griffith (1927), Fairman (1938), Arkell (1950) notes on sites at Wawa, Agula, Delgo, Sabu, and Tombos and Schiff Giorgini (1965, 1971) were the earliest. A number of important groups of rock drawings have also been identified by

Chittick (1961), Allard-Huard and Huard (1983,1985) and Leclant (1982,1984). Recent elaborate workers are Osman (1969-2007) and Edwards (1992 -2000).

Other important authors are listed alphabetically, Adams (1977-1980),Alexander (1994), Bedri (1969), Berti *et al*; (1986), Bonnet (1978-2006), Breasted (1908), Brovarski, (1982), Honegger (1999), Kronenberg (1987), Peterson (1967), Petti Suma(1964), Privati (1988), Rose (1996), Rossi (1949), Sjöström (1994), Thelwell (1982), Trigger(1965-82), Vila (1975-1980), Welsby (1993-1996), Whiteman (1971), and Williams(1983).

1.3.4. The Mahas Archaeological Survey Project (MASP)

The Mahas Archaeological Survey Project (MASP) of University of Khartoum started in 1990 by Prof. Ali Osman Mohamed Salih (Dept. of Archaeology, University of Khartoum). More than 1000 sites were recorded in different seasons in the region and its hinterland. A series of reports, papers, university thesis and books have been published. The project was funded by Mahas Cooperative Society and University of Khartoum. Lately, other organizations such as the British Institute in Eastern Africa have participated in funding the project.

In the four seasons, the project has identified several hundred sites or groups of sites along the Nile and in the surrounding desert. The methodology adopted by the (MASP) has been organized around a hierarchy of 6 levels of survey. In brief the different levels were:

1. Desk-based assessment based on documentary records and other sources such as local oral traditions.
2. Initial reconnaissance to verify and check reported sites and locate major new sites.
3. Extensive systematic walking surveys to locate and register a full range of sites.

4. Preliminary identification, classification and recording of individual sites, to include sketch plotting.
5. Limited site surveys.
    a. Full measured ground survey of selected sites with possible sondages.
    b. Intensive and systematic walking surveys of selected areas. (Edwards and Osman 1992).

The results of the fieldwork of the Mahas Survey, combined to the results of earlier works, particularly on the historic sites, has shown that archaeological sites of relevance to the cultural heritage of the people of the Mahas region can be found.

The region has become the focus of the University of Khartoum since 1990 (Edwards and Osman, 1992, 1994, 2000, Osman & Edwards 2002).

Many Ph.D thesis have been written on the archaeology of the area like, Osman (1978), Syghron (2001) Sadig, (2004) Abd Al-Mageed (2007). M.A thesis are, Saeid (2005) and Shambool (2007) etc. Nowadays, there are many students preparing their postgraduate degrees in this area.

1.3.5. The Importance of the Third Cataract Region

The Third Cataract Region is one of the important regions of northern Sudan from the archaeological perspective. The reasons for that are:

1. The Third Cataract Region was a unique and borderline area among the neighboring lands through historical times. It was a buffer zone during medieval kingdoms of Nobadia and Makuria (Osman, 2004).

2. It is clear that the region has its own naturally unifying factors such as the geology, topography, ecology and ethnicity.
3. The political situations that the area has been subjected to through historical times and the local cultural reception and absorption of accompanying cultures are reflected on the archaeological remains of the area.
4. Osman (2004) mentioned that among the reasons; the Nile diverging and running in an eastern direction especially in Arduan area; the presence of agricultural land although cataract region and presence of palaeochannels.

These reasons and the large number of sites that have been discovered need deeper, statistical analysis. To test the assumption of unity and homogeneity of the region, it has been divided into four different areas according to microclimate and landscape. These are:

1. Western bank,
2. Eastern bank,
3. Islands
4. Remote channels (wadis and khors).

The area is a unique area in many aspects such as archaeology, history geology and geography. It falls in the Sahara region and within this desert environment there are many habitats ranging from riverine fresh water and closed island to bare rocky and sandy desert with many water channels (Khors).

This reflects on the distribution of human populations and activities which in turn are reflected in the distribution patterns of archaeological sites both typologically and according to period of occupation.

The MASP has now completed the survey work registering more than 1000 sites. In addition, some excavations and salvations have been conducted on some of the identified sites. Despite this, considerable work remains to be done.

This thesis analyses some of the collected data making interpretations based on statistical analysis.

1.3.5.1. Materials and Methods

The materials in a series of reports relating to the MASP (1990-2003) was used in this statistical analysis. The sites were grouped according to the date and the function. The percentages of the different microclimates were counted. (Graph 3 and 4).

1.3.5.2. Results and Conclusion

Statistical analysis of the archaeological sites identified in the four different regions revealed that there was an overall similarity in the distribution pattern of sites according to their period and types.

1.3.5.3. Distribution According to Date (Table 1-5, Graph 1-5)

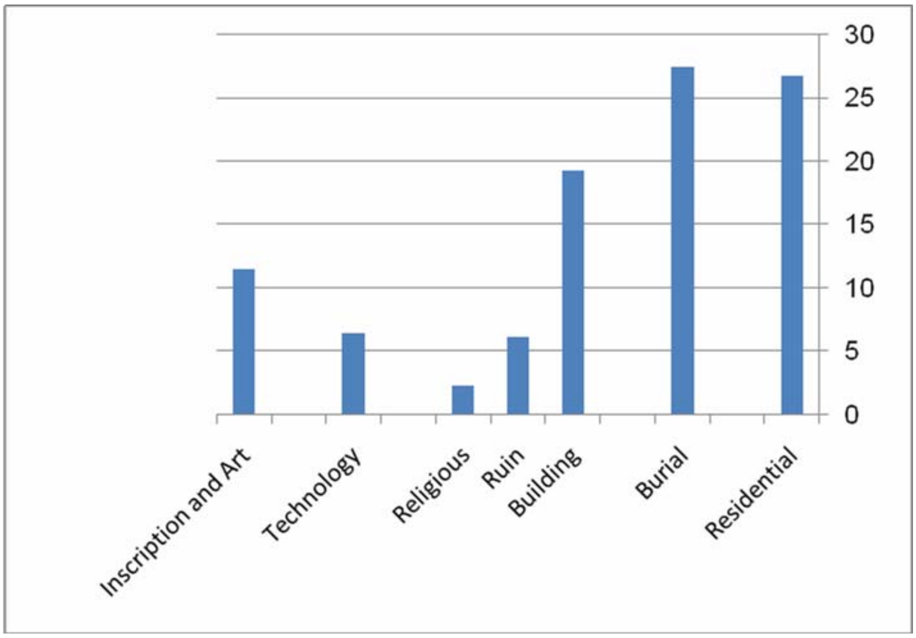
1- If the four habitats of the area's are compared with each other, the exceptional area is wadi and khors in, which water was the limiting ecological factor to human habitation especially after Kerma periods, this in turn reflects on scarcity of religious sites.

2- Another important notification from the analysis is the homogeneity of the region from prehistorical times to now, although lmost towns and capitals have been situated along the eastern bank of the Nile since early times.

3- Islamic, Christian and Kerma period sites are the most abundant. In contrast, Napatan and Meroetic sites are rare. Osman (2004) suggested that there may be reasons for this scarcity beyond that of economy, i.e. the presence of the desert route from Kerma directly to Kedurma (a Meroetic site), which is situated north of the end of the Cataract at Sabu village. The flourishing of the western bank during the medieval period was also another factor which has been suggested, hinting that there may have been some sort of connection with western Sudan at that time. (Prf. Ali Osman; personal communication). Old theory of Priese, Hofmann, Bechhaus-Gerst on the settlement of Nubians in Nile Valley, says that the Nubians were pushed to the Nile through the Wadi Hower when the climatic conditions became dryer during late and post Meroetic times and settled there. This may also be a reason beyond the sudden increase of population in Nubia.

4- The Nubian Group's (A, C etc.) site also is rare. The presence of only a few sites may be due to the buffering character of the area.

Graph (1-3): Showing Sites Types of Mahas Third Cataract Region



Graph (1-4): Showing the Number of Archaeological Sites of Third Cataract Region in Different Habitats

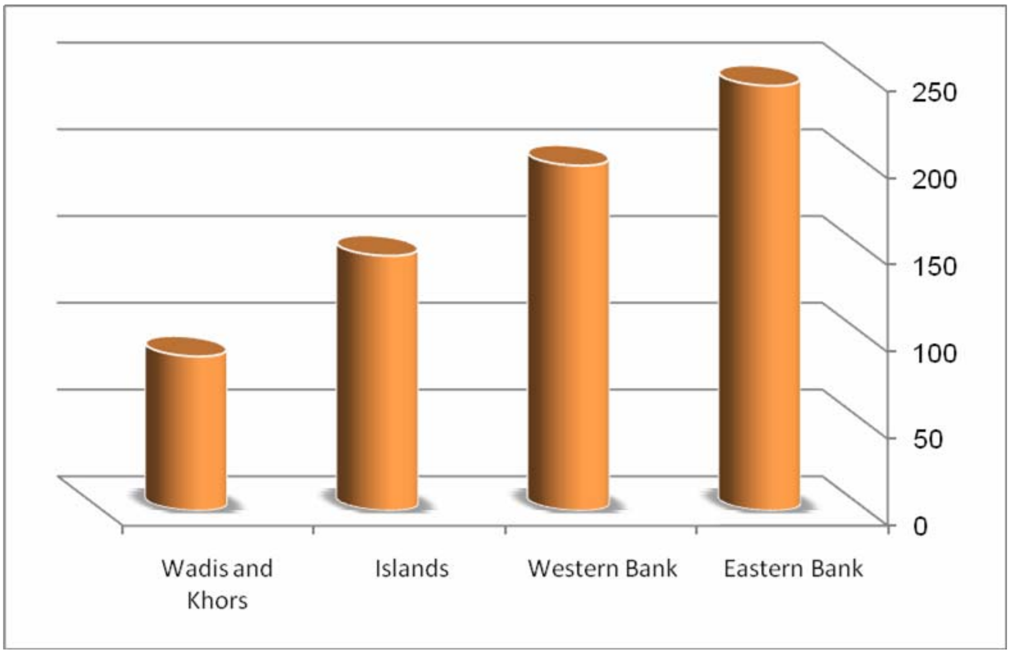
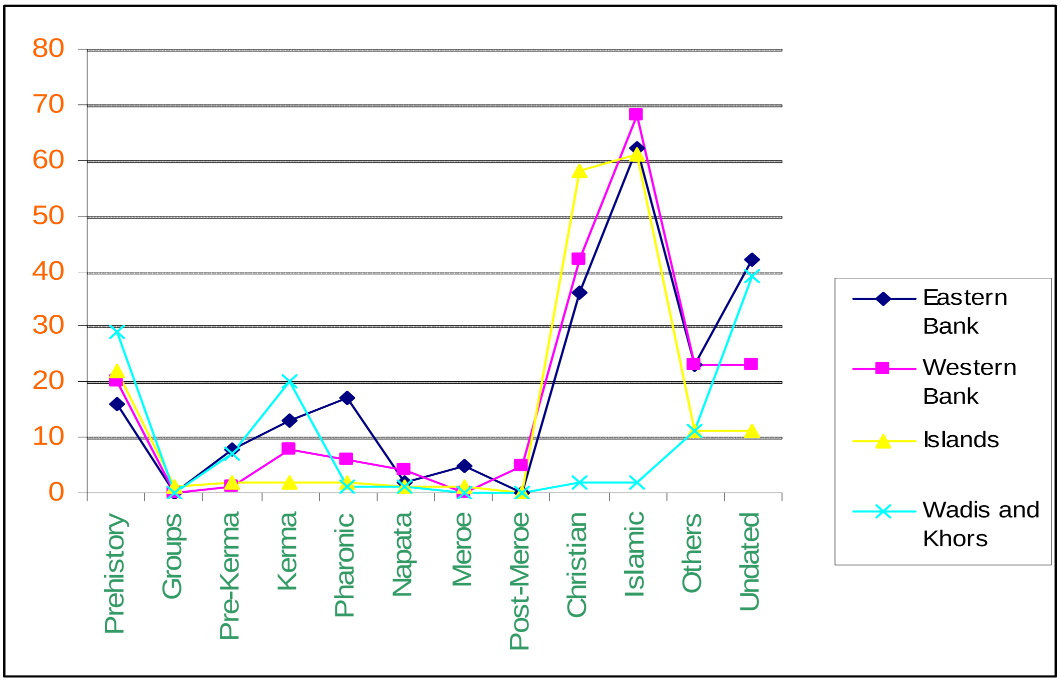


Table (1-5): Showing the Registered Sites of Mahas Third Cataract Region According to Periods

Periods/ Regions	Eastern Bank	Western Bank	Islands	Wadis and Khors	Total	%
Prehistory	16	20	22	29	87	12.11
Groups	0	0	1	0	1	0.14
Pre-Kerma	8	1	2	7	20	2.51
Kerma	13	8	2	20	43	5.99
Pharonic	17	6	2	1	26	3.62
Napata	2	4	1	1	8	1.11
Meroe	5	0	1	0	6	0.84
Post-Meroe	0	5	0	0	5	0.70
Christian	36	42	58	2	138	19.22
Islamic	62	68	61	2	193	26.88
Others	23	23	11	11	78	10.86
Undated	42	23	11	39	115	16.00
Total	234	200	172	112	718	100%

Graph (1-5): Showing the Distribution Pattern of Sites of Different areas of Mahas Third Cataract Region According to Periods



1.3.5.4. Distribution According to Function (Table1- 6, Graph 1-6)

1- The percentages of rock art and gongs sites along the eastern bank; western bank; wadis and khors and islands are 44.9%, 29.5%, 14.1% and 11.5% respectively. They are more abundant along the eastern bank of Nile and decrease significantly in islands. One possible explanation for this could be the abundance of settlements and suitable rocks along the eastern bank.

2- The percentage of technology sites along the eastern bank; western bank; wadis and khors and islands are 20.5%, 29.5%, 6.8% and 43.2 respectively. They are more abundant in the wadis and khors and decreased significantly in islands. This could be explained because the quarries were situated in wadis and khors. However, this doesn't mean the stones were used locally but were transported to other areas.

3- The percentage of burial sites along the eastern bank; western bank; wadis and khors and islands were 43.2%, 36.5%, 16.3% and 9.0% respectively. They were more abundant along the eastern bank and decrease significantly in islands. One reason for this is that, in medieval times the western bank peoples buried their dead in the eastern bank.

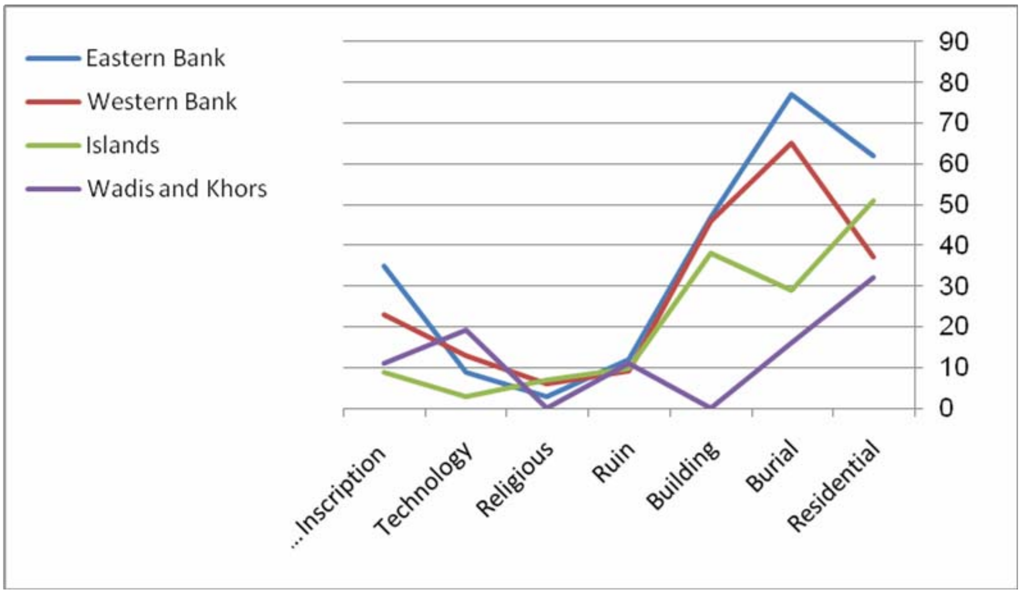
4- The percentage of religious sites along the eastern bank; western bank; wadis and khors and islands were 18.75%, 37.5%, 43.75% and 0.0% respectively. They were more abundant in the islands and along the western bank. There were no such sites in the wadis. The social religious trend seems to be stronger in islands and on the western bank and this is attributed to presence of ancient Egyptian temples (Solb and Sesebi) on the one hand, and the beginning of heavy settlement of west bank during medieval periods (Osman, 2004) on the other hand.

5- The percentage of residential sites along the eastern bank; western bank; islands and wadis and khors were 34.1%, 20.3%, 28.0% and 17. 6% respectively. They were more abundant along the western bank. This could be explained because the overall settlement of the eastern bank was more abundant than the others, even in wadis the residential sites are reasonable percentage; also the settlements have been abandoned for a long period.

Table (1-6): Mahas, Third Cataract Region, Archaeological Sites According to Function

Periods/ Regions	Eastern Bank	Western Bank	Islands	Wadis and Khors	Total	%
Residential	62 (34.1%)	37 (20.3%)	51 (28.0 %)	32 (17.6 %)	**182**	**26.76**
Burial	77 (43.2%)	65 (36.5%)	29 (16.3%)	16 (9.0%)	**187**	**27.5**
Building	47 (35.8%)	46 (35.2%)	38 (29.0%)	0 (0.0%)	**131**	**19.26**
Ruin	12 (28.6%)	9 (21.4%)	10 (23.2%)	11 (26.2%)	**42**	**6.18**
Religious	3 (18.75%)	6 (37.5%)	7 (43.75%)	0 (0.0%)	**16**	**2.36**
Technology	9 (20.5%)	13 (29.5%)	3 (6.8%)	19 (43.2%)	**44**	**6.47**
Inscription and Art	35 (44.9%)	23 (29.5%)	9 (11.5%)	11 (14.1%)	**78**	**11.47**
Total	**245**	**199**	**147**	**89**	**680**	**100**
%	**36.03**	**29.26**	**21.62**	**13.1**		

Graph (6): Showing the distribution Pattern of Sites of Different Areas of Mahas Third Cataract Region According to Function



Eastern Bank
Western Bank
Islands
Wadis and Khors
90
80
70
60
50
40
30
20
10
0
...Inscription
Technology
Religious
Ruin
Building
Burial
Residential

Table (1-7): Mahas Third Cataract Region, Different Areas Archaeological Sites According to Function

Major grps.	Residential No. of sites			Burial					Building					Ruin		Religious			Technology					Inscription and Art			Total
Types	Habitation	Settlemen	Occupati on	Cemetery	Grave	Tomb-	Shrine	Cairn	Castle	Building	Fortified	Enclosure	Diffi	Structure	Ruins	Temple	Church	Mosque	Quarry	Kiln	Saqia	Matmura-	Wall	Inscription	Rock drawing	Rock	
E. Bank	5	11	46	25	37	5	8	2	-	6	5	1	35	12	-	-	1	2	1	3	2	2	1	4	27	4	
Total	62			77					47					12		3			9					35			245
%	**25.3**			**31.4**					**19.2**					**4.9**		**1.2**			**3.7**					**14.3**			**100%**
W. Bank	6	8	23	29	15	7	13	1	3	-	3	4	36	6	3	1	2	3	1	4	4	2	2	1	17	5	
Total	37			65					46					9		6			13					23			199
%	**18.6**			**32.66**					**23.11**					**4.54**		**3.0**			**6.53**					**11.56**			**100%**
Islands	-	10	41	13	9	3	4	-	1	2	2	3	30	10	-	-	4	3	-	2	1	-	-	4	5	-	
Total	51			29					38					10		7			3					9			147
%	**34.69**			**19.72**					**25.85**					**6,80**		**4.76**			**2**					**6.1**			
W& K	4	-	28	4	12	-	-	-	-	-	-	-	-	11	-	-	-	-	-	2	-		17	-	10	1	
	32			16					-					11		-			19					11			**89**
%	**36**			**18**					**0**					**12.35**		**0**			**21.3**					**12.35**			
Total	**15**	**29**	**138**	**71**	**73**	**15**	**25**	**3**	**4**	**8**	**10**	**8**	**10 1**	**39**	**3**	**1**	**7**	**8**	**2**	**1 1**	**7**	**4**	**20**	**9**	**59**	**10**	**680**
Total	**182**			**187**					**131**					**42**		**16**			**44**					**78**			**680**

Major gps %	**26.76**	**27.5**	**19.26**	**6.18**	**2.36**	**6.47**	**11.47**	**100**

CHAPTER TWO

2. Definitions, Theory and Approaches

2.1. Definition of Environment

The Oxford English Dictionary (second edition) defines the environment as:" that which environs (i.e. surround) or the region surrounding any thing"

In biology, (zoology and botany), the environment is defined as: The sum total of all the conditions and elements which make up the surroundings and influence the development and actions of an individual. The external surroundings of an organism, consisting of biotic (living) and abiotic (non-living) factors which will affect the life of all the organisms within it. The environmental conditions of earth are ideal for life to exist and steadily evolve within. (www.biology-online.org/dictionary/Environment, 2006).

Environment may be defined as the complex of climatic, biotic, social and edaphic factors that act upon an organism and determine its form and survival. It, therefore, includes everything that may directly affect the metabolism or behavior of a living organism or species, including light, air, water, soil, and other living organism. (www. Wikipedia .com (the free encyclopedia.)

In geographical sense, an environment is a complex of external factors that act on a system and determine its course and form of existence. An environment may be thought of as a superset, of which the given system is a subset. An environment may have one or more parameters, physical or otherwise. The environment of a given system must necessarily interact with that system. Generally, the environment of some object or action consists of the substances, circumstances, objects, or conditions by which it is surrounded or in which it occurs. (www. Wikipedia .com (the free encyclopedia.)

2.1.1. Definition of Ecology

Ecology, according to M. Bates (1953:4) is concerned with the external factors that control the survival and abundance of individuals and populations. Although "ecology" has traditionally been preempted by biologists and anthropologists, both "ecology" and "geography" are applicable to a broad spectrum of studies dealing with man, with the environment and with man-land interactions.

2.1.2. Definitions of Environmental Archaeology

Butzer (1971: 5) defined the term: Individual research by the natural sciences usually carried out independently in the field or laboratory by geologist, geographers, soil scienctists, botanists, zoologists and metrologists. Although the range of specific goals or interests may vary greatly, most of our basic techniques and paleo-environmental data have been obtained in this way .

Evans (1978:1), defined: Environmental Archaeology as the study of the past environment of man. It views the human animal as a part of the natural world, interacting with other species in the ecological system or ecosystem.

Renfrew and Bahin (1996) define Environmental Archaeology as themes, methods and practice of archaeology. Archaeologist showed a tendency to be divided into two camps:

First those that regard Environmental Archaeology as "a set of techniques used in Archaeological Science addressing the nature of past environments (and in particular human behavior in environmental context) or "a range of methods used to analyze ancient plant and animal remains.

Second those that gave a more holistic view of Environmental Archaeology as a distinct discipline concerned with the ecological study of the human past through Archaeology and related disciplines.

According to Wilkinson and Stevens (2003) the term Environmental Archaeology is 'the study of people and past society from their material remains so it is the study of the landscapes that were inhabited by past human populations and the economies they constructed, on the bases of preserved biological remains and geological phenomena. In other words, environmental archaeology concerns the study of vegetation (flora) and animals (fauna), which lived in association with the people of the past, and the way in which humans interacted with these other living organisms. Perhaps more fundamentally, environmental archaeology is also about reconstructing the physical landscapes in which people lived, hunted and farmed (geomorphology) (Wilkinson and Stevens, 2003).

More recently, the web site Wikipedia defined that the environmental archaeology is the study of the long-term relationship between humans and their environments. Various sub-disciplines, geomorphology, palynology, geophysics, landscape archaeology, human biology and human ecology. Environmental archaeology has seen a surge of interest in recent years, as it is one of the few disciplines that are able to provide and to show how humans have responded to rapid climatic changes in the past. From :www. en. wikipedia.org/wiki.Landscape archaeology (2006).

www.flmnh.ufl.edu/envarch defines environmental archaeology as the study of past human interactions with the natural world that encompasses plants, animals, and land. Environmental archaeology researchers attempt to reconstruct not only the ancient environs associated with archaeological sites, but also the use of those environs by people, the impact people had on the world around them, and the way ancient peoples perceived their surroundings and the plants and animals on which they relied (www.flmnh.ufl.edu/envarch, The Florida Museum of Natural History, University of Florida (2006)

Environmental archaeology is now a well-developed discipline in its own right. It views the human animal plant of the natural world, interacting with other species in the ecological system or ecosystem. The environment governs human life. Latitude and altitude, landforms and climate determine the vegetation which in turn determine animal life. All these taken together determine how and where human have lived - or at least they did until very recently. Archaeologist showed a tendency to be divided into two camps:

- First: those that regard Environmental Archaeology as "a set of techniques used in Archaeological Science addressing the nature of past environments (and in particular human behavior in environmental context) or "a range of methods used to analyze ancient plant and animal remains.
- Second: those who gave a more holistic view of Environmental Archaeology as a distinct discipline concerned with the ecological study of the human past through Archaeology and related disciplines.

2.1.3. Environmental Factors

Evans, (1978:1) mentioned that the environment includes every conceivable factor of man's surrounding, from the earth's magnetic field to the smallest virus which affects his mode of life. The type of the remain itself and its chemical constituents and physical condition as well as burial speed are the determinants of the existence of the remain. The environmental parameters are:

Climate: can influence preservation of environmental remains. In hot countries, seeds and even hair and skin can be preserved by desiccation. Very cold climates where ice and permafrost occur will preserve whole bodies. Mammoths which were found in Siberia were preserved in this way. These factors or parameters are precipitation of rain and snow, temperature, seasonality, wind and length of growing season

Geology: The factors of this parameter are distribution of land masses; distribution of volcanic and earth cracks; Faunal Remains; topography, and inorganic raw materials, minerals and rocks

The kind of soil found on an archaeological site affects the preservation of environmental remains. Waterlogged soils are very good for preserving seeds, pollen, insects and wood. Chalky soils provide excellent preservation of bones and shells. If seeds get accidentally burnt in an oven or hearth, the burning process stops the seeds decaying and they will survive in the ground for thousands of years. other factors are such as the type, salinity, alkalinity, acidity, moisture, plant roots and bacteria and topography of the soil.

- Flora: The factors of this parameter are that in part exploited for food and in part exploited for other purposes.
- Fauna: The factors of this parameter are that in part they were exploited for food and in part exploited for other purposes..
- Time: it is an important factor in determining magnitude of the chemical reactions, physical changes, biological activities and geological processes.

2.1.4. Subdivisions of Environmental Archaeology

The definitions outline aboved are based upon the purpose to which environmental archaeological studies are put and the approach taken by those who carry them out. However, few practitioners of environmental archaeology would think of themselves as palaeoenvironmentalists or palaeoeconomists, but would instead group themselves by the type of materials they look at. To better understand how environmental archaeological study works within a larger archaeological project, it is useful to divide the sub-discipline along technical grounds; in other words, based on the methodologies employed by particular groups of specialists (3). The most obvious of these subdivisions is that on the basis of the branch of natural science in which the study is based:

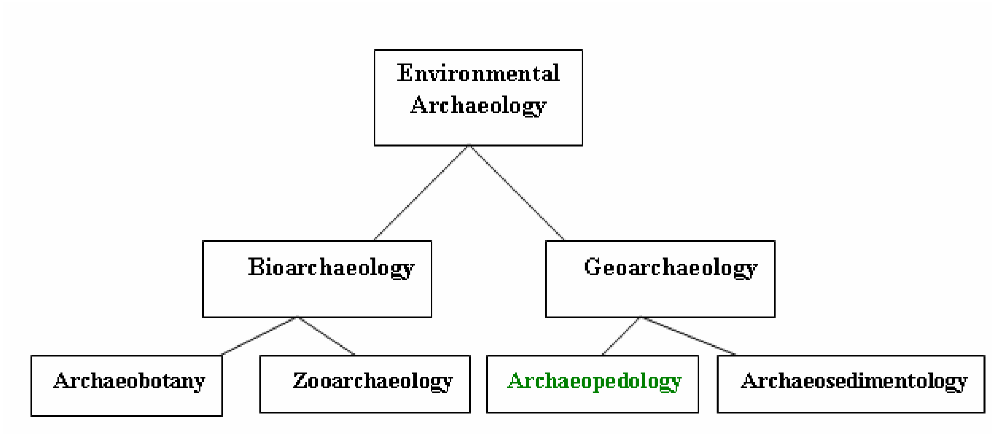
2.2. Bioarchaeology and Geoarchaeology

2.2.1. Bioarchaeology

Archaeological sites may contain many remains of biological origin. These are sometimes, termed ecofacts. These biological residues may be divided into those that result from (a) activities of human beings and (b) those that exist naturally. Investigation of the taphonomic pathways by which plant remains came to be deposited on archaeological sites or in natural locations is therefore of considerable importance in establishing the environmental or economic significance of the remains recovered. The types of biological organisms that are studied are called zooarchaeology and archaeobotany for the study of ancient animal and plant remains respectively

2.2.2. Geoarchaeology:

Geoarchaeology derives its evidence from the abiotic components of the ecosystem under study in particular from the shape of the land (geomorphology), deposits within the land (sedimentology) and soils developed across it (pedology). (www. york.ac.uk/inst/eau/University of Edinburgh, Department of Archaeology, Association for Environmental Archaeology, Compiled and edited by Geraint Coles).



The previous terminologies are not universally accepted. In part this is a cultural phenomenon relating to the history of study in a particular region of the world, but there are also differences of a technical nature. For example, archaeobotany is the European term for the archaeological study of plant remains, while in North America, what is essentially the same area of study is termed paleo-ethnobotany**.** Indeed, in a recent essay Ken Thomas has questioned whether the term 'environmental archaeology' is in itself useful. He sees bioarchaeologv and geoarchaeology as being mature disciplines in their own right, while the term 'environmental archaeology' has run its course and is now both ambiguous and redundant.

From what has been written above, it is obvious that this analysis look agreeable. On the other hand, some North American geoarchaeologists, such as George Rapp, see many of the bioarchaeological areas of speculation to be components of geoarchaeology and hence see that sub-discipline.

2.2.3. The Development of Environmental Archaeology

Wilkinson and Stevens (2003) explored the history of the subject now known as archaeology which spans the last 300 or so years. The academic discipline with the same name has been taught in British universities since at least the beginning of the twentieth century

Environmental archaeology has a much shorter history, the first use of the term for this sub-discipline only occurred in the 1950s. The same decade also saw the first environmental archaeological post at a university, when Friednch Zeuner became Professor of Environmental Archaeology at the Institute of Archaeology, London in 1952 (Wilkinson and Stevens, 2003).

In their recent book *Geoarchaeology: Earth-Science Approach Archaeological Interpretation*, George Rapp and Christopher Hill divided that discipline into three phases of development:

The First, foundation phase, which covers the nineteenth century and before. There was no real boundary between archaeology and the natural sciences and indeed individuals worked across what we would now see as a range of disciplines. Many of these early researchers were, in northern Europe. Early examples include John Frere, who in 1797 noted Palaeolithic tools at a brick pit in Hoxne. Later examples included Jacques Boucher de Crevecoeur and Sir Charles Lyell, who in the 1850s recognized that at sites in south England and the Somme valley in north-eastern France Palaeolithic tools were often found in association with extinct mammals such as mammoths. The mid-nineteenth century is also important for developments in the biological sciences, such as the studies of evolution by Charles Darwin and Alfred Russell Wallace. They demonstrated that species gradually evolved in form over time, but also suggested that the geographical distribution of particular species also altered in response to outside effects such as climate, predation and colonization by other species. This was a highly significant discovery, as it suggested that past environments were not necessarily the same as those found at present (Wilkinson and Stevens, 2003).

By the last decades of the nineteenth century, those working in archaeology, geology and biology were going their separate ways, occasionally natural scientists were asked to apply their specialism to a particular site.

The second collaboration phase of development recognised by Rapp and Hill, and is characterised by natural scientists working together with archaeologists to research problems of interest to both. This collaboration phase lasted during the Second World War. In northern Europe it is typified work on land snails from excavations carried out in Neolithic causewayed enclosures in Sussex in British Iron Age sites. In North America, a different tradition emerged as geoarchaeology began to develop. Two geologists, Ernst Antevs and Kirk Bryan, worked extensively on the stratigraphic context of Palaeo-Indian sites. In addition to collaborating with archaeologists, natural scientists were making discoveries and developing techniques that would later prove of great importance for archaeological study. For example, the Swedish geologist Lennart von Post had developed pollen analysis by 1916, as a means of reconstructing past vegetation. Similarly in 1908 two Danish geologists, Biytt and Sernander, had published an account of their use of macroscopic plant remains to reconstruct the past environments of bogs in the south of Denmark.

The final, integration, phase of environmental archaeology runs from the end of the Second World War to the present. The development of ideas during this period was profound and ultimately led to the development of the archaeological science we know today. Indeed, advances in archaeological theory in the post-war years were arguably only possible because new archaeological techniques had been formulated. Possibly the most important was radiocarbon dating, developed as a by product of the research on atomic weapons by Willard Libby. It not only revolutionised prehistoric chronology, but for the first time allowed different world cultures to be compared (Wilkinson and Stevens, 2003).

In North America in particular, there was a growing awareness that people interacted with their environment, ideas that were encompassed within the term cultural ecology, first coined by Julian Steward in the 1950s. In Britain, broadly similar developments took place as archaeologists tried to move away from a dependence on artefacts for interpretation. In this respect Grahame Clark's excavations in the early 1950s at Star Carr in Yorkshire were groundbreaking. There were few structures at Star Carr, but there were extremely well-preserved biological remains, which were studied in meticulous detail. These models formed part of an approach termed economic prehistory that saw prehistoric populations as being entirely dependent upon the landscape for all elements of subsistence and, consequently, society (Wilkinson and Stevens, 2003).

In the 1960s and 1970s, archaeological methodologies developed rapidly, in part as a result of the widespread rescue excavations that were being carried out in much of Europe. Processual archaeology was to improve scientific rigor of investigation and to introduce an element of anthropology into archaeology. Thus from the 1960s there was a greater focus on quantifying archaeological data, while a further emphasis was placed on making use of the world's 'primitive' peoples as a living laboratory, as it focused on taphonomy, which have become particular foci of geoarchaeology.

