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ENVIRONMENTAL TRAINING & MANAGEMENT IN AFRICA (ETMA)

ENVIRONMENTAL MANAGEMENT IN THE SUDAN

UMM KADDADA DISTRICT
(NORTHERN DARFUR PROVINCE)

Final Report

By

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INTRODUCTORY NOTE

Residents of the Umm Kaddada Area in Eastern Darfur, like any others in their comparative latitudes in the Sudanese-Sahelian belt who previously practiced a sort of farming which enabled them to restore the soil fertility, are now suffering from a self-perpetuating cycle of drought, deforestation, shortened fallows, loss of soil fertility and declining crop yields. Their future well-being depends largely on breaking this cycle.

Before the current destructive cycle began, farmers grew millet, sorghum, groundnuts, sesame and watermelon, all adjusted in a rotation of 3-10 years which allowed for the practice of gum arabic production. This practice allowed the farmers to earn cash income by selling the gum arabic for export and simultaneously the nitrogen-fixing and soil-retaining properties of the trees restored the fertility of the soil. The advent of drought conditions in the area, aided by population growth, increased local demand for fuel and pressure for more food production, has led to decreased periods of fallow and hence to the removal of the vegetation cover and the dismantling of the top soil layer on the Qoz sands. The ultimate result of this process is the reactivation of the consolidated sand dunes and the enhancement of the moving sands with all its ecological and socio-economic consequences.

Decreasing income has forced the local population to resort to other alternatives which in turn add to the process of degradation. At the same time prevalence of drought conditions in the northern parts of Darfur and Kordofan has pushed into the area under study nomadic herders in huge numbers searching for pasture and drinking water, thus intensifying the ongoing process of desertification.

These changing circumstances, however, received for a long time no corrective measures at all. The remoteness of the area and its harsh environmental conditions have sheltered it from any attempts to measure the scope and magnitude of destruction. The sporadic attempts to counteract desertification and deforestation made in other parts of the country since the early forties were not felt in this area. Even the Master Plan to combat desertification in the Sudan which was prepared jointly by the Ministry of Agriculture, the U.S. National Research Council, the United Nations Environment Program and Development Program and the Food and Agriculture Organization did not include this area. The resulting Desert Encroachment Control and Rehabilitation Program (DECARP) was not felt in this area despite the previous contribution of the area to the gum arabic production. None of its three subprojects, sand dunes fixation, shelterbelt establishment and gum belt restocking, has been implemented in this area.

This present work is concerned with some aspects related to the physical and non-physical environment of the Umm Kaddada area in Eastern Darfur. The work is an outgrowth of research on environmental changes as caused by prolonged drought conditions and the irrational interference of man. It is a joint effort of the IES (Institute of Environmental Studies) of the University of Khartoum and Clark University in the USA. It is prepared for the United States Agency for International Development. It is part of the E.T.M.A. (Environmental Training and Management for Africa) Program in the Sudan. It covers one of eight sites selected for resource inventory and monitoring research in the country.

This particular site stands out for its remoteness from the centre of development in Eastern Sudan and for its harsh environmental conditions. It is well characterized by neglect despite its rather unique historical,

cultural and political backgrounds. Rapid changes, particularly in the last few decades, in the sphere of socio-economic life, have left their impacts on the natural resource and population dynamics. Accordingly the area is found to be interesting in many respects.

This work is primarily composed of three main phases complementing each other. The first phase is mainly resource inventory report whose main objectives are to pick up the indicators of change and to review the physical and non-physical components of the area in the past hundred years as a foundation and background to the present situation. For monitoring purposes and formulation of future plans this phase is extremely important. In this respect both environmental stimuli and human responses are taken as the main focus of the study.

Materials collected in this phase are presented in part one of this work under the heading of a Basline Trend Analysis Report. Basic information was gathered from the Civil Secretary Reports of the British Administration in the Sudan prior to the independence of the country. Other sources of information for this part are Sudan Notes and Records, scattered administrative reports and information fragmented in literature. It is worth mentioning here that comprehensive data for this area are completely lacking which suggests the urgent need for intensive investigation. The findings of this part are summed up, assessed, analyzed and displayed in the form of texts, maps, figures and tables depicting the natural and human factors relevant to the problem of environmental degradation in the area. It is concerned with three main spheres of inquiry: 1) the ecological structure of the area, i.e., classification of the area into different ecological units with different resource potentials; 2) Landuse inventory mainly from LANDSAT imaging and aerial photos (agricultural statistics of the Ministry

of Agriculture, Food and Natural Resources are completely lacking in this area) and 3) human ecology as an actual initiator of ecological degradation in the area, i.e., assessment of the human assets and constraints as well as human settlements and conditions of infrastructure.

The second phase of the study is monitoring of the physical and non-physical components of the area. It is essentially based on phase one and studies the indicators selected therein. Data for this second phase were mainly collected through field research conducted by scholars with different academic backgrounds (climatology, meteorology, geology, pedology, ecology, agriculture, animal husbandry, hydrology, rural development demography, geography, sociology and economics). Approach, methodology and findings of this phase are presented in part two of this work under the heading of Environmental Monitoring. This part is mainly analysis and assessment of the data collected in the field through a number of field investigations. Together with part one it presents the main features of change and transformation and attempts to measure the magnitude of environmental degradation with the aim of formulating future plans to correct the situation in the area.

Phase three is concerned with the organization and conduction of a regional seminar at Umm Kaddada town, the centre of the study area. The idea was to disseminate the knowledge gained through the previous phases among the local inhabitants. The meeting of scientists from different academic disciplines at central and regional levels together with the actual affected people within the affected area is intended to add new scientific perspectives by investigating degraded and desertified areas. Objectives and results of this phase are presented in part three of this work. This part is mainly composed of the proceedings of the seminar and the proposals formulated by the participants for the future development of the area.

It is worth mentioning here that each part of this work was primarily a separate task with its own approach, methodology, results and conclusions. The three parts are by no means contradictory but rather complementary to each other, reflecting the situation in the past, the changes taking place at present and the transformation potentialities and possibilities of the future. Therefore we can safely regard part three as the summary and conclusions of the whole work.

PART ONE

BASELINE AND TREND ANALYSIS REPORT

I. INTRODUCTION:

A) Criteria for selection:

The Umm Gadlada area, located in northern Darfur, has certain characteristics that make it attractive to environmental monitoring.

The area is very remote and has been a sort of back water often ignored by development work. Data about the area is not only quite limited but is also scattered throughout many pamphlets and reports. There is no comprehensive study about this particular area. Thus rather than being a full blown baseline/trend analysis, this paper is more of a feasibility study to see what is actually there and what potential the area has for a monitoring program.

The study area is dominantly a sandsheet formation bounded on the east and west by hills of the Nubian sandstone formation. This sandsheet is located on top of an underground water basin. There is no surface run-off in the area.

The study area is in the rain shadow of central Darfur highlands thus experiences a relatively lower amount of rainfall than other places on the same latitude (see climatic description of the area in section IIB of this report).

The study area is part of what is called a sedentary zone located between zones of camel owning nomads to the north and cattle owning nomads to the south. Therefore the area is clustered by a number of settlements, the location of which is a function of water availability and nearness to the transportation routes.

The study area is dominated by the Berti tribes whose members are accustomed to a sedentary way of life and are more attached to their lands than the other tribes to the north and south. Conflicts often occur between the

sedentary Berti tribes and the mobile tribes, since the settlement area of the former separates the grazing area of the latter.

Permanent settlement around water sources has induced over-stocking and signs of desertification, the result of which is the declining importance of the study area as a sedentary zone. This is evidenced by the reactivation of the goz sands which result from deflation and sand accumulation processes. This, in turn, has resulted in the reduction of cultivated areas, forcing a movement toward the use of reserved lands. Satellite photos reflect clearly "N-S" strips of lands, with bright colour within the zone of the wood land savanna (Combertum Gordofanum-Dalbergia Albizzia Sericocephala woodland savanna). In addition, in this woodland savanna zone of the study area there are a number of isolated islands with bright colour surrounding the settlements. This indicates that the repeated cultivation of millet, groundnuts and sesame without shifting practice and fallow periods has caused the reactivation of the goz sands and increased the rate of desertification.

The study area was once part of the transportation zone crossed by west-east and south-north routes. It was a thriving commercial area 60 years ago when lorry transport to the west was focused in the region. From the end of the 1950's through the beginning of the 1960's drastic changes occurred due to the opening up of Southern Darfur and the shift of the transport zone southward, thus bypassing the study area. The significance of this development will be elaborated in Part III.

The main hypotheses which this baseline report should touch can be summarized as follows:

Umm Kaddada declined in importance as an administrative centre as part of the British administration policy in Western Sudan.

The transport zone centered around Umm Kaddada has shifted southward in response to development measures in Southern Darfur.

The sedentary zone previously including the Umm Kaddada area shifted to the south in response of deteriorating environmental conditions.

At the very time water became available in the Umm Kaddada area, people started to migrate southward. This situation tends to contradict the hypothesis that water is the key factor for development.

The people of Umm Kaddada have responded differently to the recent changes. Their traditional socio-economic foundations were challenged and put under question.

The Umm Kaddada area was pushed into the backwater of development.

B) Location of the study area (Umm Kaddada area):

The study area is the Eastern District of Northern Darfur Province with Umm Kaddada settlement as its centre. It is geographically located within the 12th and 15th degrees of latitude and the 25th and 28th of longitude, covering an area of some 40,000 sq km^2 (see locator Fig.1).

C) Main indicators to be used in the monitoring program:

The main indicators to be used in the monitoring program are:

1. The climatic data which will help in explaining the climatic fluctuations and forecasting the future trends.
2. The morpho-dynamic processes which produce the present morphological features in the forms of extensive sand-sheets, consolidated and reactivated sand dunes, buried and uncovered Nubian sandstone formations.
3. The presence of underground water in relation to the Nubian sandstone formations.

4. Removal of the vegetative cover in relation to the environmental deterioration and types of economic activities and the effect of that on the quality of soil.

5. The decline of Umm Kaddada as an administrative and trading centre.

6. The southward shift of the transport and sedentary zones.

7. The southward movements of the people of Umm Kaddada in response to the recent environmental and socio-economic changes.

II. Environmental conditions of the study area:

A) Geology of the study area:

The study area is mainly composed of a belt of fixed or recently reactivated sand dunes which are superimposed on the Nubian sandstone formations. The latter appear at the surface in confined localities, near Umm Kaddada, Burush and El Hilla settlements, in the Northern part of the study area particularly in the surroundings of the Berti Hills. The Basement Complex emerges at the surface in form of isolated pockets particularly in the eastern and western fringes of the study area.

In the south-western part of the study area alluvial clays and sands are found deposited in Wadis and drainage basins, particularly in W. Abu Hamra, W. Keira, W. Golo and W. El Ku.

The drainage system of this study area is predominantly composed of periodic run-off. Permanent surface run-off is completely absent. The presence of of a number of wells scattered all over the study area gives the indication that the whole study area is located on top of an underground water basin the significance of which will be discussed in relation to the socio-economic conditions in the study area (See Fig. 5).