In some ways techniques and approaches developed in the 1980s and 1990s have merely refined those of earlier decades. The major change in archaeological thinking, so-called post-processual theory, has hardly impacted the way that environmental archaeology is carried out, except to change the way data are interpreted. Perhaps the single largest change of the last two decades has taken place in the minds of those who work as environmental archaeologists. Today environmental archaeologists are both archaeologists and natural scientists and have been trained in both areas. In this respect the situation has reverted to that of the nineteenth century. The most important implication of this change is that those practising environmental archaeology are in theory fully conversant with the archaeological process and its associated problems, and can therefore take them into consideration in their sampling and analysis. (Wilkinson and Stevens, 2003:18-23).

2.2.4. Evidences of Remains from Different Environmental Localities

Renfrew and Paul Bahn (1991) wrote on the Evidences of Remains from Different Environmental Localities: There are different localities in which we find the biological remains, these includes.

2.2.4.1. The Oceans

The sediments of the ocean floor accumulate very slowly microfossils such as the shells of planktonic foramini-fera. As in an archaeological stratigraphy, one can trace changes in environmental conditions through time by studying cores extracted from the seabed and fluctuations in the species represented and the morphology (physical form) of single species through the sequence

In the eastern Mediterranean, analysis by Robert Thunell (2003) of forami-nifera in sediment samples has enabled him to estimate sea-surface temperatures and salinities at different periods. He has established that about 18,000 years ago, at the height of the last Ice Age, the winter temperature was 6°C cooler than now, and the summer temperature was 4°C cooler. Climatic information can be carried out by analysis of organic molecules in the sediment. Changes in ocean temperature over the last half million years are known from the oxygen isotope technique. Ancient Winds can be studied; by Isotopes and can thus be used not merely for temperature studies but also for data on precipitation. The temperature difference between that place and the equatorial region can be calculated also from the ocean sediments. Temperature difference between equatorial and polar regions increased by 20-25 percent. Confirmation has come from a deep-sea core off the coast of West Africa, analysis of which led to estimates of wind strength over the last 700,000 years.

2.2.4.2. The Rivers

The reconstruction of past landscapes around major rivers - which tend to be areas of rapid change, through erosion or deposition of sediments along courses and at river mouths- is particularly valuable to archaeology because these environments were frequently the focus of human occupation. In certain cases, such as the Nile, Tigris-Euphrates, and Indus, the floodplains proved crucial to the rise of irrigation agriculture and urban civilization.

Many rivers actually changed their course at different periods, through complex processes of erosion, silting, and varying gradients. The channel of the Indus in modern Pakistan is not incised into the plain like those of most rivers, and therefore has a tendency to change its course from time to time. The lower Indus is shallow, with a gentle gradient,and thus deposits large quantities of alluvial material in its channel, actually raising its bed above the level of the surrounding plain, and frequently breaking out and inundating large areas with fertile silt, vital to early agriculture and, for example, the ancient city of Moheniodaro.

Similarly, the lower Mississippi Valley is covered with the traces of meander changes over a long period. These abandoned channels have been detected and plotted, by topographic survey and aerial photograpty, for the period AD 1765-1940. Using this information, a pattern of meander changes plotted at 100-year intervals has been constructed for the last 2000 years. Like the work on fossil beach lines in Alaska, this sequence has formed the basis for a rough chronology for site located particular abandoned channels. (Renfrew and Bahn 1991: 195-232).

2.2.4.3. The Cave Sites

A different type of abandoned water-channel is represented by the limestone cave, a category of site that has been of tremendous importance to archaeology through its conservation of a wide variety of evidence, not only about human activities but also about local climate and environment.

Caves and rockshelters, although of enormous archaeological interest, are nevertheless special cases. Their importance as places of habitation has always been exaggerated in prehistoric studies at the expense of less well-preserved open sites. What can we learn from the great outdoors where people have spent most of their time? (Renfrew and Bahn 1991: 195-232).

2.2.4.4. The Landscape

Archaeologist should study the sediments and the surrounding landscape. The aim is to achieve the fullest possible reconstruction of the local area. There is a possibile loss of sites through erosion, burial under sediment, or inundation. Such a study will declare possible reasons why it changed and how people adapted to the new conditions. (Renfrew and Bahn 1991: 195-232)

2.2.4.5. The Sediments and Soils

Investigation of sediments and soils can reveal much about the conditions that prevailed when they were formed. The organic remains they may contain will be examined in subsequent sections on plants and animals, but the soil matrix itself yields a wealth of information on weathering, and hence on past climates. Geomorphology incorporates specializations such as sedimentology, which itself includes sedimentary petrography and granulometry. These combine to produce a detailed analysis of the composition and texture of sediments, ranging from freely-draining gravel and sand to water-retentive clay. The size of constituent particles in sediments, ranging from pebbles to sand or silt; and the degree of consolidation, ranging from loose to cemented. In some cases, the orientation of the pebbles gives some indication of the direction of stream-flow, of slope, or of glacial deposits. The X-ray diffraction technique can be used to identify specific clay minerals and thus the specific source from which sediment is derived. Soil texture of this kind provides a basis for assessing landscape history and land-use potential.

2.3. Biological Remains

Renfrew and Bahn (1991) mentioned that the biological materials are used in environmental reconstruction. The basic principle in utilizing plants and animals is that each species lives in a particular habitat, which may be more or less clearly defined. With reference to their present-day habitat preferences and geographical ranges, remains of organisms in ancient deposits can be used to reconstruct former environments. However, there are two problems that must be taken in account. The first concerns the way in which the structure and composition of living populations becomes distorted at death by various depositional and destructional processes. The second is concerned with ecological aspects of the organisms themselves. (Ager, 1963).

Plant remains studies have been always overshadowed by faunal analysis because bones are more conspicuous and survive better but plant remains are greater in number as in recent years it is discovered that some plant remains were more resistant than believed (Renfrew and Bahn 1991: 207).

2.3. Floral Remains

The plant remains from archaeological sites are of two categories, macrobotonical (conspicuous) and microbotonical (invisible to naked eyes). For example seeds can give direct evidence of the type of plants people were eating, using for medicinal purposes and exploiting for industrial and agricultural use. Pollen from plants, which come from specific habitats, are tolerant of certain climates can he identified, and give an indication of environmental conditions over a long period as well as the paeloeconomy of the area. The two types integrate each other in archaeological researches.

2.3.1.1. Pollen Analysis

2.3.1.2.Definition of Pollen Grains

The pollen grain is formed in male organs of the flower (anther). When the pollen ripens, the surrounded wall breaks down and liberated pollen grains are transferred to the pistil where the fertilization takes place. They range in size from 5 to 200 µm. A typical grain consists of three concentric layers. The centric portion is the living cell, which is surrounded by a covering of cellulose. Neither of these survive in the fossil form. The grain has an indestructible outer shell (exine) of waxy material called sporopollenin, that can survive tens of thousands of years. (Faegri and Inverson, 1975: 1, 59). The way in which the pollen is transferred from the stigma to the environment is important in the evaluation of the pollen-analytical data. The pollen grains are dispersed by wind (anemophilous), water, insects (entomophilous), animals, birds and man (Lowe and Walker, 1984: 158). A few aquatic plants pollinate under water so the pollen is embedded in sediment and fossilized and is so difficult to be identified. Other groups are autogaous plant, in which no pollen is exposed. (Faegri and Inverson, 1975: 1, 59).

The technique was developed in 1916 by a Norwegian geologist, Lennart von Post. It provides information on chronology as well as environment-indeed, until the arrival of isotopic chronological methods; pollen analysis was used primarily for dating purposes (Faegri and Inverson, 1975:1).

2.3.1.3. Field and Laboratory Work

Pollen and spores are usually well preserved in lake and pond sediments and in peats. They are also found in soils (Dimbleby 1957, 1961) and in cave earths (Campbell 1977), where they are less well preserved, and they have even been discovered in ocean floor sediments (Heusser and Balsam 1977). Good accounts of laboratory procedures and examples of pollen keys can be found in Faegri and Iversen (1975) and Moore and Web (1978).

2.3.1.4. Pollen Diagrams

Where samples have been taken from a stratified sequence of sediment such as a lake or peat deposit, analysis at different horizons will list; changes in pollen content (and, by inference, in vegetation composition over time, and such changes can be depicted graphically in the mm pollen diagrams.

2.3.1.5. The Interpretation of Pollen Diagrams

The interpretation of a pollen diagram is the most difficult part of pollen analysis because of the fact that not all plants produce the same amount of pollen. To know something about the occurrence of fossil pollen in a body of sediment. wind-borne pollen is deposited within a few kilometers.

A third factor to be considered when pollen diagrams are being interpreted concerns the nature of pollen deposition. Differential settling velocities of pollen in lakes and ponds, coupled with the disturbance of sediment on the lake floor either by currents or by burrowing organism can lead to complications in the fossil record.
Cushing (1967b) has described four categories of deterioration in pollen grains:

a) corrosion: where the exine is pitted or etched;
b) broken: where the grains are ruptured or split, or pieces completely broken away;
c) crumpled: where the grains are folded, twisted or collapsed

d) degraded: where the structural elements are fused together.

Finally, there is a vexed question of how far it is possible to relate pollen assemblages to plant communities, and how far we are justified in making inferences about former climatic and environmental conditions on the basis of pollen analytical data. it is occasionally possible to identify pollen grains to the species level; distinctions can usually be made, for example, between species of plantain. This method is known as the indicator species approach and usually involves taking the distribution of a particular plant and then attempting to fit that distribution to selected climatic parameters

2.3.2. Fossil Cuticle

Palynology is particularly useful for frosted regions, but the reconstruction of past vegetation in grassy environments such as those of the tropics has been much hindered by the fact that grass pollen grains can be virtually indistinguishable from one another, even in the scanning electron microscope. Fortunately, help is at hand in the form of fossil cuticle. Cuticles are the outermost protective layer of the skin or epidermis of leaves or blades of grass, of cutin, a very resistant material that retains the pattern of the underlying epidermal cells which have characteristic shapes. The cuticles thus have silica cells of different shapes and patterns, as well as hairs and other diagnostic features.

Renfrew and Bahn, (1991:210) found abundant charred cuticular fragments in core samples from lake sediments in East Africa. The fragments were deposited there as a result of the recurrent natural grass fires common during the dry season, and her samples date back at least 28,000 years. Many of the fragments were large enough to present well-preserved diagnostic features that, under the light microscope or electron microscope, have enabled her to identify them to the level of subfamily or even genus, and hence reconstruct changes in vegetation during this long period. Cuticular analysis is a useful complement to palynology wherever grass material, whole or fragmentary, is to be identified, and it is worth noting that cuticles can also be removed from stomachs or feces. (Renfrew and Bahn, 1991:210).

2.3.3. Phytoliths

A better known and fast-developing branch of microbotanical studies concerns phytoliths, it is known since 1908, but has only been studied systematically in the last few decades. These are minute particles of silica derived from the cells of plants, and they survive after the rest of the organism has decomposed or been burned. They are common in hearths and ash layers, but are also to be found inside pottery, plaster, and even on stone tools and the teeth of herbivorous animals: grass phytoliths, for example, have been found adhering to ungulate teeth from Bronze Age, Iron Age, and medieval sites in Europe.

These crystals are useful because, like pollen grains, they are produced in large numbers, they survive well in ancient sediments, and they have myriad distinctive shapes and sizes that vary according to type, though it is usually difficult to identify their genus or species, even with a SEM. They inform us primarily about the use people made of particular plants, but their simple presence adds to the picture of the environment built up from other sources.

In particular, a combination of phytolith and pollen analysis can be a powerful tool for environmental reconstruction. The two methods have complementary strengths and weaknesses. The American Piperno (2003) has studied cores from the Gatun Basin, Panama, whose pollen content had already revealed a sequence of vegetation change from 11,300 years ago to the present - from mature tropical forest to mangrove, freshwater swamp, and finally to clearance throug agriculture. She found that the phytoliths in the cores confirmed the pollen sequence, with the exception that evidence for agriculture and forest clearance (i.e. the appearance of maize, and an increase in grass at the expense of trees) appeared around 4850 years ago in the phytoliths, about 1000 years earlier than in the pollen. This early evidence is probably attributable to small clearings which do not show up in pollen diagrams because grains from the surrounding forest infiltrate the samples, as well as to the relatively poor production and dispersal of non-arboreal pollen.

Pollen analysis will nevertheless remain the more important technique, if only because of difficulties in phytolith identification.

2.3.4. Diatom Analysis

Another method of environmental reconstruction using plant microfossils is diatom analysis. Diatoms are unicellular algae that have cell walls of silica instead of cellulose, and these silica cell walls survive after the algae die. They accumulate in great numbers at the bottom of any body of water in which the algae live; a few are found in peat, but most come from lake and shore sediments.

Diatoms have been recorded, identified, and classified for over 200 years. The process of identifying and counting them is much like that used in palynology, as is the collection of samples in the field. Their well-defined shapes and ornamentations permit identification to a high level, and their assemblages directly reflect the floristic composition and the productivity of the water's diatom communities, and, indirectly, the water's salinity, alkalinity, and nutrient status. From the environmental requirements of different species (in terms of habitat, salinity, and nutrients), one can determine what their immediate environment was at different periods. The botanist J.P. Bradbury looked at diatoms from nine lakes in Minnesota and Dakota, and was able to show that the quality of their water had become "eutrophic" (more nutrient) since the onset of European settlement around the lakes in the last century, thanks to the influxes caused by deforestation and logging, soil erosion, permanent agriculture, and the increase in human and animal wastes.

Since diatom assemblages can also denote whether water was fresh, brackish, or salt, they have been used to identify the period when lakes became isolated from the sea in areas of tectonic uplift, to locate the positions of past shorelines, to indicate marine transgressions, and to reveal water pollution. For instance, the diatom sequence in sediments at the site of the former Lake Wevershoof, Medemblick (the Netherlands) suggests that a marine transgression occurred here around AD 800, taking over what had been a freshwater lake and causing a hiatus in human occupation of the immediate area. (Wilkinson and Stevens, 2003).

2.3.5. Rock Varnishes

Even tinier fragments of plant material can provide environmental evidence. Rock varnishes, which have been formed on late Pleistocene desert landforms in many areas such as North America, the Middle East, and Australia, are natural accretions of manganese and iron oxides, together with clay minerals and organic matter. The organic matter comes from micrometer-sized airborne plant debris that accumulates on rock surfaces and is thus metabolized and cemented into the varnish by bacterial action. Less than 1 percent of the varnish is organic matter, however, so thousands of square centimeters are required for adequate analysis.

The reason for the analysis is that a strong correlation has been found between the ratio of stable carbon isotopes ("cy'O in modem samples and their different local environments (desert, semi-arid, montane-humid, etc.). Therefore, the stable carbon isotope ratios of the organic matter preserved in the different layers of varnish on rocks can provide information about changing conditions, and especially about the abundance of different types of plant in the adjacent vegetation. The American scholars Ronald Dorn and Michael DeNiro have sampled surface and subsurface layers of varnish on late Pleistocene deposits in eastern California, and found that the basal layers were formed under more humid conditions than those on the surface, which supports the view that the Southwest of the United States was less arid in the last Ice Age than during the succeeding Holocene. Similarly, samples from the Timna Valley in Israel's Negev Desert revealed a sequence of arid, humid, and arid periods.

The rock varnish technique, when combined with radiocarbon dating, can provide a minimum age for some landforms - and even for certain types of stone tool which also accumulate varnish - as well as for any rock art which underlies the accretions. However, there are difficulties with the technique, primarily because the layers are so thin that distinguishing stratification is not simple. Future work may resolve these problems.

All these microbotanical techniques - studies of pollen, cuticles, phytoliths, diatoms, and rock varnish - are clearly the realm of the specialist. For archaeologists, however, a far more direct contact with environmental evidence comes from the larger plant remains that they can actually see and conserve in the course of excavation (Wilkinson and Stevens, 2003).

2.3.6. Remains of Wood

Study of charcoal is making a growing contribution to archaeological reconstruction of environments and of human use of timber. A very durable material, charcoal is usually found and extracted by the archaeologist. Once the fragments have been sieved, sorted, and dried, they can be examined by the specialist under the microscope, and identified normally at the genus level, and sometimes to species. Since no chemicals need to be used, charcoal has in addition proved the most reliable material from which to take samples for radiocarbon dating.

Many charcoal samples were derived from firewood, but others may come from wooden structures, furniture, and implements burnt at some point in a site's history. Samples therefore inevitably tend to reflect human selection of wood rather than the full range of species growing around the site. Nevertheless, the totals for each species provide some idea of one part of the vegetation at a given time.

Occasionally, charcoal analysis can be combined with other evidence to reveal something not only of local environment but also of human adaptation to it. At Boomplaas Cave, in southern Cape Province (South Africa), excavation of the deep deposits by Hilary Deacon and his team has uncovered traces of human occupation stretching back to about 70,000 years. There is a clear difference between all Ice Age charcoals and those postdating 12,000-14,000 years ago at the site. At times of extreme cold when conditions were also drier, as between 22,000 and 14,000 years ago, the species diversity both in the charcoals and the pollen was low, whereas at times of higher rainfall and/or temperature the species diversity increased. A similar pattern of species diversity is seen also in the small mammals.

The vegetation around Boomplaas Cave at the time of maximum cold and drought was composed mainly of shrubs and grass with few fruits and corms that could be used by people. The charcoal samples were dominated by the so-called rhinoceros bush, a small shrub that grows today in relatively dry areas. The larger mammal fauna during the Ice Age was dominated by grazers that included "giant" species of buffalo, horse, and hartebeest. These became extinct by about 10,000 years ago.

The Boomplaas charcoal directly reflects the gradual change in climate and vegetation which led to the disappearance of the large grazers, and to a corresponding shift in subsistence practices by the cave's occupants. The charcoal analysis also highlights more subtle changes that reflect a shift in the season of maximum rainfall. The woody vegetation in the Cango Valley today is dominated by the thorn tree. *Acacia karroo*, characteristic of large areas in southern Africa where it is relatively dry and rain falls mostly in summer. Thorn-tree charcoal is absent in the Ice Age samples at Boomplaas but here and at the nearby site of Buffelskloof it appears from about 5000 years ago and by 2000 years ago as the dominant species. This shift to hot, relatively moist summers after about 5000 years ago in the Cango Valley is traceable also in the carbon isotope analysis of a stalagmite from the nearby Cango Caves. With encroachment of summer rainfall species the inhabitants of the cave were able to make more use of a new range of fruits; the seeds of some of these were preserved in deposits that postdate 2000 years.

By no means all wood subjected to this kind of analysis is charred. Increasing quantities of waterlogged wood are being recovered from wet sites in many parts of the world. And in some conditions, such as extreme cold or dryness, ***desiccated wood*** may survive without either burning or waterlogging. Examination of a small slice (less than 1 mm (0.04 in) thick) under the light microscope and in the Scanning Electron Microscope permits identification of wood in pristine condition (Wilkinson and Stevens, 2003).

2.4. Faunal Remains

2.4.1. Reconstructing the Animal Environment

Animal remains were the first evidence used by 19th-century archaeologists to characterize the climate of the prehistoric periods encountered in their excavations. Thus, concepts such as the

Mammoth Age, the Aurochs Age, and the Reindeer Age were in common use until the classification of stone tools replaced them. Underlying these terms was the realization that different species were absent, present, or particularly abundant in certain layers and hence also in certain periods, and the assumption that this reflected changing climatic conditions.

Today, in order to use faunal remains as a guide to environment, we need to look more critically at the evidence than did the 19th-century pioneers. We need to understand the complex relationship between modern animals and their environment. We also need to investigate how animal remains arrived at a site -either naturally, or through the activities of carnivores or people and thus how representative they may be of the variety of animals in their period.

Man has always had a close relationship with animals, using them for many purposes. Evidence for this relationship in the past comes from the bones of animals which were found on archaeological excavations. Sometimes many bones are recovered from urban sites. Analysis of bones can tell us about the species of animals being kept and how old they were when they died. We can also discover from the butchered bones which parts of the animals people were eating and what use was made of the bones afterwards, such as tools or decorative items. Natural occurring remains also add to our knowledge about the palaeolecology.

These are the species most commonly encountered. A specialist can obtain a great deal of environmental information from the associations and fluctuations of these seemingly insignificant creatures, since most of them are present in archaeological sites naturally rather than through human exploitation.

It is necessary to ensure as far as possible that the bones were contemporary with the layer, and that burrowing has not occurred.

One should also bear in mind that, even if the remains were not intrusive, they would not always indicate the *immediate* environment. If they come from owl pellets, for example, they may have been caught up to a few kilometers from the site (the contents of bird pellets can nevertheless be of great value in assessing local environment (Evans, 1978). Recently, many modern techniques such as DNA are used in identification of species from tiny particles (Wilkinson and Stevens, 2003).

According to Evans, (1972) plants and animals remains fall under two categories as follow:

2.4.2. Microfauna

Just as tiny plant remains tend to be of great importance to environmental studies the small animals (microfauna) are better indicators of climate and environmental change than are large species, because they are sensitive to oscillations and adapt relatively quickly, whereas large animals have a relatively wide range of tolerance. In addition, since microfauna tend to accumulate naturally on a site, they reflect the immediate environment more accurately than the larger animals whose remains were often accumulated through human or animal predation. Like pollen, small animals, and especially insects, are also usually found in far greater numbers than larger ones, which improves the statistical significance of their analysis. It is essential to extract a good sample by means of dry and/or wet screening or sieving. Huge quantities are otherwise missed in the course of excavation.

A wide variety of microfauna is found on archaeological sites:

2.4.3. Mollusca

Mollusc shells, of freshwater or terrestrial deposits, are most common fossil remains in Quaternary sediments. In the late nineteenth and early twentieth centuries, however, workers in Britain such as A. S.

Kennard, B. B. Woodward and F. W. Harmer began to utilise molluscs as palaeoclimatic indicators (Evans 1972).

Molluscs are invertebrates in which the soft parts of the body are generally enclosed within calcareous shells. The crystalline form of calcium carbonate in the shells of most molluscs is pure aragonite, although the internal shells of certain slugs are composed of calcite. In both cases, the shells are subject to little change either in their crystalline or chemical composition following the death of the organism, and are therefore usually referred to as subfossil rather than fossil (Evans 1972).

Land and freshwater Mollusca are extremely useful palaeoecological tools because of their wide distribution and preservation in a variety of deposits. They show a marked preference for habitats that possess sufficient lime for building their shells, In general, the richer the base status of the locality, whether it be land or freshwater, the richer was the fauna, and mollusca (Sparks 1961). Terrestrial molluscs were also found in a variety of archaeological deposits including soils and ditch (Evans 1972).

Marine molluscs occupy a great range of ecological niches from pools and rock outcrops in the inter-tidal zone to the deeper waters off the edge of the continental shelf.

2.4.3.1. Land Molluscs.

The shells of land molluscs are preserved in many types of sediment, but especially in alkaline contexts where pollen analysis is constrained. They reflect local conditions, and can be responsive to changes in microclimate.

As usual, it is necessary to establish whether the shells were deposited *in situ*, *or* washed or blown in from elsewhere. The sample of shells needs to be unbiased - sieving should ensure that not merely the large or colorful specimens that catch an excavator's eye are kept, but the whole assemblage. Once the assemblages have been determined, one can trace changes through time, and hence how the molluscan population has altered in response to environmental oscillations. Temperature and rainfall are the dominant factors; where a species is near the limit of its normal range, it can be a very sensitive indicator of change.

A great deal of work has been done on this topic by the British John Evans and others at a number of prehistoric sites in Britain. For example, snails from sections at the Neolithic monuments of Woodhenge and Durrington Walls show that the area was wooded in that period. At Avebury nearby, the relative percentages of species found in successive layers of soil beneath the site's bank indicate a tundra environment about 10,000 years ago, open woodland 8000-6000 years ago, closed woodland 6000-3000 years ago, and followed by a phase of clearance and plowing, and finally grassland.

2.4.3.2. Marine Molluscs.

The middens of marine molluscs can sometimes help to delineate ancient shorelines, and their changing percentages of species through time can reveal something of the nature of the coastal micro-environment - such as whether it was sandy or rocky - through study of the modern preferences of the species represented. The climatic change suggested by these alterations in the presence or abundance of different species can be matched with the results of oxygen isotope analysis of the shells - a strong correlation between the two methods has been found by Hiroko Koike in her work on Jomon middens in Tokyo Bay where, for

example, the disappearance of tropical species implied a cold phase at 5000 or 6000 years ago, confirmed by an increase in oxygen 18 (and hence a decrease of water temperature) around 5000 years ago. Worms and Insects, besides molluscs, a narrow range of nematodes and annelids may be found, especially in waterlogged deposits including cesspits, as well as a wide range of arthropods such as mites and insects, the latter in the form of adults and larvae.

2.4.3.3. Field and Laboratory Work

Molluscan remains can be collected from open sections in the field by hand, Molluscan remains can either be removed by hand, or with the aid of a moistened brush under low-powered binocular microscope or scanner. Identification of molluscan subfossils that have been damaged by mechanical abrasion, others have their diagnostic characteristics masked by carbonate overgrowths. small fragments to be identified. For example, the marine genera *Mytilus*, *Modiolus* and *Pinna* have shells which possess a characteristic crystal structure that can be recognised with a high-powered microscope (Norton 1977). Similarly, differences in shell microsculpture are often diagnostic of land Mollusca, and specific determination of fragmentary remains can be made using scanning electron photomicrographs (Preece 1981).

The results of molluscan analyses can be presented in a variety of ways. Some workers prefer the use of species lists, perhaps using symbols to depict the frequency of occurrence (+ = presence; * = common; 0 = abundant, etc). This type of tabular format is usually adopted where a limited number of samples have been taken from a profile and where a full quantitative assessment of the change in species composition over time is required. It is often employed in studies of marine Mollusca (Peacock *et al.* 1978). More frequently, however, the data are depicted graphically, either in histogram form for single samples or, where a sequence of sediments is being investigated, on a diagram which has the vertical axis showing the depth below ground datum, and the horizontal axis the number of species plotted. The results can be presented in terms of relative abundance or absolute numbers. In both cases the histogram bars being drawn proportional to the thickness of the sampled horizons.

Once constructed, the diagram can be divided into molluscan assemblage zones which allow further palaeoecological inferences to be made. These zones will initially be of local significance, but may be extended (as in pollen analysis) to form a zonation scheme that has regional applicability, as has been demonstrated by Kerney *et al.* (1980) for southern Britain.

2.4.3.4. Molluscan Analyses and Quaternary Environments

Non-marine Mollusca. Mollusca possess a number of advantages over other fossil groups that have been used in the reconstruction of Quaternary environments. First, specimens can nearly always be identified to species level, and therefore more meaningful palaeoenvironmental conclusions can be drawn. Secondly, shells are present in oxidised sediments (e.g. slopewashes, loess, tufa) which generally lack other fossil remains such as pollen or Coleoptera. Thirdly, specimens are large enough to be recognised in the field (Kerney and Cameron, 1979).

2.4.4. Insects

The orders of insects include bugs (Hemiptera), (Diptera), caddis flies (Trichoptera), (Hymenoptera), (Odonata) and (Coleoptera), they provided useful palaeoenvironmental information (Osborne 1972). The Coleoptera, and this particular insect order has tended to dominate the interests of Quaternary entomologists (Lowe and Walker, 1984)

Fossil insects are often accumulated in ponds or near lake margins, in backwaters of rivers, in peats or indeed in any depositional environment where conditions were suitable for the preservation of plant debris. The insect remains are usually striking because of their brilliance (Lowe and Walker, 1984:)

The study of *insects* (paleoentomology) was rather neglected in archaeology until about 30 years ago. Since then a great deal of pioneering work has been done, particularly in Britain. Insect exoskeletons can be quite resistant to decomposition, and some assemblages comprise thousands of individuals.

Since we know the distribution and environmental requirements of their modern descendants, it is often possible to use insect remains as accurate indicators of the likely climatic conditions (and to some extent of the vegetation) prevailing in particular periods and local areas. Some species have very precise requirements in terms of where they like to breed and the kinds of food their larvae need. However, rather than use single "indicator species" to reconstruct a micro-environment, it is safer to consider associations of species, as with mammals or plant communities.

In view of their rapid response to climatic changes, insects are useful indicators of the timing and scale of these events, and of seasonal and mean annual temperatures. A few depictions of insects even exist from the Ice Age, and reveal some of the types that managed to survive in preglacial eras.

2.4.4.1. Coleoptera (Beetles and Weevils)

The study of subfossil beetles is becoming an important tool in understanding past environmental change. Virtually any non-marine sediment that has identifiable organic remains will include remains of insects, and many of these will be beetles (Elias, 1994: 284).

Coleopteran remains were often abundant in Quaternary deposits, usually outnumbering all other insect types. The chitinous exoskeletons were highly robust and contain sufficient structural detail to permit many fossil types to be identified to the species level. The order Coleoptera is the largest in the animal kingdom and within Britain alone over 3800 named species are known to occur (Coope, 1977 a). They occupy a very wide range of habitats (Coope, 1977b). Yet, many species are distinctly *stenotypic* in that they show a very clearly marked preference for particular environments, and it is this characteristic above all others which makes the Coleoptera such valuable palaeoecological indicators (Lowe and Walker, 1984).

They are particularly useful insects for microenvironmental studies. Their head and thorax are often found well preserved; almost all those known from the Pleistocene still exist; they are sensitive indicators of past climates, responding quickly to environmental change (especially temperature); and they form a varied group with well-defined tolerance ranges - some species are very selective in terms of vegetal environment, and live exclusively on particular plants, such as oak, or on certain fungi.

In a recent study, the climatic tolerance ranges of 350 coleopteran species that occur as Pleistocene fossils were plotted; the mutual climatic range method was then applied to 57 coleopteran faunas from 26 sites in Britain. It was found that there had been very rapid major warmings at 13,000 and 10,000 years ago, and a prolonged cooling trend from 12,500 years ago (when conditions were the same as now, with average July temperatures around 17°C, 62.6°F) to 10,500 years ago, together with a number of minor oscillations.

Occasionally the discovery of insects in archaeological deposits can have important ramifications. To take a major example, the remains of the beetle *Scolyti scotytus*, found in Neolithic deposits in Hampsted and London, occur in a layer before the sharp decline elm pollen known just before 5000 years ago in the lake sediments and peats of Europe. This archaeologically famous decline was originally attributed to climatic change (degrading soils, and later to clearance by early farina requiring fodder. However, *Scolyti scolytus* is the beetle that spreads the pathogenic fungus causing Dutch elm disease, and thus provides an alternative, natural explanation for the elm decline 5000 years ago. The recent outbreak of elm disease in Europe has allowed scientists to monitor the disease effects on the modern pollen record. They have indeed found that the decline in elm pollen is of similar proportions to that in the Neolithic; not only that, but the accompanying increase in weed pollen caused by the opening of the woodland canopy is the same in both cases. This fact, together with the known presence of the beetle in Neolithic times, makes a strong case for the existence of elm disease in that period (Lowe and Walker, 1984).

Insects have also come to the fore in excavations at York, where some Viking timbers seem to have been riddled with woodworm. A 3rd-century AD Roman sewer in the city was found filled with sludge, which had concentrations of sewer flies in two side channels leading to lavatories. The sewer was known from its position to have drained a military bath-house but the remains of grain beetles and golden spider beetles in the mud showed that the sewer must also have drained a granary (Lowe and Walker, 1984).

Clearly, insects are proving invaluable for the quantity and quality of information they can give archaeologists, not just about climate and vegetation, but about living conditions in and around archaeological sites as well.

The ecological affinities of most coleopteran species do not seem to have changed to any great extent during the Quaternary living assemblages. Moreover, independent evidence of a palaeobotanical or geological nature indicates that most fossil species were associated with similar types of environment to those that they occupy today. It does seem, therefore, that physiological stability in Coleoptera accompanied morphological constancy throughout the greater part of the last two million years. There are, however, exceptions to the rule Coope (1977a) notes (Lowe and Walker, 1984).

2.4.4.1. Laboratory Methods

The insect fragments can be removed by hand. More frequently, however, flotation techniques are required (Coope 1968). This step is followed by careful sieving. The residues remaining on the sieves are then mixed with paraffin (kerosene) and are sorted under a low-power binocular microscope. The fossil remains are then gummed onto cards or stored in alcohol and examined under a microscope. In recent years, as in other fields, increasing use has been made of the electron microscope

Data from fossil insect analyses are usually presented in the form of a species list showing numbers of individuals occurring within a particular sample as well as the parts of insects that have been recovered (Lowe and Walker, 1984).

2.4.5. Rats

As with large mammals, certain small species can be indicative of fairly specific environmental conditions. Richard Klein of Stanford University has noted a strong correlation between rainfall and the size of the modern dune mole rat of South Africa - the rats seem to grow larger in response to a general increase in vegetation density brought about by higher rainfall. His analysis of the fauna from Elands Bay Cave, South Africa, revealed that the rats from layers dating to between 11,000 and 9000 years ago were distinctly bigger than those of the preceding seven millennia, and this has been taken as evidence of a rise in precipitation at the end of the Pleistocene (Lowe and Walker, 1984).

2.4.6. Birds and Fish

Bones of birds and fish are particularly fragile, but are well worth studying. They can for example be used to determine the seasons in which particular sites were occupied. Birds are sensitive to climatic change, and the alternation of "cold" and "warm" species in the last Ice Age has been of great help in assessing environment, though it is sometimes difficult to decide whether a bird was present naturally or has been brought in by a human or animal predator.

2.4.7. Macrofauna

Remains of large animals found on archaeological sites mainly help us build up a picture of past human diet. As environmental indicators they have proved less reliable than was once assumed, primarily because they are not so sensitive to environmental changes as small animals, but also because their remains will very likely have been deposited in an archaeological context through human or animal action. Bones from animals killed by people or by carnivores have been selected, and so cannot accurately reflect the full range of fauna present in the environment. The ideal is therefore to find accumulations of animal remains brought about by natural accident or catastrophe - animals caught in a flash flood perhaps, or buried by volcanic eruption, or mired (as in the case of the wide range of Pleistocene fauna found in the famous tarpits of Rancho La Brea, Los Angeles), or which became frozen in permafrost. But these are by any standards exceptional finds - very different from the usual accumulations of animal bones encountered by archaeologists(Lowe and Walker, 1984).

Bones are usually only preserved in situations where they have been buried quickly, thus avoiding the effects of weathering and the activities of scavenging animals. They also survive well, in a softened condition, in non-acidic waterlogged sites. In some cases, they may require treatment in the field before it is safe to remove them without damage. In sediments, they slowly become impregnated with minerals, and their weight and hardness increase, and thus also their durability.

After collection, the first step is to identify as many fragments as possible, both as part of the body and as a species. This is the work of a zoologist or one of the growing numbers of zooarchaeologists, although every archaeologist should be able to recognize a basic range of bones and species. Identification is made by comparison with a reference collection. The resulting lists and associations of species can also sometimes help to date Paleolithic sites

2.4.7.1. Assumptions and Limitations

The anatomy and especially the teeth of large animals tell us something about their diet and hence, in the case of herbivores, of the type of vegetation they prefer. However, most information about range and habitat comes from studies of modern species, on the assumption that behavior has not changed substantially since the period in question. These studies show that large animals will tolerate i.e. have the potential to withstand or exploit a much wider range of temperatures and environments than was once thought. Thus species characteristic today of arctic and temperate regions in fact show a marked overlap in their habitats, and share a very similar minimum-temperature tolerance. This means that we can no longer assume, as archaeologists once did, that Pleistocene species such as the woolly rhinoceros or cave bear necessarily indicate cold climate. The presence of these species should be regarded merely as proof of their ability to tolerate low temperatures (Lowe and Walker, 1984).

If it is therefore difficult to link fluctuations in a site's macrofaunal assemblage with changes in *temperature*, we can at least say that changes in *precipitation* may sometimes be reflected quite directly in variations in faunal remains. For example, species differ as to the depth of snow they can tolerate, and this affects winter faunal assemblages in those parts of the world that endure thick snow-cover for much of the winter (Lowe and Walker, 1984).

Large mammals are not generally good indicators of *vegetation*, since herbivores can thrive in a wide range of environments and eat a variety of plants. Thus, individual species cannot usually be regarded as characteristic of one particular habitat, but there are exceptions. Some animals such as ibex, which today are restricted to the higher reaches of mountains, were forced by glaciations to live at lower altitudes, and there were similar latitudinal shifts by other animals and birds. For example, reindeer reached northern Spain in the last Ice Age, as shown not only by bones but also by cave art. Such major shifts clearly reflect environmental change (Lowe and Walker, 1984).

Fauna can also be used to determine in which seasons of the year a site was occupied. The techniques described there can go some way toward showing how the local environment changed from season to season. It is possible as well to correlate macrofauna and other types of evidence.

Many faunal sequences in areas such as Europe or southern Africa display changes of species that are independent of culture change, span thousands of years, and can be correlated with sequences derived from sediment or plant studies.

In coastal sites, including many caves in Cantabrian Spain, or around the shores of the Mediterranean (Franchthi Cave), or on the Cape coast of South Africa (see box overleaf), marine resources and herbivore remains may come and go through the archaeological sequence as changes in sea level extended or drowned the coastal plain, thus changing the sites' proximity to the shore and the availability of grazing.

However, one always has to bear in mind that faunal fluctuations can have causes other than climate or people; additional factors may include competition, epidemics, or fluctuations in numbers of predators. Moreover, small-scale local variations in climate and weather can have enormous effects on the numbers and distribution of wild animals, so that despite its high powers of resistance a species may decline from extreme abundance to virtual extinction within a few years.

There is clear evidence from many Polynesian islands, as will be seen below, that the first human settlers devastated the indigenous fauna and flora. But in other parts of the world the question of animal extinction, and whether and how people were involved, still forms a major topic of debate in archaeology. This is particularly true of the big-game extinctions in the New World and Australia at the end of the Ice Age, where losses were far heavier than in Asia and Africa, and included not just the mammoth and mastodon, but species such as the horse in the Americas.

There are two main sides in the big-game extinction debate. One group of scholars, led by the American scientist Paul Martin, believes that the arrival of people in the New World and Australia, followed by over-exploitation of prey, caused the extinction. This view, however, does not account for the extinction at about the same time of mammal and bird species that were not obvious human prey, or that would not have been vulnerable to hunting. In any case, the precise date of each extinction is not yet known, while the dates of human entry into both continents are still uncertain and constantly being pushed back well beyond the extinctions.

The other view, presented by the geologist Ernest Lundelius and others, is that climatic change is the primary cause. But this does not explain why the many similar changes of earlier periods had no such effect, and in any case many of the species that disappeared had a broad geographic distribution and climatic tolerance.

Extinctions caused by climatic change had occurred previously, but always tended to affect all size classes of mammal equally, and those that disappeared were replaced by migration or the development of new species - this did not happen in the Pleistocene extinctions. All big-game species weighing over 1000 kg (1 ton) as adults (the megaherbivores) disappeared from the New World, Europe, and Australia, as did about 75 percent of the herbivore genera weighing 100-1009 kg (0.1-1 ton), but only 41percent of species weighing 5-100 kg (11-220 Ib), and under 2 percent of the smaller creatures (Wilkinson and Stevens, 2003).

2.5. Other Environmental Evidences

2.5.1. Drawings and Stores

A great deal of information on vegetation in the less remote periods studied by archaeologists can be obtained from art. In the rock art of the Sahara, too, one can see clear evidence for the presence of species such as giraffe and elephant that could not survive in the area today, and thus for dramatic environmental modification, as Mahas rock drawings, Shona (grain stores) and Meroetic (Shinnie, 1967), reported that the Meroites used millet and barley, tender twigs, reeds roots, etc. as food. He also reported a rock engraving of the Meroitic king Sherkarer (A.D. 12-17) at Jebel Qeili where heads of sorghum appear in the scene. Also from texts, e.g. Roman farming texts, accounts and illustrations by early explorers such as Captain Cook, and even from photographs.

2.5.2. The Tree-Rings and Climate

Tree-rings, like varves, have a growth that varies with the climate, being strong in the spring and then declining to nothing in the winter; the more moisture available, the wider the annual ring. These variations in ring width have formed the basis of a major dating technique. However, study of a particular set of rings can also reveal important environmental data. The study of tree-rings and climate (dendroclimatology) has also progressed by using X-ray measurements of cell-size and density as an indication of environmental productivity. More recently, ancient temperature have been derived from tree-rings by means of stable carbon isotope *($^{13}C/^{12}C$)* ratios preserved in their cellulose. A 1000-year-old kauri tree in New Ziland has been analyzed in this way, and correlated quite well with those spanning the same period obtained from New Zealand stalagmites and stalactites (see box on caves, above) - i.e., a series of fluctuations in mean annual temperature, with the warmest phase in the 14th century, followed decline and then a recovery to present condition.

The importance of tree-rings makes it clear that it is organic remains above all that provide the richest source of evidence for environmental reconstruction. We must now take a detailed look at the sum traces of plants and animals (Renfrew and Bahn 1991:195-232).

2.5.3. Varves

Lowe and Walker (1984) mentioned that studies of recent sedimentation in lakes and sea have shown that annual rhythms are common in temperate regions. As general rule both sedimentation and biomass production is affected by seasonal variations. In some areas of calcareous bedrocks light summer layer of CaC03 alternate with dark winter layer rich in organic humus (Welton 1944). The particle size variation of the precipiting soil emphasize contrasts between winter and summer layers (Sararnisto, 1979). In winter the small particles precipitate slowly while they precipitate quickly in summer. The vigor of the season reflects on the layer thickness.

Finally, no single category of evidence can provide us with a total picture of local or regional environment, of small-scale trends or long-term changes: each produces a partial version of past realities. Input is needed from every source available. These must be combined with results from the other forms of data studied in order to reconstruct the best approximation of a past environment.

2.6. The History of Archaeobiological Research in Sudan

2.6.1. The History of Archaeoethnobotanical

Magid (1982) *concluded that: generally, archaeoethnobotanical research is not yet fully recognized in the field of geological studies in the Sudan. This is probably due to the following factors:*

1-the scarcity of evidence in the recovered archaeological material for specialized tools and equipment associated with the different activities of exploitation of food-plants, e.g. gathering, cultivation.

2- the poor preservation of the plant remains, e.g. grains, seeds in the archaeological sites; the older the site is, the lesser are the chances of preservation of these remains. These factors are most likely the reason for the general tendency among archaeologists to underestimate the essence of such type of evidence in the study of the past economic strategies and their development as regards exploitation of food plants. However, despite; problems a number of contributions were made in this field of research throught uncoordinated efforts. An attempt will be made in this account to bring these contributions together, with the main emphasis on the studies which deal with the Central Sudan in the period between c. 9000 to 1700 B.P.

During the previous years, increasing attention has been drawn to palaeoenvironmetal and palaeoeconomic studies in the Sudan based on archaeological research. Arkell was the first who studied the archaeoethnobotanical research in Sudan (Magid, 1982: 4).

2.6.2. Northern Sudan

There are many studies on the macroflora and the microflora mainly from archaeological sites in northern part of the Sudan dated to different periods such as that of Wendorfs (1968: 10, 1051), Adams (1982: 30) and Roowely-Conwy (1986: 110-111).

Kerma is situated in the south of the Third Nile Cataract. Around 2,500 B.C. a unique culture developed in that region. Contemporary with the Old Empire in Egypt. Chaix and Grant (1993) research has mainly involved the study of the animal and plant remains recovered from the two main areas of the site, and concerned both the environment and the economy of the settlement.

Attempts to recover preserved pollen grains carried out by David Taylor has demonstrated that they were sometimes preserved, if fairly poorly, in sheep and goat coprolites. The species so far identified all suggest flora very similar to that of the present day. The pollen from several types of acacia, jujube and various *Urticiceae*, *Gramir.ae* and *Ciperaceae* and preserved macroscopic plant remains, such as the cassia seeds found in a sheep's stomachs, together with the wood charcoal also confirm this impression of the environment. There are however, several lines of evidence to suggest moister environment than the present (Chaix and Annie Grant, 1993: 399-405).

Katharrina Neumanni (1993) identified 22 samples of old vegetation from Selima dated back to 5700- 6300 b.p. This consisted of nine taxa: *Acacia* sp, *Acacia albida*, *Mearua crassifolia*, *Leptodinia pyrotechnica*, *Ziziphus* sp, *Bosica senegalensis*, *Balanites aegypttiaca*, cf. *Cassia senna and Chenopoiaceae.* (Katharrina Neumanni, 1993:160).

2.6.3. Central Sudan

The first botanical evidence from the Central Sudan which consisted of seeds of *Celtis integrifolia* Lam. (Ar. *Labanja*) was recovered by Arkell during his excavations of the site of the Early Khartoum, (Arkell, 1949: 108-109, P1.45). Also Arkell also listed the presence of seeds of *C. integrifolia*. as indicators for a higher rainfall (500 mm). In Shaheinab site, Arkell recovered seeds of *C. integrifolia*. (Arkell, 1953: 103). The majority of these seeds were desiccated which a few specimens exhibit carbonized exteriors indicating their probable exposure to fire. Beside these seeds, one *Acacia* sp., *Ziziphus* sp. and a carbonized shell of *Elaeis guineensis* Jacq. (Ar. *shagarat zeit el-nakheil)* were also found (ibid: 80, 103).

From the Jebel Tomat, which is a post-Shaheinab site, a number of carbonized and desiccated plant remains were recovered and identified as: *Acacia* sp., *Salvador-a persica* (Ar. *arak)* *Ziziphus sp.* (probably Z. *spina-christi* Lam. (Ar. *nabag)* and *Ficus* sp. (Ar. *gameiz)* (dark, J.D., and A.B.L. Stemler, 1975: 588). Some of these species have edible fruits, e.g. *Ziziphus spina-christi* Lam. However, the most important botanical material was the finding of large quantities of carbonized grains of *Sorghum bicolor* (L.) Moench (Ar. *aishldurrd)* which is dated to A.D. 245±60 (ibid: 589-590).

Shinnie (1967) mentioned that the geographer Strabo has reported, after his visit to Egypt in 25-19 B.C., that the Meroites used millet and barley, tender twigs, reeds roots, etc. as food (Shinnie, P.L., 1967: 18-19).

The 1970s witnessed the most active operations of archaeological research in Sudan especially in the area of Khartoum (Haaland, 1987a: 16-20; Mohammed-Ali., 1982: 10-21). These included the earliest successful attempts of extracting positive casts from impressions of plants in pottery. Although some attempts were previously made to find evidence of plant impressions, e.g. the attempts made by Arkell (Arkell, 1949), Klichowska (1978) was probably the first palaeoethnobotanist to find such evidence. In a preliminary report, Klichowska (1978) stated that a number of plant impressions were found in pottery recovered from the Kadero, which was a site of a typical Shaheinab tradition. Most of these impressions were identified as being of domesticated species such as *Sorghum vulgare* L. (Ar. *aishltdurrd)*, three species of millet, e.g. *Pennisetum* sp. (Ar. *dukhun)* and *Eleusine coracana* Gaertn. (Ar. *telebun)*, one species of *Setaria* and barley, *Hordeum* sp. (Ar. *shaeir*) (Klichowska, 1978: 42-43).

Further examinations of plant remains and their impressions from the same site, Kadero, revealed the presence of desiccated seeds of *C. integrifolia* Lam., *Hyphaena thebacia* (L.) Mart. (*Aldom)* as well as impressions of grains of wild sorghum, two species of millets and seeds of other wild grasses, e.g. *Setaria* (Krzyzaniak, 1978: 160-166). (ibid) Krzyzaniak has also taken soil samples to be treated for pollen analytical study, but no pollen grains were obtained. (Krzyzaniak, 1979: 69). Haaland (1981) reported that desiccated seeds of *Celtis integrifolia* Lam. were found at all the excavated sites all of Shaheinab type, on the east bank of the Nile River north of Khartoum (Haaland, R., 1981: 195). Moreover, she presented recovered evidence of grain impressions of wild sorghum, *S. verticilliflorum* (Steu Stapf. on potsherds from the Shaheinab type of sites of Zakiab, Direwia and Kadero I (ibid).

Mohammed-Ali (1982) published the results of identification of the flora recovered from the site of SRB-1, an Early Khartoum type of site situated on the west bank of the Nile river north of Khartoum. These fossils included *Ziziphus* sp., *Salix subserrata* Willd. (Ar. *safsaf)* and an impression of a leaf-fragment of an unspecified monocotyledonous species (Mohammed-Ali, 1982: 82,172).

Magid (1982) studied the archaeoethnobotanical material dated to c. 8000-4000 B.P. in the area of Khartoum. A review of previous works in this field of research (ibid: 4-8) was presented with new data from the sites of the Nofalab and Islang on the west bank of the Nile river north of Khartoum.

Flotation of soil samples from the site of Saggai did not yield any results as regards retrieval of plant remains (Costantini, 1983: 47).

2.6.4. Eastern Sudan

Costantini, *et al*, (1982) identified carbonized plant remains from the prehistoric sites in Kassala area. These results show that three different species were identified: *Hordeum* sp., *Ziziphus* sp., and

Leguminosae. In 1983, more results from other sites of the area were published but these consisted of plant-impressions (Costantini, *et al*; 1983:18). The majority of these impressions were identified as domesticated sorghum *bicolor* (L.) Moench. The others belong to *Setaria glauca* Beauv. and less (fly *Paspalum* sp). On the basis of the typology of pottery, these finds were dated second millennium B.C. (ibid). What has been identified as *Hordeum* sp. from this, dated the second millennium B.C. (ibid). Magid, 1984 published a preliminary report on the initial results of identifying the plant remains retrieved from the cave-site of Shaqadud Carbonized grains of *Pennisetum* sp. (Brum.) Stapf. and Hubbard, wild *Sorghum* Sp., *Panicum turgidum* Forsk. (Ar. *tumam)*, *Setaria* sp., *Grewia tenax* (Forsk.) Fiori. (Ar. *guddeim)* and desiccated seeds of *Ziziphus spina-christi* Lam. (Magid, 1984: 27-28).

In this connection, it should be mentioned that it has been suggested that the earliest evidence of domestic millet in the Sahel was recovered from the same cave- site at Shaqadud and dated to about 2500 B.C. (Marks, *et al*, 1985: 275).

2.6.5. Western Sudan

Wadi Howar is an ancient river sytem that was connected with the nile during the early and middle Holocence (Pachur and Kropelin, 1978). Katharrina Neumanni (1993162) identified samples of palaeobotanical material from Wadi Howar dated back to around 7000 b.p. This consisted of 12 woody taxa: *Terminalia* cf. *macroptera*, *Anona senegalensis*, *cf Rhus sp*, *Crateva adonsonii*, *Celtis integrifolaa*, *Ximenia americana*, *Ficus* sp. and *Acacia albida. Celtis integrifolaa* which was now in the sahel only is also detected. Around 5700 B.P. onwards, the Sudanian vegetation in Wadi Hower was replaced by sahelian types as *Acacia* sp., *Ziziphus* sp., and cf *Grewia* sp.

2.6.6. The History of Zooarchaeologica

Tigani (1982) wrote: *Our knowledge of the Pleistocene and Holocene fossil fauna of the Sudan is rather poor due to the fact that few studies have yet been carried out. Nevertheless, these few studies furnish valuable information about the composition of the prehistoric fauna in some parts of Sudan. He added that foregoing study of the zooarchaeological research: in the Sudan shows clearly that large parts of the country were virtually unexamined, and that research has been largely confined to what we call Nubia and Central Sudan.*

2.6.7. Central Sudan

Singa yielded a fragmentary human skull, originally described by Woodward (1938) as proto-bushmanoid; but Stringer (1979) concludes that it was probably derived from a late archaic *Homo sapiens* individual. A radiocarbon date on a crocodile tooth from the Abu Hugar assemblages gave an age of ca. 17300 B.P., but the sample is said to be far from adequate (Whiteman 1971:124). Arkell (1949) and Bate (1949) studied the faunal remains excavated at the Khartoum hospital site dated to the 9.th millennium B.P. It was the type site of the Early Khartoum culture.

The fauna includes: Freshwater mollusks fishes; (*Polypterus sp., Labeo sp., Clarias sp. ,Synodonti.s sp., Lates niloticus, Tilapia sp. and Hydrooyon forskali); Reptiles (Cpoaodytus sp. Python sf. Varanus sp.,Trionyx sp.and Testudo spp.); Birds (very rare)* and *mammals* (Hyena, Wolf-jacka, water Mongoose, Leopard, wild cat, porcupine, Reed Rat, White-nosed Rat, Spiny Field Rat, Hippopotamus Warthog, Nile Lechwe, White-eard Cob, Oribi, North-eastern Buffalo, Equine, Black Rhinoceros and African Elephant).

Singa and Abu Hugar (Blue Nile) yielded a diversified assemblage which included forms now extinct. From these localities Bate (1951), identified a freshwater snail, crocodile, zebra, *Rhinoceros* sp. (possibly white rhinoceros), hippopotamus, giraffe, *Oryx sp*, *Gazella* sp., *Antelope*s and an extinct giant buffalo.

In El Shaheinab site (dated to the 6.th millennium B.P), Bate and Arkell (1953) recorded the excavated fauna which include: many species of freshwater mollusks species, many insect *(Cleopatra)* and land snails; fish: (*Clarias* ;sp., *Synodonti.s* sp. Nile perch); Reptiles (*Croaodilus* sp., *Python* sp., *Varams* sp., *Tritonyx* sp., *Testudo hermanni*); birds (much more frequent than at Early Khartoum Site); mammals (Grivet monkey, jackal?, striped hyena, lion, leopard, African wild cat, African civet, honey badger, genet, black-tipped mongoose,. porcupine, hare, gerbil, ground squirrel, hippopotamus, warthog, roan antelope Oryx, greater kudu, red fronted gazelle, gazelle, bush duiker, dwarf domestic goat, twisted horned goat or sheep, buffalo, giraffe, black rhinoceros and African elephant).

Singer and Bone (1960) identified the sivatherine from Abu Hugar as *Stivtherium olovaiense*. Wells (1963) identified the so-called antelope or caprine as a reduncine *(of. Kolbus* sp.).

Clark (1973) published a faunal list from another Early Khartoum type of site at Shabona the fauna includes: elephant, hippopotamus, giraffe, bovids of various size, buffalo, reduncines, *Kobus* sp., Warthog, reed rat, dassie (Hyrax), mongoose, turtle and tortoise, python, catfish and Nile perch. Furthermore, *Pila* sp. was found concentrated in pits.

A preliminary report on the fauna of El Kadero (a Khartoum Neolithic type) was published by Sobocinski (1977). Preliminary results are as follows: *Pila ovata*, *Cleopatra bulvnoides*, *Aspatharia rubens*, *Corb'icuta aonsobr-ina*, *Ethepia elliptica*, *Zooteous insularis*, *Lirmco'lapia oa-illiaudi*, *Engina mendicayia*. Fishes (lungfish, catfish and Nile perch); reptiles: (monitor lizard); birds (small species); mammals: (wild cat, serval, honey badger, porcupine, hare, gerbil, squirrel, hippopotamus, warthog, buffalo, bovids dog cattle and sheep/goat).

The faunal remains from Jebel Tomat, probably related to Jebel Moya site, are briefly recorded by Clark (1973). They include small domestic cattle, small livestock, dog and gazelle (*Dorcas gazelle*?), klipspringer, bush pig, cane rat, mongoose, porcupine, hare, hedgehog, a jerbil, geret, monitor lizard, several birds and Ampullarid shells (*Pila sp*.).

2.6.8. Northern Sudan

Within fauna assemblage found at Kerma there were bones from some of the large African mammals, creatures of the grassy or wooded savannas. They included giraffe, black rhinoceros and hippopotamus. Drawings of giraffes were also used as decorative motifs on pottery.

There were in addition two drawings of rhinoceros, one apparently white and other black, and probably a Roan antelope (Hilzheimer 1931). Finds of ostrich eggs, although not of ostrich bones might be used to support the presence or close proximity of a more developed grassy or wooded savanna (Chaix and Annie Grant, 1993: 399-405).

2.7. Quadrennial Geology and Climate Definition and Determinants

Climate means the total experience of the weather at any place over some specific period of time (Lamb, 1982:8). The items that together determine the climate are:

1. The radiation balance- the balance between incoming energy originating in the sun and outgoing energy from the earth. This gain and loss depends on the latitude and aspect of the place as earth slopping.
2. The heat and moisture brought and carried away by the winds.
3. The heat and moisture stored in, transported by, and supplied from the sea and other water bodies. The ocean currents and their variations are important.

4. Characteristics of the locality and its surroundings, particularly the amount of the water present in and on the soil, the vegetation, the friction and channeling of the wind by hills, mountains, color and reflective power of the surface.

2.7.1. Paleoclimatology

Past climate can be reconstructed by many records among them are metrological instrument records and these records were just for only the last few decades. Other important records are dairy, annals and chronicles. Other natural records were mentioned previously. Paleoclimatology is the study of climate change taken on the scale of the entire history of Earth. The history of Earth is classified to periods. Recent is the Quaternary Period which extends up to, and includes, the present day. Together with Tertiary it forms the Cenozoic, the fourth of the great geological eras. In the geological timescale, periods are conventionally divided into epochs, and Quaternary is often held to include two intervals of epochs status: the Pleistocene epoch and the present warm Holocene epoch. The Tertiary (Pliocene) roughly ended before 1.806 million years ago.

Major Geological Time and History of the World (Ma= million years**)**

Time	Events
4,000 Ma	earliest biogenic carbon
3,450 Ma	earliest bacteria
3,000 Ma	earliest photosynthetic bacteria
2,700 Ma	oldest chemical evidence of complex cells

2,300 Ma	first green algae (eukaryotes)
2,000 Ma	free oxygen in the atmosphere
1,700 Ma	end of the banded iron formations and red beds become abundant (non-reducing atmosphere)
700 Ma	first metazoans late Proterozoic (Ediacaran Epoch) - first skeletons
100 Ma	development of the angiosperms (flowering plants)
2 Ma to present	modern world and man's appearance on earth
0.01 Ma	end of the last ice age
0.001 Ma	warming trend of the middle ages
0.0001 Ma	end of the mini ice age
0.00022 Ma to present	industrialized human world.

2.7.1.1. The Quaternary Period

The Quaternary Period includes:

2.7.1.2. Pleistocene Epoch

The Pleistocene epoch on the geological timescale is the period from 1,808,000 to 11,550 years BP (Lourens *et al;* 2004). The Pleistocene epoch had been intended to cover the world's recent period of repeated glaciations. The end of the Pleistocene corresponded with the end of the Paleolithic age used in archaeology.

The name Plio-Pleistocene has in the past been used to mean the last ice age. But since only a part of the Pliocene is involved, the Quaternary was subsequently redefined to start 2.58 Million years ago as more consistent with the data (Clague, *et al;* 2006).

2.7.1.3. Glacial Features

It is estimated that, at maximum glacial extent, 30% of the Earth's surface was covered by ice. The mean annual temperature at the edge of the ice was −6°C; at the edge of the permafrost, 0°C. Each glacial advance tied up huge volumes of water in continental ice sheets 1500–3000 m thick, resulting in temporary sea level drops of 100 m or more over the entire surface of the Earth. There were glaciers in New Zealand. The current decaying glaciers of Mountain Kenya, Mountain Kilimanjaro, and the Ruwenzori Range in east and central Africa were larger. Glaciers existed in the mountains of Ethiopia and to the west in the Atlas Mountains. Deserts were drier and more extensive.

Rainfall was lower because of the decrease in oceanic and other evaporation. Pleistocene climate was characterized by repeated glacial cycles, termed a "glacial." Glacials are separated by "interglacials." Corresponding to the terms glacial and interglacial, the terms pluvial and interpluvial are in use (Latin: *pluvia*, rain). A pluvial is a warmer period of increased rainfall; an interpluvial, of decreased rainfall.

In Sudan, during the terminal Pleistocene the climate was cool, dry and windy at latitude 10-12 and semi-arid in southern Sudan (Wickens, 1982).

2.7.1.4. Holocene Epoch

The Holocene epoch is a geological period, which began approximately 11,550 BP (about 9600 BC) and continues to the present. The Holocene has also been called the "Alluvium Epoch", but this name has fallen into disuse. The Holocene starts late in the retreat of the Pleistocene glaciers. Human civilization dates entirely within the Holocene.

Paleontologists have defined no faunal stages for Holocene. The subdivision periods of human technological development such as the

Mesolithic, Neolithic and Bronze Age were usually used (http://www.stratigraphy.org/gssp.htm).

Climatically, the Holocene may be divided evenly into the Hypsithermal and Neoglacial periods; the boundary coincides with the start of the Bronze Age in western civilization.

2.7.1.5. Geology

Melting ice caused world sea level to rise about 35 m in the early part of the Holocene. In addition, many areas above about 40 degrees north latitude had been depressed by the weight of the Pleistocene glaciers and rose as much as 180 m over the late Pleistocene and Holocene, and are still rising today. The sea level rise and temporary land depression allowed temporary marine incursions into areas that are now far from the sea.

2.7.2. Climate

Although geographic shifts in the Holocene were minor, climatic shifts were very large. Ice core records show that before the Holocene there were global warming and cooling periods, but climate changes became more regional at the start of the Younger Dryas. However, the Huelmo/Mascardi Cold Reversal in the Southern Hemisphere began before the Younger Dryas, and the maximum warmth flowed south to north from 11,000 to 7,000 years ago. It appears that this was influenced by the residual glacial ice remaining in the Northern Hemisphere until the latter date.

The hypsithermal was a period of warming in which the global climate became 0.5–2°C warmer than today. However, the warming was probably not uniform across the world. This period ended about 5,500 years ago, when the earliest human civilizations in Asia and Africa were flourishing.

The early Holocene (c.10.500-6000 BP) was wet and warm in central Sudan. Late Pleistocene dunes become submerged under White Nile alluvium and further west small lakes and swamps occupied the depression between the now vegetative and stabilized dunes. From about middle Holocene onwards the climate become drier and then there was a progressive shift southwards of the rainfall, hence flora and fauna (Wickens, 1982).

The Holocene warming was an interglacial period and there was no reason to believe that it represented a permanent end to the Pleistocene glaciation. However, the current global warming may result in the Earth becoming warmer than the Eemian Interglacial, which peaked at roughly 125,000 years ago and was warmer than the Holocene. Compared to glacial conditions, habitable zones have expanded northwards, reaching their northernmost point during the hypsithermal. Greater moisture in the Polar Regions has caused the disappearance of steppe-tundra.

2.7.2. Flora and Fauna

Animal and plant life have not evolved much during the relatively short Holocene, but there have been major shifts in the distributions of plants and animals. A number of large animals including mammoths and mastodons, saber-toothed animals and giant sloths disappeared in the late Pleistocene and early Holocene. Throughout the world, ecosystems in cooler climates that were previously regional have been isolated in higher altitude ecological "islands."

The beginning of the Holocene corresponded with the beginning of the Mesolithic age in most of Europe; but in regions such as the Middle East and Anatolia with a very early neolithisation, Epippaleolithic is preferred in place of Mesolithic. Both are followed by the a ceramic Neolithic (Pre-Pottery Neolithic A and Pre-Pottery Neolithic B) and the pottery Neolithic. (http// wwww.Wikipedia.com).

2.7.2.1. Lake Fluctuation in Africa

Street, Alayne and Grove (1979) summarized the lakes level in Africa from 21000- years BP – Present as follow:

Period	***Pluvial condition.***
21000-20000 BP	Onset of dry condition in intertropical Africa.
18000-17000 BP	Aridity spread across Africa except north west Sahara.
15000- 14000 BP	Aridity more intensive.
12000-11000 BP	Lake levels rising including Chad and equatorial lakes.
90000-8000 BP	Lake levels rose dramatically in coherent pattern after 10000 yr BP. Although nerth west Sahara remained anomalously dry.
6000-5000 BP	Lakes began to dry out at round 7000 BP although Ethiopia subject to wetter influences.
40000-1000 BP	After 4500 BP strong drying trend began in tropical Africa. High lakes levels recede towards equator with minor reversal between 3500 and 3000 BP
1000 BP - present	Present millennium appears to be most arid of the late Quaternary.

2.7.2.2. Palaeoclimate in Sudan

In Sudan, Wickens (1982) summarized the climatic changes as follows:

Phase- date	**Event**
A- 20000-15000 BP	Very arid
B- 15000-12000 BP	As present
C- 12000- 7000BP	Very wet
D- 7000-6000 BP	Short dry
E- 60000-3000 BP	Wet
F- 3000 BP – present	Present

As Noorwdijk (1984) in Ecology Textbook of Sudan wrote:

1. In Pleistocene (20000-12000) years ago, the weather was cool dry and windy. The vegetation zone was south of the present days zone by 450km.
2. In Holocene (during 11000- 7000BP), the weather was warm and wetter. The vegetation zone was north of the present days zone by 450 km.

   During 6500-4500 BP the weather was dry but more humid than present. The vegetation zone was north of the present days zone by 100-250 km.

   During 4500-2000 BP the weather was more dry and but more humid than the present. During this time the Eastern Sahara was desiccated .This was accompanied by exudation of the population to Nile Valley.

   During the last 2000 years the climatic fluctuation as follow:

   - 1200 AD- dryer than to day
   - 1300-1500 AD- wetter than present
   - 1600-1850 AD- dryer than to day

2.8. Arial Archaeological Techniques

2.8.1. Remote Sensing:

In the broadest sense, remote sensing is the short or large-scale acquisition of information of an object or phenomenon, by the use of either recording or real-time sensing device(s) that is not in physical or intimate contact with the object (such as by way of aircraft, spacecraft, satellite, buoy or ship). In practice, remote sensing is the stand-off collection through the use of a variety of devices for gathering information on a given object or area. Thus, Earth observation or weather collection platforms, ocean and atmospheric observing weather buoy platforms, monitoring of a pregnancy via ultrasound, Magnetic Resonance (MRI), Position Emission, Emission Topography (PET), and space probes are all examples of remote sensing. In modern usage, the term generally refers to the use of imaging sensor technologies including but not limited to the use of instruments aboard aircraft and spacecraft, and is distinct from other imaging-related fields such as medical imaging. (From www.Wikipedia.com , the free encyclopedia)

Remote sensing uses a variety of devices that receive radiation (electromagnetic) or sonar information reflecting variations in the topography, density or other aspects of the earth's surface. This includes conventional photographic images obtained from aircraft or satellites, using the visible and non-visible (e.g. infra-red. light spectra, radar sensors, sonar techniques (echo sounders), and recently lasers**.** Some of the more widely-used techniques in Quaternary research.

2.8.2. Aerial Photography

Since the First World War, aerial photographic reconnaissance has increased both in frequency of use and in degree of sophistication. Good quality aerial photographs are now available even for the most inaccessible areas allowing at least a preliminary map to be made of any prominent or strongly-patterned landforms (e.g. Karlen 1973; Hjort; 1979. A system of grid corrections can be used for transferring details from photographs to maps where scales differ, or where the photographs contain serious distortions (Kilford 1963; and Wolf 1974, for relevant techniques). Aerial photographs are particularly useful in the mapping of landforms in that:

a) They direct attention to areas where landforms are most evident or abundant, thus avoiding much wasted ground reconnaissance;
b) They illuminate ground detail that is not obvious at ground level;

c) They reveal larger scale landform patterns that are often not visible on the ground, such as shorelines of lakes in semi-arid areas;
d) They may record morphological features
e) Repeated surveys allow the monitoring of, for example, changing landscapes, changing landform assemblages or changes in the position of glacier termini through time.

Disadvantages of aerial photographs include distortions due to camera tilt or variation in camera altitude, loss of detail due to cloud cover or shadow effects, poor tonal contrasts so that, for example, drift cannot easily be separated from bedrock surfaces, and difficulty in detection of small-scale, yet often geomorphologically significant landforms. Field mapping therefore remains essential, and even where mapping is based on large-scale, good quality aerial photographs, the results must be viewed as a *provisional* map of the Quaternary geomorphology of a region until the interpretations can be checked on the ground. For areas where good topographic maps are unavailable, aerial photographs provide the only reliable basis for analysing landform distributions, and enlargements can be made for this purpose (Gordon 1981).

Recently aerial photography was highly developed by using new technologies having an impact in different ways. Computer enhancement of picture scan improves their sharpness and contrast. Digital manipulation of images has also been developed and enables a single image, from an oblique or vertical photograph, to be transformed to match the map of the area. Use of aerial data as Geographical information system (GIS) layer, leads to fruitful results. So new world archaeological projects now routinely use the commercially available, black and white aerial photographs (Renfrew and Bahn, 2000).