LOCATION OF THE STUDY AREA & INVESTIGATED SETTLEMENT

Fig(1)

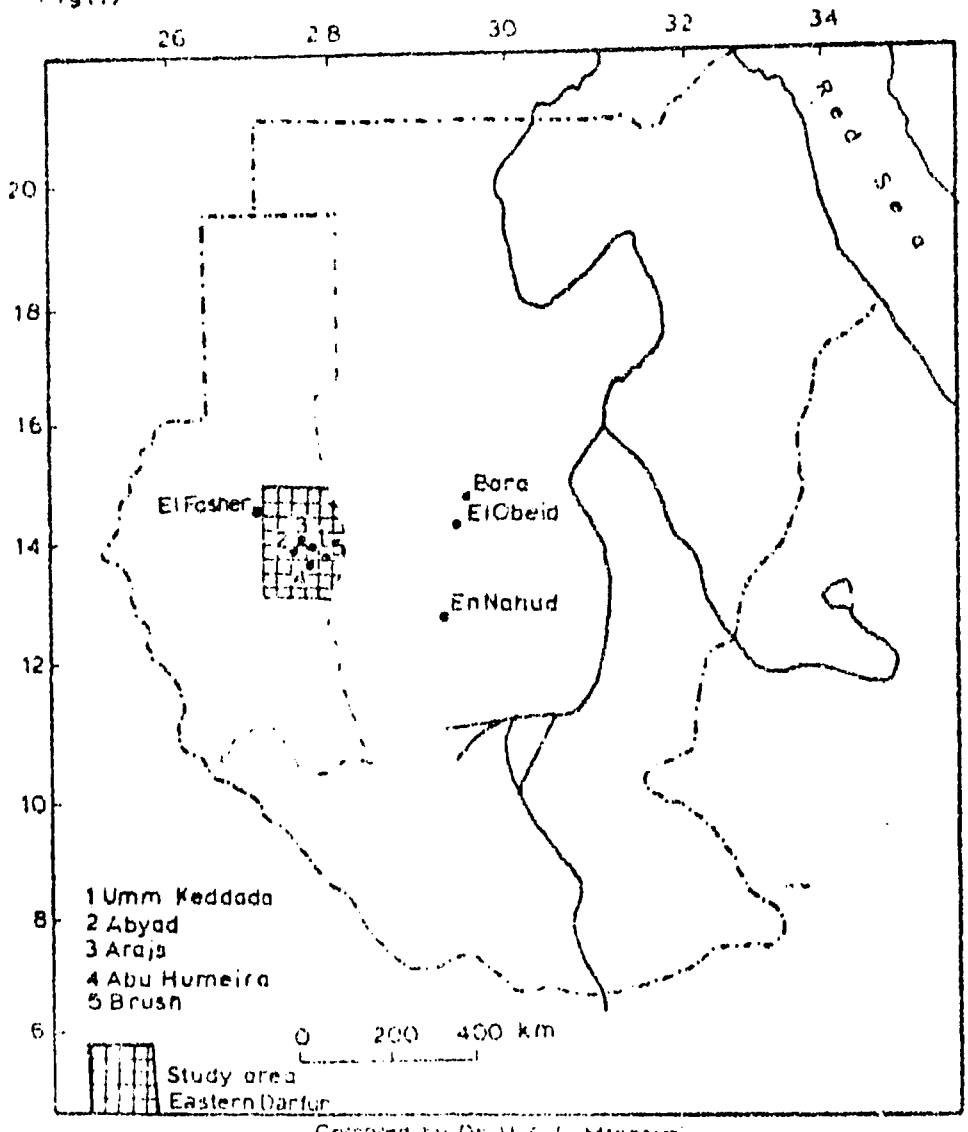

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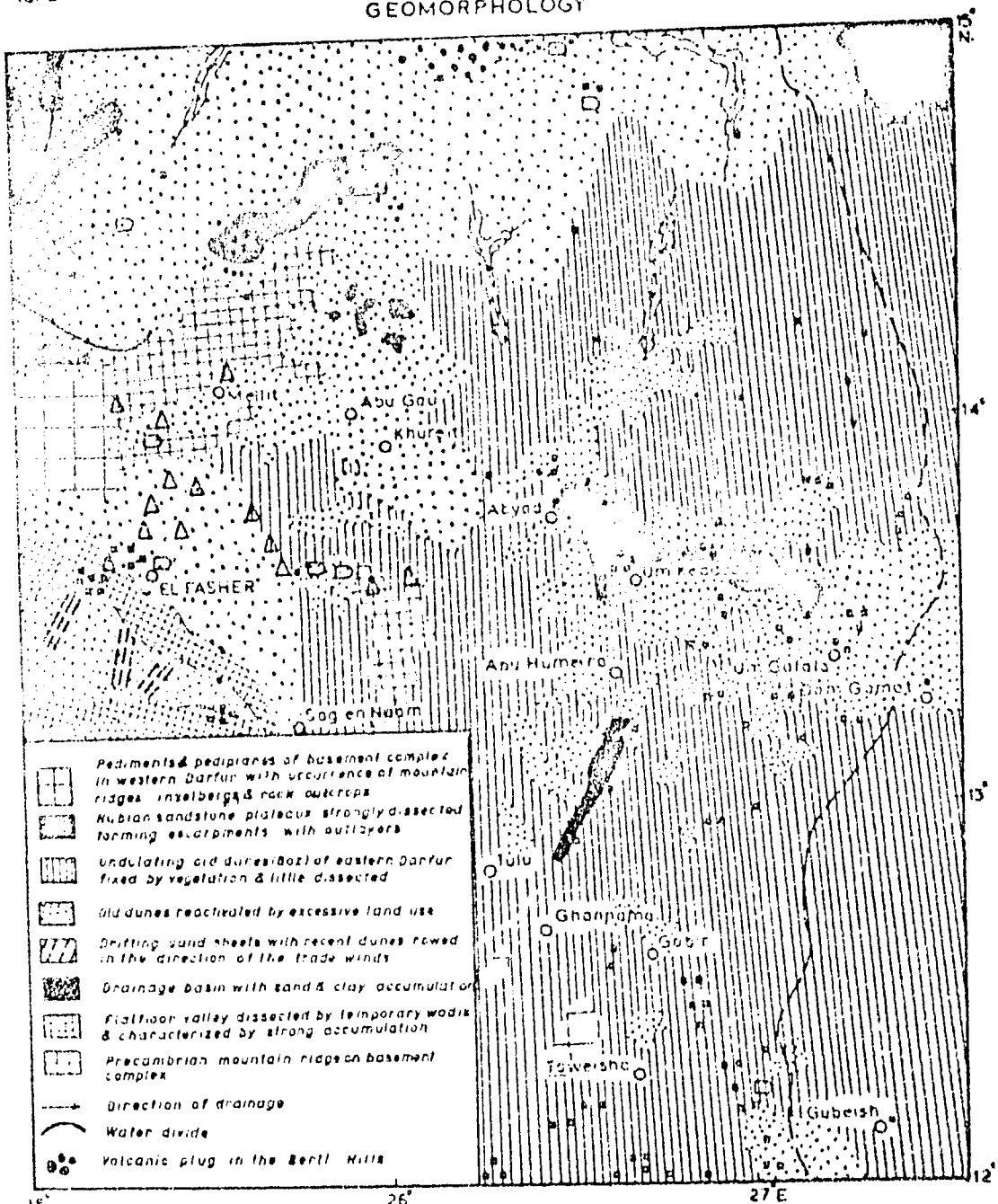
FIG. 2