2.8.3. Satellite Imagery

For many years people have suggested that satellite imagery could be a valuable resource for prospecting for archaeological sites. Until recent years the resolution of easily available imagery has been insufficient to see most archaeological features. A number of spacecraft have produced images of the earth that can form the basis for terrain evaluation, but the most useful so far have been the American satellites LANDSAT-1, (launched 1972), LANDSAT-2 (launched 1975) and SKYLAB-1 (launched 1973). LANDSAT makes a circular orbit of the earth fourteen times each day, and transmits images continuously to receiving stations in Maryland, California and Alaska. The image sensors in each LANDSAT can cover the entire globe, with the exception of the poles, every eighteen days. The great advantages of satellite imagery over aerial photographs are that distortions are minimised . The process is much more rapid, and repetitive images of large parts of the earth's surface can be obtained. Conventional photographs are obtained by the simultaneous recording of all features viewed through the lens, whereas scanning sensors operate by sensing one spot at a time as they sweep across the area in view. The incoming radiation is focused onto a detector which transforms radiation intensity into an electronic signal and an image is composed by assembling a large number of spots (pixils), in a similar manner to the formation of a television picture (Verstappen 1977). In multi-spectral scanning (MSS) the energy received from different narrow wavelengths is recorded simultaneously, and images can be produced using only one spectral band, or, all of the information can be combined in a 'colour composite' image (NASA 1976; Townshend 1981). This technique has opened up new areas in remote sensing, for the use of infra-red or near infra-red wavelengths permits image sensing of features not observable in the visible part of the spectrum where, for example, objects are obscured by cloud, haze, smoke or even vegetation. The potential of satellite imagery in the analysis of Quaternary landforms is considerable, and present applications range from the mapping of former lake shorelines in Africa (Verstappen 1977; Ebert and Hitchcock 1978), to the investigation of landform assemblages in presently glacierised areas (various photographs in Sugden and John 1976).

2.8.4. Radar

This operates on the principle of the emission of pulsed signals, usually in the microwave and higher radio frequencies, from a transmitter, and the recording of the 'echos' of these signals as they are bounced back from the ground surface. The returning signals are affected by ground surface roughness, by the orientation of upstanding features, and by the density and electrical properties of ground materials. In dry sediments or cold ice, boundaries between stratigraphic units or ice layers can often be determined. Airborne radar equipment ('echo sounders') have been developed that automatically transform received signals into images (imaging radar), usually referred to as sideways looking airborne radar (SLAR). As in satellite scanners, the pulsed signals scan the terrain to one side (sometimes to both sides) of the aircraft, and the received signals are converted into electrical impulses that are recorded directly onto magnetic tape or transformed into a photographic image. Once again, the great advantage of this technique in geomorphological mapping is that data can be obtained even in cloudy or adverse weather conditions. Radar has proved particularly useful in the investigation of ice thickness, and of the nature of subglacial topography in presently glacierised regions (Morgan and Budd 1975; and Robin *et al.* 1977).

2.8.5. Sonar and Seismic Sensing

A number of techniques have been developed that are based on the gravitational, magnetic or electrical properties of the earth. Movements of acoustic or sonic waves are affected by the density and other characteristics of different materials.

2.9. Paleoeconomy

2.9.1. The Nature of Economies

Paleoeconomy is the study of the past economy. The economist Adam Smith expressed the view that economy was the paramount factor that governed societies. Accepting this view, and bearing in mind that one of the prime goals in archaeology is the deciphering of ancient society, and then the study of past economies is of fundamental importance. By 'economy' here we are referring to the production and consumption of goods and services. The way people organized the production of food, pottery, metalwork, houses etc. is one side of the economic equation, the other side is how these things were distributed amongst the people and used for consumption. By distribution the emphasis was not on how objects or products were transported but rather on how they were shared out among the wider populace.

In order to explore these economic ideas a series of questions that concentrate on those issues are most pertinent to environmental archaeology such as breeding of animals, growing of crops and the production of food, drink, textiles and other objects from them were posed. The questions are based on an approach developed by Dee DeKoche (2003) for studying the British Iron Age. They aim was to give rise to more detailed descriptions and understanding of past economies by environmental archaeologists. The questions lead the investigator to examine the biological components which related to what was consumed and produced, through ecological and practical considerations as well as to the nature of the production sequence itself that set the resultant information within a social context.

At the most basic level the division between production and consumption is the difference between making and using something. Production is not a single event but a sequence of events. The narrowest definition of subsistence refers to the activities of those individuals who farm for their food (agriculturalists) or hunt and gather (foragers) it from the wild.

Subsistence activities can be divided into three stages: primary production (harvesting of crops and the slaughter, milking, bloodletting or shearing of animals), procurement (activities leading to the ripe crop being ready for harvest or the breeding and raising of animals to an age where they are ready to exploit) and processing (involves the conversion of harvested crops to clean gram, grain to flour or malt, and these components through various cooking procedures into food. Animals will be butchered removing the meat from the bone, perhaps skinned and dehorned.

Another aspect of subsistence is how communities manage risk, or in other words what farmers or hunter-gatherers do when things go wrong. For example when droughts cause crops to fail or alter the routes of migratory animals, or when severe disease decimates a herd. Paul Halstead and John O'Shea (2003) identified four types of risk strategy for traditional societies; mobility, diversity, storage and exchange.

Exchange takes many different forms. As a risk strategy it is the procurement of extra resources by direct payment or the promise to pay later.

The term mechanical solidarity refers to societies where farmers are self-sufficient with little interdependence and the term organic society refers to those societies in which there was great deal of interdependence.

Karl Polanyi classified what he termed as modes of exchange into three groups, while we have added a commonly used fourth. They are: market exchange, redistribution, reciprocity and inheritance. The main differences between these modes are the relationships between the participating individuals.

The important aspect of market exchange is not only the existence of the market, but rather that such a mode of exchange may be undertaken by two individuals who are unknown to each other. Redistribution is the collection of goods (or money) from the wider society by a centralized administrative body. These goods, or goods purchased with money, are then reallocated to the wider society and in this sense modern taxation systems are redistributive (Wilkinson and Stevens, 2003).

2.9.2. Means of Interpreting the Palaeoeconomy

This can be achieved by recognizing and using the biological data to understand past economies. The main categories of botanical data is plant macro-remains and depends, mainly on the examination of seeds. Preservation of these proxy records is by charring, waterlogging, mineralization and desiccation. Of these, attention has been overwhelmingly focused on charred plant macro-fossils as these are ubiquitous finds on most archaeological sites. They are also the category of plant macrofossil that best survived in those areas of the world which witnessed the origins of agriculture, namely the Near East and the Middle East. For each preservation circumstance, the types of contexts in which macrofossils survived should be examined. It is important to understand the taphonomy of the deposit, methods of extraction and analysis and, most importantly, the frameworks of interpretation. If a cereal crop was produced, the bioarchaeological signal tells us of past economies and subsistence. Concentration should be in particular on the processing stages that come with and follow the harvest, and how specific suites of plant macro-remains can be indicative of how much processing had been carried out prior to crop storage

In the zoological data, attention must be paid to vertebrates, particularly mammals, for human subsistence. Attention should be concentrated on animal bones. Animal bones survive well on the majority of archaeological sites that do not have acid subsoils and are usually recovered in a similar way to artifacts. Animal bones are identified, land then quantified in order to examine the importance of individual species to subsistence, then age-estimated and sexed. The bone record can be informative both usage and how carcasses have been dismembered. Depending on use and signs of animal husbandry for milk, wool and hide can be recognized from the bone data.

Biomolecular studies are a relatively new area of environmental archaeology that is rapidly evolving into a separate sub-discipline of archaeology. The sub-discipline reveals how residues can be chemically examined from ceramic vessels to determine what liquids they once held and how morphological evidence from starch grains allows us to reconstruct ancient brewing practice. Isotope studies are an even more recent development, which enables researchers to determine the relative contribution of marine and terrestrial foods for prehistoric peoples using ratios of carbon and nitrogen isotopes. An important addition to bioarchaeology is concerned is the analysis of DNA and its contribution to examining the domestication process. By this technique archaeologists now know domesticated maize was bred from a single population of teosinte in central Mexico and that the first wheat domesticated (einkorn) originated in south-eastern Turkey. (Wilkinson and Stevens, 2003)**.**

2.9.3. The Palaeoeconomy of the Sahara

Environmental conditions in central and southern Sahara (Mali, Niger, Libya, Egypt and Sudan) were characterized by abundance of water and perennial lakes in 7-8 the millennium B.C. (Andew B. Smith 1980:452). The collected archaeological material revealed that humans exploited these lakes. Such archaeological material included aquatic crocodile, turtles and hippopotamus, as well as fish (*Lates* and *Calarias*). So, the economy was of the lacustrine based type of fishing, hunting and gathering society (Smith, 1976).

The pottery found in this area was especially similar to that found by Arkell (1949) at Khartoum. This strongly suggests that there was some cultural link between Nile Valley and Central Sahara.

After 7500 B.P deteriorating environmental conditions in central Sahara resulted in the drying up of many of lakes. This led to a shift of economy towards domestication of animals as appears from the archaeological materials. This was around 7000 B.P. the animals involved were cattle, goats and/ or sheep. The plants of the same period were many such as *Rhytchne* sp and sorghum (Clark *et a*l; 1973; Smith, 1976: 192)

Clark (1976) stated that the first sorghum domestication was in Ethiopian highlands. He also found carbonized domesticated sorghum in Jebel et Tomat in Central Sudan. It was morphologically primitive compared to the one grown now but dated to more recent times than the Ethiopian specimen (245± 60 AD).

Some researchers like Harlan (1975) suggested that plant growing occurred in the Sahara highland after the drought period (6000-5000 B.C). Pearl millet is an example of such plants.

Stemler (1980) mentioned that the most domesticated plant were pearl millet and emmer wheat in Lower Egypt (Fayum) and

Sahara. They were probably domesticated in Asia and introduced to Egypt around 4000 B.C (Stemler, 1980: 509).

On the other hand, he suggested that the mixture of African and Asian settlement in Egypt strongly suggest that people who grew the crops were not all migrants from Asia. It is more probable that a small number of people moved from south western Asia to North Africa and Europe bringing with them their domesticated animals and plants (Stemler, 1980: 505).

Krzyzaniak (1992) commented on the successful economy of the environs of Khartoum and indicated this that this area had a crucial importance in the spread of cultural adaptation from northeast to east Africa. there is no doubt that pictorial technology and domestic animals which were known near Khartoum c.4900 BC, came from the north. The developed for more than a millennium before reaching eastern Sudan and lake Rudolf in east Africa where they come to be known c. 2500 BC. (Krzyzaniak, 1992:247).

2.9.4. Some Palaeoeconomicl Aspects in Sudan

2.9.5. Central Sudan

Arkell in 1949 stated that the gathering of wild fruits such as *Celtis* and wild grass-seeds was an activity practiced during the Early Khartoum tradition (c. 9000- 6000 B.P.) probably as a supplementary source of food which was mainly obtained from aquatic resources, e.g. fish, molluscs, and wild game. However, despite his statement, seeds of wild grasses were gathered as food. Arkell did not functionally relate the preparation of these grasses and the grinding tools recovered from the same site. He interpreted the function of these grinders to be used mainly for grinding ochre (Arkell, 1949: 51, 52-53). Arkell (1949) suggested that *E. guineensis* Jacq. was most likely brought from elsewhere because the area of Khartoum was not then a natural habitat for its growth.

On the basis of the recovered plant remains from the site of the Shaheinab, Arkell (1949) concluded that cultivation activities were not yet initiated but gathering of food-plants was still practiced. Since no evidence of cereals was found, he also stated that grinding equipment was used for purposes other than preparation of food-plants (ibid: 54). More detailed analysis of the new data from sites of the Shaheinab tradition and the re-evaluation of the previously analyzed data from this site were recently made. The results of these provided both new evidence and new interpretations on the economic strategy related to the exploitation of food-plant. It also seems that Arkell's findings plant remains were chance discoveries picked by hand while excavating and screening. This evidence, which is dated to A.D. 245±60, represents the earliest direct evidence of domesticated sorghum from Central Sudan (ibid: 589). On the basis of these finds, faunal remains and the remains of material culture, it has been suggested that the economy was one of mixed farming in which sorghum was cultivated during the rainy season (ibid: 589-590).

On the basis of these results it has been suggested that the occupants of the Kadero site practiced both plant gathering and cultivation (ibid). Regarding the environment, Arkell (1949) suggested that a savanna type with patches of forest, shrubs, and grasses prevailed during the occupation of the site**.**

Correlating this evidence with the large number of grinders found at these sites, Haaland hypothesized that occupants of the site practiced the cultivation of food-plants, namely sorghum (Haaland R., 1981: 197, 213; 1987a: 221). This hypothesis gave further support to Krzyzaniak's interpretation that gathering and cultivation were practiced during the occupation of the Kadero (Krzyzaniak, 1978: 160-166). The morphological similarities between cultivated sorghum species and the free breeding population were seen to be related to the methods of sowing and harvesting (Haaland, 1981: 211-215; 1987a: 202-2).

The presence of barley as food in Central Sudan round 25-19 B.C. indicated either that it was cultivated by means of regular irrigation or that it was imported from elsewhere, e.g. Egypt, because it could not have been grown by means of rain fed cultivation in Central Sudan which at that time received a maximum of 250 mm of summer rain. This plant species requires at least 300 mm of winter rain. No plant remains were reported from Jebel Moya. However since the material culture and faunal remains were similar to those from Jebel Tomat, it is assumed that the occupants of Jebel Moya had a similar economy, e.g. mixed farming, to that of Jebel Tomat (Clark, 1973: 59, 60).

2.9.6. Northern Sudan

In the food refuse of the town of Kerma, cattle comprise over 50 per cent of the animal bones. In the necropolis, some of the tombs were surrounded by cattle bucrania that suggests a major slaughter of these animals, including not only adult animals but also juveniles and even very young calves (Chaix 1982; 1984). The large number of cattle present in the region is confirmed by an Egyptian text of 2,720 B.C., which says that Pharaoh Snefrou brought more than 20,000 cattle back from Nubia.

The area of pasture necessary to feed the cattle can be estimated using modem information. The 129 cattle surrounding tomb 115 would have required between 100 and 200 hectares, while those round the large tumulus would have required between 400 and 800 hectares. Comparison with the present situation in Nubia is telling. Cattle now form less than 5 per cent of domestic animals, while sheep and goats account for nearly 90 percent. Palaeobotanical work carried out at several sites in the desert of the Northern Province has suggested that the limit of the true desert during the third millennium B.C. was 400 km further to the north than at present (Jackson, 1957;

Wickens, 1975; Mawson and Williams 1984; Ritchie and Haynes 1987). Kerma would thus be situated in the shrubby savanna zone, with more plentiful food resources, which would support the larger African fauna as well as significant herds of cattle and of sheep and goats. Survey work in the Eastern Desert has also shown that settlements existed close to the courses of the now dry rivers, and suggest that the cultivation of much more extensive areas of land was once possible (Chaix and Annie Grant, 1993: 399-405).

The volume of water brought down during the annual Nile flood may well have been far greater than at present, allowing much larger areas of land to be cultivated and providing the moisture to support much more extensive areas of pasture for the feeding of the domestic flocks. Irrigation would be an obvious way of further exploiting the Nile waters, but no traces of any irrigation systems have yet been found (Chaix and Grant, 1993: 399-405).

A well developed agriculture, probably capable of producing a surplus beyond the subsistence needs of the population is suggested by the cereal remains found in the tombs and the bakeries with their batteries of ovens.

The size of the town, and the number of burials found in the cemetery, suggest a sizable population. There are also many indications that the society was very hierarchical.

Sheep sacrifices, sometimes numbering over 20 in a single tomb, consisted of the whole animal, whereas cattle were represented only by their horns and part of the skull. However, the killing of such a large number of animals, suggests not only the production of a large surplus, but also the organization and social control of a large population to provide the animals for slaughter and to consume the meat produced (Chaix and Grant 1992).

The husbandry of sheep and goats, perhaps the most suitable animals for the local environment, was one with the clear aim of producing food, and in particular meat, with milk and skin products being of less importance. In this respect, it was remarkably similar to that of the present day. At ancient Kerma sheep, like cattle, seemed to have also had a symbolic importance, In several of the tombs, some of the sacrificed lambs, carry circular ostrich feather headdresses attached by leather thongs between their horns, and bead pendants hanging from the tips of the horns (Chaix and Grant 1987; Bonnet 1984; Chaix 1987 and Clark, 1989).

It is clear that at this site, assessment of the role of domestic animals is complicated with the difficulty of separating their economic from their ritual and symbolic value. The work completed so far on the animal and plant remains from the site of Kerma has provided a tantalizing and often contradictory glimpse of the environment, economy and social complexity of this important site.

2.9.7. Western Sudan

Far from the Nile, in the Western Wadi Hower the sites were Khartoum Neolithic type. The investigation revealed that the economy was based on fishing (40 species identified) and cattle herding (Birgt Kedin, 1993:433).

Stephen Kropellen *et al;* (2001) conducted archaeological, bioarchaeological and geoscientific reaches on Wadi Hower.

2.9.8. Eastern Sudan

Early first millennium B.C. features were studied by Karim Sadr in Kassala and Gash. The faunal and macrobotonical remains suggested that Late Kassala phase subsistence economy was based on agriculture, pastoralsism, hunting and perhaps gathering. Actual sorghum seeds were found there. Domesticated animals were cattle, goats and sheep. In addition some gazelle and giraffe bones were recovered (Karim Sadr, 1993: 423).

The early Holocene was represented by a small number of sites located in the Atbra River Nile Valley. At first they were preceramic and their economy was based on hunting and fishing with a few sickle blades suggesting some plant processing (Anthony, 1993:379).

Fattovich (1993) stated that Gash Group's ceramics exhibits some affinities with the Kerma and C-group. Fattovich (1993) suggested that the subsistence economy of the Gash Group people relied on cattle and sheep/ breeding and most likely on plant cultivation (Fattovich, 1993:438-442).

2.9.9. Some Palaeconomical Techniques Used in Ancient Sudan

Food storage techniques were mentioned by Clark and Stemle (1975: 588.). They said that some of these species were edible fruits, e.g. *Ziziphus spina-christi* Lam. However, the most important botanical material is the finding of large quantities of carbonized grains of *Sorghum bicolor* (L.) Moench (Ar. *aishldurrd).* These were recovered from a storage pit but were also found scattered in the settlement debris. This evidence is dated to A.D. 245±60 (ibid: 589-590).

Labanja (Ar., name) tree fruits were recovered by Arkell during his excavations of the site of the Early Khartoum. (Arkell, 1949: 108-109). He interpreted the presence of these seeds to be an indication that the fruits of *Celtis* sp. were gathered as food.

Fishing practice was known since Dark (1973) found Ampullarid shells (*Pila sp*.) frequent in Jebel Moya site. He added that they may have been used as bait for fishing. The main occupation of this site was probably contemporary with Meroe. From a test excavation at Jebel Moya itself Clark recorded cattle and goat bones. In Jebel Um Marrahi, Gauiter *et al*; (2002) found that fish was the main component of the diet.

Northwestern Sudan might have played a crucial role in the process of introduction of domestic animals, since domestic animals were apparently present in the Sahara earlier than in Central Sudan (Wendorf *et al;* 1977).

Some later period's farming activities were mentioned by Shinnie (1967). He stated that the geographer Strabo has reported, after his visit to Egypt in 25-19 B.C., that the Meroites used millet and barley, tender twigs, reeds roots, etc. as food (Shinnie, 1967: 18-19). He also reported a rock engraving of the Meroitic king Sherkarer (A.D. 12-17) at Jebel Qeili where heads of sorghum appear in the scene (ibid: 50-51).

CHAPTER THREE

3. Field Work in The Study Area: Wadi Farja

In past times Sudan had a network of water channels. Because of certain climatic and geological processes some channels were buried, whilst others changed their courses. Accordingly there is a large number of palaeochannels known in Sudan. They are rich in archaeological remains, such as those in western Dongola Reach (Macklin *et al.;* 200l) and Wadi Howar (Jesse and Keding, 2002).

The Mahas Survey Project reported many archaeologically important paleochannels in the Third Cataract region. They were on both banks of the Nile. These are Gaamuffa (near Ashshaw village), Kokka (east of Kokka village), Sesebi-Gorgod (west of Sesebi and Gorgod villages). It is now well known that Khors (water drainage channels) also contain archaeological sites not only near the Nile but even, sometimes, deep in the desert.

One of the notable ongoing geological processes in the Third Cataract is that affecting the seasonal channel called Fad. The Fad stream flows east of Arduan Island (near the study area) and connects with Wadi Farja at Masida village. After the Nile flood retreats (September-October), Fad stream becomes a series of lakes. It was noticed in recent years that the stream is threatened by silt precipitation, leading to the disappearance of several pre-existing lakes.

Edwards and Osman (1994) recognized that many earlier sites, including those of Kerma date, may await discovery in areas further away from the river which are now true desert.

The Mahas Project carried out some limited reconnaissance in the desert hinterland in only two areas: the bend of the river on east bank of the Nile north of Tombos and near Sesebi-Gorgod on the west bank. Bonnet and Reinold in 1993 discovered a number of Kerma-period sites in the desert at a distance of 17 km east of the Nile (Bonnet and Reinold, 1993).

3.1. Geology of Wadi Farja

The study area is situated immediately north of the Third Cataract of the Nile region eastern bank. It is considered to be the most important Nile palaeochannel in the area, and it is rich in both archaeological and palaeoenvironmental remains.

The wadi includes the main wadi and many other inlet and outlet drainage channels (Khors) to the east and west. It extends from Simit West village (19°45 517 /30°23 120) in the south to Masida village in the north (19°53 619 /30°23 402). Another branch comes from the south from Tombos and Kabodi villages (19°44 434 /30°22 488) and connects to the main channel east of Simit West (19°47 524 /30°22 465). Its length is estimated to be 12 km, crossing the rocky desert in a north-easterly direction (Map 1).

Just north of Kerma there is a sudden change in the scenery as the river crosses onto the crystalline basement complex rocks; the landscape becomes rugged, with numerous small granite Jebels.

The river itself breaks up into numerous channels passing around islands which have been counted to be more than 65. There is an abrupt change from the northerly flow at Arduan Island to an easterly flow.

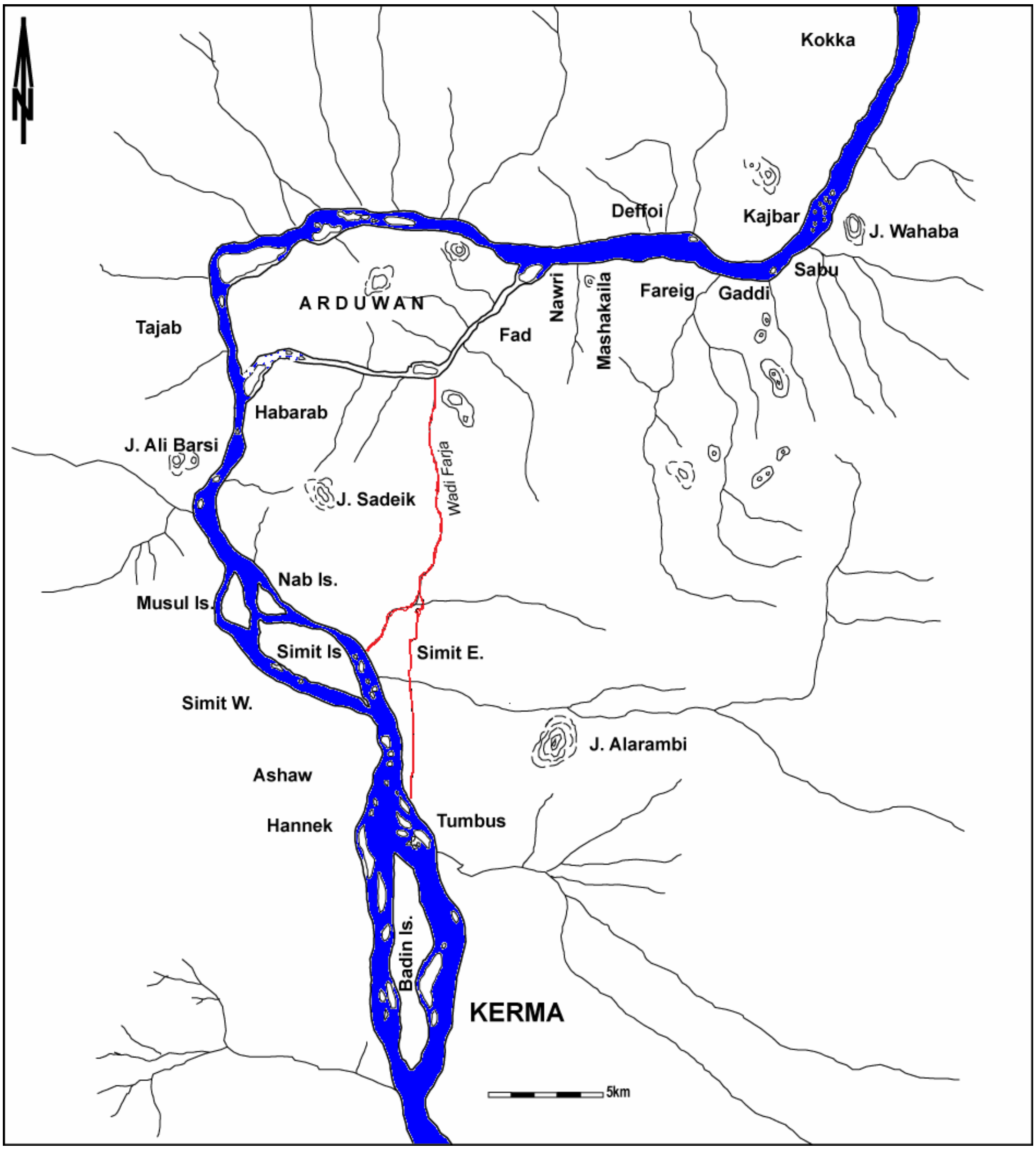
The general geological structure of the area is Nubian sandstone but in this area it is cut with dykes and volcanic rocks. The belly of Wadi

Farja is covered mostly by sand and alluvial soil. (Map 2 and Satellite Image 1a ,1b).

3.2. Research Protocol

The following methods were adopted to test the hypothesis that Wadi Farja is a palaeochannel. These methods were:

1- Biological Evidences: Searching for non-artifactual organic and environmental remains (ecfacts) as aquatic fossil remains along the wadi.



Map (3-1): Showing Wadi Farja in Third Cataract Region

2- Archaeological Evidences: Mapping of the archaeological sites along the wadi banks.
3- Morphological Means: Studying Topography, the slope of the land for possibility of water running. Also the soil of the wadi's belly identified through satellite images.

3.3. Biological Evidence

3.3.1. Methods

3.3.2. Computer Technique of Satellite

Before the conduct of field work, the computer technique of satellite image map of the area (UNSCO Bilko (03)) was used to locate the proposed artificial stone walls. This type of map provides the exact position. The map was provided by Dr. David Edwards (Leicester University, England).

Satellite maps were used to study the topography mainly to identify the soil type along the wadi belly.

These computer techniques were also very useful in distributing the archaeological sites on the map, this also was done.

3.3.3. Archaeological Field Work

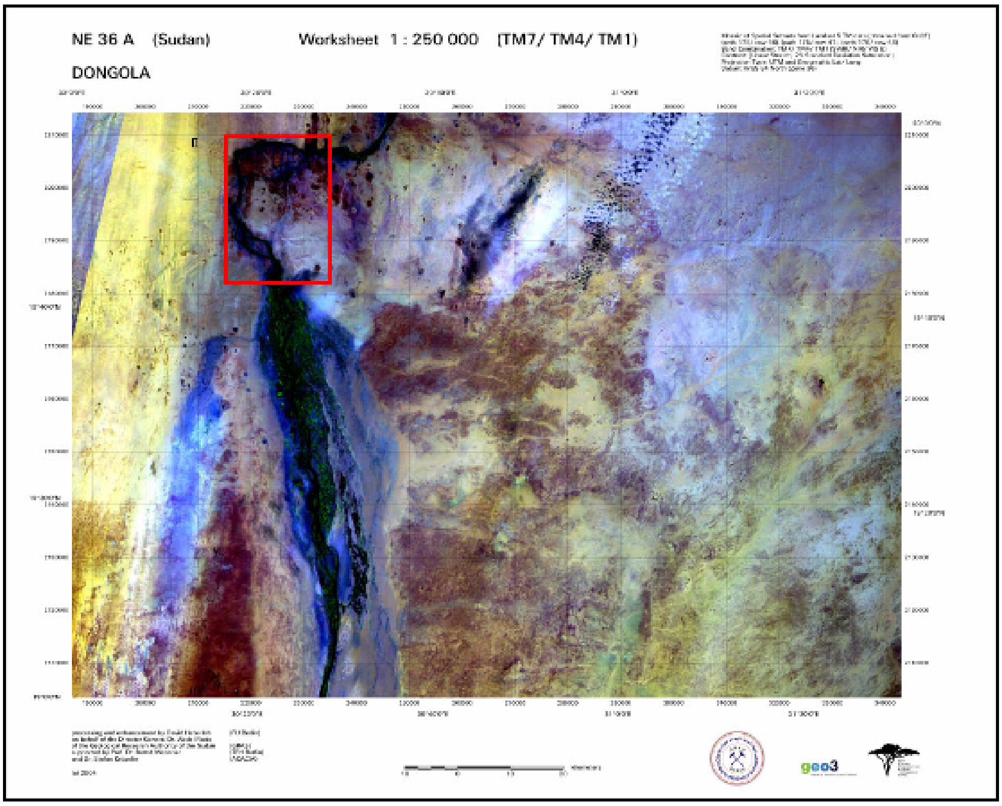
Field work was carried out in two disciplines:

Walking survey of the region was done in March 2004, June 2005 and January 2007. Surface materials were collected using simple methods of measuring the dimensions of wadi walls were measured and photographed using a digital camera. One important step of field survey, was taking notes and studying the topography of the surrounding area of the wall.

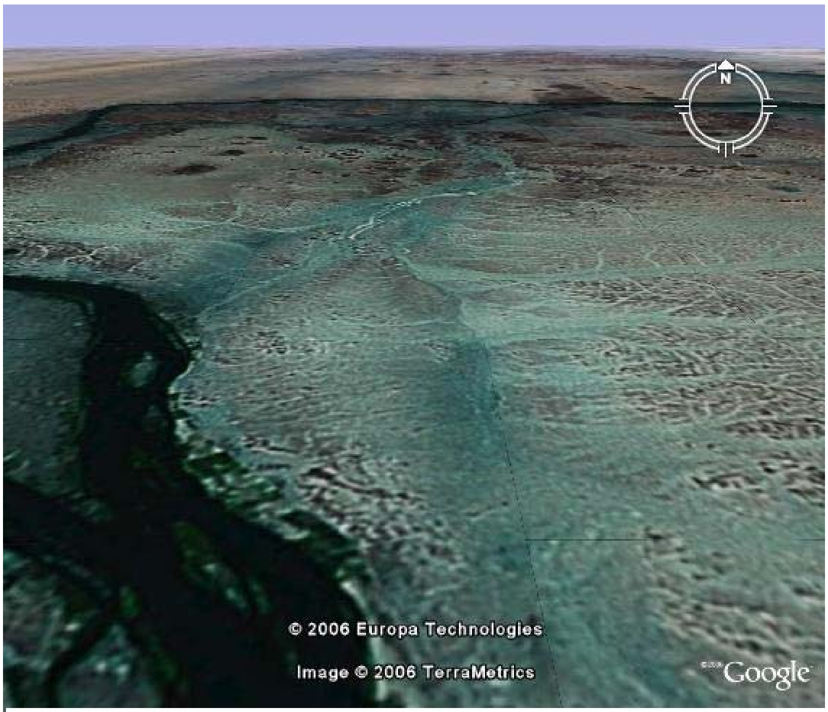
Three test pits were digged at the beginning and middle of the wadi and at northern end.

3.3.4. Topographical Field Work

Another field survey of topography was done by reading the sea elevations beginning from the two mouths of the wadi to point of their connection and then to the end.



Satellite Image (3-1a): Third Cataract Region



Satellite Image (3-2-b): Magnified Satellite Image Showing Wadi Farja Side View (South)

3.3.5. Laboratory Work

Later on, collected samples were identified in different laboratoies. Also some samples were dated in The University of Waikato, Radiocarbon Dating Laboratory, New Zealand.

3.3.6. Archaeological View of Wadi Farja

A quick look at the archaeological sites of this wadi reveals that its highest period of occupation was in Neolithic to Kerma periods (Table 3-1 a; Graph 3-1). This coincided with high levels of lake volume and river flow in Africa, at a peak around 8000 BP prior to aridity during and after the Ice Age. Lake volume was high between 5000-3000 BC with two short drought periods around 2150-1200 BC (Evans, 1991). It can be concluded that the wadi was a permanent water body, i.e. with a lake at least as permanent as the nearby presently existing Fad seasonal stream. Fortunately, Nile oyster shells samples from Wadi Farja were dated back to mid-Holocene 7617± 50 BP and the second as7687± 50 BP. This agreed with the history of high levels of lake volume and river flow in Africa. de Henizelin (1968:47-48) mentioned that, the level of the Nile rose to maximum of 13 m above the modern floodplain during Arkin (Wadi Halfa) aggradation. Wendorf and Shcild (1976:303) had dated materials by c14 and found that the maximum rise of the Nile was around 7140BC± 180 years. The 6m aggradation's Charcoal yielded an age of 5960± 120 years as Nile Oyster shell from Jebel Halfa yielded an age of 9250C± 285 years. Following the maximum rise in the Nile level, according to de Henizelin (1968) there was a gradual decline of the Nile until around 3350 BC, when there was a sudden drop that exposed large surfaces of the river bed, and incipient soil could develop.