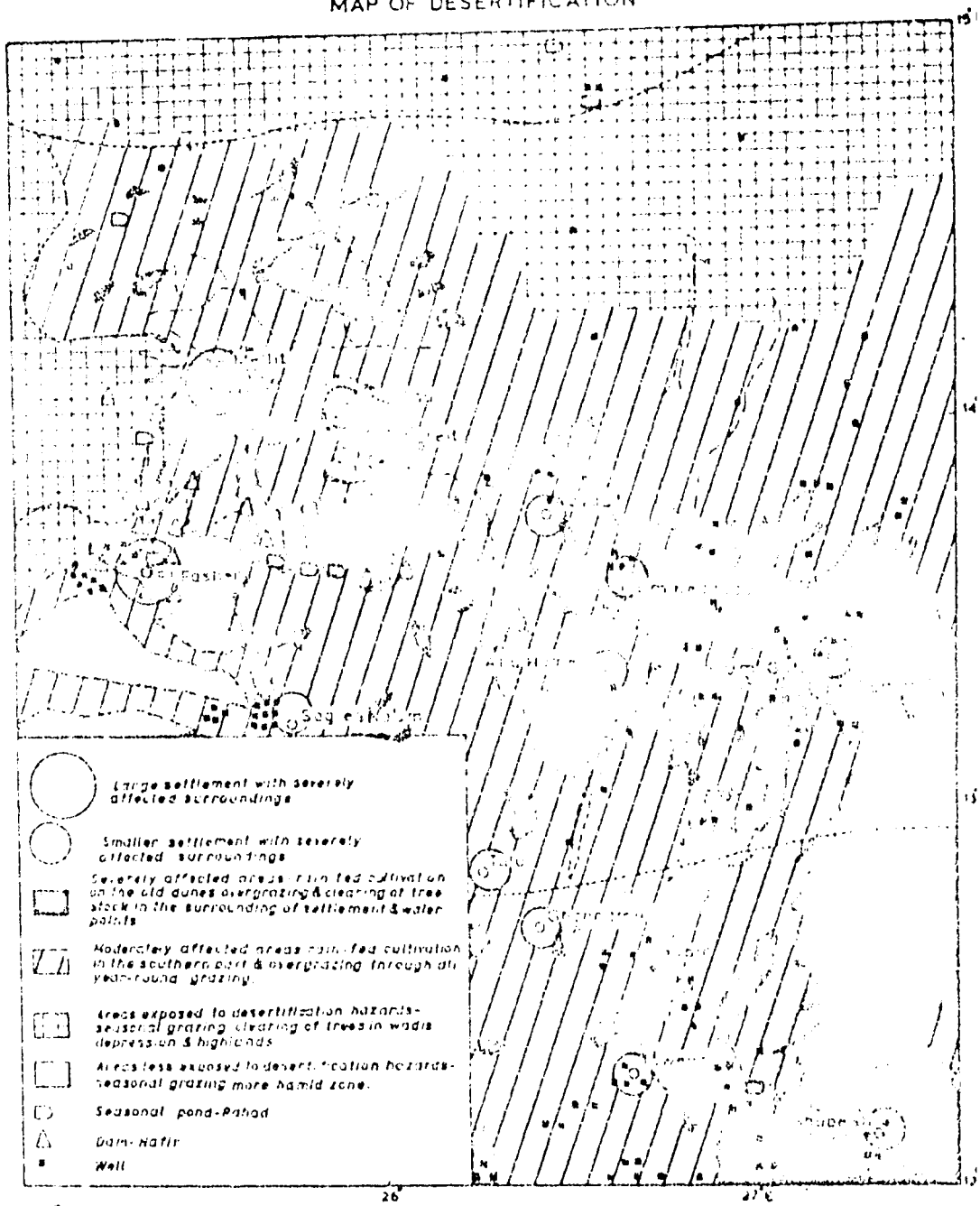
EASTERN DARFUR GEOMORPHOLOGY



* Compiled by Dr H A El Mangouri – March 1985

FIG. 3

EASTERN DARFUR
MAP OF DESERTIFICATION



* Compiled by Dr. H A El Mangouri—March 1985

FIG. 4

EASTERN DARFUR
LAND USE

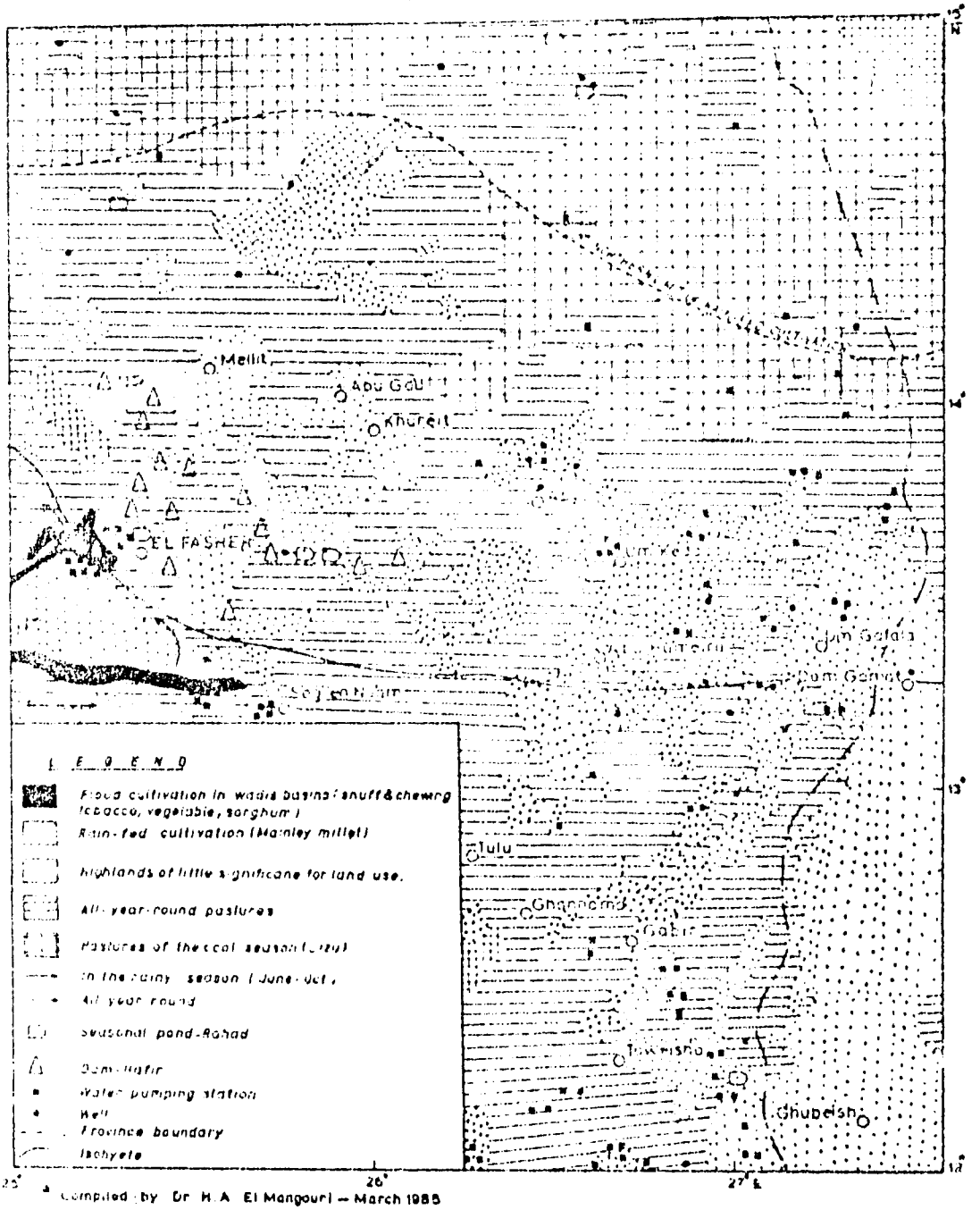


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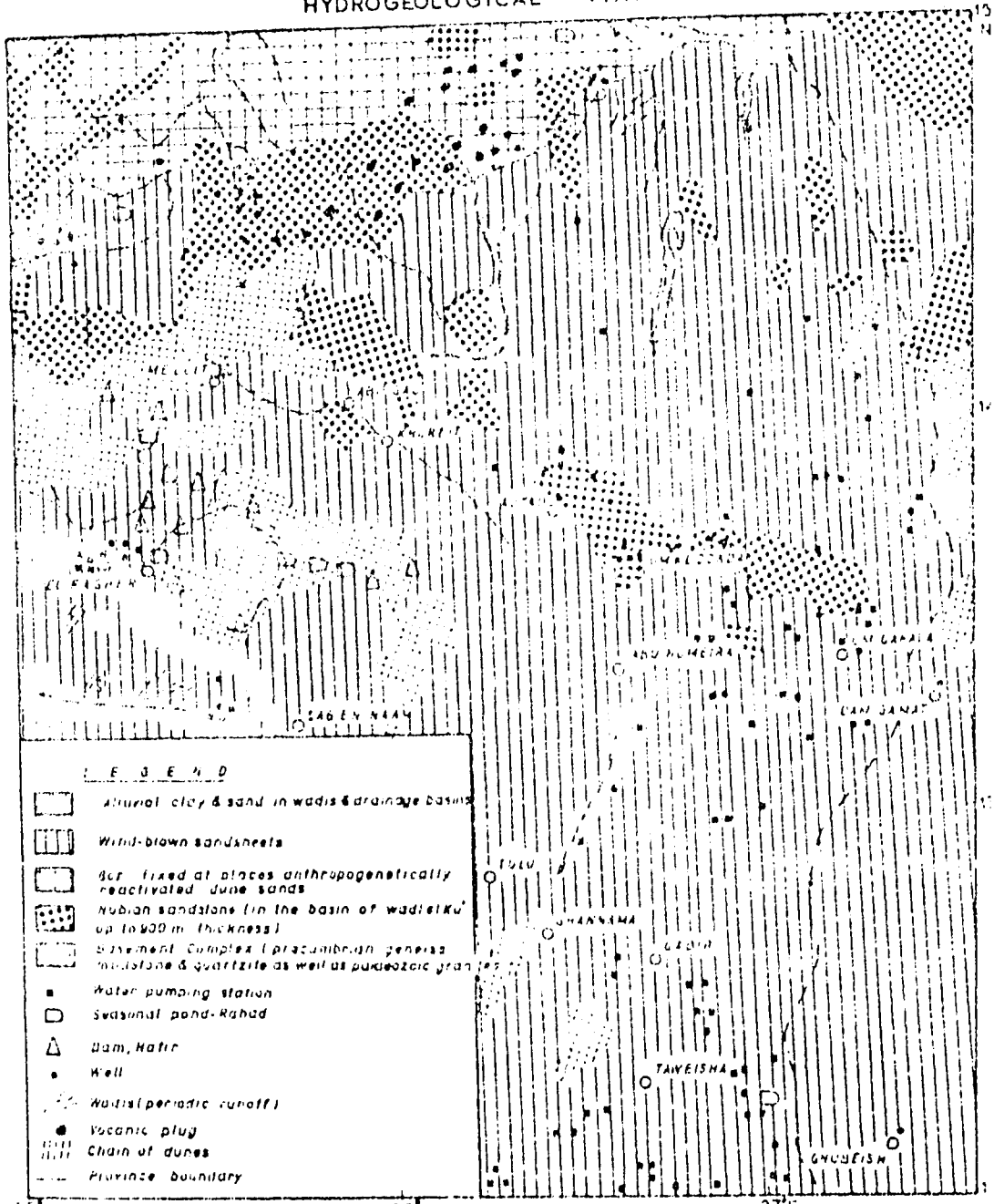
FIG. 5

EASTERN DARFUR HYDROGEOLOGICAL MAP



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The western part of the study area is dissected by periodic streams originating in the eastern part of Jebel Mara (see Fig.2).

B) Climatic Conditions:

The study area can be divided climatically into two main parts: the southern part, south of the Dam Gamad-Sag el Na'am line, falls within the 300-500 mm isohyet. North of this line the area falls within the 200-300 mm isohyet. So it can be generally said that the whole study area falls within the 200-500 mm isohyet. In the western part of the study area the isohyets are pushed further north, thus reflecting the effect of central Darfur highlands. The significance of this position is well illustrated by the following climatic cross-section and the attached Fig.(6) showing the distribution of rainfall.

Human activity is shaped and influenced by climatic norms. Deviations from the norm affect the well-being of communities. In areas of subsistence economy, below average rainfall can seriously affect the life of the people whose very existence may be threatened by the deviation. Drought can be ameliorated by relief from other areas if the region hit is easily and quickly accessible, but Umm Kaddada district is rather remote. Drought recurrence can lead to extinction of plant species. The lack of plants and resultant lack of soil moisture make the soil susceptible to erosion. At the fringe of the desert, as is the case of Umm Kaddada, wind blown sands can be deposited and soil sterilization can be the ultimate nearly irreversible result. The impact of climate on the environment is great, and better understanding of climatic features can save an area from catastrophe. Because of this great impact of climate on the environment, the issue is dealt with at some length.

1. Basic Climatic Features

Average annual rainfall over the district is less than 300 mm, (Figs. 6,7). Both El-Fasher (in the western part of the district) and Umm Kaddada town (to the east) show an average of 264 mm. The maximum atmospheric evaporative demand estimated by Awadalla (1977) is 2151 mm, which results in an annual deficit of more than 1800 mm. The two wettest months are July and August for each of which potential evapotranspiration exceeds rainfall. Considering a carry-over of soil moisture in a simple water balance, deficits are 99 and 32 mm for July and August, respectively.

Different systems of climatic classification designate Umm Kadada District as "ARID". Applying the well known system of Thornthwaite (1948), Awadalla (1981) designates the area as a part of the Arid Zone in the Sudan (see also Natakopan 1965, and Fayed 1965).

Maximum rainfall ever received in one day at El-Fasher in the standard period 1951-1980 was 88.5 mm on the first of August 1974. The coolest month is January when the normal mean temperature is 19.8°C. The hottest month is July when the mean temperature is 30.7°C on the average. Temperatures of about 0°C were recorded more than once in 1951-80.

There is bright sunshine at 91% of the maximum possible time ($\frac{n}{N}$) in January. July and August, expectedly, are the most cloudy months when relative bright sunshine duration is about 60% ($\frac{n}{N}$ = 60%). At this time the cloud coverage is about $\frac{3}{4}$ of the sky, while relative humidity is well over 60%.

Wind direction and speed are gauged routinely by the Meterological Department. Wind speed varies appreciably within short periods, but the average for September is 4 M.P.H. From March to July the average speed reaches 6 M.P.H. Studies on wind direction, however, can delineate the rainy season. When winds of a northerly

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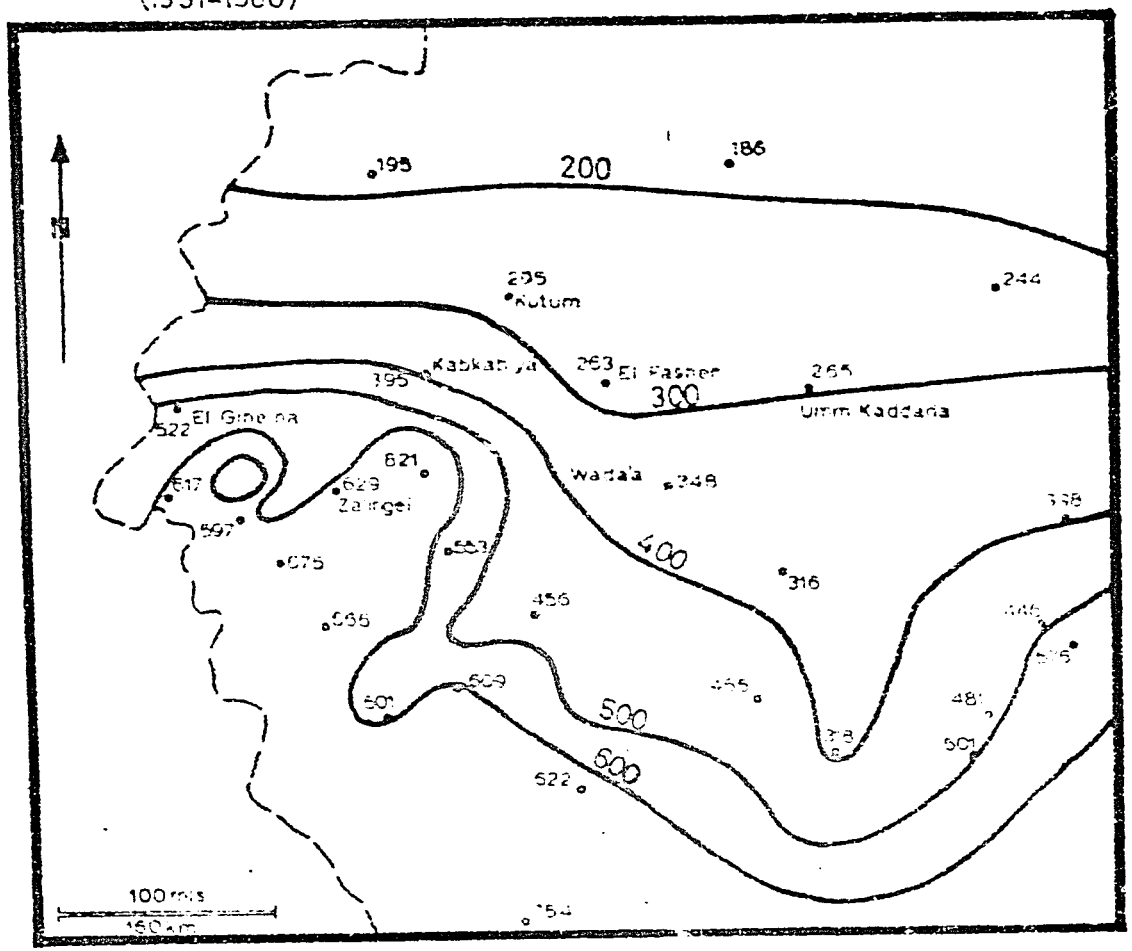
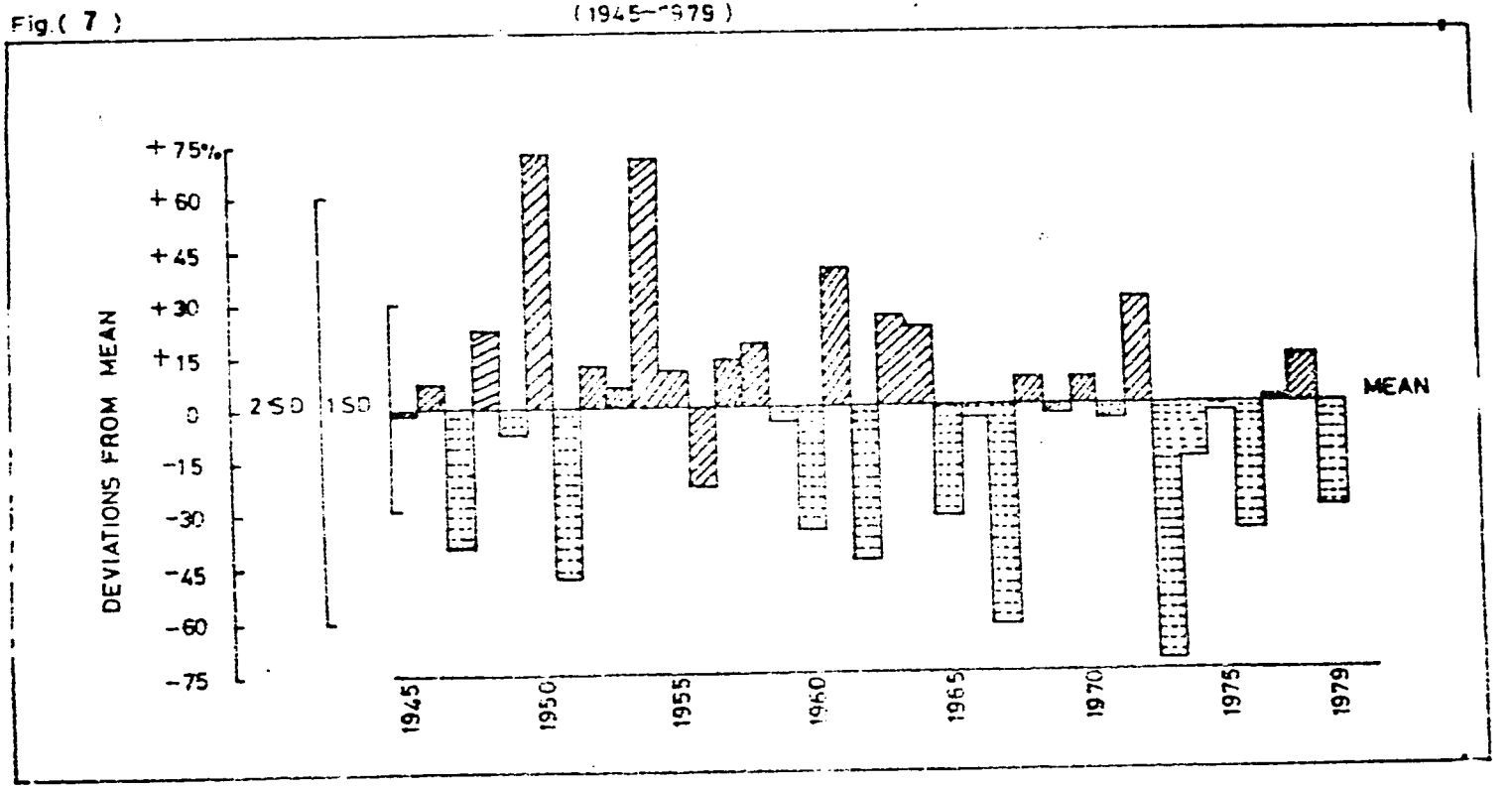
Fig. 6 Average Annual Rainfall Over Western Sudan in(mm) (1951-1980)



UMM KEDADA RAIN GAUGE YEAR-BY-YEAR DEVIATIONS OF RAINFALL FROM THE MEAN

(1945–1979)

Fig.(7)



component dominate, dry conditions prevail, and the opposite is true for winds from the southwest. In fact the Northeasterlies prevail from September to April after which month the dry East Northeasterly winds weaken and the moist Southwesterlies push further inland to dominate the area, indicating the possibility of some rains. By and large, the drying and erosive powers of the wind are determined by its nature, its humidity, from which direction and how forceful it blows. For problems of desication and desertificiation, wind data among other, are of great relevance.

2. Annual Rainfall Amount, Variability and Reliability:

The geographical location of the district results in low amounts of rainfall. The western part is rain-shadowed by Jebel Marra. There the humid southwesterlies are depleted of their moisture on the western slopes of the Jebel. On the eastern slopes and further on, the Fohn effect is shown on the records of El-Fasher where the average annual rainfall is 264 mm compared with 625 and 828 mm at Zalingei and Kiertoti, respectively, on the western slopes.

The eastern part of the district, on the other hand, is reached by the southwesterlies but only after they have travelled long distances inland during which their moisture is discharged by several storms, and is thus depleted, resulting in a lower precipitation potential. The rain shadow is not an issue in this eastern part, but causation of relative dryness is a matter of continentality.

3. Rainfall Variability and Reliability:

Statistical indicators of variability include the range, the mean deviation, the standard deviation, the coefficient of variation and the interannual variability index. Reliability, however, is better assessed on the basis of probability of receiving critical thresholds of rainfall. For this study different indicators of variability were employed. In these investigations a range of

456 - 73 mm has been revealed by records of Umm Kaddada town for the period (1945-1979). In the two successive years of 1950 and 1951 annual values were 456 and 137 mm, showing a drop of 70%. For this period of 1951-1979 the Standard Deviation (S.D.) is about 33%. This means that in each year to come, in the near future, the amount of rainfall is expected to deviate by about ± 33% of the average, (Fig.8). At El-Fasher, the Coefficient of Variation is even greater where it reaches 36%.

The Interannual variability Index, however, is concerned with the year-to-year fluctuations rather than relating fluctuations to the mean as in the case of S.D. and C.V. Having this in mind, El-Fasher shows an Interannual Variability Index (I.V.I.) of 17.5% compared with less than 11% at El-Geneina further west.

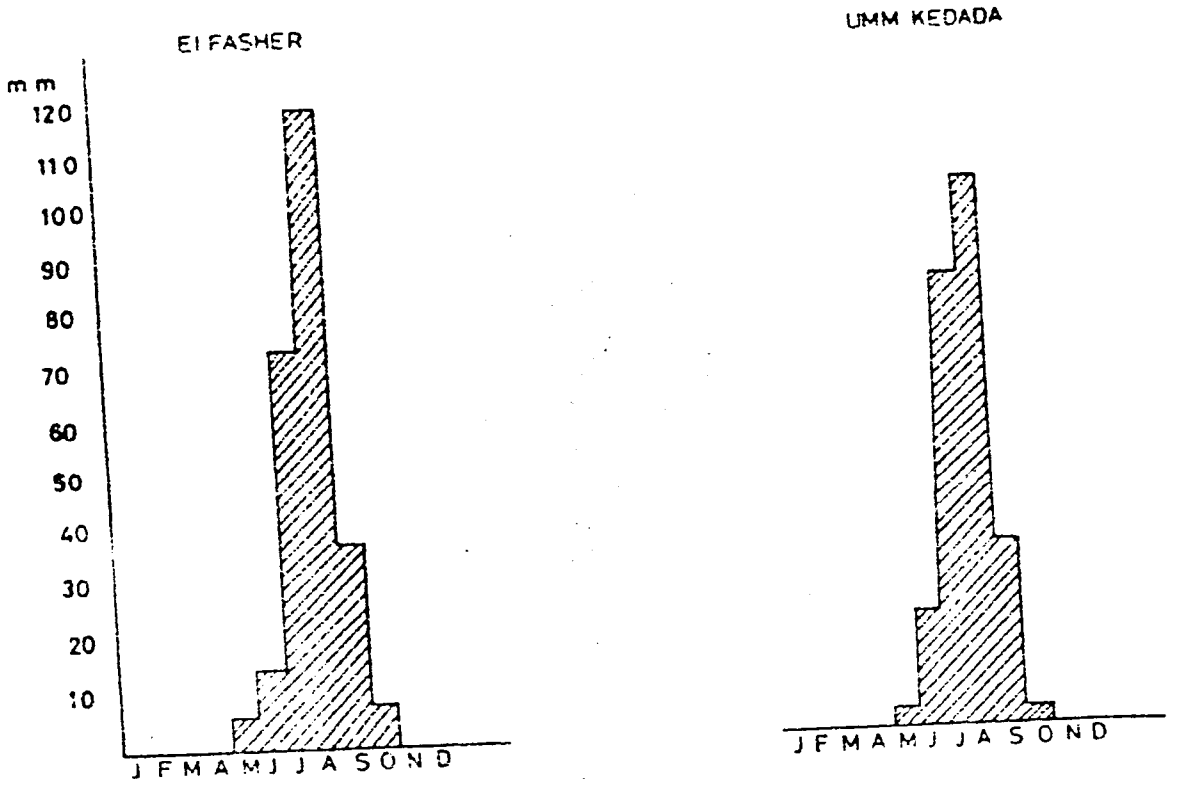
Assessment of probability of critical amounts of rainfall is useful and adds to the understanding of reliability of rain fall over the district. It is possible to arrive legitimately at some probability levels, but normality of data should be assured. In the present case data are skewed and some transformations (using the square root on the long values as appropriate, it being a matter of trial and error) are necessary before making further computations.

4. Seasonal Rainfall: Amount and Distribution:

Not all the amount of annual rainfall is effective and available for plants (whether crop or pasture). Prior to the growing season some rainfall may scatter in small amounts which may evaporate immediately from the surface before penetrating and infiltrating the ground. Such small amounts neither add to the build-up of soil moisture nor get tapped by the plant.

Based on soil moisture balance, Awadalla 1981 defines the wet season. For him the wet season commences in the first pentad (5-day period) of three consecutive

Fig (8) MONTHLY RAINFALL OVER UMM KEDADA DISTRICT (1951–80)



ones in each of which the available moisture in the soil can meet at least 80% of the evaporative demand of medium term sorghum at germination and early post-germination periods. Accordingly, the event was defined at El-Fasher from 1951 to 1976 year by year. This revealed a mode of commencement in mid-July and an average time of commencement 10 days later. It is to be stressed here that the commencement referred to is that of the wet season (the growing season) which happens later than that of the rainy season.

In 1972 El-Fasher received a total precipitation of 106 mm., but, according to the above definition, the growing season failed to commence effectively because of the unfavourable distribution resulting in storage of moisture insufficient to enable germination and early growth of sorghum. Another aspect of ineffectivity relates to rainfall of small amounts within the growing season. Values of less than 5 mm/day are generally considered ineffective, because of the problems of surface evaporation to which the moisture is subject. For different parts of the Sudan such rainfall amounts to 10% of the annual or just less than that. Accordingly, seasonal rainfall should be evaluated.

Using Penman's model (Penman 1948) for estimating potential evapotranspiration and using a modulated water balance approach based on the 5-day unit of time, the within-season distribution of soil moisture was evaluated by Awadalla 1981. A peaky curve was revealed, the primary maximum of which accounts for about 90% of the total variance. This maximum shows itself after 30 days from the onset or just after that on the average.

In conclusion of this section, Umm Kaddada District is an arid region whose rainfall is hardly reliable in amount or timing. The onset of the wet season is a highly variable event as is the duration of the wet season, an important agroclimatological parameter. In length it

varies appreciably from year to year. By-and-large, the area is delicately marginal, and measures of famine relief, among other issues of environmental conservation, should not be overlooked.