Table (3-1): Archaeological Sites of Wadi Farja and Hinterland (Edwards and Osman , 1991; Osman and Edwards 2000)

S.N	Site Code	Position	Site Type	Date
1.	FAR 001	19°52.276/30°23.506	Structure	?
2.	FAR 002	19°52.563/30°23.468	Occupation	Kerma
3.	FAR 003	19°52.924/30°23.503	Structures	?
4.	FAR 004	19°52.692/30°23.655	Occupation	Kerma
5.	FAR 005	19°52.369/30°23.448	Rock Drawing	-
6.	FAR 006	19°51.596/30°23.53	Wadi walls, Occupation	Kerma?
7.	FAR 007	19°50.747/30°23.993	wadi walls	-
8.	FAR 008	19°50.29/30°23.933	structures	Kerma?
9.	FAR 009	19°50.255/30°24.054	Occupation	?
10.	FAR 010	19°49.676/30°23.608	Occupation	Neolithic
11.	FAR 011	19°49.424/30°23.150	wadi walls	?
12.	FAR 012	19°49.143/30°22.806	Graves	Neolithic
13.	FAR 013	19°48.402/30°22.493	Grave-structures?	Neolithic?-Kerma
14.	FAR 014	19°52.523/30°23.489	Rock Drawings	?
15.	FAR 015	19°48/30°23.886.	Habitation	?
16.	FAR 016	19°50.775/30°23.849	Habitation	Kerma
17.	FAR 017	19.49.15/30.24	Occupation	pre-Kerma?
18.	FAR 018	19.48.246/30.23.028	Occupation	Neolithic
19.	FAR 019	19°49.894/30°23.728	Occupation	Neolithic
20.	FAR 020	19°49.904/30°23.691	Occupation	Neolithic
21.	FAR 021	19°50.695/30°23.847	wadi walls	Prehistoric?
22.	FAR 022			
23.	FAR 02	319°49.453/30°23.221	Occupation	Early Kerma?
24.	FAR 024	19°49.499/30°23.423	Occupation	Pre-Kerma?
25.	FAR 025	19°49.594/30°23.303	Occupation	Neolithic
26.	FAR 026	19°49.332/30°23.196	Occupation	Neolithic
27.	FAR 027	19°49.307/30°23.055	Occupation	Neolithic
28.	FAR 028	19°49.824/30°23.095	Occupation	Pre-Kerma?
29.	FAR 029	19°50.719/30°23.987	Occupation	Neolithic?
30.	FAR 030	19°50.671/30°23.965	Burial	Napatan?
31.	FAR 031	19°50.656/30°23.965	Structure	?

32.	FAR 032	19°50.617/30°23.822	Structure	?
33.	FAR 033	19°50.643/30°23.821	Graves	Kerma
34.	FAR 034	19°50.732/30°23.797	Grave	Islamic?
35.	FAR 035	19°50.76/30°23.822	Grave	
36.	FAR 036	19°50.855/30°23.833	Structures	
37.	FAR 037	19°50.923/30°23.746	Wall	
38.	FAR 038	19°50.982/30°23.866	Structure	
39.	FAR 039	19°51.082/30°23.933	Burnt mounds	
40.	FAR 040	19°51.939/30°23.401	Rock Gong	
41.	FAR 041	19°51.529/30°23.614	Rock Drawings & walls	
42.	FAR 042	19°48.754/30°22.593	Occupation	
43.	FAR 043	19°48.097/30°22.463	Occupation	Pre-Kerma/Kerma
44.	FAR 044	19°48.091/30°22.376	Rock Drawings	
45.	FAR 045	19°48.047/30°22.311	Graves	Kerma?
46.	FAR 046	19°51.869/30°23.588	Structures & Burials	
47.	FAR 047	19°51.792/30°23.569	Wall	
48.	FAR 048	19°51.834/30°23.573	Wall	
49.	FAR 049	19°51.840/30°23.534	Wall	
50.	FAR 050	19°49.796/30°23.75	Graves & occupation?	Kerma
51.	FAR 051	19°48.097/30°22.112	Occupation	Pre-Kerma
52.	FAR 052	19°47.112/30°22.254	Wall+ Occupation	Prehistoric
53.	FAR 053	19°47.302/30°21.940	Occupation	
54.	FAR 054	19°74.300/30°21.820	Grave	Kerma
55.	FAR 055	19°47.329/30°21.696	Occupation	
56.	FAR 056	19°47.304/30°21.824	Settlement	Pre-Kerma Kerma
57.	FAR 057	19°47.209/30°21.635	Graves	
58.	FAR 058	19°47.262/30°21.815	?	Occupation
59.	FAR 059	19°48.513/30°21.860		Palae-Epipalaeolithic
60.	FAR 060	19°49.427/30°22.790	Occupation+ Graves	Kerma?
61.	FAR 061	19°49.427/30°22.827	Hideout	?
62.	FAR 062	19°50.902/30°23.111	Wall & well?	?
63.	FAR 063	19°49.930/30°22.675		?
64.	FAR 064	19°49.930/30°22.675		?
65.	FAR 065	19°49.300/30°22.042	Occupation	?
66.	Others possible Sites	19°52.530/30°23.475 19°52.326/30°23.548	Rock drawing Rock drawing	Rock drawing

Southern Branch of Wadi Farja				
67.	-	19°43.430/30°23.500	Occupation?	Snails shell, fish bone & mammalian bone
68.		19°54. 325/30°24.350	Occupation?	Snails shell, fish bone & mammalian bone

Simple statistical analysis of wadi's sites reveals that most of the sites were occupation sites (37.8%) (Table 3-1- b; Fig 3-1). It is reasonable to suggest that the past dwellers in the area were members of settled societies rather than pastoral ones. This will be elaborated on more in the next chapter.

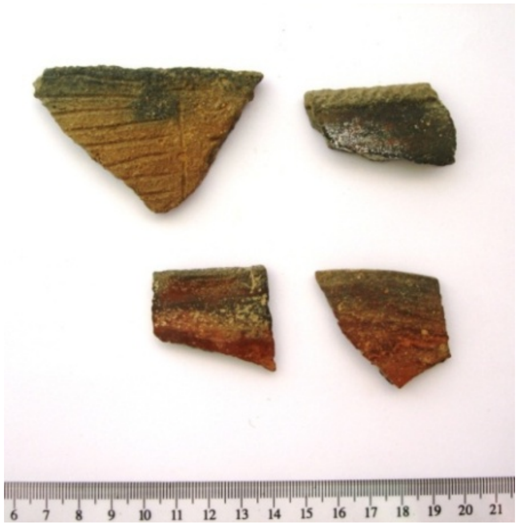
Lands neighboring the area of study can be identified geographically extending to Arduan Island, which contains some of the oldest sites; out of 11 prehistoric sites 9 are Palaeolithic. On the Nile bank, from Abu Fatima to Farja villages, sites of Pharaonic date are the most prominent feature of the area, whilst in both areas medieval settlements are represented strongly (Table 3-2). Otherwise, the Wadi Farja contains mostly Neolithic-Kerma sites (Table: 3-2 -a & b; Fig 3-3 & Photo: 3-1, 3-2 a & b).

The Paleolithic sites were rare because the area was arid. This agrees with Wendorf and Schild, (1992) who found that the west of Nile the data indicated that there was a major period of aridity with a lower water-table, deflation and dune migration between the latest Final Acheulean and the earliest Middle Paleolithic (Wendorf and Schild, 1992, p. 54). Nearby to Wadi Farja is Arduan Island which is rich in Palaeolithic sites, because the Island is situated on the Nile banks.

Another important indication is the concentration of most sites in the middle of the western bank of the wadi, suggesting the presence of an island which may have been more secure for the inhabitants (Satellite Image2). This agreed with Osman (2004) who mentioned that the settlement in the Third Cataract Region was enhanced by the prevalence of security from possible intruders or enemies.

Other very well preserved archaeological sites were the rock drawings (FAR005 19°52.692 /30°23.655; FAR014 19°52.523 /30°23.489; FAR041 19°51.529 /30°23.614 and FAR044 19°48.499 /30°22.376) in the area and on many neighboring sites. These included human figures, bovines, giraffe, elephants, a leopards, hippopotamii, and antelopes. Rock drawings reflected the long-lasting interaction between people and their environment (Photo 3-3 a-f).

Photo (3-1): Neolithic Pottery Sherds - FAR 013



FAR 013 FAR 02

Photo (23-a & b): Kerma Pottery Sherds

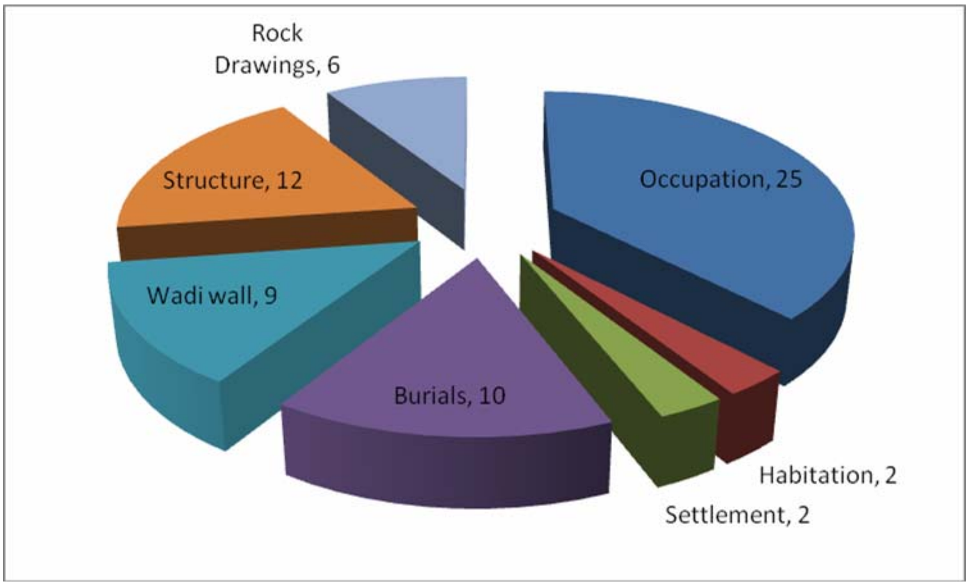
Table (3-2- a): Percentages of Periods of Archaeological Sites in Wadi Farja

Period	No. of sites	%
Paleolithic	1	1.5
Neolithic	13	18.8
Pre-Kerma	11	15.9
Kerma	13	18.8
Pharonic	1	1.5
Napata-Meroe	1	1.5
Medieval	2	2.9
Undated	27	39.1
Total	69	100

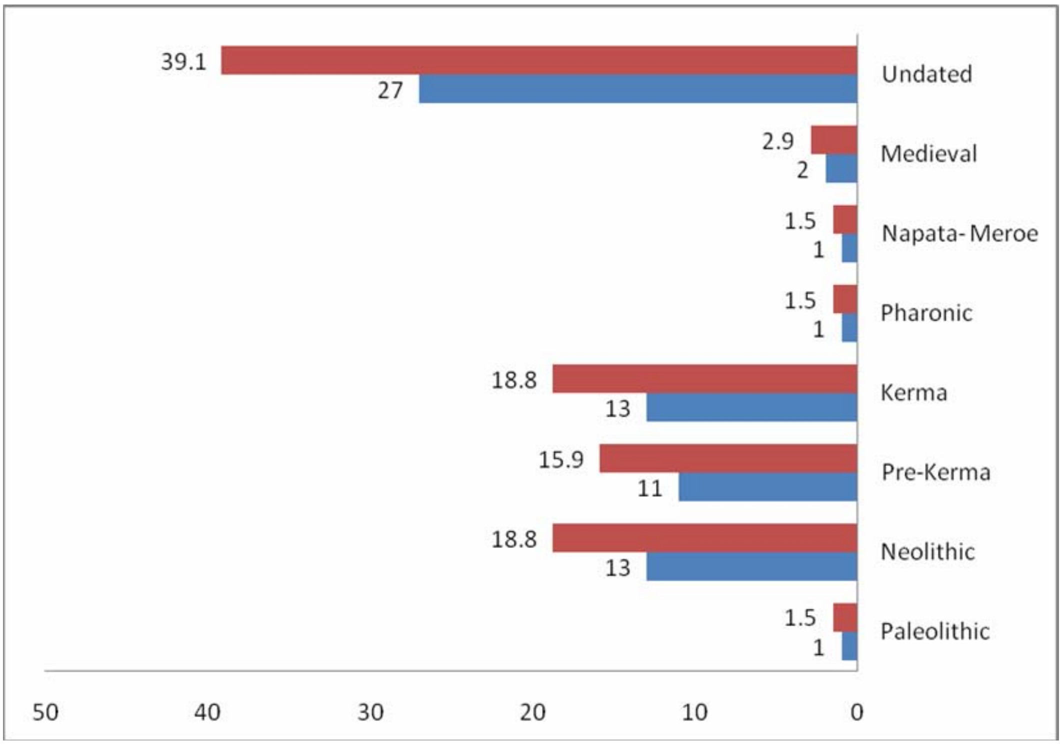
Table (3-2-b): Percentages of Types of Sites in Wadi Farja

Type of site	No. of sites	%
Occupation	25	37.9
Habitation	2	3
Settlement	2	3
Burials	10	15.2
Wadi wall	9	13.6
Structure	12	18.2
Rock Drawings	6	9.1
Total	66	100

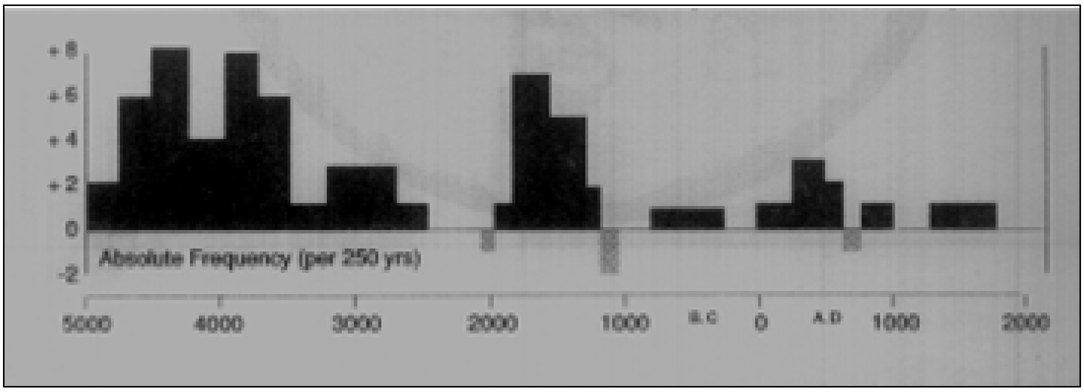
Fig (3-1): Showing the % Sites in Wadi Farja



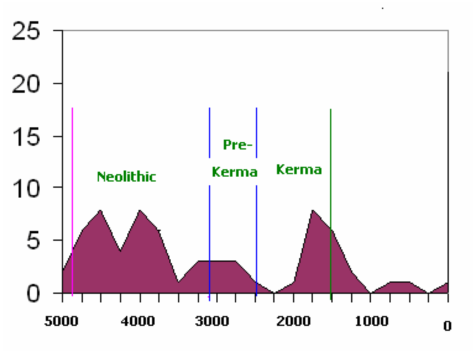
Graph (3-1): Percentage and Number of Archaeological Periods Sites in Wadi Farja

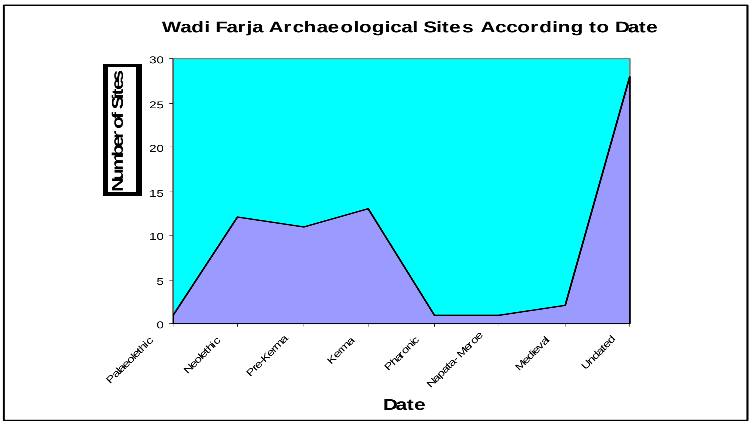


Graph(3-2): Percentages of Periods of Sites in Wadi Farja compared with Calibrated C14 Dates for Increased Lake Volume and/or Stream Discharge in the Sahara and East Africa since 5000 B.C (After Butzar, 1976).



Calibrated C14 Dates for Increased Lake Volume and/or Stream Discharge in the Sahara and East Africa since 5000 B.C (After Butzer, 1976)





3.4. Bioarchaeological Materials

One of the important features of the Wadi Farja archaeological contents was that it was relatively rich in bioarchaeological material such as bone and shell fragments (Table 3-3). The second feature was the existence of natural Hearths (burnt mounds) (Photo 3- 3 a and b). Other very well preserved archaeological sites were the rock drawings which are present n the area and on many neighboring sites (Photo 3-3 f-g).

Table (3-3): The Archaeological Feature of Sites in Wadi Farja

Site	Coordinates	Mean Archaeological Feature
FAR010	19°49.676 /30°23.608	Bone and shell fragments
FAR051	19°47.302 /30°21.940	
FAR058	19°47.262 /30°21.815	
FAR060	19°49.016 /30°22.790	
FAR023	19°49.453 /30°23.221	
FAR024	19°49.499 /30°23.423	
FAR010	19°49.676 /30°23.608	Hearths (burnt mounds)
FAR023	19°49.453/30°23.221	
FAR024	19°49.499 /30°23.423	
FAR039	19°51.082 /30°23.933	
FAR005	19°52.692 /30°23.655	Rock drawings
FAR014	19°52.523 /30°23.489	
FAR041	19°51.529 /30°23.614	
FAR044	19°48.499 /30°22.376	

Photo(3-3- a): Hearth (FAR 039 19°51.082 /30°23.933)

Photo (3-3-b): Fallen Tree Stem Hearth (FAR 010 19°49.676 /30°23.608)

Photo (3-3- c): Hideouts

Photo (3-3- d): Kerma Graves

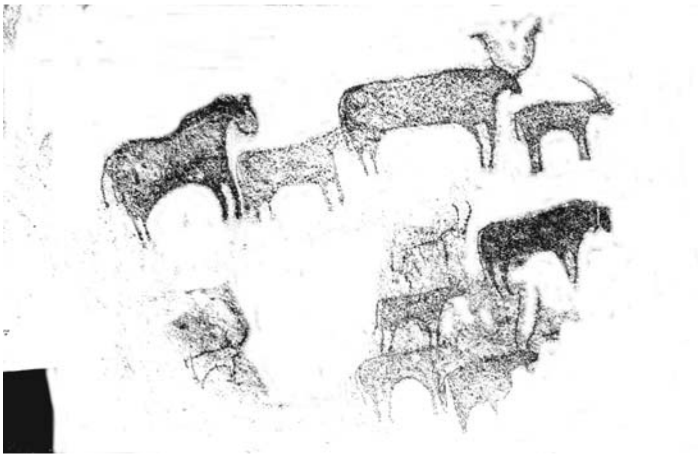


Photo (3-3 –f): Rock Drawing- FAR 05

Photo (3-3- g): Rock Drawing- Antelopes

3.4.1. Zooarchaeological Evidence:

Biological evidence in the form of fossil plants and animal remains has always been used in the reconstruction of Quaternary environments. The approach has traditionally followed uniform principles in that it has been assumed that the present can be used to unlock the history of the past thus by applying what is known about the environmental factors that influence the distribution of modern plant and animal populations to fossil assemblages; it is possible to make inferences about the types of landscapes and climates that existed in earlier times. The method has a sound logical basis (Rymer 1978). In practice, however, things are not quite so straightforward, for in order to derive meaningful information from fossil evidence, certain assumptions have to be made both about the fossil evidence itself and also about our present-day knowledge of plant and animal ecology. The most important of these assumptions are:

a) that the environmental parameters governing present-day distributions of plants and animals, should be fully understood and isolated.
b) that presence plant and animal distributions are in equilibrium with those controlling environmental variables.
c) that former plant and animal distributions were in equilibrium with their environmental controls.
d) that former plant and animal distributions have analogues in the modern flora and fauna.
e) that the ecological affinities of plants and animals have not changed through time.
f) that a fossil assemblage is representative of the death assemblage and has not been biased by differential destruction

of its original component parts or by contamination by older or recent material.

g) that the origin of the fossil assemblage (taphonomy) can be established; and
h) that the fossil remains can be identified to a sufficiently low taxonomic level to enable uniform principles to be applied to other (Lowe and Wallker,1984).

3.4.2. Zooarchaeological Remains of Wadi Farja

Zooarchaeological remains were collected from Wadi Farja as well as a surface collection from sites and test pits. Collected samples were kept in plastic bags or containers for further study. Labels were put into each individual bag or container. In the Laboratory, the collected material was identified, classified and measured. Mammalian bone fragments, fish bones and snails were identified in the University of Khartoum, Department of Anatomy (Faculty of Veterinary Medicine) and the Department of Zoology (Faculty of Science).

Fish vertebrae were used by Chwgunova (1959) in aging of fish. According to Bagenal and Tresh (1978) the growth of the body and the ageing structure are proportional to each other. Unit vertebra was cleaned and examined under a binocular microscope where the annual rings were counted. The size and weight of the fish were obtained using the back calculation method from previously known equations Chwgunova (1959).

3.4.3. Aquatic Zooarchaeological Remains

3.4.3.1. Class: Mollusca

3.4.3.2. *Etheria elliptica* (Nile Oyster)

It is usually found 10 m below the surface of the water in large rivers and lakes. When the levels of the water is low the uppermost shell become exposed. In strongly moving water they attached themselves to rocks and also to other shells of their kind (Pilsbry and Bequaetert, 1927:453. Coated from: Tigani, el Mahi Ali, 1984).

The Nile oyster, *Etheria elliptica* was very common in the Wadi Farja. It has a thick shell and it needed clear, well-oxygenated and hence flowing water and mainly occured at the Nile cataracts (Rodrinues *et al;* 2000). It is usually attached to rocks by one valve.

Two samples of the Nile oyster from site FAR 039 were dated in the Dating Laboratory, University of Waikato Radiocarbon, New Zealand. The result obtained was 7617 ± 50 BP and 7678 ± 50 BP i.e mid-Holocene. Rodrinues *et al;* (2000, 181-187) showed the seasonality of Wadi Howar, an annual pattern of two rainy seasons by using shell isotope data technique.

3.4.3.3. *Coelatura* sp

Bivalves are very common in Wadi Farja, they were collected from many sites (e.g. FAR 010-19°49.676/30°23.608). They were identified as *Coelatura* sp. Large numbers of growth rings were noticed but the aging was difficult because no adequately documented age assessments have been made previously for this species in Sudan. Jones (1989) commented on the growth structures of bivalves. The internal shell growth patterns are best viewed in cross-section and this technique is applied to bivalve shells which possess annual patterns of growth increments. These are typically recognizable as large white bands alternating with thin dark bands. The periodicity of supposed yearly increments in a given bivalve species is variable because of the potential variability in timing and cause of ring formation. Aging study of bivalves has become very important in palaeoenvironmental studies because they have a long lifespan and the ranges in the size of rings are thought to reflect periodicities such as daily light-dark cycles, and annual (seasonal) temperature cycles (Jones, 1989: 2-13).

3.4.3.4. *Pila* sp

Samples of *Pila* species were collected from site (FAR 010-19°49.676/30°23.608). *Pila ovata* (Oliver) (Photo 3- 4 a & b) belongs to family Piliadae and lives in the Nile Valley; it lives on mud when water recedes, as well as on rocks, feeding on aquatic plants and phytoplankton (Malek and Cheng, 1974: 66, 69).

Photo (3-4 –a): Bivalves in Site (FAR010)

Photo (3-4- b): Snails *(Coelatura* sp) Collected from Site (FAR010)

3.4.3.5. Class: Osteichthyes

3.4.3.6. Nile perch

Fish vertebrae were collected from two sites (FAR 010, FAR 060 and FAR 065). Bones were identified and classified as Nile perch (*Lates niloticus*) vertebrae (Photo 3- 5).

The sample belongs to a freshwater fish of the family Centropomidae. It is widespread throughout much of the African fresh water bodies, being native to Lake Chad and Lake Turkana, and to the Congo, Nile, Senegal, Volta, and other river basins. It also occurs in the brackish waters of Lake Maryut in Egypt. It is one of the largest freshwater fishes and reaches a maximum length of nearly two meters, and weight of up to 200 kilo gram. An adult Nile perch occupies all habitats, but it prefers deep water (10-20 meters) with sufficient oxygen concentration. As a predator that dominates its surroundings, the Nile perch feeds on fish, crustaceans, and insects; the juveniles also feed on zooplankton. The species is of great commercial importance as a food fish.

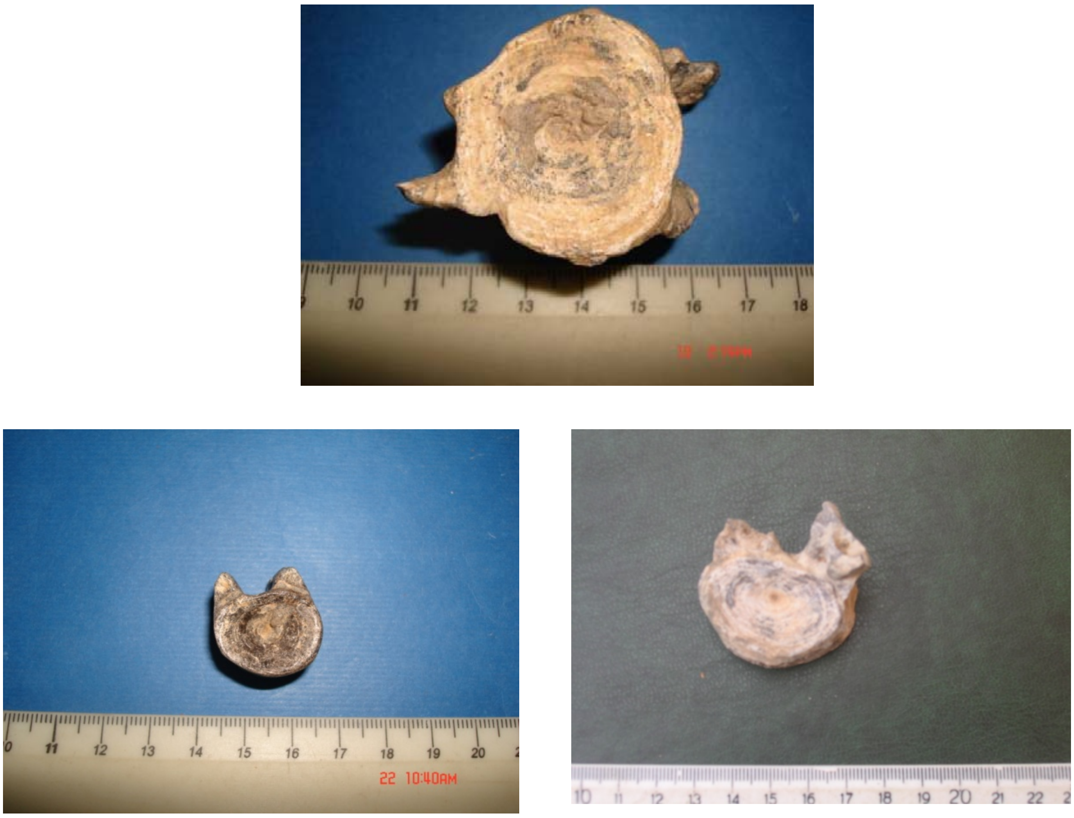


Photo (3-5): Nile Perch Vertebra Collected from different Sites

3.4.3.7. Class: Mammalia

Lamb (1982:90) wrote: *the archeology of man and larger mammals is less informative about past climates than the records of insect,s pollen and microorganisms in the sea and that mammals are at the mercy of their immediate surroundings.*

3.4.3.8. Hippopotamus (*Hippopotamus amphibius*)

Two broken Hippopotamus radius bones, with other fragments, were collected site FAR 053. These were identified in the lab (Photo3- 6). The animal is a large, plant eating African mammal, belonging to the family Hippopotamidae. The hippopotamus' lifespan is commonly 40 to 50 years and it reaches sexual maturity at 5 to 6 years. Hippos average 3.5 meters long, 1.5 meters tall and weigh 1100-2600 kg (Dorst and Dandelot, 1970). They spend most of the day with the majority of their body submerged in water to stay cool. They consume as much as 50 kg of vegetation per day. Their closest living relatives are cetacean – whales, porpoises and the like (Saikawa *et al.;* 2004). Before the last Ice Age, the hippo was wide-spread in North Africa and Europe (BBC, 2005). They were distributed in rivers and lakes surrounded by grasslands throughout sub-Saharan Africa. They avoid water with strong currents and depth of more than 1.5 meters (Grizmek, 1972:117) and prefer muddy water with dense vegetation on the edge of rivers and lakes (Mackenzie, 1954:5).

The hippopotamus is now extinct in Egypt and northern Sudan, where it was a familiar animal of the Nile into historic times. The last time the hippopotamus was seen was in the Mahas area in 1823 and at Kerma in the 1890s, but it is still found in the Nile River south of Kosti. It is now restricted to the Nile and its southern tributaries (Mackenzie, 1954:5). Burckhardt (1819:57) mentioned that hippopotamus was seen in Dongola, Mahas, Sikkot and Halfa areas. He added that natives ate its meat. *Hippopotamus amphibius* is highly territorial; a male often marks his territory along a river bank from which to draw in a harem of females. *Hippopotamus amphibius* is usually found in shallow water, and rarely come out of that depth. Most of them look as though they are floating but are, in fact, standing or lying on the bottom. They feed on land mostly at night, consuming tons of food per day.

Photo (3-6): Hippopotamus Bones Collected from Different Sites and location

3.4.4. Other Animal's Remains

3.4.4.1. Cattle Bone:

Bone fragments were common remains in Wadi Farja and were collected from different sites and localities.

3.4.4.2. Large Mammals Bone Fragments:

Large mammal (Class: Mammalia) bone fragments (including canine teeth) were collected from the sites e.g. (FAR 053 19°47.302/30°21.940; FAR060 19°49.016/30°22.790). (Photo:3-7, 3- 8).

3.4.4.3. Ostrich Egg Shell:

Ostrich (Class: Aves) egg shell fragments (FAR 051 19°47.148 /30°22.112). (Photo 3-8).

3.4.4.4. Tortoise back Carapace:

Unidentified fossil horn and 2 pieces of tortoise back carapace (Class: Reptilia) were collected from location 19°49.300 /30°23.042 (Photo 3- 9).

Tooth

Horn

Radius fragments

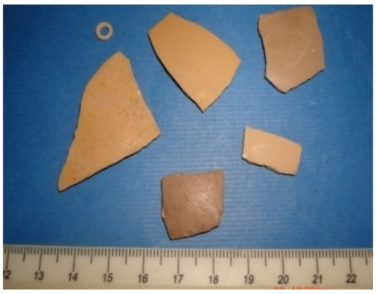
Photo (3-7) :Different Cattle Bones

Scapula?

Horn or Teeth?

Radius fragments?

Metatarsals?



Ostrich Egg Shell

Teeth?

Photo (3-8): Mammalian Bones and Ostrich Egg Shell from Different Sites and Localities of Wadi Farja

Tortoise back carapace

Tortoise back carapace

Photo (9): Pieces of tortoise back carapace

3.4.5. Palaeoenvironmental Implications

The large numbers of growth rings noted in bivalves indicated the long lifespan of the bivalve and, consequently, the persistence of a water body, as the rings reflect seasonality of the past climate. The presence of *Pila* sp has ecological implications, namely the existence of muddy shores and the water receding within the palaeochannel. Many workers in the Sudan identified such animals e.g. (Arkell, 1953) in central Sudan.

The age of *Lates niloticus* vertebra specimens was in the range of 4-8 years. By back calculation method an 8-year old fish would attain an estimated length of 80 cm (Abdelrahaman, 1989) in that area. This suggested that the palaeochannel's water was oxygenated i.e. running and perennial; deep and rich in biota. Accordingly, it is suggested that it was a running stream in the past. The presence of such main Nile species, strongly suggests the connection of the channel with the river.

Hippopotamus is highly territorial, this indicated that the bone remains were indigenous to the wadi. The presence of hippopotamus remains indicated the presence of shallow waters and sandy banks. The most distinct implication of these remains was the pre-existence of rich vegetation grassland on the land on which this large animal lived. Because of the complex topography and branching of the wadi, it is suggested that there were many lakes or swamps, which may have been also fed by local rainfall. Many workers found such animal remains for instance, Chaix and Grant in 1993 found within the faunal assemblage at Kerma bones from some of the large African mammals, creatures of the grassy or wooded savannas. They include giraffe, black rhinoceros and hippopotamus (Chaix and Grant, 1993: 399-405).

The different classes of remains collected are indicative of the extent of animal biodiversity and the prevalence of savannah conditions at that time.

3.4.6. Ecological and Archaeological Test-Pits

Three test pits were dug in the mouth (Photo 3-10)., middle of the wadi and at northern end (FAR04 Photo 3- 11). For more convenes also one of the pits was in belly of the wadi and one on the edge of the bank (FAR 011-(Photo 3-12) as the third was on the top of the bank. The aim was to study the startography, soil sampling and material collection.

3.4.6.1. Results

3.4.6.2. Soil

In the test- pits dug in the mouth of the wadi, the second layer 10 cm deep there is dark alluvial soil also, some organic carbonized materials were collected. This was indicative of past wetting and precipitation of alluvial soil.

3.4.6.3. Biological Materials

The test- pits dug in FAR011, some biological materials were obtained. These were snail shells. In the second layer, 10 cm deep there was a dark alluvial soil, seen also indicating the past wetting of the area.

3.4.6.4. Artifacts

The test-pits dug in FAR 04 some artifacts were found. These were Kerma sherds and some undiagnosed carbonized materials.

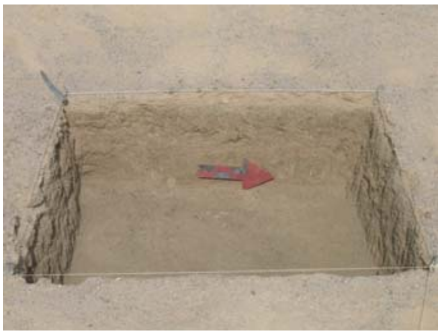
 

Photo (3-10): Test-pit Location:(19°47.282/30°21.889 **)Mouth of Wadi Farja**

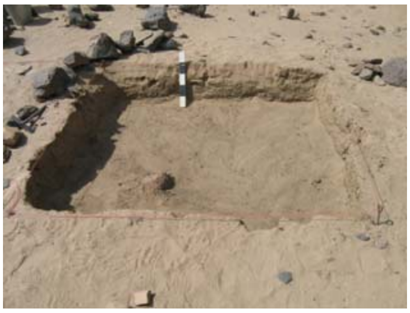
 

Photo (11): FAR 4 - Test-Pits

Photo (3-12): FAR 11 General View and Test- Pit

3.5. Dating Materials

Three items were sent to England for carbon ^{14}C dating. These were particles of hearth, different mammalian bones and Nile oyster shells. Unfortunately, only the Nile oyster shells were dated because the others dating is faced with technical problems. Two samples were dated as 7617± 50 BP and the second as7687± 50 BP. The details are below:

The University of Waikato Radiocarbon Dating Laboratory

Private Bag 3105Hamilton,

New Zealand.

Fax +64 7 838 4192

Ph +64 7 838 4278

email c14@waikato.ac.nzHead: Dr Alan Hogg

12/4/07

Sample 1

Report on Radiocarbon Age Determination for Wk-20617

Submitter: D N Edwards

Submitter's Code: FAR039/C1

Site & Location : Wadi Farjar, Sudan

Sample Material: Nile oyster shell

Physical Pretreatment: Sample was washed in an ultrasound bath, rinsed and dried.

Chemical Pretreatment Sample acid washed using 2 M dil. HCl for 250 seconds, rinsed and dried.

Result:

7617 ± 50 BP

Comments:

• Result is Conventional Age or % Modern as per Stuiver and Polach, 1977, Radiocarbon 19, 355-363. This is based on the Libby half-life of 5568 yr with correction for isotopic fractionation applied. This age is normally quoted in publications and must include the appropriate error term and Wk number.

• Quoted errors are 1 standard deviation due to counting statistics multiplied by an experimentally determined Laboratory Error Multiplier of 1 .

• The isotopic fractionation, . 13C, is expressed as ‰ wrt PDB.

• Results are reported as % Modern when the conventional age is younger than 200 yr BP.

Sample2:

12/4/07

Report on Radiocarbon Age Determination for Wk-20618

Submitter: D N Edwards

Submitter's Code: FAR039/C2

Site & Location: Wadi Farjar, Sudan

Sample Material: Nile oyster shell - freshwater

Sample was washed in an ultrasound bath, rinsed and dried.

Chemical Pretreatment Sample acid washed using 2 M dil. HCl for 200 seconds, rinsed and dried.

Result:

7687 ± 50 BP

Result is Conventional Age or % Modern as per Stuiver and Polach, 1977, Radiocarbon 19, 355-363. This is based on the Libby half-life of 5568 yr with correction for isotopic fractionation applied. This age is normally quoted in publications and must include the appropriate error term and Wk number.

• Quoted errors are 1 standard deviation due to counting statistics multiplied by an experimentally determined Laboratory ErrorMultiplier of 1 .

• The isotopic fractionation, . 13C, is expressed as ‰ wrt PDB.

• Results are reported as % Modern when the conventional age is younger than 200 yr BP.

Mid-Holocene date(7687 ± 50 BP) obtained from Wadi Farja Nile oyster samples is more or less similar to that obtained from Lower Wadi Howar samples of the same species by Rodrinues *et al;* (2000)(6835 ± 110 and 6635± 105 BP).

3.6. Morphological Evidences

In reconstructing the Quaternary history of an area, it is often necessary to determine the precise altitude of, and differences in altitude between particular landforms. Altitudinal data can aid in the interpretation of landform assemblages, and may also enable landforms of different age to be identified. The same applies also to the investigation of abandoned shoreline features.

The comparison of altitudes of landforms, especially from widely-separated localities, requires a common datum, a plane of known altitude to which all subsequent measurements can be referred. A frequently employed datum has been sea-level (Lisitzin 1974).

Surface altitudes have been obtained in the field using: (a) an aneroid barometer; (b) hand-held levels; and (c) a surveyor's level. Comparison of altitudes for a series of stations using this method is termed barometric leveling. The method, however, is frequently inaccurate as a consequence of relatively rapid pressure and temperature changes during variable weather conditions. This may be an old technology for obtaining the earth elevations.

Nowadays the new simple technological instrument as of Global Positional System reads directly the elevation of the land using the sea level as datum point.

3.6.1. Field Work

Using GPS about 130 locations were read in Wadi's belly, the sea level elevations were recorded. Twenty three readings were recorded from Nile bank in Tombos village to the north east direction up to the connection of the other branch (Table 3-4). A set of 45 readings were recorded from Simit East village to the end the wadi in Masida village (Table 3-4). The third set of reading was recorded for the branch of the wadi west- north middle of the wadi (Table 3-4). A car was used in following the wadi, but in some localities where the car can not be derived, reachings were made on foot.

The readings then were plotted in a graph as area chart using the Microsoft axel program.

Table (3-4): Elevation -Sea level reading from East Simit village to Farja village

East Simit village to Farja village		
Seria l No.	Location	Elev. Feet)
1.	19°46 32.68 /30°21 46.50	685
2.	19°46 29.36 /30°21 42.68	692
3.	19°46 48.11 /30°21 53.13	716
4.	19°47 03.23 /30°22 60.70	714
5.	19°47 19.47 /30°22 12.63	720
6.	19°47 33.39 /30°22 24.34	720
7.	19°47 47.30 /30°22 24.27	722
8.	19°48 01.56 /30°22 22.68	720

Tombus village to connection		
Serial No.	Location	Elev. (Feet)
1.	19°44 33.93 /30°22 43.96	686
2.	19°44 36.64 /30°23 58.76	720
3.	19°44 41.07/30°23 07.66	722
4.	19°45 09.32 /30°22 0.120	736
5.	19°45 25.07 /30°22 02.74	735
6.	19°45 50.60 /30°22 17.70	730
7.	19°46 36.64 /30°23 43,96	732
8.	19°46 16.44 /30°23 16.90	734

9.	19°48 47.30 /30°22 24.27	719
10	19°48 17.36 /30°22 35.59	719
11	19°48 25.77 /30°22 37.94	718
12	19°49 40.79 /30°22 49.18	715
13	19°49 51.33 /30°22 01.48	714
14	19°49 10.72 /30°22 56.51	715
15	19°49 19.87 /30°22 57.72	712
16	19°49 26.71 /30°23 17.18	716
17	19°49 32.32 /30°23 28.44	714
18	19°49 25.77 /30°23 37.94	709
19	19°49 49.09 /30°23 47.14	715
20	19°49 53.02 /30°23 54.47	708
21	19°50 50.02 /30°23 59.37	715
22	19°50 14.73 /30°23 56.49	710
23	19°50 24.25 /30°24 02.53	713
24	19°50 33.35 /30°23 56.61	714
25	19°50 41.54 /30°23 55.27	710
26	19°50 50.38 /30°23 54.20	708
27	19°50 53.07 /30°23 55.27	708
28	19°51 08.00 /30°23 50.91	710
29	19°51 12.28 /30°23 49.95	710

9.	19°46 46.29 /30°23 18.39	730
10.	19°46 36.83 /30°23 19.67	730
11.	19°46 46.35 /30°23 18.29	729
12.	19°46 54.07 /30°23 12.21	735
13.	19°46 59.50 /30°23 14.20	731
14.	19°47 46.29 /30°23 18.39	733
15.	19°47 15.62 /30°23 05.63	734
16.	19°47 21.17 /30°23 59.61	735
17.	19°47 25.92 /30°22 58.67	730
18.	19°47 32.03 /30°22 56.56	733
19.	19°47 54.08 /30°22 54.91	730
20.	19°47 45.47 /30°22 51.98	735
21.	19°47 46.51 /30°22 49.83	733
22.	19°47 47.18 /30°22 45.22	731
23.	19°47 33.00 /30°22 43.19	714

west- north Branch		
1.	19°49 48.72 /30°23 01.22	744
2.	19°50 55.87 /30°22	749

30	19°51 24.78 /30°23 45.08	711
31	19°51 28.96 /30°23 44.25	705
32	19°51 41.13 /30°23 46.19	707
33	19°51 44.28 /30°23 45.55	708
34	19°51 50.51 /30°23 40.91	705
35	19°51 59.80 /30°23 31.71	710
36	19°52 09.28 /30°23 30.92	709
37	19°52 17.85 /30°23 27.91	709
38	19°52 24.62 /30°23 32.78	705
39	19°52 49.42 /30°23 33.30	710
40	19°52 55.18 /30°23 30.91	706
41	19°53 01.93 /30°23 25.69	704
42	19°53 04.57 /30°23 25.62	701
43	19°53 08.91 /30°23 31.13	704
44	19°53 15.27 /30°23 30.97	690
45	19°53 29.93 /30°23 62.12	694
46	19°53 42.74 /30°23 32.59	694

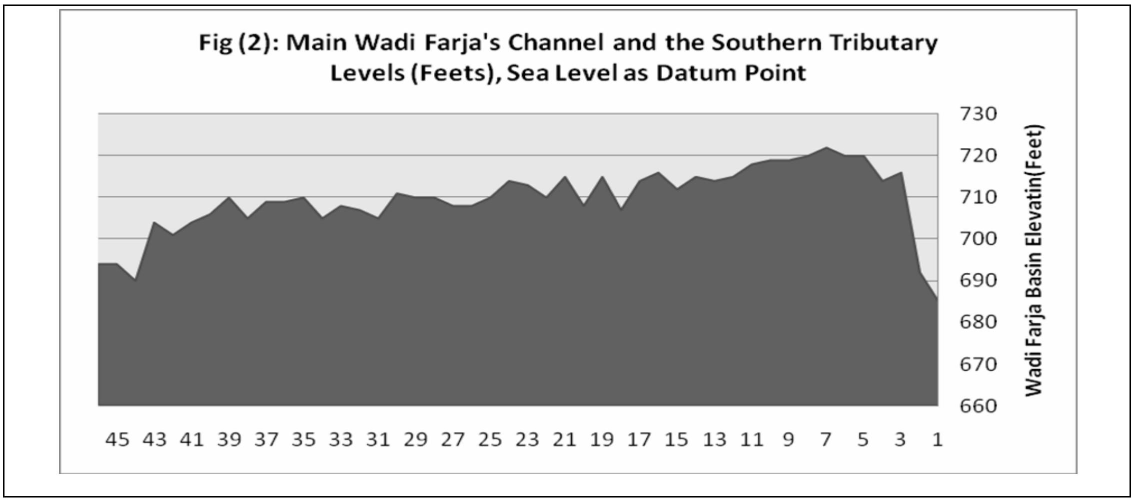
	02.70	
3.	19°50 12.13 /30°22 58.13	761
4.	19°50 29.58 /30°23 00.21	752
5.	19°50 40.91 /30°23 02.92	753
6.	19°50 56.53 /30°23 08.03	755
7.	19°50 01.39 /30°23 14.92	750
8.	19°50 57.05 /30°23 28.07	727
9.	19°50 58.45 /30°23 48.55	723
10.	19°51 52.98 /30°23 03.29	713

3.6.2. Result

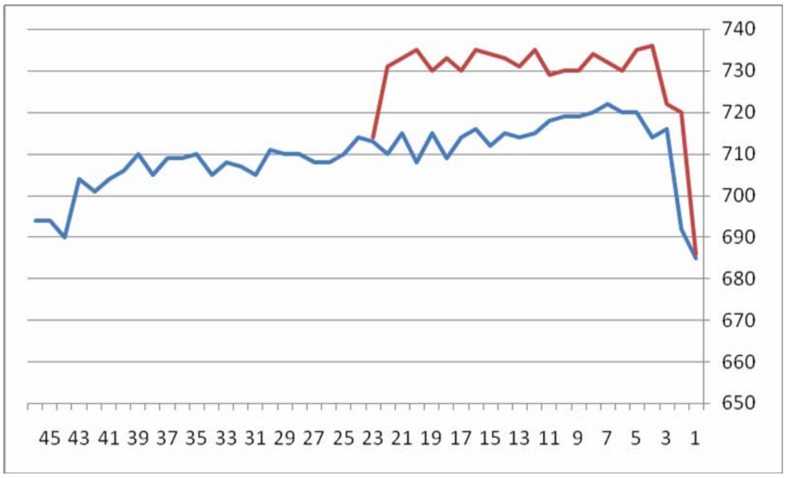
The plotting (Fig 2) of readings clearly shows the there is possibility of water flow from the mouth of the wadi in East Simit to northeast wards, although there are some intermittent relatively high land as cataract.

The plotting levels of readings of the northern branch, clearly shows that it is connected to the main channel and the possibility of water flow is present knowing that it passes via relatively higher land.(Graph 2).

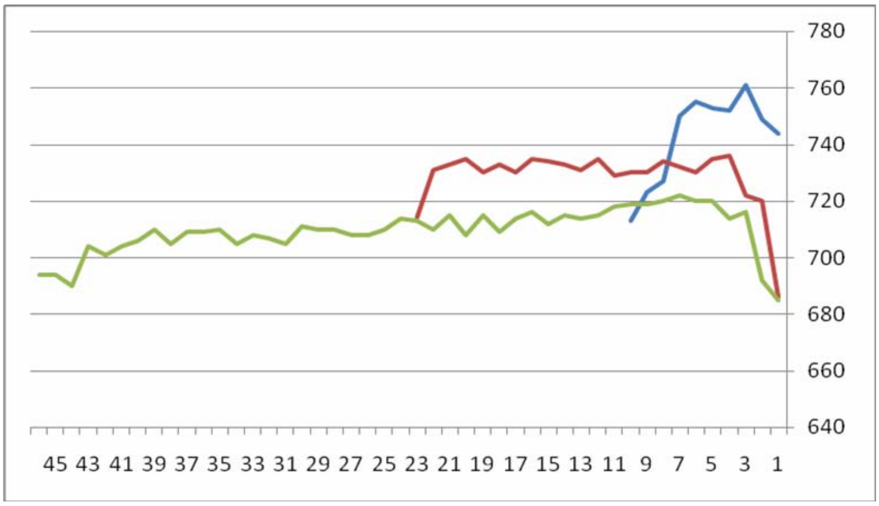
Thirdly, plotting levels of readings west-northern branch shows it is in very relative level of the land and may had flown water collected locally in areas of Jebel Sadeik. (Graph 4).



Graph (3-3): Main Wadi Farja's Channel and Southern Tributary Level (Feet), Sea Level Datum Point



Graph (3-4): Main Wadi Farja's Channel, Southern Branch Level and the West-Northern Branch Level (Feet), Sea Level Datum Point



3.7. Archaeological Evidence

Aerial Photography maps provide the reliable basis for analysing landform distributions, and enlargements can be made for this purpose (Gordon 1981). Use of aerial data as Geographical information system (GIS) layer, leads to fruitful results. So new world archaeological projects now routinely use the commercially available, black and white aerial photographs. (Renfrew and Bahn, 2000).

Remote Sensing and Satellite Imagery are used in archaeology and more widely-used techniques in Quaternary research. For many years people have suggested that satellite imagery could be a valuable resource for prospecting for archaeological sites. Until recent years the resolution of easily available imagery has been insufficient to see most archaeological features (Verstappen, 1977; (ordon, 1981)

3.7.1. Aerial Survey of Wadi Farja Sites

Aerial Survey is the broad term used to describe the various activities related to the discovery of archaeological sites from the air. This includes both the actual taking of new photographs and the mapping and interpretation carried out using both new and previously existing photographs.

The Mapping Programme provides primary information and synthesis for archaeological sites and landscapes of all periods from the Neolithic to the twentieth century.

Pinpointing of sites and features on a regional map is an essential next step in reconnaissance survey. Topographic maps represent differences in elevation relates the structures to surrounding landscape. (Renfrew and Bahn, 2000).

Two types of satellite imagery were used in this study. Before the conduct of field work, the computer technique of satellite image map of the area (UNSCO Bilko (03)) was used to locate the proposed sites. The image covers most of Wadi Farja area and hinter land. This type of map provides the exact position of the sites. Consequently, UNSCO Bilko programmed satellite maps also can be used easily in distribution of the sites on the map.

In this study, exact plotting of sites on amap – it's exact latitude and longitude were plotted using a computer. Key symbols were chosen for different dates and types of the sites.

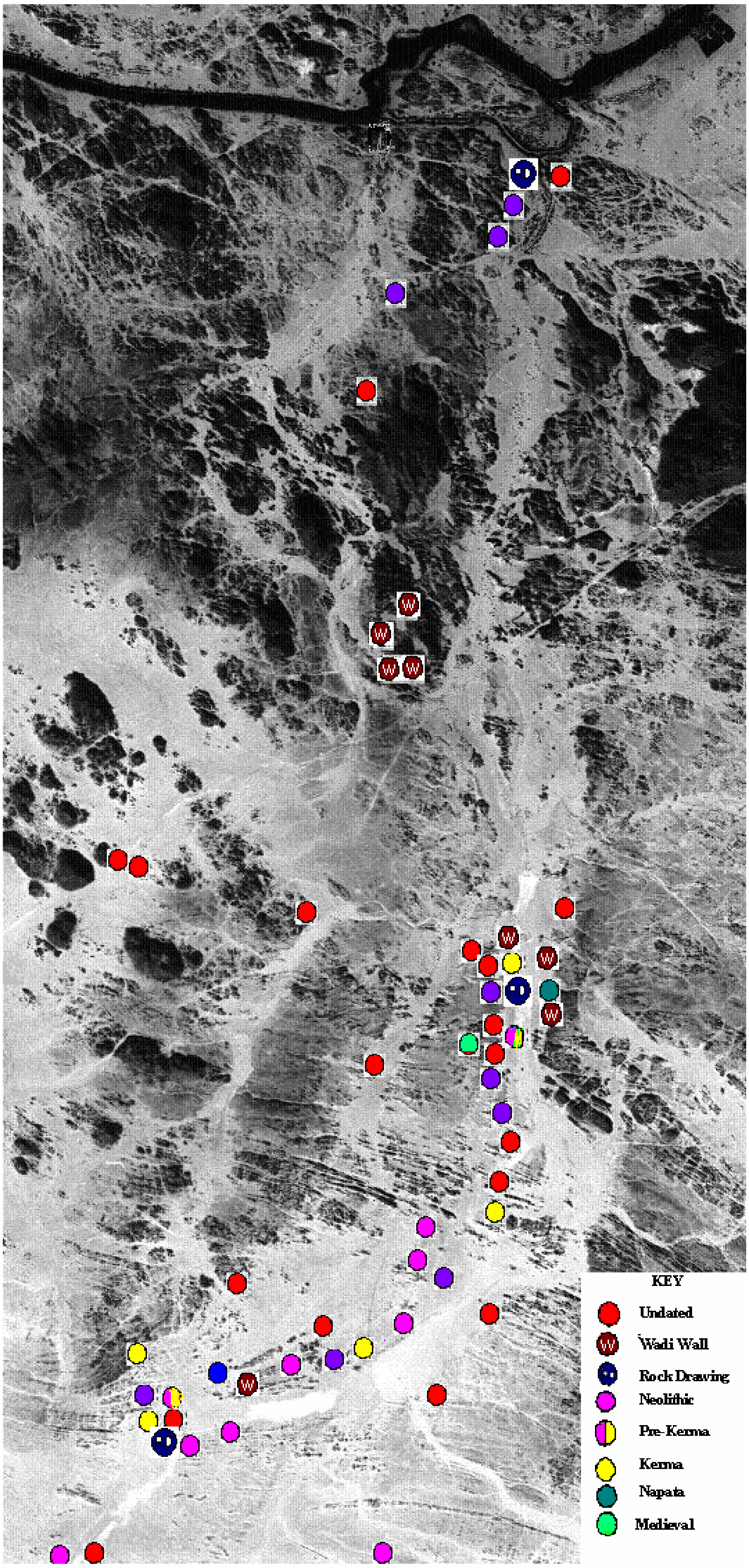
The other type of maps, which were used in following the wadi channel and shows the soil covering the channel was provided by Google Earth Maps on the internet. It is simply can be downloaded and the proposed area can be cut. There are two types of images i.e. conventional enhanced image is an enhanced image which is intended for interpretation. Geological structures were detectable in all eighteen of the final enhanced images. enhanced image were use in this study.

The first type map plotting of the sites (Satellite Image 3) revealed the followings:

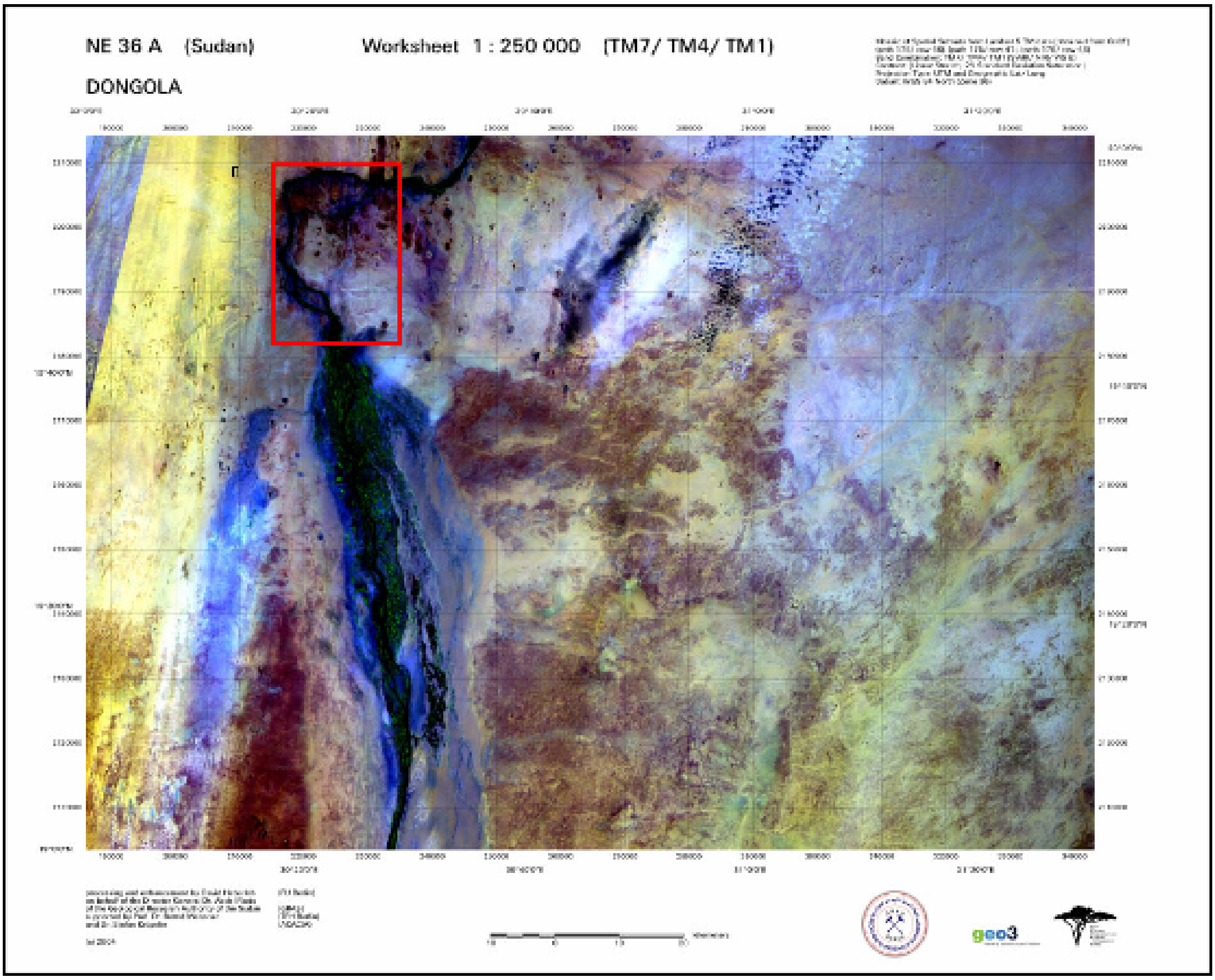
- The concentration of most sites on the banks of the wadi, suggesting the presence of water, and that most of the sites were settlement, occupation and habitation types.
- The sites concentrate on the western side. This suggested the presence of an island. Similar observation were commented by Welspy (1995) in Dongola reach survey the palaeochannels of Alferda and Selima Niles for a distance of 8 km .
- The distribution of wadi walls, that some of them seemed to be used for water control.
- The second type shows clearly the silt and sand precipitation with blue color as well. The channel could be seen from different angles (Satellite Image 4).

3.7.2. Results

All images show that the wadi Faraja is a palaeochannel of the Nile with two branches and the belly of the Wadi is filled with silt and sand.



Satellite Image(3-3): Distribution of Wadi sites in Wadi Farja



Satellite Image (3-4): The Alluvial and Sand Soil Filling the Wadi Farja Basin

3.9. Conclusions and Recommendations

Different methods and techniques which were applied in this archaeological study were biological, geological and archaeological. They collectively gave the same results, for reconstructing the Wadi Farja's ecology. Also these methods or most of them were applied in case of Wadi Howar by University of Colon. This multidisciplinary approach is now successful and it is the new trend in the world different types of research.

According to the dating results and dated archaeological sites, Wadi Farja was a running stream since mid-Holocene and it very clear tha human settlement there was intensive from Neolithic period. The few Palaeolithic sites suggested a earlier date. The area of wadi Farja and Arduan Island were very near to political center (capital Kerma). They have different protective landscape so, it seems to be that they were very important land and cultural components of Kerma.

Scarcity of more recent date sites and the presence of wadi walls in the belly of the wadi in addition to wells could be related to recent hyper-arid (first millennium) times in which the water flow became seasonal or even stopped completely.

The different evidences used in this study strongly recommended that:

i. The Wadi Farja was possible perennial or a seasonal tributary of the Nile
ii. This stream was running at least from mid Holocene
iii. Human settlement was there from Holocene up to Kerma period
iv. Reduction in the amount of water in this wadi began at least 2000 years ago
v. Seasonality of the stream can be studied by studying growth rings of snails and fishes.

vi. The methods adopted here can be applied for other similar wadi.

CHAPTER FOUR

4. Palaeoeconomy

4.1. Palaeoeconomy of Third Cataract Region

Studies on the palaeoenvironment and palaeoeconomy of the Third Cataract Region are rare and have concentrated on the medieval period. Among the archaeologists who have considered these aspects, Osman (1978) mentioned that fish have played an important role in the economy of medieval Nubia. Cattle were kept not just for food but also to drive the *Saqia*, while donkeys have played an important role as war animals during the Christian period. He added that, although the camel seems to be present since Meroitic times, there is no evidence of its economic importance until the Funj Kingdom (1505-1822) (Osman, 1978:108-110)

Some recent studies have been made in modern agricultural regimes in the region. These have provided valuable information on the range of crops and the types of cropping regimes practised in small-scale farming in recent times (Al-Batal 1994a, 1994b).

One major objective of the Mahas Survey Project, has been to assess the potential for archaeobotanical studies in the region. This has been done at Nauri (NAR001) with ‘Post-Classic’ and ‘Late Christian’ settlement. Identification focused on the economic plants. Samples collected revealed the presence of *Triticum sp* grain ,*Hordeum vulgare* grain, *Sorghum bicolor* grain. *Carthamus tinctorius, Citrullus lanatus* and *Vitis vinifera*. The most prominent plants from sieving were sorghum and barley, as well as evidence for wheat and a small millet-grass (*Brachiaria* cf. *ramosa*), which may have served as a wild food source and as a fodder. Mixed seeds with discarded pulses, discarded fruit seeds, as well as a few seeds that may have eroded out of animal dung, were also seen (Fuller and Edwards, 2001).

4.2. Palaeoeconomy of Wadi Faraja

4.2.1. Neolithic- Pre-Kerma Sites;

4.2.1.1. Preliminary Analysis of Archaeological Sites

Archaeological sites in Wadi Faraja are grouped into:

1. Four main functional categories: human residence, structures and walls, burials and art. Two categories were related directly to the palaeoeconomy of the area. These were settlements (Table 4-1) and stone structures sites. The two categories clearly identify the type of society as had been a settled one (Tahir, 2006,).
2. Three main periodical categories: Neolithic, Pre-Kerma and Kerma.

The distribution map of sites (Satellite image 2) revealed the position of the sites on the wadi bank near water resources. Hence, their economy had been dependent on permanent water. According to Rouse (1971:94-107) remnant settlement patterns in archaeology are divided into dispersed, concentrated and co-operative types. Each of people's sites may contain virtually the same set of activity loci. This will be true if people's residential communities and other institutional groups concentrated their activity in one spot, as simple farming communities tend to do, regardless of whether they have sedentary or shifting pattern of residence. A shifting pattern of residence can be studied by analysing the seasonal growth rings in shell and fish remains in the samples collected from the sites. However, this needs a standard reference key extracted from living animal species samples, which are not available currently. In addition, some complications of layers of the shell were encountered by Abell *et.al.,* (1996) in samples from the Wadi

Howar when compared with those from Lake Victoria, but the case may not be different in Wadi Farja when compared with Nile samples.

Although many authors prefer to use grinding stone as evidence in archaeological sites, only on most of Neolithic and Pre-Kerma sites surfaces are there scattered grinding stones which were surely used for grinding grains, either collected or cultivated. (FAR010,012,019, 024, 056).

Bourliere (1963:128-129) stated that settlement of hunters in the most favorable area –grassland savanna with permanent surface water and a large biomass provided by one or two species of large game animals- can be expected to produce some of the largest semi-permanent groupings possible at the hunter-gatherer level.

In the case of Wadi Farja, the settlement sites were of the concentred type and were located in the south-eastern part of the island, (Satellite image 1). Other activity loci such as graves were present but rare (only two burial sites). If Wadi Farja's settlements were seasonal, then our search for such burials on neighbouring land on the main Nile failed to find them in a percentage higher than in the wadi. This statement raises a question, where were the burials?

No workshop sites have been discovered yet. This may be attributed to the fact that the wadi consisted of very complicated tributaries and in future such sites may be discovered. An other possibility is that, past dwellers of the area may have brought their stone tools from a remote area i.e. on the permanent Nile bank. So, these sites may have been seasonal. This would agree with Sadig (2004) who mentioned that such sites were seasonal. This also agrees with Arkelll's suggestion in 1953, that the flood level of the Nile was five meters higher above the alluvial plane in Neolithic times than now, so people moved to higher lands during the flood season.

Table (4-1): Settlement and Burial Sites In Wadi Farja

Period	Occupation	Burials
Neolithic	8	2
Pre-Kerma	7	-
Kerma	5	5
Napatan	-	1
Islamic	-	1
Unknown	9	1

Table (4-2): Neolithic –Kerma Sites in Third Cataract Region

Village	Neolithic Occupation	Neolithic Burial	Pre-Kerma Occupation	Pre-Kerma Burial	Kerma Occupation	Kerma Burial
Tombos	1	0	1	0	0	0
Kabodi	1	0	0	0	1	0
East Simit	5	1	0	1	0	0
Habarab	2	0	1	0	0	1
Masida	3	0	0	0	0	0
Barja	0	0	0	0	0	0
Nauri	0	0	0	0	1	0
Arduan	2	1	2	0	0	0
Meljab	1	0	0	0	0	1
Nauri	0	0	0	0	1	0
Mashkela	0	0	1	0	1	0
Fareig	0	0	0	0	2	0
Geddi	1	0	0	0	1	0
Sabu	1	0	0	0	1	1
Ashshaw	1	0	0	0	2	0
Simit W	4	0	0	0	3	0
Taajaab	2	0	1	0	3	0
Gawgul	0	0	0	0	4	0
Defoi	3	0	0	0	1	0
Kajbar	2	0	0	0	0	0
Simit	2	0	0	0	1	0
Musul	1	0	0	0	0	0
Nap	1	0	0	0	2	0
Total	**35**	**2**	**6**	**1**	**24**	**2**
Wadi	**8**	**2**	**7**	**0**	**5**	**5**

Farja						

Anyone visiting the floodplain in the Third Cataract region will discover quickly that it is very narrow (2-400 m) except in Fareig village where it may reach 1.8-2km. If one looks at the Neolithic sites on the distribution map (Satellite Image 1) he can see also that there were no alternative sites for flood season camps as it is noticeable that most of the sites are in the vicinity of rocks. Therefore, the suggestion by Arkell based on central Sudan where a wider floodplain there was may not be valid here.

Reconstruction of the social system was difficult at this level of the study because it needed excavations of settlement sites and graves. To draw such conclusions all sites seemed to be similar and of a homogenous society.

Honegger (2003) worked out the status of the Kerma settlements, which were distorted and partial, whereas the cemeteries were abundantly documented because they were better preserved. He added that, over the last eight years, the mission of the University of Geneva concerning prehistoric settlements around Kerma has carried out excavations and surveys. The main goal is to reconstruct the evolution of society from the last hunter-gatherers up to the emergence of the Kerma civilisation. The periods were dated respectively from around 7400 cal. BC (Early Khartoum), 4600 cal. BC (Neolithic) and 3000 cal. BC (pre-Kerma).

4.2.1.2. Early Khartoum settlements (around 7400 cal. BC)

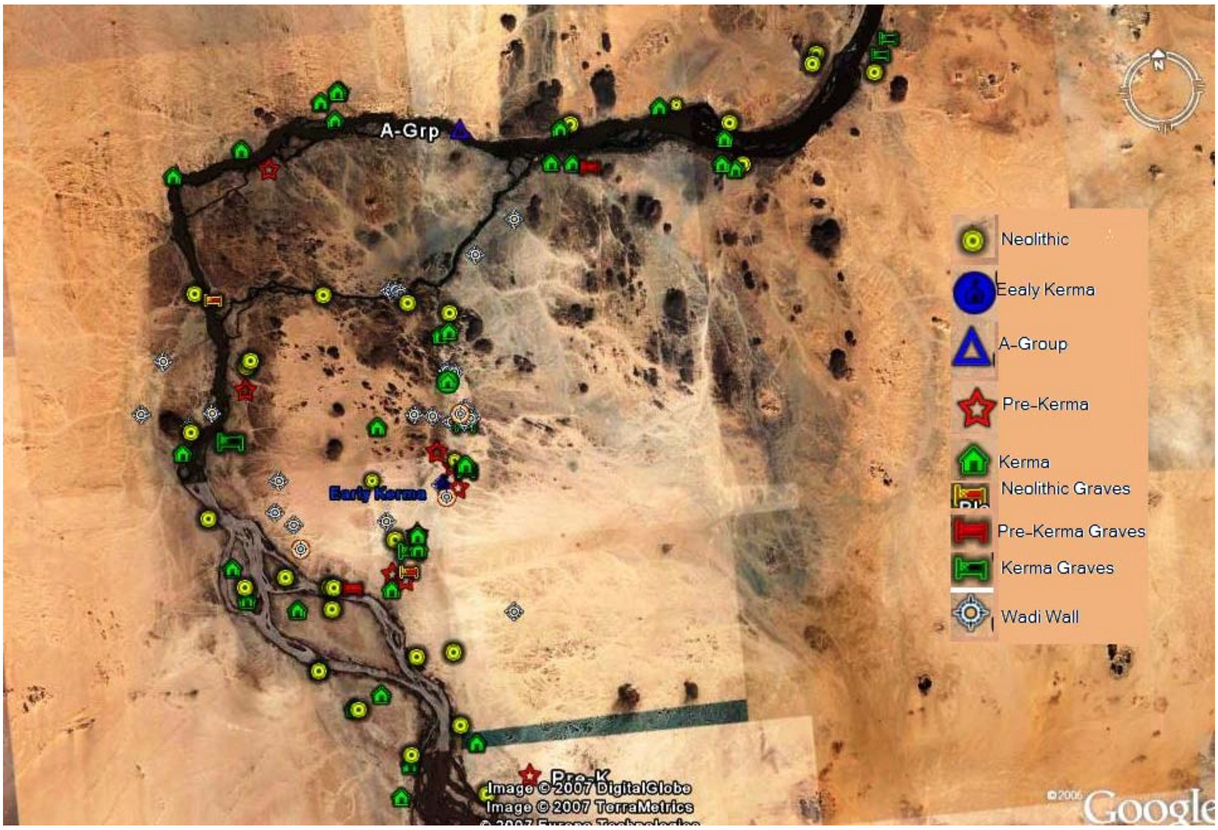
Settlements occured at the edge of the alluvial plain. The fauna of the latter consisted mainly of wild animals from an aquatic environment (hippopotamus, cat-fish, tortoise and crocodile). The populations from this period practised an economy centred on fishing, hunting, and the gathering of wild plants. These populations tended to become sedentary over time, and this phenomenon was tested archaeologically by settlements yielding abundant remains, and cemeteries. (Honegger 2003).