C) Vegetation of the study area:

The northern and central parts of the study area are dominated by the Acacia Senegal Savanna. The most northern limit, north of Umm Kaddada settlement where rainfall hardly exceeds 300 mm., is dominated by seasonal grasses (mainly Aristida types) with scattered small trees (mainly Balanties aegyptiaca and Acacia raddiana). These plant species form the basis for the nomadic way of life of the Zeiyadiya and Meidob tribes who are presently moving southwards in response to recent environmental fluctuations.

The natural vegetation cover is excessively removed as a result of overstocking, overcultivation (necessitated by the increase of population particularly in the sedentary zone) and environmental fluctuations. Stands of Acacia Senegal Savanna are continuously decreased and the grasses (Aristida, Cenchrus biflorus, Eragrostis tremule) are removed from all settlement surroundings.

The southern part of the study area (south of latitude 13°N) is dominated by the tree savanna of the Qoz soils of Eastern Darfur (Combretum Cordofanum - Delbergia - Albizzia sericocephala wood land savanna).

Harrison & Jackson have presented the vegetation of the study area in the following classification (Harrison & Jackson vegetation classification, 1955):

Deserts - no subdivision:	Ephemeral herbs and grasses spring up after a rare rain, "Gizzu grazing"
Semi-deserts:	Acacia tortilis Maerua crossifolia clay soils

Acacia mellifera
Commriphara qoz (sand soils)
Acacia glancophylls

Semi-desert plants: Anifida plumosa (ar. bayad)
Blepharis (Blenoicifolia)(ar. bogheil siha)
Monsonia gum

These semi-desert plants have been eliminated due to overgrazing. The ones that remain are:

Schmidtiu pappophoraides (mamlicha)
Cenchues biflorus (heskanit)
Eragostis tremula (bannu)
Annual Gristida (gau)

The best browsing bushes of the two sub-divisions are:

Acacia raddiana (seiyal)
Acacia mellifera (kitter)
Maerua crossifalia(surha)

Optimum stocking rate for both subdivisions taken together was estimated to be about 10 animal units per sq.mile.

Savanna wood Land: Eragroslis tremula(bennu)
Cenchrus biflorus (heskanit)
Blepharis (Bogheil)
Zornia diphyalls (lusseig, shillini)
Annual aristida (gau)

Blepharis is the chief grazing plant for camels and sheep. During the dry season cattle exist on eragrostis and arishida. Zornia diphyalla and brachiaria spp of xantheleuca are the best grazing in the "Hamaraya Qoz".

"Dukhn" (millet) Pennisetum typhoideum and "Batikh" (watermelon) Citrudlus nulgaris are the principal qoz

crops. Dukhn is the staple grain of the people of Western Sudan.

III. Socio-Economic structure of the study area:

A) Historical background:

1. Umm Kaddada as an administrative and market centre:

The name Umm Kaddada refers originally to a well that existed long before any settlement was established around the water source.1/ This well was used by villagers scattered at short distances.

Before the advent of the colonial administration in Dafur (1916) the most important settlement in the eastern fringe of this region was Jebel Hilla, used as a front-line post. It was used by the Sultan of Darfur as a district headquarters for all of Eastern Darfur. In 1916 the condominium troops managed to subjugate the kingdom of Ali Dinar in Darfur, and in 1918 the Anglo-Egyptian administration chose Umm Kaddada to be the district headquarters.

The presence of a water source in Umm Kaddada with better quality than that of Jebel Hilla had stimulated the Anglo-Egyptian administration to establish a new settlement at the present Umm Kaddada. Additional wells were dug to meet the increased demand of the new settlers, who were partially compelled to move to the newly established administrative centre. Subsequently Umm Kaddada developed into a big market for all the surrounding relatively smaller settlements.

2. Umm Kaddada as a crossroads:

Because of its location in the sedentary zone of central Sudan, Umm Kaddada served as a crossroads in the

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1/ The name Umm Kaddada means salty soil around the settlement.

transport zone of central Sudan and as a main truck route across the continental savanna belt. In fact Umm Kaddada was known since the days of the Darfur Sultanate as one of the waterstops along the trade and pilgrimage route from Senegal, across West Africa, Chad and Sudan to Saudi Arabia. This route linked Umm Kaddada with the most important centres of Darfur, Kordofan and east central Sudan (El-Fasher, Nyala, Geneina, En Nuhud, El Obeid, Umm Ruwaba and Omdurman). Moreover, it was reported that Umm Kaddada has been linked with Darb - el Arbain by some feeder roads from western Kordofan.

The Umm Kaddada route really gained momentum when the Sudan belt became partitioned after the First World War by the British and the French. As a result of this partitioning a strong administration was established at Umm Kaddada to provide peace and security for the transport routes.

The camel caravan routes between El Fasher in the west and El Nuhud and El Obeid in the east passed through Umm Kaddada and Jebel Hilla for watering animals and rest.

As motor cars and haulage trucks were introduced in 1927 in western Sudan, Umm Kaddada became a larger and more important stopping centre offering fresh water and resting facilities.1/

Benzine lorries would often over-heat near Umm Kaddada, thus drivers were compelled to stop and cool the engine before resuming the journey. This increased the functions of Umm Kaddada as a market and administrative

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1/ According to the Civil Secretary Report 65/A/5/15 of 1927 the first private Motor Transport Project in Kordofan and Darfur was applied for by Gabriel Mirza through Aziz Kafori. The route proposed to operate was El Obeid-El Nuhud, El Fasher and vice versa. The weight of the vehicles unladen is from 2-3 tons, and the weight of the vehicles laden is between 6-9 tons. The Director of Works of the Sudan government refused to accept the private motor transport project because these new types of vehicles would destroy the road and it would need yearly maintenance.

centre. The settlement of Umm Kaddada grew as more services were needed for the travellers.

The exact transport route through western Sudan was determined by the location of water points. The route usually went through Kuma, El Obeid, Umm Kaddada, Jebel Hilla, Sharif Kabbashi and Damgamat before passing towards Wad Banda and El Fuhud.

Water was the critical factor in this transport and sedentary zone which became famous for watermelons. During the dry season travellers without access to underground water stayed near settlements that cultivated and stored watermelons to be used as a source of drinking water. Thus hundreds of acres of watermelon were cultivated in this transport and sedentary zone.

3. Umm Kaddada as a grain producing centre:

Umm Kaddada was one of the largest grain producing centers in Eastern Darfur, even supplying El Fasher with grain.[1] The major economic activity in the Umm Kaddada area was rainfed cultivation with millet, sorghum and watermelons as main crops. Groundnut cultivation was popular in the northern part of the area. In addition, Gum Arabic was widely collected throughout the area. The Berti tribe, the dominant ethnic group in the area, practiced rainfed cultivation.[2] They supplied neighbouring tribes (Kababish, Kawahla, Meidoub and Zagawa) with grain.

1/ It was reported in SNR (Sudan Notes and Records) that the grain arriving at El Fasher market in January 1946 amounted to 782 "ardebs" (ardeb = 2 sacks). In January 1949 there was a shortage of grain in El Fasher and Umm Kaddada. The grain collected in El Fasher market in that month amounted to 1058 ardebs.

2/ The inhabitants of Eastern Darfur in general and Umm Kaddada area in particular are predominantly Berti. A multitude of other ethnic groups are also represented. In Umm Kaddada itself the other important groups in terms of numbers and political influence are Gawamaa. Other groups include Sararia, Gilaidat, Bazaa, Dar Hamid, Bidairya, Bani Fadul, Bani Umran, Kaja, Meidob, Zaghawa, Bargo and Karobaat. The first eight groups are Kordofanian groups.

Livestock rearing started to spread in the district only after independence when trading in animals became popular. The people of the Umm Kaddada area gradually started to adopt a sort of transhumance by introducing sheep from the Kabbabish area. The earlier start of the rainy season (2-4 months earlier in Southern Darfur), particularly in Dar Saeid, stimulated periodical movement of the males to participate in the cultivation of groundnuts and sesame as cash crops. The commercialization of groundnut production in Dar Hamar has further stimulated the periodic movement of the wage labourers from Umm Kaddada. This activity provided an additional source of income to the Berti people while not conflicting with their own cultural practices.

4. The decline of Umm Kaddada as an administrative centre:

In the early 1930's the British administration decided to reduce the function of Umm Kaddada as an administrative centre. The British made a subdivision of the central district administered from El Fasher. It was thought that Umm Kaddada was only artificially a native centre and in many ways awkwardly situated as the headquarters of the Eastern District. It was suggested by the civil secretary in May 1930 that a court for the Eastern District (Umm Kaddada) should be institutionalized under the presidency of "Shartai" Daw el Beit Abdel Daiyyim of Taweisha. Accordingly, Umm Kaddada should be reduced from a double inspectorate with full complement of 2 sub-Mamurs, clerical staff and police to a sub-division of the Central District administered from El Fasher with the assistance of one extra Asst. District Commissioner based at El Fasher and with one sub-Mamur and a small staff at Umm Kaddada. It was advocated by the Civil Secretary that the administrative functions by Shartai Daw el Beit as a local "native authority", together with the proposed well bores at Taweisha, might well result at some later date in an entire regrouping

of the population and the emergence of Taweisha as the true headquarters of the native administration. At the same time the Civil Secretary emphasized the importance of Umm Kaddada as a telegraph and watering station on the western line of communication. In view of the strategic importance of Umm Kaddada as a well centre and petrol station on the main line of communications between El Fasher and the East, it was suggested that the withdrawal of complement should proceed only partially. Accordingly, it was decided that a police post should be maintained in the interests of public security over the long stretch of sparsely inhabited road lying between El Fasher and El Nuhud. It was argued that the native administrative body was not qualified to undertake the security task. The following government staff were then stationed at Umm Kaddada: Sub Mamur, Accountant, Translator, Postmaster, Sanitary Hakim, Mulahiz of Police, 30 men mounted police and 7 men mounted wardens.

5. The decline of Umm Kaddada as a transport service point:

From the end of the 1950's through the beginning of the 1960's drastic changes occurred in Umm Kaddada. Southern Darfur was being gradually opened up as the result of the expansion in crop production, particularly groundnuts, gum arabic and tobacco. The most significant change, however, was the shifting of the transport zone southwards passing from El Nuhud through Abu Karinka, Babanusa, El Daein, Nyala, to El Genena. Thus the zone of transport by-passed the Umm Kaddada and El Fasher areas.

The new diesel lorries, introduced in the end of the 1950's could travel further than the old benzine engine lorries without overheating, so although the new transport route was longer, it was not a problem for the new diesel lorries.

The extension of the railway line to the west and south in the beginning of the 1960's helped to strengthen this new southern transport zone. The town of Babanusa

became the junction of the southern and western lines and later developed into a major urban centre. El Dacin, which was once a small village, developed very fast into a major commercial centre. Nyala, the railway terminal, became the main centre of Darfur.

As a consequence of the southwards shift of the transport zone, the sedentary zone shifted southwards. This shift began in the early 1960's and is still continuing today. This southward shift has been facilitated by more favourable environmental conditions in Southern Darfur. The rainfall is more reliable and makes agricultural production attractive.

The end of the 1950's and the early 1960's witnessed the opening of the northern route for lorry transport which starts from Omdurman and goes through Sodiri and Umm Quozein to El Fasher and El Geneina. This route is still important in transporting the products of western Sudan, particularly gum arabic, groundnuts and tobacco to the markets of North-Central Sudan from which consumer goods are transported to the provinces of Western Sudan. This route has also greatly enhanced the recruitment of labourers needed in the development schemes of North-Central Sudan.

As a result of all these changes Umm Kaddada area gradually slipped into the backwaters of Western Sudan. The town of Umm Kaddada which was once on the main truck route of the sedentary Sudan belt became an isolated town and now can only be reached from El Fasher. Even the trading activities between Umm Kaddada and El Fasher have declined since the early 1970's due to the diminishing role of the latter as a commercial centre. Umm Kaddada's importance as a commercial centre diminished as Nyala flourished.