4.2.1.3. Neolithic settlement (around 4600 cal. BC)

Neolithic sites were buried under several dozen centimetres of Nile silt. These settlements may have been seasonal, the inhabitants practising animal husbandry and occupying the alluvial plain during the dry season seeking pastureland. Their herds were found to consist of cattle and domestic goats and sheep. The houses consisted of oval huts and rectangular buildings (Honegger 2003).

4.2.2. Pre-Kerma Settlement (around 3000 cal. BC)

Unlike the Neolithic sites, this settlement was not covered by Nile silt. The people of this period must have been used to store food, mainly grain. Their houses were circular in construction, including huts, which had a diameter of one to seven meters. Two rectangular buildings were seen also. Pits that were found, could be linked to the rising importance of agriculture in the economy and, in consequence, to increasingly permanent habitation sites, even though animal husbandry still played an important role. This evolution of the subsistence economy was probably one of the conditions necessary for the emergence of more complex societies, such as the one present at Kerma during the second half of the third millennium BC (Honegger 2003).



Satellite Image (4-1): Distribution Map Neolithic-Kerma Settlement Sites of Third Cataract Region

4.2.2.1. Zooarchaeological Findings

Zoarchaeological finds from sites that were related to human consumption were fish bone, mollusc shell and other mammalian bone mainly cattle (Fish vertebra -FAR 60, 65; Snail shell -FAR 010, 58;Ostrich eggshell fragments FAR 050,051; mammalian bone fragments FAR 01,024,051,053 058). Photo :(4-1 and 4- 2).

The Neolithic culture of the Third Cataract Region resembles that of Early Shehinab or in general central Sudan around Khartoum, as well as that of Abkan sites (Sadig, 2004:65-66), so the tradition of gathering food and hunting should be suggested. On the basis of the plant remains recovered from the site of Shaheinab, Arkelll concluded that cultivation had not yet begun but gathering of food-plants was practised. Since no evidence of cereals was found, he also stated that grinding equipment was used for purposes other than preparation of food-plants (Arkelll, 1949:54).

Arkell in 1949 stated that the gathering of wild fruits such as *Celtis* and wild grass-seeds was an activity practised during the Early Khartoum tradition (c. 9000- 6000 B.P.) probably as a supplementary source of food which was mainly obtained from aquatic sources, e.g. fish, molluscs, and wild game. Little Neolithic archaeobotanical material has yet been found in the Middle Nile but there have been recent finds of barley deposits in Neolithic graves of the 5th millennium BC at Kadruka near Kerma (Reinold, 2000). Archaeobotanical screening of Wadi Farja sites in future, will provide a clearer picture.

Gautier (2003) re-examined the fauna and found that the meat consumption in Kadero was mainly of cattle but there was some opportunistic fishing and also hunting, mainly of gazelle. Domestic animals such as bovines and goats were the most numerous in the faunal remains here, but with a large proportion as well of wild animals such as small antelopes. Because of the large size of some of the cattle, it seems that the people here may have practised castration since that leads to larger size. Cattle were very important (80% of the total faunal remains) for the economy of this people.

Photo (4-1) : FAR 10: Snail Shell

Photo (4-2): FAR 54: Mammalian Bone

Nevertheless, our zooarchaeological collections contain fish bones and mollusk shell in sites e.g FAR010. Dark (1973) found Ampullarid shells (*Pila sp*.) frequent at the Jebel Moya site; he added that it may have been used as bait for fishing. The main occupation period of this site is probably contemporary with Meroe. From a test excavation at Jebel Moya itself Dark records cattle and goat bones.

Wendorf (1988) stated that vegetable remains were a rarity in Palaeolithic context and these new date determinations on material from southern Egypt established securely the date of an intensive grass-tuber and fish economy in the Nile Valley towards 20,000 years ago. In Jebel Um Marrahi (Early Khartoum type, on the western bank of the Nile), Gautier *et al*; (2002) found that fish was the main component of the diet.

4.2.2.2. Kerma Sites:

4.2.2.3. Preliminary Analysis of Archaeological Settlement Sites

It seems that during Kerma the settlement continued in the same area, south-east of the island. But, noticeably, the society becames more settled. There were two lines of evidence concerning this aspect. These were:

1. The number of burial and of settlement sites were equal. The case during Neolithic and Pre-Kerma was different, namely, only two burials sites were known (Table 4-1). This aspect also needs more survey and excavations of burials.
2. Another important piece of evidence for permanent settlement was the presence of stone structures of different sizes and shapes (Table 4- 3) probably huts, which are indicative of habitation settlement.

Table (4-3): Stone structures of Wadi Farja

Site Code	Site Type	Date	Notes
FAR 001	Structure	?	12m square, built of stone slabs- possibly matara(Well). Kerma pottery in the vicinity
FAR 003	Structures	?	Subcircular structures, c. 5m in diameter, 1m high in wadi floor. No dateable material present
FAR 006	Wadi walls, Occupation	Kerma?	Well-defined low wall lines along rocky gravel banks on W side of wadi. Kerma pottery with some imported Egyptian material
FAR 008	structures	Kerma?	3 low stone mounds, possibly robbed cairns or small huts. Date uncertain but occasional Kerma sherds in vicinity.
FAR 009	Occupation	?	Rough stone structure on low raised stony bank in the wadi. Possibly 3 'rooms', max. 14m across with walls standing max. 1m high.
FAR 015	Habitation	?	Rectangular stone enclosure, probably a small hut, measuring 4 x 5m. A few abraded sherds of undiagnostic red wheelmade pottery were noted.
FAR 016	Habitation	Kerma	Small, massively built stone structure. Dense scatters of pottery around and within the structure include Middle and Classic Kerma material, and occasional Egyptian imports.
FAR 031	Structure	?	Low stone kidney-shaped structure with rough stone walls with entrance in S wall. No associated artefacts.
FAR 032	Structure	?	Low stone structure in small area of open ground overlooking W side of wadi, c.5m (E-W) x 4.2m (N-S). No associated finds.
FAR 036	Structures		Cluster of stone structures along c.50m of W side of wadi. One of these could be a collapsed tomb superstructure. No artifacts associated with site.

FAR 038	Structure		Subcircular stone structure c.4-5m across within area of outcropping rocks in wadi centre. Partially buried in wadi deposits. No artefacts in this area.
FAR 062	Wall? & well?	?	Circular structure with (c.11m diameter) within wadi on east side of car tack. About 50 meters to south a well-defined low wall line crosses the wadi, buried by wadi deposits in places.
FAR 063		?	Small stone structure.
FAR 064		?	Small stone structure.
FAR 065	Occupation	?	Small rough stone structure amongst rocks. Some fish bone fragments are found in the vicinity.

One of the core concepts in archaeology is known as 'settlement pattern studies' ('non-site archaeology'). Settlement pattern studies involve investigations which examine regions or areas, rather than focusing on individual sites. Settlement patterns are probably most associated with the understanding of how a particular society used the available resources in its region (Hirst, 2007).

Flannery (ibid) summarized the relationship of house shape to settlement types:

- Roughly 10 m square of house floor space were available per individual in the Neolithic type of settlement.
- Circular dwelling tended to correlate with nomadic or semi nomadic societies; rectangular dwellings tended to correlate with fully sedentary societies.
- Rectangular structures replaced circular ones through time in many areas around the world.
- While circular structures may be easier to construct it was much easier to add units to rectangular structures.

According to Flannery (1971:23-53) early permanent settlement is characterised by the circular hut, still widespread in Africa and in Sudan. They are found among sedentary cultivators and herders. He mentioned that a residence hut, often with stone foundations and 3 meters in diameter, houses only one adult but that a larger one 5 meters in diameter housed a man and two cows or many goats. In our study area the sites containing possible houses were as follows:

1. the first type was present in (FAR 08, possible 063,064,065)
2. the second type were present in (FAR 03, 012, 031,038)
3. rectangular structures were present in (FAR 01, 09, 015,038)
4. some structures were not defined well.

Most identified sites were dated to Kerma period, and no such stone structure was present at Pre-Kerma and Neolithic sites. In conclusion, the Kerma community in Wadi Farja comprised sedentary cultivators and herders. This conclusion will be strengthened by the discussion of wadi wall later in this chapter.

In the Pre-Kerma settlement (4000BP), (Hakim and Bonnet, 1990) found huts, with diameters of 4-5 meters. This type continued until the end of Classic Kerma when they shifted to rectangular wider houses (Hakim and Bonnet, 1990:118-120). Honegger (2003) discovered about 50 huts (1-4 m in diameter) for housing and another set of huts (7m in diameter) may have belonged to certain important persons or have been workshops. Finally, structures of 1 m diameter were used as grain storage or as calf fences.

The difference between Flannery's model in the findings of Hakim and Bonnet (1990) and Honegger (2003) in the sites of Kerma, capital of Kush, was that the huts were without stone foundation. This may attributed to lack of stone in Kerma basin.

4.2.2. 4. Zoarchaeological Findings

In 1990 Hakim and Bonnet wrote that cattle amounted to 34% of the animals reared at Kerma and played a very important role in the economy. Sheep and goats comprised 45% of the animals. Donkeys were reared and were edible meat. Dogs were also found.

Chaix (1982; 1984) commented that the cattle of Kerma would be situated in the shrubby savanna zone, with more plentiful food resources, which would support the larger African fauna as well as significant herds of cattle and of sheep and goats. At Kerma, in the food refuse of the town, cattle comprise over 50% of the animal bones (Chaix 1982; 1984).

That a large number of cattle was present in the region is confirmed by an Egyptian text of 2,720 B.C., which says that Pharaoh Snefrou brought more than 20,000 cattle back from Nubia. Survey work in the Eastern Desert has also shown that settlements existed close to the courses of now dry rivers, and suggest that the cultivation of much more extensive areas of land was once possible (Chaix and Annie Grant, 1993: 399-405).

The husbandry of sheep and goats, perhaps the most suitable animals for the local environment was for producing food and, in particular, meat, with milk and skin products being of lesser importance. In this respect, it was remarkably similar to that of the present day (Chaix and Grant 1987; Bonnet 1984; Chaix 1987).

Chaix and Grant (1993: 399-404) explained that the animal and plant remains from the town and necropolis of Kerma seemed to yield contradictory information on the environment and economy. There was evidence that the environment at the time of the occupation of the ancient town was similar to that of the present day. However, the remains of a larger African fauna and of significant herds of cattle suggest Kerma was situated in a shrubby savanna zone. It was possible the Nile brought down a far greater volume of water, but no traces of any irrigation system have yet been found. The quantity of animals slaughtered at some burials sites suggested not only the production of a large surplus, but also the organization and social control of a large population.

Chaix (2003) found, in the Kerma site at Gism el-Arba, large numbers of bones of domestic mammals but very few fish. This could be due to the perishable nature of the latter. Some of the remains were also of wild animals. Cattle were often of very large size. Among the caprines most were goats (about 60%) and sheep came to about 30%. Dogs and donkeys were only marginally present here. There were similarities between this site and Kerma in the domestic animal picture, although at Kerma the caprines are present in a much larger proportion. There were many more small figurines representing bovines or caprines here than at Kerma, which might be one more aspect of the diversity between the metropolis, so to speak, and other more remote communities (Chaix, 2003).

4.3. Walls of Wadi Farja in Terms of Economy

Edwards and Osman (1990), Osman and Edwards (1994, 2000) and Tahir (2006) recognized many earlier sites, including those from Kerma period by the river side. Remote sites away from the river may await future discovery. The Mahas Survey Project discovered about 65 sites in the Palaeochannel of Wadi Farja. They were dated as far back as the Palaeolithic period but to no later than the Kerma period.

One of most prominent archaeological features of the Wadi was the presence of a large number of stone wall structures with a function yet to be determined. Its possibility that these walls are correlated with past human activity and hence they were indicative of the palaeoeconomy of the area.

In 1969, Hobler and Hester found such walls in the Libyan Desert (Kukur and Dungul areas) and correlated the walls to C-Group people (1690 B.C±180). They mentioned that these walls were game traps built across wadis and between Jebeles for capturing ostrich and possibly gazelles. Hobler and Hester (1969) recorded that the walls enclosed several kilometers. Similar stone walls have been mentioned by Reimier (2004) in the southern Great Sand Sea of Egypt (dated to *C*. 6500-4900 B.C). He, too, identified the walls as game drives or traps. In Sudan, Wolf and Nowotnick (2005) found such structures comprising stone walls in the Forth Cataract Region but with no artifacts which could be used for relative dating (Photo 4-3 and 4- 4). This chapter attempts to throw light on the nature and function of the Wadi Farja stone walls.

Photo (4-3): Stone Wall in Forth Cataract Region – Sudan (Wolf and Nowotnick ,2005)

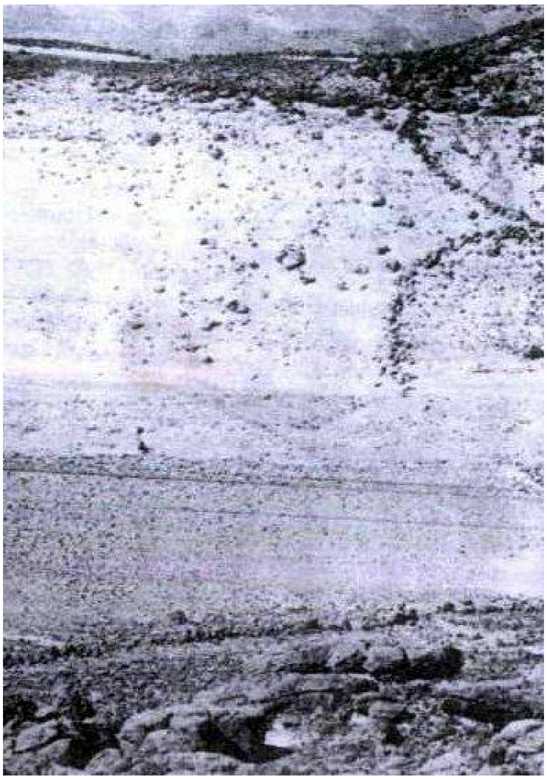


Photo (4-4): Stone Wall in Libyan Deseret (Hobler and Hester,1969)

4.3.1. Field Work

Before the field work, a satellite image map of the area (UNSCO Bilko (03)) on computer was used to locate the proposed artificial stone walls. This type of map provides the exact position of features. A walking survey of the region was done in March 2004, June 2005 and January 2007, including the collection of surface materials. Later on, snail shell samples were dated (The University of Waikato, Radiocarbon Dating Laboratory, New Zealand). Using simple methods of measuring dimensions the wadi walls were measured and photographed using a digital camera. One of the important aspects of the field survey, was noting and studying the topography of the area surrounding each wall.

4.3.2. Wadi Walls in the Third Cataract Region

It is obvious from the records of different seasons that walls are not restricted to Wadi Farja, but have been found in other areas, which are summarized in table 4- 4; and shown in satellite images (4- 2,4- 3 and4- 4) and (Photo 4-5 and 4- 6).

Table (4-4): List and Position of Walls in Third Cataract Region

Village	Number of Wall	Situation to Wadi Farja
Habarab	3	North-east
Masida	2	North-west
Fad	2	North
Fogo	3	North-east
Kabodi	2	South
Taajab	2	North-east
Faring	1	East –north

Photo (4- 5): Stone Wall in Foot of Jebel Ali Barsi

Photo (4-6): Long Stone Wall (600 meters) in Vicinity of Kobodi village

(19°44.595/30°23. 735**)**

Satellite Image (4-2) : Stone Walls at Foot Jebel Ali Barsi

Satellite Image(4- 3): Long Stone Wall in Vicinity of Masida Village

Satellite Image(4-4): Long Stone Wall in Vicinity of Fareig Village

4.3.3. Wadi Walls in Wadi Farja

Wadi walls of Wadi Farja are summarized in Table (4-5) and their distribution is shown in Satellite Image (4-1).

Table (4-5): List and Position of Walls in Wadi Farja

Site Code	Position
FAR006	19°51.596 /30°23.530
FAR007	19°50.747 /30°23.530
FAR011	19°49.424 /30°23.150
FAR016	19°50.775 /30°23.849
FAR021	19°50.995 /30°23.849
FAR037	19°50.923 /30°23.764
FAR047	19°51.792 /30°23. 691
FAR048	19°51.834 /30°23.573
FAR049	19°51.840 /30°23.534
FAR052	19°47.112 /30°22.254
FAR062	19°59.902 /30°23.111

4.4. Walls in Wadi Farja - Situations and Sizes

4.4.1. Physical Categories:

The walls can be classified into 3 categories according to their physical position:

1. Those present on the top of a bank or on raised areas.
2. Those present in the bed of a channel.
3. Those on the edge and sloping downwards into the bed of the wadi

The walls can also be classified into 3 categories according to their length:

1. Short walls -less than 100 meters.
2. Medium walls -100-500 meters.
3. Long walls -more than 500 meters.

Examples of Stone Wall measurements are summarized in Table (4-6).

Table (4-6): Examples of Stone Wall Measurements in Wadi Farja

Site Code	Orientation	Length (Meter)	Width (Meter)	Height (Cm)	Notes
FAR007	North-north	320	0.5-2	40	• No artifact associated • Part of the wall on bed of the Wadi and extends to top of the bank
FAR047	West-east	45.6	1.8-2.2	-	• No artifact associated • Situated in the belly of the Wadi
FAR048	West-east	46.6	2-2.5	50	• No artifact associated • Situated in the bed of the Wadi
FAR049	West-east	45	1.9-2	50	• Palaeolethic artifacts associated • Situated on the edge of the Wadi's western bank
FAR011	Curved	26.5	1.2-1.5	20-40	• No artifact associated • Situated on the edge of the Wadi
FAR052	West-east	60	2	20-40	• Scattered lithics Situated on the edge of the

					Wadi and crosses the Wadi bed to the other bank

4.4.1. Building Technique:

The wadi walls were constructed by piling smaller blocks of stone around large outcrops of the mountain and hills on which they were built. Therefore, the walls were stout and strong and at many points were high enough to hide a standing man. The walls which were built on open areas and wadi regions were built by piling stone roughly and irregularly. Therefore, all walls were mainly strong, rough and porous i.e. they cannot hold water. (Photo4- 7).

4.5. Possible Functional Categories:

4.5. 1. Animal Trap or Fence

Some walls could be for a game trap or drive, especially the long walls near water pools like that of FAR 07. The idea was that animals came to drink at evening, through a main gate as shown in FAR 7 (Satellite Image 4-5 and Photo 4-6). The animals get trapped inside the enclosing wall. This agreed with Reimier (2004) and Wolf and Nowotnick (2005), because one category of these walls was situated on the top of the bank and passed downwards to the bed of the wadi. Some very long (800 meters) parallel walls also were seen in the vicinity of East Simit village on higher ground; these could be possibly for game drives.

Another possibility was that the walls were to keep herds fenced against attacks of wild animals as was done today by natives who keep their herds fenced (zariba) to avoid attacks by hayaenas on the one hand, and to keep their herd animals away from agriculture on the other hand. (Chapter 1 -Photo: 1-6-a and 1-7).

Satellite Image (4-5): FAR0 7 Stone Wall -Possible Trap or Fence

Photo (4- 7): Wall Building Technique

Photo(4- 8): FAR0 7 Stone Wall

It is suggested that this type of economy involving game trapping existed mostly during the Neolithic and Pre-Kerma periods, which agrees with the findings of Hobler and Hester (1969), Reimier (2004) and Honegger (2003).

4.5. 2. Silt Precipitation

The walls might be used for silt precipitation as is done by the natives on the Nile. This technique is used now in Nubia where they built walls very similar to those of Wadi Farja in both size and shape to precipitate silt for agricultural purposes. This is quite applicable to the walls that lie on the edge of the wadi and slope downwards or those in the bed of the wadi. Burckhardt (1819: 11) noticed in Nubia such walls were constructed for the above purpose.

4.5. 3. Water Storage and Irrigation

One set of walls was associated with wells, as in FAR 062 (Satellite Image 4-5; Photo (4-10, 4-11), this may be a later construction during dry periods. Wells have been used for water, possibly operated by *Shadoof* or *sagia*, for irrigation or drinking. These walls might also have been for the protection of such a vital place.

Some walls cross the wadi from one bank to the other. This might have been a water storage technique. Others might have been for controlling the water system (Satellite Image 4-6 -a & 4- b).

This possibility is suggested to be likely during the Kerma period for the following reasons:

1. A farming economy was practised during Kerma (Satellite Image 4- 7).
2. The water table of the wadi become lower in this period and the channel possibly became seasonal as the neighboring current Fad seasonal stream (stream near

Masida village). Thus water storage is needed for irrigation and for herds to drink.

3. Most of this type of wall are near Kerma sites

Satellite Image (4-6 -a): FAR062 Wadi Farja Walls Crossing the Wadi and Associated with a Circular Structure in the Wadi Bed

Satellite Image (4-6- b): FAR 006 Kerma Occupation Associated with Walls

Satellite Image (4- 7): Crossing Walls, Possibly for Irrigation?

(19°50. 501 /30°22.940)

Photo (4-9): FAR62 Wall Crossing the Wadi

Photo (4-10): Wall crossing the Wadi and Disturbed by Car Tracks

4.5. 4. Territories and Roads

Some of the walla might have been used as territory markers and/or borders for grazing, agriculture or settlement belonging to peoples or communities. (Satellite Image 6). Roads were discovered by Hester *et al;* (1970). Those found in Nubia (Kalabsha and Dakka - Aswan High Dam) comprise two types of road. Type one is formed by cleared land, the roads being 10m in width and the stones put at the margin. The second type is marked by stone columns, usually placed in pairs. Hester mentioned very long roads up to 11 km. Although there were some physical differences between this type and the Wadi Farja's stone walls, I think they wrer comparable. Nowadays Nubians use such landmarks for arable (*Gref*) land along the River Nile bank.

Another possibility is that some of these walls might have been road marks for people or their herds, especially during rainy seasons when the bushes and trees may have grown so that the rough rocky land surface disappeared or markers that led to a water pool were obscured. At present the natives prepare such a road (however, without using stone as markers), called *Ottie* in Nubian, which leads to the Nile especially in areas where the edge of the bank is high (Satellite Image 4-8 and Photo 4-11).

Photo (4-11): FAR 011 (Edwards & Osman, 1994)

Satellite Image (4-8): Wadi Wall on the Top of Rock Outcrops

Different walls and a well from Wadi Farja are shown in Photo (4- 12).

Photo(4-12- a): FAR 0 1 Bir Giha (Buried Well)

Photo (4-12- b): Stone Wall From Wadi Farja

Photo(4-12 c): Stone Wall From Wadi Farja

Photo (4-12 –d): Stone Wall From Wadi Farja

4.6. Conclusion

- The paleoeconomy of Wadi Farja seems to be changed from seasonal settlement during Neolithic and Pre-Kerma to settled society during Kerma.
- Most archaeological sites are located on wadi banks, near water resources. Hence, their economy has been dependent on permanent water. According to Bourliere (1963:128-129) this type of settlements were expected to produce some of the largest semi-permanent groupings possible at the hunter-gatherer level. <u>This is type of economy is suggested for Neolithic population of Wadi Farja</u>.
- Honegger (2003) explained that the people of Pre-Kerma period must have been used to store food and this could be linked to the rising importance of agriculture in the economy in addition to animal husbandry.

  But in case of Wadi Farja there is a problem because of the scarcity of burials
- Rouse (1971:94-107) mentioned that the concentrated settlement patterns in archaeology means co-operative types. Each of a people's sites may contain virtually the same set of activity loci. In the case of Wadi Farja, the settlement sites are of the concentred type and are located in the south-eastern part of the island. <u>This is type of economy is suggested for Kerma period population of Wadi Farja.</u>

The large numbers of bivalves, *Lates niloticus* and cattle bones that were associated with human settlement sites were indicatives of human consumption as food or other purposes. The palaeoenvironmental implications of hippopotamus bone fragments collected from the area were the evidence of presence of shallow waters and sandy banks as well as the high rich vegetation grass land. The different class of remains collected were indicative of animal biodiversity and the prevalence savannah conditions at that time. So, the paeoloeconomy of food collection phase at that time is possible. Such conditions in addition to security of land by nature attracted human habitation at that time.

The Wadi Farja walls were not associated with artefacts or other evidence which may aid in dating as were those in the Libyan Desert (Hobler and Hester,1969) which belong to the C-Group or as walls dated back to mid-Holocene in Egypt (Reimier, 2004). However, archaeological sites in Wadi Farja indicate human settlement during the Neolithic to Kerma periods, which includes the C-Group period. Honegger (2003) defined two phases of the Pre-Kerma culture, the transition to Kerma and the contacts with the A-Group. However, few of Wadi Farja's walls were associated with artefacts dated to the Neolithic, Kerma and, with imported Egyptian pottery and the New Kingdom periods (Osman and Edwards, 2000).

In addition, Nile Oyster samples collected from Wadi Farja, FAR039 were dated to mid-Holocene (7617 ± 50 BP).

Some walls in Wadi Farja were in the form of straight parallel lines and are situated on raised areas, thus giving rise to the probability of their having been game drives. Some walls in Wadi Farja seem to be more complex and need more investigation. The building of such long walls needed much effort and some form of administration or power, so it can be said that the past residents of the Wadi were formed into a well organized and hierarchic society.

CHAPTER FIVE

5. General Discussion and Conclusions

5.1. Discussion

The Mahas region has a length of 100 km, lies along the Nile, and most of it belongs to Third Cataract Region. In addition, Nile bends, the seasonal streams and the islands add the habitable lands of the area. The region is unique in its geology and there are few published works on, its geology. It differs from the southern Dongola reach and northern land of Sikkot and Halfa reach. The gneiss rises on both banks from beneath Nubian Sandstone, forming a major cataract and many islands (Vial *et a;l* 1973).

The ground in the area is rugged; with numerous small granitic jebels rising up to a hundred meters (Vial *et a;l* 1973). These natural barriers were the determinant factors of human secured settlement. These rocks were also used as materials for different purposes.

One of the conspicuous features of the area is the presence of dissected channels, marked by deposits of alluvium and sand; and numerous archaeological sites. Also the region is marked by khors and wadis. These have their own ecological and archaeological implications.

In this region, there are many palaeochannels and possible palaeolakes. The sudden appearance of the rocky land in the Third Cataract Region leads to hindrance of the Nile passage with consequent, appearance of numerous channels and lakes. These were filled during Holocene when the whole area was wet as the Nile flood was high. Another very important factor was Yellow Nile (Wadi Hawer) which gave an additional water supply with two flood seasons increasing the Nile flood north to Dongola. These past Nile tributaries were very rich in archaeological sites coinciding with time when they were permanent running rivers. Other paleaochannels of the area are Gaamuffa, Fogo, Jawgul, Kokka, Difoi and Gorgod. They are rich in both archaeological and natural materials and their study will reveal more about the area's history specially during Neolithic and Kerma periods.

The last geological events in the area were the deposition of alluvium. This process of deposition and erosion has continued up to the present time such as the deposition of the silt in seasonal stream of Masida. The alluvial depositions in addition to formation of islands became the substrate on which fauna (including man) and flora survived. The area's soil can be divided into four main categories. These are *gerif, seluka, sagia* (permanent land) and desert soil. Every type has its own flora and fauna increasing the biodiversity of the area.

No pervious ecological studies were carried out in the area. The area is inviting to such studies because it is unique in many aspects such as geology, geography, history and archaeology. The present preliminary studies in addition to those of Adms' (1977), revealed that the ecological zones are water and wet land (Nub; *Aman and Amangar*), the basin strip (Nub; *Farry*), the strip of top edge of the Gref (Nub; *aery*), islands (Nub; *Arties*), the cultivated land or the top ridge of the Nile valley and human settlement strip (houses), Khors (Nu; *Farkies*) and open desert (Nub; *Najae*).

The area is rich in flora and fauna species diversity but not by quantity. The life is manifested near water banks, due to water, limiting factor, so the desert contains no life. One of the abundant groups of animals are migratory birds specially during the winter season. Some rare reptile's species like *Uromastyx* sp. are present in the area.

Archaeologically, the Third Cataract region is fairly well known. Many classic writers, visitors and travelers passed through the area and recorded their observations.

Real archaeological work was conducted by Mahas Archaeological Survey Project of University of Khartoum which established in 1990 by Prof. Ali Osman Mohamed Salih (Dept. of Archaeology, University of Khartoum). The project has recorded more than 750 sites in different seasons in the region and hinterlands. The results of the fieldwork of the Mahas Survey combined with the results of earlier works, particularly on the historic sites. These results have shown that archaeological sites were relevant to the cultural heritage of the people of the Mahas region. This could be found in all of the sites that have been examined. Human habitation since palaeolithic time are concentrated in

Arduan Island and continued to the present time. It has been noticed that such sites were rare like in Napatan and Meroetic periods. This raises a question: why these settlements decreased during these times? Osman (2004) referred this to the assumption of presence of remote desert route avoid passage through the rocky and rugged land of the area. This may be one of the reasons but still the question is not fully answered. Other important notification is the homogeneity of the region. In, most areas of Sudan the archeological sites are concentrated on the eastern bank of the Nile such as the capitals of Kerma, Napata, Meroe, Christian kingdoms and even Islamic kingdoms.

This assumption of unity and homogeneity of the Mahas region is tested by dividing the region into four different habitats according to microclimate and landscape. They showed unity and homogeneity in archaeological aspects. At this point, if the region is compared with neighbors, it can concluded that it is unique in its settlement pattern an it's distribution.

The Third Cataract Region is one of the important parts of northern Sudan from the archaeological point of view. The reasons beyond that are: Third Cataract Region was a unique and borderline area among the neighboring lands throughout historical times. It is clear that the region has its own naturally unifying factors such as the geology, topography, ecology and ethnicity. The political situations in that area was subjected through historical times the local cultural aspects and contemporary cultures. This was reflected on the archaeological remains in the area.

The area invites such studies because it is a unique area in many aspects such as archaeology, history geology and geography. It falls in Sahara region, within this desert environment there are many microhabitats ranging from riverine fresh water and closed island to bare rocky and sandy desert with many water channels (Khors). The study in this work area is an inhabited. It is the richest area of the region in Neolithic, Per-Kerma, Kerma and rich in natural remains. About 65 sites are now registered and some hinterlands are not surveyed yet. This truly invites exploration of the large numbers of wadis and palaeochannels.

This difference may reflects on the human population distribution and activities which in turn should be reflected on the archaeological sites distribution patterns in both ways typologically and periodically.

Now we turn to Wadi Farja to comment on its archaeology, environmental changes, palaeochannel evidences. Different methods and techniques which are applied in this archaeological study are biological, geological and archaeological. They are collectively cropped the same result, reconstructing the Wadi Farja's past ecology as ancient Nile stream. The results confirm Osman's (2004) pre-suggestion, that the wadi was a seasonal stream. Also these methods or most of them are applied in case of Wadi Howar by University of Colon. This multidisciplinary approach is now successful and it is the new trend in the world's different types of research.

According to the dating results and dated archaeological sites, this wadi was a running stream since mid-Holocene. Wickens (1982) estimated that during 60000-3000 BP the area was in wet phase. Noordiwjk (1984) also claimed that during 6500-4500 BP, the weather was dry but more humid than present. The vegetation zone was north to the present zone by 100-250 km. this was accompanied with increased population. He also added that during 4500 - 2000 BP, the weather was drier again and more humid than present. During this time the Eastern Sahara was desiccated. This was accompanied with exudation of population to Nile Valley. Alayne and Grove (1979) mentioned that during 90000-8000 BP, lake levels rose dramatically in coherent pattern after 10000 yr BP, although north west Sahara remained anomalously dry. He also added that from 6000 to 5000 BP Lakes began to dry out at round 7000 BP although Ethiopia was subjected to wetter influences. Our results agree with these findings.

It is very clear that the human settlement pattern in Wadi Farja was relatively intensive relatively from Neolithic period. The Palaeolithic sites were fewer because the human population also was fewer than the dry phase was prevailing at that time. As well as some area’s hinterland is not surveyed yet, but nearby in Arduan Island (which its western and northern sides are situated on the main Nile) there are reasonable number of such sites. The area of wadi Farja and Arduan Island are very near to political center (capital Kerma) they have different protective landscape, so, is seems to be that they are very important land and cultural components of Kerma. This agrees with Osman's (2004) findings.

It seems after the gradual desiccation of wadi Hower before 2000 PC and due to general climatic dry phase, the wadi had become a seasonal stream. This may be one of the reasons of economy shift to agriculture and herding. Some wadi walls constructed for irrigation and water storage accompanied with this climatic change, as some of them were for herd keeping.

Scarcity of more recent date sites and the present of wadi wall in the belly of the wadi in addition to wells could be related to recent hyper-arid (first millennium) times in which the water flows become seasonal or even stopped completely. Presence of some well structures as Bir Giha approve of this assumption. After 7500 B.P. determining environmental condition in central Sahara resulted in drying up of many lakes. This lead to shifting of economy towards domestication of animals as appears from the archaeological arterials around 7000 B.P. the animals involved were cattle, goats and/ or sheep (Honegger 2003).