6. The decline of Umm Kaddada as a grain producing area:

The drought of the late 1960's and early 1970's was first reflected in decreasing grain production. This decrease was estimated by Fouad Ibrahim (1977) to be as high as 50% of the production prior to the drought period. Accordingly the Umm Kaddada area can no longer produce enough grain to satisfy the needs of its own population. This situation intensified the traditional wage labour movements. The area became more dependent on Dar Hamar and El Obeid for employment opportunities. Gradually this led to the socio-economic isolation of Umm Kaddada from the rest of Northern Darfur province.

B) Trend Analysis:

1. Water availability trend analysis:

The water availability trend analysis gives a different profile from the one discussed so far.

The Umm Kaddada area, being in the rain shadow of central Darfur highlands, receives very little rainfall relative to its latitudinal position (see the climatic cross-section). Surface run-off is almost absent in the area due to the sand sheet formations which are very deep and porous and which immediately absorb all precipitation.

Water has always been considered a key factor for settlement and economic activities because it is found in such restricted areas.

Prior to the 1960's the main sources of water came from hand dug wells. These wells were 10-15 feet deep with varying amounts of water. Some of these dried up before the end of the dry season which is why the area became famous for drinking watermelon juice during the critical dry period of the year.

In the 1960's a large ground water basin in the Umm Kaddada area was tapped. The following table shows the number of wells dug between 1940 and 1980.

Table 1

wells dug in Umm Kaddada in the period 1940-1980 (number and production in gallons)

Decade	No. of wells completed	Production in gallons
1940's	4	4,940
1950's	7	8,540
1960's	42	28,351
1970's	31	15,200
Total	84	57,031

Source: F.N. Ibrahim, 1980.

The above table strengthens the hypothesis that water is the key factor in defining the Umm Kaddada area as a transport and sedentary zone. However, the recent shift of the sedentary zone southwards cannot be interpreted in terms of water availability. At the very time when water became available and dependable through the exploitation of the huge underground water basin, the area became very much isolated and neglected since the transport zone by-passed it and the sedentary zone followed the transport south.[1/]

2. Environmental changes trend analysis:

The new situation of the Umm Kaddada area should be dealt with from a regional perspective. The deterioration of the environmental conditions together with the steady increase in population and livestock numbers are continuously affecting the mode of economic activities in Northern Darfur Province including the area of Umm Kaddada.[2/]

1/ It is paradoxical that even though the Umm Kaddada area was no longer a viable centre, 90% of its water supply was built when the area was declining. This may make the area attractive to environmental monitoring.

2/ The population number increased from 130,000 in 1913 to 310,000 in 1945 (260%) to 728,000 in 1955(560%) to 904,000 in 1975(600%) and to 1,050,000 in 1977(810%). Fouad F. Ibrahim, 1980, p.108.

The increased overcultivation, overstocking and overcutting of trees due to the population and livestock pressure 1/ have caused a reduction in the vegetation cover. Fouad Ibrahim (1980) estimated the overstocking to be 575,936 livestock standard unit (31%), i.e., this number was calculated to be in excess of the actual capacity of the grazing areas. The estimation of Mukhtar (1974) was even higher than this (79%), (see part 3 chapter II, section 4.1).

The ultimate result of the overstocking and overcultivation is the removal of the vegetation cover. According to Otterman (1974), the removal of the vegetation cover increases the albedo, thus reducing the probability of rainfall in North Darfur. 2/ Therefore, it may argued that the increased utilization by man of the cultivated and grazing areas coupled with wood cutting in response to the increased population is contributing to the problem of drought prevailing in the area since the late 1960's. The above mentioned scholars argued that the removal of the vegetation cover is not an effect of the prevailing drought but it is a cause of the matter.

1/ The increase in the livestock number is shown by the following table:

	1956 All Darfur	1976 All Darfur	1976 North Darfur	Increase in % 1956 = 100
Cattle	1,960,000	3,642,500	908,100	184
Camel	170,000	368,200	226,100	217
Sheep	1,080,000	2,641,600	1,409,500	245
Goat	890,000	2,310,200	1,198,000	260

Source: Fouad N. Ibrahim, 1980, p.123.

2/ Otterman (1974) argued that removal of the vegetation cover affects the probability of rainfall since the albedo is liable to be raised on a bare ground surface. This causes cooling down of the lower air layers, thus reducing the heat reflected to the atmosphere. In this way the probability of convectional rainfall will be reduced to a minimum, (See also Charney, 1975).

The result of the prevailing drought was well documented by Fouad N. Ibrahim (1980) who described a progressive desertification process encroaching from Northern to southern Darfur. This process is reflected in the reactivation of old stable sand dunes. The effect of this reactivation is reflected in the reduction of cultivated area either by removing the top soil or by covering it with blown sands. Consequently it is expected that the cultivated area will continuously decrease in proportion to the rate of desertificiation which increases, in turn, in proportion to the degree of land utilization.

The present situation in the area of study is reported to be increasingly critical. According to Fouad Ibrahim (1980), the desertification process has enhanced the removal of the rich organic top soil by deflation. The effect of this is not only the reduction in soil fertility but the lowering of the water table.[1/] This means that water potentialities for the plants are effectively reduced, and the previous amount of rainfall can no longer sustain the previous vegetation cover and the previous pattern of land use. This situation induces people in the Umm Kaddada area to search for an alternative to their deteriorating traditional way of life.

3. Response trend analysis:

Although it is not our aim at this stage to present an analytical study of the people's response to the new situation, it will be useful to give a general idea about that.

1/ The removal of the top soil, composed of clay, silt and organic substances, through the deflation process permits the percolation of water to a lower depth which cannot be reached by plant roots (the roots of millet and other grasses in North Darfur hardly exceed 20 cm.) Fouad, 1980, p.83.

The first response to deteriorating environmental conditions and the decreasing socio-economic role of the Umm Kaddada area was the expansion of the area cultivated to compensate for expected failure. This has resulted in the cutting down of many Acacia senegal trees (Hashab trees), thereby reducing the prospects of gum arabic production. In fact the fall in the gum arabic prices in the last decade encouraged further cutting down of Hashab trees.

The second response was the tendency towards animal rearing. Previously the Berti people were sedentary cultivators keeping only a few animals. Most of the animals grazing in the area of Umm Kaddada were immigrant, belonging to the Kabbabish and Meidob pastoralists.

The Umm Kaddada area became increasingly attractive to pastoralists because of its fresh water sources. Even in the years with insufficient rainfall the wells of the Umm Kaddada area did not dry up. This stimulated a new sphere of economic pursuit among the Berti. They began investing in water pumps to meet the increasing demand for drinking water. The first privately owned pump was installed in 1978. Today there are 12 pumps in Umm Kaddada settlement and 5 in Jughud.

The area became a major watering centre for Kabbabish, Kawahla and Meidob pastoralists. Needless to say, this has resulted in overgrazing around the waterwards.

The increased competition between the different tribes for grazing areas for large herds is causing intertribal conflicts. As a result of these conflicts some indigenous people are forced to move further south into areas having better natural conditions (rainfall, cultivated area, good quality soil and availability of drinking water).

This new trend of moving southward of the Umm Kaddada people negates the hypothesis that the Berti tribe of the Umm Kaddada area are more attached to their lands than any other tribe in Darfur.

Traditionally the Berti were sedentary cultivators, and very few of them were engaged in pastoral transhumance. The social organization of the Berti group is patrilineal, and the system of residence is patriarchal. Members of the same tribe or family used to stay on land that traditionally belonged to them. The lineage acquired through time is of cardinal importance in the life of the Berti since it regulates land ownership, political membership in sub-groups and marriage transactions. Thus it was believed that the Berti group was compelled by this patrilineal lineage to stay on their land even under severe environmental circumstances such as drought and/or famine.

The recent trends of the movement southward put the whole partilineal lineage and patriarchal residence system of the Berti group in the Umm Kaddada area under question. There must be overwhelming factors which are working together to break up this system and to induce the mobility of the Berti tribe. Identifying and analyzing these factors deserves specific investigation, which adds to the importance of environmental monitoring for the Umm Kaddada area.

IV. Conclusion:

The foregoing presentations revealed that the Umm Kaddada area was continuously declining in importance as far as its functional location as a transport, trading and administrative centre was concerned. Accordingly the previous sedentary zone with its centre at Umm Kaddada is shifting southward.

The actual reasons for this shift are not precisely known, but some explanations can be given which, we believe, might have contributed to the declining importance of the Umm Kaddada area.

The decision of the British Administration, as early as 1930, to reduce Umm Kaddada to a subdivision of a central district administered from El Fasher must have had a bearing on its socio-economic development. This was reflected not only in the reduction of government institutions but also in the reduction of services. These reductions affect negatively the trade transactions between Umm Kaddada and other places, particularly El Fasher. This development was further intensified by the shifting of the transport route southward, i.e., the previous transport route passing through Umm Kaddada area from east to west shifted to the south. Reasons for this shift could be explained by the declining importance of Umm Kaddada as an administrative and trading centre on the one hand and in the deteriorating environmental conditions, reflected in the decreasing grain production, on the other hand. The favourable environmental conditions in Southern Darfur have stimulated the extension of the railway line to Nyala to tap the potentialities of this region, particularly after the commercialization of groundnuts.

The introduction of diesel lorries facilitated the overcoming of long distances to reach the southern and western limits of Darfur Province.

As a result of this shift of the transport route some settlements like Nyala and Daein replaced Umm Kaddada as transport centres.

The ultimate consequence of all these changes was and is the decreasing importance of the Umm Kaddada area which was neglected and gradually pushed into the back water of development.

Now the area is confronted with a serious problem, which we believe is a direct result of the above presented changes, namely the present trend towards migration away from the area. In fact this was argued to be the obvious response of the population to the recent changes. Other responses like adopting new economic pursuits within the area need to be thoroughly investigated.

Paradoxically, the movement of people started at the time when water became available. The hypothesis that water availability is a key factor for development can no longer be valid, at least in the case of Umm Kaddada. The validity of this hypothesis needs to be tested and evaluated.

Having said all this about Umm Kaddada, we should attempt to use this information as a feasibility study and to use the indicators outlined in this report (deterioration of environmental conditions expressed in terms of climatic fluctuations; degradation of soil; removal of vegetation cover and enhanced desertification process; reduction in grain production; changing social organizations of the Berti tribe; adoption of new economic activities; availability of underground water and lack of surface water; the recent development in Southern Darfur and the shift of transport zone southward) for detailed studies to show how these factors are working, separately or together, to produce the present situation in Umm Kaddada area.

The second step is to find out whether the present situation is reversible or irreversible by forecasting the prospect of these indicators. The ultimate aim of all these inquiries is to save and preserve the rest of the region's potentials before it is too late.

This can only be done through an intensive research in the region which should identify and analyse the most effective factors responsible for the degradation or upgrading of the region's socio-economic structure. The available data about this neglected part of the country can hardly permit any sort of monitoring program, let alone planning for future development. The need for gathering current information about this region is becoming increasingly vital, especially in regard to the recent regionalization policy and the proposed development strategies for the whole country in general and southern Darfur in particular. We believe that the increased degradation process es of this region will affect adversely the development programs in the whole Darfur Province if it is only seen in the increased out-migration and concentration of people in a few areas which still have rewarding potentials. In the longer prospect this concentration, if not duly avoided or modified, will produce the same features presently prevailing in Umm Kadiada area. Therefore the ultimate aim of a proposed study in this area is not only to reverse the process of degradation in Umm Kadiada area but to protect adjacent regions against that degradation.

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27/3/12 Personality Sheet Umm Kaddada 1956-60
29/2/7 El Fasher Market Town 1922-38
36/1/2 Umm Kaddada Merkez Orders 1944-59
42/1/1 Population Statistics Darfur Province
Civil population in Darfur 1935-55
42/1/2 Population of El Fasher 1944-55
53/1/3 Province Transport Establishment and Replacement 1946-48

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PART TWO

MONITORING REPORT

PREFACE

Most of the material in this monitoring study is based upon a number of stays in the area described, first during a reconnaissance visit to the study area in March-April 1984, then as a group leader for investigation of environmental changes in July-August 1984 and a follow-up visit to the area in December 1984-January 1985.

The main informants have been the local population in some six settlements around Umm Kaddada town together with some official administrators and government authorities.

Hospitality and willingness to participate in discussing current issues concerning recent environmental changes and their impact on the socio-economic set-up of the area were the source of learning and inspiration for all field staff.