We have collected the biological data and analyze the settlement pattern to achieve the understanding of past economies. In the zoological data, the attention must be drawn to the vertebrates, particular mammals, to human subsistence live concentrated on animal bones. Animal bones survive well on the majority of archaeological sites that do not have acid subsoils and are usually recovered in a similar way to artifacts. Animal bones identified in wadi Farja mainly belong to cattle. This explains the important of the cattle. Chaix commented on Kerma bone remains: in the food refuse of the town, cattle comprise over 50 per cent of the animal bones, (Chaix 1982; 1984; 1986; 1988). Rock drawings and bone remains reflect clearly that there were many animals endogenous of the rear and now are restricted to the south of Sudan theses are graffiti, elephants, loins, leopards, hippopotamus and antelopes.

Other materials were fish bone and moluskan shells. This indicates the that Wdi dwellers exploited the water resources. The archaeological material collected revealed that Human exploited these lakes, among them were aquatic (crocodile, turtle and hippopotamus) and fish (*Lates* and *Calaias*) materials. The economy of Sahara was of lacustrine based type of fishing and hunting and gathering society. (Smith, 1976). Fishing practice was known since dark (1973) found Ampullarid shells (*Pila sp*.) frequent in Jebel Moya site. He added that it may have been used as bait for fishing. The main occupation of this site is probably contemporary with Meroe. From a test excavation at Jebel Moya itself Clark records cattle and goat bones. In Jebel Um Marrahi (early Khartoum type, on the western bank of the Nile), Gauiter *et al*; (2002) found that fish was the main component of the diet.

However most occupation in Wadi Farja sites specially those of Kerman are associated with grinding stones. Haaland (1987) correlated the large number of grinders found at sites in centeral Sudan to food. Haaland hypothesized that occupants of the site practiced the cultivation of food-plants, namely sorghum (Haaland, 1987). This hypothesis gave further support to Krzyzaniaks interpretation that gathering and cultivation were practiced during the occupation of the Kadero (Krzyzaniak, 1978).

Concerning the geographical zone of Wadi Farja, our findings agree with Chaix and Grant (1993) who mentioned that Kerma would thus be situated in the shrubby savanna zone, with more plentiful food resources, which would support the larger African fauna as well as significant herds of cattle and of sheep and goats. Survey work in the eastern desert has also shown that settlements existed close to the courses of now dry rivers, and suggest that the cultivation of much more extensive areas of land was once possible. (Chaix and Annie Grant, 1993: 399-405). Osman (2004) suggested that the Wadi Farja was a rural area for the Capital Kerma.

Our work needs more examination of the bone remains for studies such as sexing, aging etc…to reveal more information on this subject. The completer work on the subject is the study of plant remains and we hope so. Palaeobotanical work carried out at several sites in the desert of the Northern Province has suggested that the limit of the true desert during the third millennium B.C. was 400 km further to the north than at present (Jackson 1957; Wickens 1975; Mawson and Williams 1984; Ritchie and Haynes 1987). The plants accompanied were many among them are *Rhytchne* sp and sorghum. (Clark *et a*l; 1973; Smith, 1976).

Wadi walls are one of the conspicuous economical-archaeological features of the wadi. These walls are not classified as houses or for defence. All interpretations agree in that they were for economic purposes such as hunting and cultivation.

These walls are not associated with artefact or other evidences which may aid in dating as those in Libyan Desert (Hobler and Hester,1969)which belongs to C-Group as walls dated back to mid-Holocene in Egypt (Reimier, 2004). However, Wadi Farja's archaeological sites indicate human settlement during Neolithic to Kerma periods, which include the C-Group period. Osman and Edwards (2000) suggested the correlation of wall with water-harvesting system. However, few of Wadi Farja's walls are associated with artefacts dated to Neolithic, Kerma and imported Egyptian pottery (new kingdom) periods, (Osman and Edwards, 2000).

However our research revealed that wadi walls in Wadi Farja are more complex and of different types and functions. All authors' suggestions are possibly applicable here in addition to my new suggestions which needs more investigations.

In addition, Nile Oyster samples collected from Wadi Farja, FAR039 are dated back to mid-Holocene (7617 ± 50 BP).

Some walls in Wadi Farja are in the form of straight parallel lines and are situated on raised areas, thus probability of game drive. Some walls in Wadi Farja seem to be more complex and need more investigations. Building such long walls needs effort and a sort of administration or power, so we can say that the past residents of the wadi were in the form of a well organized and hierarchic society. This water system may be one of the oldest in the world.

5.2. Conclusions

1. Statistical analysis of the archaeological sites in different regions revealed that similarity in the distribution pattern of sites was related to their period and type.

- The exceptional area is wadis and khors in which water was the limiting ecological factor for human habitation especially after Kerma periods, this in term reflects on scarcity of religious sites.
- It is important to notify that the region has been homogenous from prehistorical times to the present time.
- Human settlements were most abundant in Islamic, Christian and Kerma periods. Settlements were in the Groups (A, C and X), Meriotic, Naptan and Postmeriotic periods.
- The Mahas Survey Project has finished surveying and registering more than 750 sites in addition to some excavations and salvation of some sites. This needs a tremendous amount of work.

2. This study of Wadi Farja proceeded evidence that:
   - The Wadi Farja was a perennial or possibly seasonal tributary of the Nile and started running at least from mid Holocene
   - Human settlements in wadi possibly began from Holocene till to Kerma period
   - Water scarcity and dryness of the stream began at least 2000 years ago

5.3. Recommendations

1. More survey and excavations of the wadi specially the western and southern areas is needed.
2. survey and excavations of paleaochannels and paleaolakes should be carried out.
3. Archaeobotanincal studies and pollen grain analysis needed to be conducted.
4. Fish bone and snail shell seasonality need to be studied.
5. Seasonality of Wadi Farja stream can be studied by studying growth rings of the snails and fishes.
6. The methods adopted here can be applied for other susceptible wadis in the area or in Sudan in general.

BIBLIOGRAPHY

Abdelrahaman, A. (1989). On Some Environmental and Physiological Factors Affecting Growth and Development of Some Variable Nile Fishes. Ph.D. Thesis, University of Khartoum

Kropelin, S. (2001). Wadi Howar: Settlement Area and Thoroughfare at Thouthern Margin of the Libyan Desert. In: www.Uni-koelnde/inter-fak/sfb389/a2/a2.mainhtm

Abell, P.I., Amegashitsi, L., and Ochumba, P. B. O. (1996). The Shells of *Etheria eleptica* as Records of Environmental Changes in Lake Victoria. Palaeogeogr. Palaeoclimato. 119. pp.215-219.

AbuGiderri, Y.B. (1984). Fishes of The Sudan. Khartoum University Press.

Adams, W.Y (1982). Qasr Ibrim: an archaeological conspectus., *Nubian Studies*, Warminster: 25-33.

Adams, W.Y. (1966). The Vintage of Nubia. Kush 14, 262-83. 1996. Qasr Ibrim. The Late Medieval Period. London.

Adams,W.A. (1977). *Nubia Corridor to Africa*. London and Princton: Allen Lane and Princeton University Press.

Ager, D.V. (1963). *Principals of Palaeoecology*. New York. McGraw-Hall.

Al-Batal, Sanaa M. (1994a). Indigenous Water-lifting Devices and Agricultural Implements in the Nubian Region of the Sudan'. In Medani M. M. Ahmed (ed.). Indigenous Knowledge for Sustainable Development in the Sudan, IAAS, University of Khartoum (233-309).

Al-Batal, Sanaa M. (1994b). Agricultural System, Practices and Traditions in the Northern Sudan: A case Study of the Nubian Region'. in Medani, M.M. Ahmed (ed.). Indigenous Farming System, Knowledge and Practices in the Sudan, IAAS, University of Khartoum, 41-93.

Anthony, E. M. (**1993**). Cilmatic and Cultural Changes in the Southern Atabai, Sudan, from the Fivth through the Third Millennium B.C. In: Envronmental Changes and Human Culture in the Nile Basin and Northern Africa

Until Second Millennium B.C., (Lech Krzyzaniak Michal Kobussiewicz and John Elexander eds.)., Poznan 1993., **379**

Arkell A. J. (1953).The Vertebrate Fauna. In: Shaheinab. Oxford University Press.

Arkell, A.J. (1950). "Varia Sudanica", *JEA.* London. 36. PP. 24-40.

Arkell, A.J. (1953). *Shaheinab. An account of the excavation of a Neolithic occupation site carried out for the Sudan Antiquities Service in 1949-50*, London: Oxford University Press.

Arkell, A.J. (1949). *Early Khartoum. An account of the excavation of an Early Occupation Site Carried out by the Sudan Government Antiquities Service in 1944-45*, London. Oxford University Press.

Bagenal, T.B. and Tesh, F. W. (1978). Age and Growth: In Banegal T. B. (ed). Method of Assessment of Fish Production in Fresh Waters, 101-136. Oxford, Blackwell Scientific Publications, 1987-356.

Bate, D.M.A (1949). A new African Fossil Long-horned Buffalo. *An. Meg. Nat. Hist. ser.*12 vol. 2., 396-498.

Bate, D.M.A (1951). The Mammals from Singa and Abu Hugar. The Pliestcene Fauna of Two Blue Nile Site. *Fossil Mammal* (Natural History).pp.1-28. London.

Bates, M. (1953). "Human Ecology" In A. L. Krober, (ed.). *Anthropology Today, and Encyclopedic Inventory*, Chicago University Press, pp.700-713.

BBC (2005). DR Congo's hippos face extinction". BBC. Retrieved Nov. 14, 2005.

Berry, L and A.J. Whiteman. (1968). The Nile in the Sudan. *Geographical Journal.* 134. England.. 1-37.

Bonnet, C.H. and Reinold. (1993). Deux rapports de prospection dans le desert oriental. *Geneva* XLI:19-26.

Bonnet, CH. (1984). Les fouilles archeologiques de Kerma (Soudan). Rapport preliminaire sur les campagnes de 1982 -1983 et de 1983 -1984. Genava N. S. 32: 5 - 20.

Bourliere, F. (1963). Observation on the Ecology of Some Large

African Mammals, in Howell, F.C. and Bourliere, F.(eds.) *African Ecology and Human Evolution.* (Viking Fund Pupl. in Anthrop., 36:), vol. 26, 43-54.

Buckland, P. C. (1976). *The Environmemntal Evidence from Church Street Roman Sewer System*. Council for British Archaeology, London.

Burckhardt, J.L. (1819). *Travels in Nubia*. John Murray, Albemarle Street. London.

Butzer, W.K. (1971). *Environmental Archaeology An Ecology Approach to Prehistory*. (Second Edition). Aldine. Atherton. Chicago and New York.

Butzer, W.K. (1976). *Early Hydraulic Civilization in Egypt*. The university of Chicago Press, Chicago and London.

Cambell, J.B. (1977). The Upper Palaeolithic of Britin (2 vols), Oxford Universty Press.

Chaix , L. (2003). Report on the 2003 Poznan Symposium by JUAN JOSÉ CASTILLOS Internet).

Chaix , L. (1982). Secondenote sur la fauna de Kerma (Soudan) Campagnes 1981 –1982. *Extrait de Genava*, *n.s.*, Vol. 30: 66 – 70.

Chaix , L. (1984). Troisiéme note sur la fauna de Kerma (Soudan) Campagne 1983 –1984. *Extrait de Genava*, *n.s.*, Vol. **32**: 30 – 34.

Chaix, L and Grant, A. (1993). Palaeoenvironment and Economy at Kerma, Northern Sudan, During the Third Millennium B.C.: Archaeozoological and Botanical Evidence (Series "Studies in African Archaeology" Lech Krzyżaniak, Michał Kobusiewicz, John Alexander (eds). Environmental Change and Human Culture in the Nile Basin and Northern Africa Until the Second Millennium B.C. Poznań 1993) pages 382-391

Chaix, L. (1993).The Archaeozoology of Kerma (Sudan)(1993), in: Biological Anthropology and Egypt , 175-185.

Chaix, L. and A. Grant. (1987). A study of a prehistoric population of sheep (Ovis anes L.) from Kerma (Sudan): archaeozoological and archaeological implications. *Archaeozoologi*a 1(1): 77 - 92.

Chaix, L. and Grant, A. (1993). Palaeoenvironment and Economy at Kerma the Third Millennium B.C.: Archaeological and Botanical Evidence: In Environmental Change and Human Culture in The Nile Basin and Northern Africa Until the Second Millennium B.C. Poznan 1993

Chwgunova, N.I. (1959). Handbook on Determination of Age and Growth of Fishes. USSR. Acad. of Sci. Press.

Clague, John *et al*. (2006). Open Letter by INQUA Executive Committee" *Quaternary Perspective*, *the INQUA Newsletter* International Union for Quaternary Research 16(1):PDF)

Clark, J. D. (1973). Preliminary Report of An Archaeological and Geomorphological Survey in the Central Sudan., January-March 1973. *Mimo.*

Clark, J. D. (1976). The Domistication Process in Sub-Saharan Africa with Special Reference to Ethiopia. Higgs, E. (ed.)., *Origin De Le Levage et De La Domestication.*

Clark, J.D., and Stemler, A.B.L. (1975). Early Domisticated Sorhum from enteral Sudan., Nature, vol., 254, No. 5501, 588-591.

Coope, G.R. (1977).Fossil Coleopteran Assemblages as Sensitive Indicators of Climatic Changes During the Devensian (last) Cold Stage, *Phil. Trans. R. Soc. Lond.*, B 280, 313-340.

Coope, G.R. (1977b). *Quaternary Coleopteran as Aid in Interpretation of Environmental History*, In F.W. Shotton (ed.) British Quaternary Studies- Recent Advances, Oxford Univ. Press. Oxford, 55-68.

Coope, G.R. (1968a). An Insect Fuan from Mid- Weichelian Deposits at Brandon, Warwickshrine. *Phil. Trans. R. Soc. Lond.*B 254, 425-456

Costantini, L (1983). Bioarcheological Analysis of Soil Sample and Pot Sherds from the Site of Saggai 1, Sudan., Pottery Using and Hunnting at Saggai (Sudan): In Precondiction for Food Production., Preistoria e Protostoria della Civilia antiche., vol.XII, 1983. 47-49.

Costantini, L., Vattovich,. R. Piperno, M. and Sadr, K. (1982). Preliminary Report of the Site of Mahal Teglinos (Kassala), November 1981. Nyame Akoma 21, 30-33.

de Henizelin, J. (1968). Geological History of the Nile Valley in Nubia, edited by Fred Wendorf, Vol.1.Dallas: Fort Burgwin Research Center and Southern Methodist Univ. Press. Pp. 47-48)

Dee DeKoche (2003). Cited from: Wilkinson, K. and Stevens, C. (2003). *Environmental Archaeology: Approaches, Theory & Applications*. Tempus Publishing Ltd. Great Britain.

Dimbleby, G.W. (1957). Pollen Analysis of Terrestrial Soils, *New Phytol.*, 56,12-28.

Dimbleby, G.W. (1961). Soil Pollen Analysis, *J.Soil Sci.*,12, 1-11.

Dorst, J. and Dandelot, P. (1970). A Field Guide to the Larger Mammals of Africa. Collins, London.

Ebert, J. I and Hitchcock, R.K. (1978). Ancient Lake MakGadigadi, Botswana: Mapping, Measurement and Paleoclimatic Significance, In E. M. Van Zindern Bakker and J. A. Coetzee (ed.) *Palaeoecology of Africa and the Surrounding Islands*, Balkema, Rotterdam, 47-56.

Edwards, D. and Osman, A. (2000). 'The Archaeology of Arduan Island - the Mahas Survey 2000'. *Sudan & Nubia* 4, 58-70.

Edwards, D.N and Osman, A. (1994). The Mahas Survey, 1990, Interim Report and Site Inventory. Report No.2 .University og Cambriges.

Edwards, D.N and Osman, A. (1992). The Mahas Survey, 1991, Interim Report and Site Inventory. Report No.2. University og Cambriges.

Elias, S. A. (1994). Quaternary Insects and Their Environments; Washington, D.C., Smithsonian Institution Press.

Evans, J. G. (1972). *Land Snail in Archaeology*, Seminar Press, London.

Evans, J. G. (1978). *An Intoduction to Environmrntal Archaeology*. Paul Elek, London.

Evans, T.E. (1991). The Nile Resource Evolution, Resource Management, Hydropolitics and Legal Issues. Prepared for publication by PP Howel and JA Allan. for Conference held in London at the Royal Geographical Society and the School of the Oriental and African Studies, University of London on 2-3 May

1990.

Faegri, K. and Inverson, J. (1975). *Textbook of Pollen Analysis*. Blackwell Scientific Publication, Oxford. London Edenbugh Melbourne: 1, 59

Fattovich, R (1993). The Gash Group of the Eastern Sudan: An outline. In: Envronmental Changes and Human Culture in the Nile Basin and Northern Africa Until Second Millennium B.C., (Lech Krzyzaniak Michal Kobussiewicz and John Elexander eds.)., Poznan 1993.,439-440.

Flannery, K. V. (1971). "The Origins of the Village as a Settlement Type in Mesoamerica and the Near East: A Comparative Study." In Peter J. Ucko, Ruth Tringham, and G. W. Dimbleby, eds. *Man, Settlement and Urbanism*. London: Duckworth, 1972. pp. 23-53.

Fuller, D and Edwards, D. (2001).Medivial Plant economy in Middle Nubia: Some archaeobotanical evidence from Nauri. *Sudan & Nubia* 5: 96-103.

Gauiter, A; Linseele, V. and Van Neer, W. (2002). The Fauna of the Early Khartoum Occupation on Jebel Umm Marrahi (Khartoum provinc, Sudan).pp. In *Tides of the Desert* -Gezeiten der Wuste (ed. Jennerstrasse 8)., 337-344

Gautier. A (2003). Kadero: the fauna revisited. Report on Poznan the 2003 Symposium by Juan Jose Castillos.

Gordon, J.E. (1981). Glacier Margin Fluctuation During the 19th and 20th Century in the Ikamiut Kangerdluarssuat Area, West Green Land, *Arct. Alp. Res.*,13, 47-62.

Grizmek, B. (1972). Grizmeks Animalss Life Encyclopedia. Vol. 13. Van and Reinhold Campany. New York.

Haaland, R. (1981). *Migretory Herd Men and Cultivating Women.*

Haaland, R. (1987). Socio-economic differentiation in the Neolithic Sudan. Oxford. BAR Intrnational Serios 350. Cambrigde Mongraph in Africa Archaeology 20.

Halstead, P. and O'Shea, J (2003). Cited from: Wilkinson, K. and Stevens, C. (2003). *Environmental Archaeology: Approaches, Theory & Applications*. Tempus Publishing Ltd. Great Britain.

Hester, J. J.; Hobler, P. M. and Russell, J. (1969). New Evidence of Early Roads in Nubia. American Journal of Archaeology, Vol. 74, No.4. (Oct.1970), pp.385-389.

Heusser, L. and Balsam, W.L. (1977). Pollen Distribution in the North- east Pacific Ocean, *Quat. Res.*, 7, 45-62.

Hirst, K. Kris. (2007). From: hpp/www.About.com, K. Kris Hirst: Archaeology (Settlement Pattern).

Hobler, P.M. and Hester, J.J. (1969). Prehistory and Enviroment in the Libyan Desert. The South African Bulletin. Vol. XXII(Part IV). No.29. pp.120-130.

Honegger, M. (2003): Report on the 2003 POZNAN SYMPOSIUM by JUAN JOSÉ CASTILLOS Internet

Hume, W.F. (1934). *The Geology of Egypt.* Vol. II. Government Press: Cairo.

Hume, W.F. (1935). *Geology of Egypt.* Vol. II. Part II. The Later Plutonic and Minor Intrusive Rocks. Government Press: Cairo.

Jesse, F. and Keding, B. (2002). Death in Desert- Burials in Wadi Hower Region (Eastern Sahara): In Tides of Desert – Gezeiten der Wuste. Edited by Jennerstrasse 8.

Jones, D. S. (1989). March Growth Rings and Longevity in Bivalves. *American Conchologist*, Vol 17, No. 1, 12-13.

Karlen, W. (1973). Holocene Glacier and Climatic Variations, Kebenekaise Mountains, Sweden Lapland, *Geogr. Annlr.*, 55A, 29-63.

Kerney, M. P., and Cameron, R. A. D. (1979). Field Guide of the Snail, Collins, London.

Kerney, M. P., Preece, R.C. and Turner, C (1980). Molluscan and Plant Biostratography of Some Late Devensian and Flandrin Deposit, Kent, *Phil. Trans. R. Sco. Lond.*, B291, 1-43.

Kilford, W. K. (1963). *Elementary Air Survey*, Pitman, London.

Krzyzaniak, L. (1978). New light on early food production in the central Sudan. *Journal of African History*. xix.2, 159-172.

Krzyżaniak, L. (1992). Late prehistory of the Central Sudan, Poznań

1992.

Lamb, H.H. (1982). Climate History and the Modern World. METHUN London and New York.

Lisitzin, E (1974). *Sea-Level Changes*, Elsevier, Amsterdam and New York.

Lourens, L., Hilgen, F., Shackleton, N.J., Laskar, J., Wilson, D., (2004) "The Neogene Period". In: Gradstein, F., Ogg, J., Smith, A.G. (Eds.), *A Geologic Time Scale 2004*. Cambridge: Cambridge University Press.)

Lowe, J. J. and Walker, M.J.C. (1984). *Reconstructing Quaternary Environments*. Longman Group (Ltd).

Mackenzie, P.Z. (1954). Catalog of Wild Mammals of the Sudan. Sudan Musuem (Natrual History). Puplication No. 4.

Macklin, G.M; Welsby, D.A. and Mark, D.B. (200l). Holecene River Dynamics in the Saharan Nile: geochronology and Geoarchaeology on the PEPIII Transect in Donala Reach, Northern Sudan.

Magid. A. (1982). *The Khartoum Neolithic in the Light of Archaebotany: A Case Study from the Noflab and Islang Sites*. Unpublished M.A. Thesis. Khartoum: University of Khartoum.

Magid. A. (1984). Macrobotonical Remains from Shaqadud: Interim Note. *Nyame Akuma*, no.24/25., 27-28.

Malek, E.A and Cheng, T.C. (1974). Medical and Economic Malacology

Academic Press New York and London

Marks, A. E. A., Mohammed–Ali, A., Peters, J. and Robertson, R. (1985). The Prehistory of the Central Nile Valley as Seen from its Eastern. *Archaeology*, vol., 12, 261-277.

Mohammed-Ali, A (1982). The Neolithic Qeriod in Sudan c. 6000-2500 B.C. British-Archaeology Reports International Series 139. Cambrige Monograph in African Archaeolog.

Moore, P. D and Web, J. A. (1978). *An Illustartion Guide to Pollen Analysis* . Hodder and Stoughton, London.

Morgan, V.I. and Budd, W. F. (1975). Radio-echosounding of the Lambert Glacier Basin, *J. Glaciol.*, 15, 103-111.

Noorwdijk, M. (1984).Ecology Textbook for the Sudan. Khartoum University Press.

Norton. P. E. P. (1977). Marine Moluska in the East Anglinan Pleistocene, In F. W. Shoton (ed.), *British Quaternary Studies – Recent Advances*, Oxford Univ. Prss, 34-53.

Osborne, P. J. (1972). Insect Fauna of Late Devensian and Flandrian Age from Church Stretton, Shropshire, Phil. Trans. R. Soc. Land., B 263, 327-367.

Osman, A. (1978). The Ecomomy and Trade of Medeivial. Ph.D Thesis. Universty of Cambridge.

Osman, A. (2004). History of Settlement in the Third Cataract Region During Ancient and Medivieal Times..*Azania*. 39. 2004

Osman, A. and Edwards, D.N (2000). The Mahas Archaeological Suvey,2000 Aprleminary Report . *'Languish, Settlement & Long-term History in Upper Nile'* . Cambridge.

Peacock, J. D., Graham, D. K. and Wilkinson, I. P. (1978).Late-glacial and Poatgliacail Marine Environment at Andyne, Scotland, and their Significance in the Interpretation of the History of the Clyde Sea Aera, *Rep. Inst. Geol. SCi.*, 78/17, 1-24.

Pilsbry, H. A. and Bequaetert, J. (1927). The aquatic mollusks of the Belgian Congo with geographical and account of Congo malacology. Scientific results of the American Museum of Natural History of Congo Expidition. General Invertebrate Zoology. Vol. 10. Pp. 69-659

Piperno (2003). Cited from: Wilkinson, K. and Stevens, C. (2003). *Environmental Archaeology: Approaches, Theory & Applications*. Tempus Publishing Ltd. Great Britain.

Preece, R. C. (1981). The Value of Shell Microculptue as a Guide to th Identification of the Land Molluskan form from Quaternary Deposit, *J. Conch.*, 30 331-337.

Raymer, L. (1978). The Use of Uniformitarianism and Analogy in Paleaoecology, In: D. Walker and J. C. Guppy (eds.) Biology and Quaternary Environments, *Astralian Acad. Sci.*, Canbera, 245-258.

Reinold, J. (2000). Archéologie au Soudan. Les civilisations de

Nubie. Paris.

Renfrew, C and Bahn, P. (1991). *Archaeology Theories Methods and Practice*. Thames and Hudson Ltd. 195-232

Riemer, H. (2000). "Abu Gerara: Neolithic Camp Sites Between Djara and Dakhla Oasis" International Symposium Cultural Markers in the Later Prehistory of Northeastern Africa and Our Recent Research Puszczykowo near Poznan, 29th August - 2nd Sep. 2000.

Rodrinues, D, Abell, P., and Kropelin, S, (2000). Seasonality in the early Holocene climate of Northwest Sudan interpretation of *Etheria Elliptica* shell isotope data. *Glopal and Planet Change*, 26(2000)181-187.www.elseveer.com/locate/glopacha.

Roowely-Conwy, P. (1986). Archaeological Evidence for Crop-plant in Lower Nubia, c. 700 B.C.- A. D.1800: Some Preliminary Results. R. Dehlin and T. Higg (eds.): Sixth International Conference for Nubian Studies, Abstracts of Communications 110-111. Klassisk Institutt. Universiteteti Bergen.

Rouse, I. (1971). Settlement Pattern in Archaeology. *Man, Settlement and Urbanism*. London: Duckworth, 1972,. 94-108

Sadig, A.M. (2004). The Neolithic of the Nubia and Centeral sudan, An Intra-Regional Approach . Ph.D Thesis. Universty of Khartoum.

Sadr, K (1993). Animal Exploitation Between fivth and Sixth Cataract *ca*. 8500-7000 B.P: A preliminary Report on the Fuana from El Damer, Abudarbein and Aneibis. In: Envronmental Changes and Human Culture in the Nile Basin and Northern Africa Until Second Millennium B.C., (Lech Krzyzaniak Michal Kobussiewicz and John Elexander eds.)., Poznan 1993.,42.

Saikawa Y, Hashimoto K, Nakata M, Yoshihara M, Nagai K, Ida M, and Komiya, T. (2004). Pigment Chemistry: The Red Sweat of The Hippopotamus, *Nature*, 429(6990): 363. PMID 15164051

Sararnisto, M. (1974). The Deglacition History of the Lake Superior Region and its Climatic Implications. *Quat. Res*.4,316-439.

Shinnie, P.L. (1967). *Meroe a Civilization of the Sudan*. Londers (Thmes and Hudson).

Singer, R and Bone, E.I. (1960). Modren giraffe and the fossil Giraffaids of Africa. *Ann. South. Afr. Mus.* 45(4).pp.375-548.

Slobodkin, L. B. (1961). Growrh and Regulations of Animal Popultions. Holts, Rinehart and Winston. New York.

Smith, A. B. (1980). The Neolthic Tradition in Sahara. In:The Sahara and the Nile.(M.A.J.Williams.ed.). 452-465.

Smith, A. B. (1976). A microlithic Industry from Adrar Bous, Niger. *VIIe Panafrican de prehistortoire, Addis Ababa, 1971.*

Smith, G. I. (1976). Paleaoclimatic Rcords in the Upper Quaternary Sediments of Searles Lake, California, USA. In S.Horie (ed.) Paleoclimatology of Lake Biwna and the Japanese Pilestocene, vol.4, C nn. South. Afr. Mus. 45(4).pp.375-548. Contribution to the to Paleoclimatology of Lake Biwna and the Japanese Pilestocene, no 155, Koyoto Univ.Otsu, 577-604.

Stemler, A. B. L. (1980).Origin of Pant in the Sahara and the Nile Valley . M. A. J. Williams and H. Faure (eds.). *The Sahara and the Nile Valley: Quaternary Environment and Prehistoric Occupation in northern Africa.*, 503-526. A. A. Balkma /Rotterdam.

Street, Alayne, F. and Grove, A. T (1979). Global Maps of Lake Levels Fluctuations Since 3000yr BP, *Quaternary Research*, 12, 83-118.

Stringer, C.B. (1979). A revaluation of the Fossil Human Calvaria from Singa, Sudan. *Bull. British Museum Natural History (Geol.)*, 32. 77-83.

Sugden, D. E, and John, B. S. (1976). Glacial and Landscape. Edward Arnold, London.

Tahir , Y. F. (2006). Palaeoenvironmental Implications of Zooarchaeological Remains from Wadi Farja in the Third Cataract Region. Proc. 11th International Conference of Nubian Studies. Warsaw University 27-Agu-2-Sep. 2006.

Tahir , Y. F. and Sadig, A.M. (2007). Nature and Function of the Walls of Wadi Farja Palaeochannel; the Nile's Third Cataract Region. Proc. Prehistoy of Boznan. 2007.

Thownshend, J. R. G. (1981). *Tertian Analysis and Remote Sensing*. Allen and Unwin. London and Boston.

Thunell, R. (2003). Cited from: Wilkinson, K. and Stevens, C. (2003). *Environmental Archaeology: Approaches, Theory & Applications*. Tempus Publishing Ltd. Great Britain.

Thurmond A. K.; Stern.R.J; Abdelsalam. M.G; Nilson. K.C ; Abdeen.M.M and Hinz.E (2004). The Nubian Swell. , *J .Afr. Ear. Sci.*,39, 401-407.

Tigani el Mahi, A. (1982). *Fauna Ecology and Socio-Economic Conditions in the Nile Environment*. Bergen Mimeo.

Vail, J. R. *et al*. (1973). *Geology of Third Cataract, Halfa District, Northern Sudan, Sudan.* Ministry of Industry and Mining, Geological and Mineral Resources Department Bulletin No. 22.

Van Andel, Tjeerd H. (1994). *New Views on an Old Planet: a History of Global Change* (2nd edition, 1994)

Verstappen, H. Th. (1977). *Remote Sensing in Geomorphology*, Elsevier, Amsterdam and New York.

Vial R.J.*et al*; (1973). Geology of the Third Cataract, Halfa District, Northern Sudan. Minstry of Industry and Mining Geological and Mineral Resources Department. Bullitin No.22.

Wells, L.H. (1963). Note on a bovid from the Peliosocene of Abu Hugar. *Ann. Meg. Nat. Hist. 6*. Pp.303-304. London

Welsby, D. A. (1995). 'The North Reach Survey'. The 1994 season. a: The Survey . SARSN 8, 2-7.

Welton, M. (1944). Pollenanalytische, Stratigraphiche und Geochronologische Untersuchugen aus dem Faulenseemoos bei Speies, Veroff.Geobot. Istt. Rubel, 21., 1-201.

Wendof,. F. and Schild, R. (1992). Middle Palaeolithic of North Africa: A Status Reort. In: New Lights on the Northeast African Past, Africa Prehistorica

Wendof,. F. and Schild, R. (1976). Studies in Archaeology: Prehistory of the Nile Valley. Academic Press.INK New York. (303-310).

Wendorf, F. (1968). The Prehistoty of Nubia. 2 vols. Dallus. (Wendorf. ed.).

Wendorf, F. , Schild, R., Haynes, C.V., Kobusiewicz, M., Gauiter, A., Hadidi,N., Wiexkowska, H. and Close, A (1977).Late Pleistocene and recent climatic changes in the Egyptian Sahara. Geographical Journal. Vol. 143.No.2. pp. 211-234.

Wendorf. F. *et al* (1988).New radiocarbon dates and Late Palaeolithic diet at Wadi Kubbaniya, Egypt , Antiquity 62, 1988.

Whiteman, A. J. (1971). *The Geology of the Sudan.* Oxford.

Whiteman, A. J. (1968). "A Dune Catena on the Clay Plains of the West Centeral Gizera, Republic of Sudan." *J.Soil.Soc.*19 PP.23-50.

Wickens, G. E. (1982). "Paleobotanical Speculation and Quaternary Environments in the Sudan". In: Adamson, D. A. and Williams, M. A. J. (eds). A Land Between Two Niles. Balkema. Rotterdam. PP. 23-50.

Wickens, G.E (1975). Change in the Climate and Vegetation of the Sudan since 20000 B.P. *Proc. 8th Plen. Session AETFAT, Geneva 1974. Boissiera 24.*

Wilkinson, K. and Stevens, C. (2003). *Environmental Archaeology: Approaches, Theory & Applications*. Tempus Publishing Ltd. Great Britain.

Wolf and Nowotnick (2005). 'The Second Season of the SARS Anglo-German Expedition to the Fourth Cataract', *SUDAN & NUBIA* 9 (2005), pp. 23-31

Wolf, P. R. (1974). *Element of Photogrammetry*, McGraw-Hill, New York

Woodward, A. S. (1938). A Fossil of the Ancesteral Bushman from Anglo-Egyptian Sudan, *Antiquity 14, 190-195.*

Worcestershire County Council (2004**).**Worcestershire.whub.org.uk/pdf .

Arabic References:

Hakim, A.A and Bonnet, C. **كرمة مملكة النوبة- تراث افريقي من عهد الفراعنة** (2003).

Honnger, H. **مجموعة (أ) وما قبل كرمة:** (2003)
(النوبة- ممالك النيل في السودان)Nubia reinos de Nilo en Sudan. Fundacion" la Ciaxa

Web Sites:

http://www.biology-online.org/dictionary/Environment"(2006)"

http// www.en.wikipedia.org/wiki/Landscape_archaeology(2006)

http// www.flmnh.ufl.edu/envarch: Environmental Archaeology, The Florida Museum of Natural History, University of Florida (2006).

http// www.Wikipedia .com (the free encyclopedia. 2006)

http// www.york.ac.uklinst/edu/university

http://www.stratigraphy.org/gssp.htm