We have thankfully received assistance from many people in Darfur region. They have all been very cooperative. We would like to express our thanks, gratitude and indebtedness to the following personalities who participated in data collection in the field and data analysis in Khartoum.

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- Ustaz/ Khalid Manuella,
  Local Government Administrator/Umm Kaddada.
- Ustaz/Omer Egemi,
  Teaching Assistant, Geography Dept. U. of K.
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  Teaching Assistant, Geography Dept., U.of K.

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- Ustaz/Saeed Musmar Ali,
  Post-graduate student.

- Ustaz/ El Tayeb A/Rahim,
  Post-graduate student.

- Ustaz/ Awad Ibrahim,
  Post-graduate student.

- Ustaz/ Awad Ibrahim,
  Post-graduate student.

Special thanks should also be given to Dr. Dosa, Minister for Agriculture; Dr. Ahmed Ibrahim, Deputy Minister and Sayed/Ali Mohammedain, Director General of Ministry of Agriculture, for their friendly co-operation and valuable assistance.

Warm thanks should also be expressed to Sayed/ Abdel Rahman Mohmoud, Deputy Governor and Minister for Region's Affairs and Local Administration, for his warm reception and kind treatment.

Our best thanks and regards should go to all personalities and dignitaries in Umm Kaddada town who facilitated our stay during all our visits to the area and assisted in conducting our field investigations and evening discussions.

Finally, we have to thank all those who assisted in one way or another to accomplish this monitoring study.

SECTION ONE

INTRODUCTION

1. Purpose of the Study:

This study is part of a whole research project in the area under consideration. It has been preceded by a base-line trend analysis study conducted by the writer and other collaborators belonging to different disciplines.[1/] This study, which is mainly an analysis of intensive field work, is justified by the need to test the indicators presented in the Baseline Trend Analysis Report. With this aim in mind the writer[2/] attempted to conduct a series of field investigations complementing each other. The first one, conducted in March-April 1984, was a reconnaissance trip intended mainly to give the writer more insight about the area for the purpose of planning for conducting intensive field work. The second field trip, undertaken by the writer and other collaborators in the period 24th of July to 15th August 1984, was meant to monitor environmental changes as perceived by the local inhabitants and observed by the different investigators. Precisely, it has been intended to register the different environmental changes and to register the awareness of the local inhabitants about environmental hazards and the complicated interactions between man and his surroundings. This stage of the whole research project in the area is believed to be crucial for assessing the present situation and planning any intervention programme in the future.

2. Approach and methodology:

Our approach is to confine the field work to a manageable geographical area to be taken as representative in many respects for surrounding areas as far as

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1/ The Baseline Trend Analysis Report was prepared for the United States Agency For International Development Project No. 698-0427, December, 1983 which constitutes part One of the Final Report.

2/ The writer is the Group Leader for Um Kaddada Study Area and the writer of this comprehensive report.

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environmental changes are concerned. Thus a certain demarcated area in eastern Darfur was selected for monitoring environmental changes.[1/] As a second step a Baseline Trend Analysis study was prepared to be used as a background for any registered environmental change in the area. Based on this Baseline Trend Analysis an extended questionnaire was formulated to cover all environmental and socio-economic aspects referred to in the area.[2/] Beside questionnaire work, there were a number of approaches for collection of data. Direct and group interviews were casually held by all team members and information was immediately registered as part of the interviewer's own observations. At the same time the group leader and other senior researchers were engaging in recording their own observations concerning the different environmental and socio-economic issues, each in his own field of interest.[3/] Moreover, data was collected from different institutions of the Darfur Regional Government at El Fasher from local institutions within the study area and from literature work fragmented in many archives of different departments.

The present study is, however, the result of analyzing the data collected through all forementioned sources. Analysis of questionnaire work is a task and responsibility of the writer who depends on his own experience in the area and his knowledge about environmental hazards and the impact of man on his surrounding environment.[4/]

1/ Criteria for selection was documented in the Baseline Trend Analysis Report, p.1, and in p.7, of this Report.

2/ Questionnaire work was conducted by a group of four post-graduate students who are well trained in field research and questionnaire work.

3/ Fields of interest of senior scholars of the team are: ranch and animal husbandry; soil management; conservation and water provision, socio-economic aspects.

4/ The writer is currently engaged, together with a German Professor (G. Heinritz from Munich University) in assessing the different working factors causing population mobility in Darfur.

3. Problems and limitations of conducting Research in the Area:

One of the main problems of conducting research in this particular area is its remoteness and harsh environmental conditions. As part of eastern Darfur the area is quite distantly located from Khartoum. Transportation and communication are quite limited. This has greatly reduced the willingness of most researchers to participate in any extended field work in the area. The group leader has been confronted with these problems and therefore had to give time and effort to stimulate scholars to collaborate in conducting an integrated field work. This problem, however, was emphasized by the writer in the paper presented to the National Seminar on Indicators of Environmental Change and Desertification in Sudan, 2-4 March 1984, Friendship Hall Conference Center, Khartoum. Nevertheless, recent concern about the problem of desertification and related consequences, both on national and international levels, has awakened more interest in the area on the part of individuals and scientific research groups.

Another problem, which is more or less related to the problem of remoteness, is that of meager information can be derived mainly from the documents of the Colonial Administration, particularly from the General Civil Secretary, more than 50 years back. Most of this information is outdated and would hardly reflect the current situation. Current literature about the area, so limited as it is, is scattered in fragmented reports and documents, in most cases inaccessible to interested groups or individuals.[1/]

A third problem is the difficulty of conducting prolonged field work in the area. The sandy nature of terrain and the sparse nature of settlements compel researchers to confine their research to a small area

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1/ Statistical data for demographic structure, landuse, productivity, animal wealth, income, population movements, social services are almost completely lacking.

which sometimes falls short of representing the whole region. Even the sampling techniques are dictated by the need to cope with the difficulty of the area on the one hand and the available time and financial requirements on the other hand. This has been reflected in our selection of certain settlements rather than others, a compulsory limitation which certainly affects the generalisation of our statements.

Information collected through questionnaire work, group interviews and verbal discussions is sometimes unreliable, since exaggerations are often inherent in the answers of most respondents. These exaggerations, however, are not always intended by respondents but are mainly due their ignorance of the real answer. Parameters such as age, income and perception of certain phenomena are rarely accurately stated. Only through cross-questioning could it be possible to reduce exaggerations of answers. On the other hand, in questions concerning family structure and the magnitude of wealth possession respondents are sometimes intentionally reluctant to give real figures. In this case direct observations of interviewers and logical interpretation might have reduced the danger of false conclusion. In this context, again, the remoteness of the area from Khartoum, where analytical work is usually performed, reduces the probability of checking or correcting doubtful answers or adding more information for the sake of optimising the results of the study. The possibility of follow-up research work is quite limited.

4. <u>The study area</u>:

1. <u>Geographical location</u>:

The study area is part of eastern Darfur comprising Umm Kaddada District Council. It is rougly confined between the latitudes 13° and 14°N. and longitudes 26° and 27°E. It is the most easterly part of eastern Darfur Province. It is centered around Umm Kaddada town which lies approximately 140 km southeast of El Fasher, the regional capital. Distance from Khartoum is approximately 1,100 km (See Fig.1 of the Baseline Report).

2. Criteria for selection:

The geographical location of the area as a transitional zone between the eastern part of Northern Darfur Province and the western part of Southern Kordofan Province provides for a comparative research work which might help in integrated regional development planning. The similarity in natural and human resources in both parts permits generalizations of findings and stimulates similar research works in other adjacent parts of the different regions.

Gemorphologically, the area of study is a centre of an extensive belt of consolidated sand dunes which have been recently reactivated through different morphodynamic processes. The northern part of the area is presently covered with wind-blown sand sheets which encroach currently at high speed, the repercussions of which deserve intensive investigation.

Topographically, it is almost a flat plain with undulating sand dunes and a few outcrops, as remnants of the previous extensive Nubian sandstone formations. The area is hardly affected by the massive Jebel Marra hills as far as drainage systems and deposited soils are concerned. This has given the area of study its unique physical set-up, which is reflected in all human and economic activities of the area (Fig.9).

Another criterion for selection is the relatively denser settlements in comparison to other parts of Northern Darfur. This fact is related to the abundance of underground water, referred to in the Baseline Trend Analysis Report. The importance of this criterion lies in the multiple dimensions of water provision as a parameter of development and at the same time, as a factor of environmental degradation (Fig.10).

A further criterion for selection is the tremendous and alarming environmental degradation. The sedentary nature of settlement and traditional human and economic

activities have reduced the area to a situation of almost no return, the overcoming of which needs intensive research work like the one under discussion.

The last but by no means the least criterion for selection is the availability of basic data collected by the writer and other collaborators which was formulated as a Baseline Trend Analysis for the area. The demarcation and analysis of the most remarkable indicators of change form a solid background to the present study. For practical reasons, testing these indicators was found possible only within a demarcated and confined area. Accordingly, a limited number of five settlements were selected. Four villages were intentionally selected in a way that each one should be located in a direction different from the others and all should be approximately equidistant from Umm Kaddada town, which was itself chosen as the fifth settlement for investigation. The other four settlements were selected as follows: Al Arais 40 km to the North; Abu Humeira 35 km to the South; Abyad 36 km to the West; and Brush 32 km to the East of Umm Kaddada town.

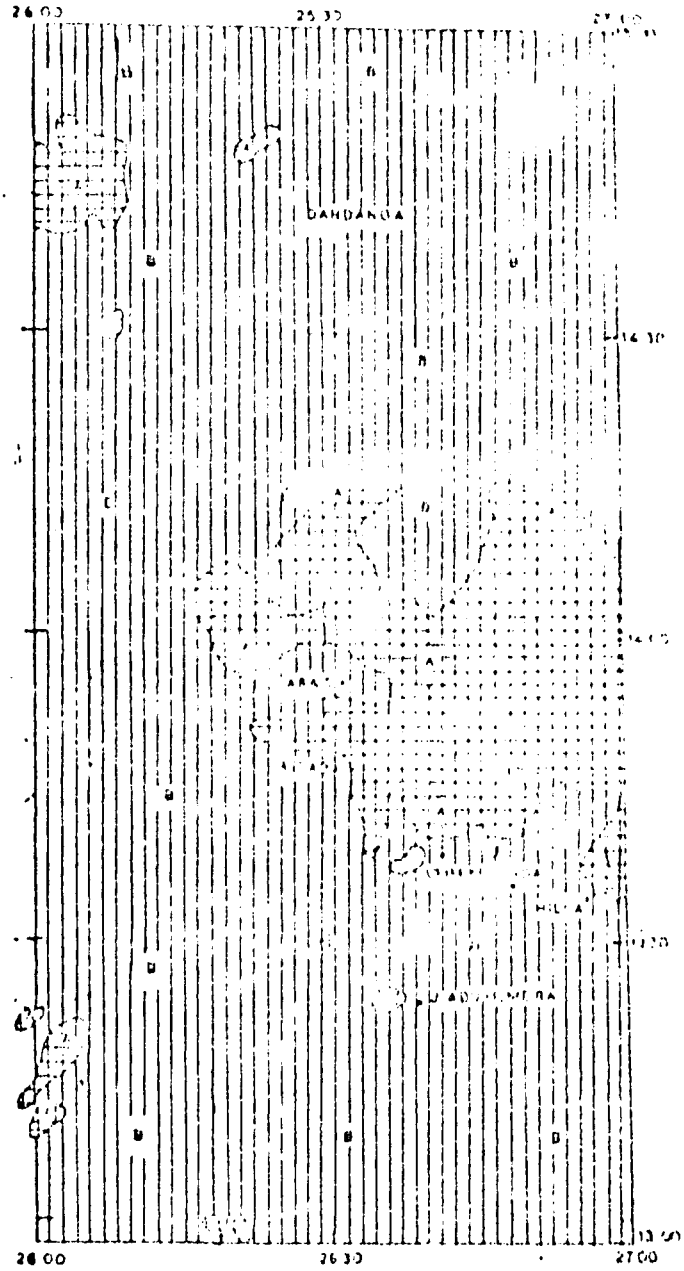
The inclusion of Umm Kaddada town was thought necessary for comparison between urban settlements on one hand and rural settlements on the other hand, as far as interrelationship between man and his surrounding environment is concerned. For all settlements a standardized questionnaire was used and observations were registered.[1/] In the following discussion the writer attempts to present the results obtained by analysing the data collected through various channels.

1/ Total number of respondents was 240, distributed as follows:

Umm Kaddada town.....	64	26.6%
Abyad.....	56	23.4%
Abu Humeira.....	56	23.4%
Brush.....	52	21.6%
Al Arais.....	12	5.0%
Total.....	240	100.0%

Fig. 9 . GEOMORPHOLOGY OF THE STUDY AREA

SCALE 1 [illegible]

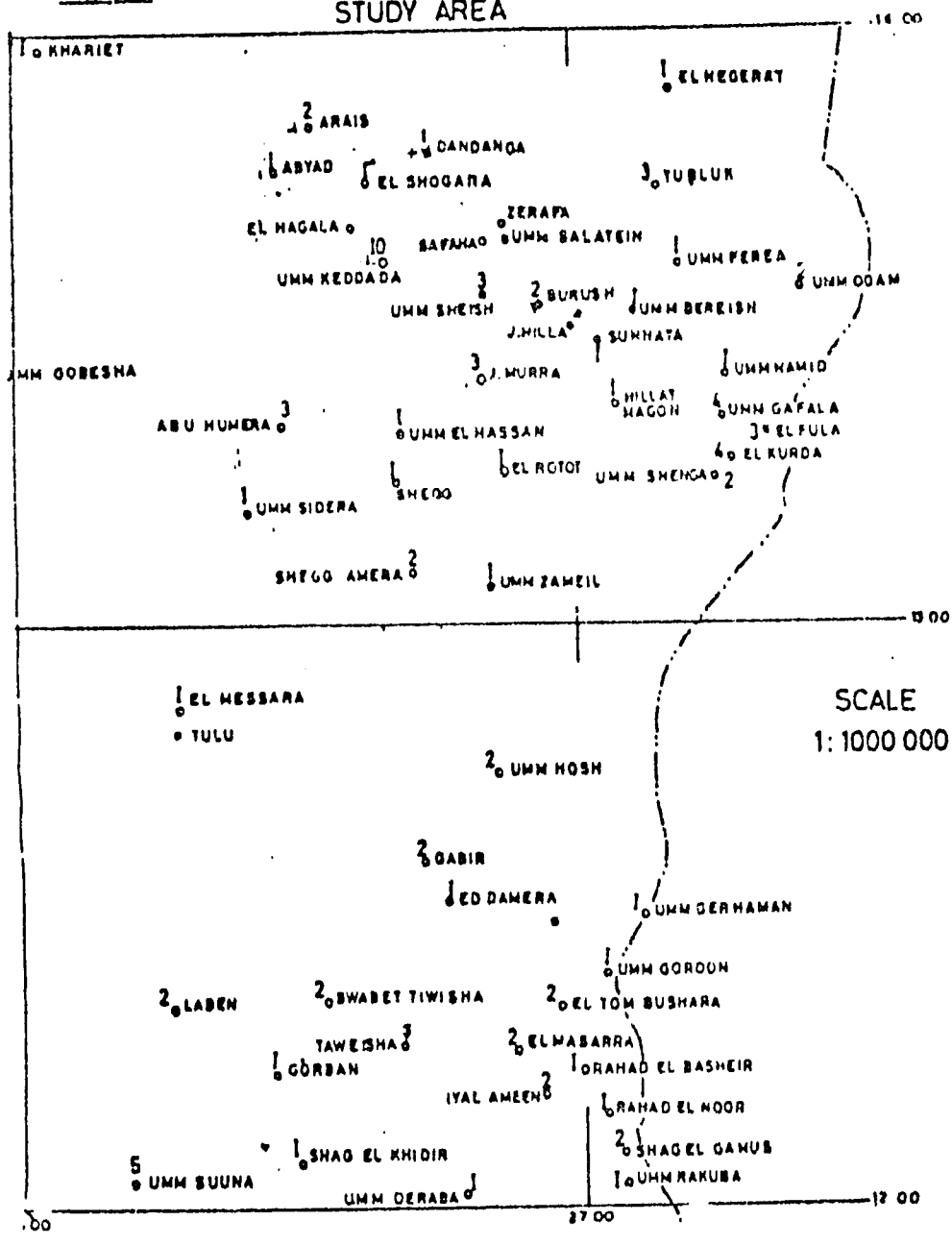


LEGEND

SYMBOLS	LANDSCAPE	DESCRIPTION OF SOILS
A	LOW HILLS AND RIDGES	BARE DISSECTED OUTCROPS INTER-SPERSED WITH RECENT AEOLIAN SAND DEPOSITS
B	SAND SHEET AND DUNE COMPLEX	DEEP SOILS OF SAND TO LOAMY SAND TEXTURE, EXCESSIVELY DRAINED, INFERTILE AND HAVE ALSO WATER HOLDING CAPACITY

BASED ON LANDSAT IMAGE INTERPRETATION AT AN ENLARGED SCALE OF 1:250000

Fig. 10 DISTRIBUTION OF BORE HOLES IN THE STUDY AREA



(*)

Table accompanying Fig. 10 (Distribution of Bore holes)

Site	Date of Drilling	No. of Bore hole	Depth of Drilling	Water Level	Production Gallon/H
Tiweisha	1930	67	410	344	1000
"	"	688	406	344	1200
"	70-71	4376	607	360	900
Gabir	46-47	179	417	332	1500
"	"	180	440	323	1200
"	71-72	5423	415	325	760
Umm Hosh	46-47	181	403	290	1900
" "	"	182	400	280	1250
Umm Gafala	50-51	249	402	320	1400
" "	"	254	410	320	1400
" "	69-70	3964	400	310	1440
" "	71-72	5523	420	310	1200
Umm Suuna	51-52	201	1226	327	1100
" "	"	299	1229	327	1100
" "	52-53	329	1050	395	1100
" "	65-66	1895	1015	395	350
" "	69-70	3586	1117	640	GERDEL
Umm Ketkot	52-53	300	320	226	1200
" "	67-68	2132	435	226	1200
J. Hilla	53-54	454	496	196	1500
" "	"	490	405	200	1400
" "	60-61	1141	350	131	960
" "	"	1164	355	230	960
Tubluk	54-55	404	416	300	1200
"	"	536	405	295	1040
"	69-70	3593	405	290	1440
Abu Humera	54-55	526	450	385	1080
" "	"	538	452	395	1075
" "	69-70	3516	405	-	GERDEL
Umm Shenga	54-55	527	375	208	1000
" "	55-56	616	380	210	960
Umm Furush	55-56	618	230	82	960
" "	56-57	664	235	82	960
Abu Odam	59-60	1062	347	190	1200
" "	"	1062	347	190	1200
El Kornok	"	1063	375	260	1200
"	"	1074	377	-	1200

(*) In Fig. 10 - The number above location represents number of bore holes e.g. 5 = 5 bore holes.

Cont../..

Site	Date of Drilling	No. of Bore hole	Depth of Drilling	Water level	Production Gallon/H
El Tom Bushara	59-60	1077	499	--	690
" "	"	1114	405	115	690
J. Marra	"	1084	400	220	460
" "	"	1100	401	230	460
" "	68-69	3136	471	--	--
El Hegalla	59-60	1101	330	170	840
"	"	1102	270	185	960
"	63-64	1680	325	175	1600
"	70-71	4370	416	--	--
Umm Kaddada	68-69	3134	397	--	--
"	"	3135	442	--	--
"	69-70	3334	443	210	--
"	75-76	7203	451	435	960
"	"	7204	450	--	GARDEL
"	76-77	7823	377	252	"
Araiss	63-64	1662	525	260	1600
"	"	1735	525	260	1700
Sheg El Gamus	65-66	1885	485	355	960
" "	"	1915	505	355	1200
Zerafa	"	1960	354	--	--
"	"	1886	351	155	1200
Fulat El Abyad	66-67	1992	540	382	1200
" "	"	2040	563	385	1440
Bwabet Tiwesha	"	2025	554	255	GARDEL
" "	"	2026	578	255	"
Umm Isheshat	67-68	2066	378	110	1440
" "	"	2114	367	170	GARDEL
" "	75-76	7205	412	150	900
Safaha	67-68	2128	678	500	311
El Botrot	"	2129	405	235	1200
Laben	"	2157	515	405	GARDEL
"	71-72	5421	501	230	800
El Kurdah	67-68	2189	400	285	1200
"	68-69	3141	435	--	--
"	71-72	5422	520	300	1200
"	71-72	5424	520	300	1200

Cont../..

Site	Date of Drilling	No. of Bore hole	Depth of Drilling	Water level	Production Gallon/H
Umm Berbeit	67-68	2190	515	405	1200
Umm Flatein	"	2223	310	195	1200
Umm Humed	"	2227	320	265	1200
Umm Gerhamar	68-69	3136	440	--	--
Umm Zameil	69-70	3338	882	440	1580
Sheg El Khider	"	3339	1242	350	1130
Iyal Amen	"	3340	745	205	3160
" "	70-71	4374	735	380	900
Rahad El Basham	69-70	3341	787	490	3160
El Ribah	"	3378	457	345	3160
El Sunata	"	3343	555	--	--
El Dendaga	"	3349	645	--	--
Sheg Mamra	"	3363	479	270	--
Azban	70-71	4176	468	365	1320
El Hegerat	"	4177	544	390	880
El Abyad	"	4371	460	160	--
Umm Gobeisha	"	4372	355	240	900
Umm Groon	"	4811	736	340	2870
Umm Rakuba	"	4812	926	340	3160
Umm Deraba	"	4814	906	360	--
Ed Damera	71-72	5423	430	--	752
Umm Sidera	"	5430	170	--	--
Umm El Hassan	76-77	7825	400	205	720
Kharet	65-66	1901	272	200	1440
Hillat Magon	68-69	3138	362	326	--
Sheg El Hemera	"	3189	479	--	--

SECTION TWO

PHYSICAL STRUCTURE

SECTION TWO

PHYSICAL STRUCTURE

1. Monitoring rainfall changes:

Rainfall amount was taken as one of the indicators of change in the Baseline Trend Analysis Report. The climatic cross section of Umm Kaddada revealed that its annual average in the period 1941-1970 was 262 mm. Our recent investigation revealed a decreasing rainfall amount.

Table 2

Distribution of rainfall amount among the 6 rainy months in the period 1975-1984

Year	May	June	July	August	September	October	Total
1975	50	45	65	108	75	--	343
1976	--	30	45	65	20	--	320
1977	15	35	20	65	17	--	152
1978	--	35	20	80	10	15	160
1979	--	16	22	30	18	6	92
1980	--	18	16	45	20	7	21
1981	--	35	16	20	18	5	94
1982	--	25	25	15	6	--	71
1983	--	25	17	30	8	--	80
1984	--	10	65	10	--	--	85

Source: Meterological Station at Umm Kaddada

The above table clearly shows the decreasing trend in rainfall amount. With the exception of the years 1975 and 1976 all other years received a total amount of rainfall far below the annual average. Of significant importance was the fluctuation within the rainy months. May received sporadic rainfall in 1975 (50 mm) and 1977 (15 mm) but in the remaining years remained dry. Rainfall amount in June fluctuated from 45 mm (1975) to only 10 mm (1984). Remarkable fluctuations, however, were recorded

in August: 108 mm (1975), 10 mm (1984). Such fluctuations are of significant importance as far as expectations of peasant cultivators are concerned. The amount of rainfall received in September for nearly all years was insufficient to complete the crop cycle, thus leading to crop failure.

Our attempt to test the people's perception about rainfall changes will be presented in the following pages.

1. Rainfall adequacy:

Generally, the indigenous people seemed to be well aware of the rainfall fluctuation both in amount and duration; 85.8% of all answers believed that rainfall was continuously decreasing. Particularly in the last five years rainfall amount was not sufficient for cultivation of the different types of crops previously grown successfully in the area (Table 3).

Table 3

Rainfall Adequacy for Cultivation and Grazing Practices in the Study Area as Perceived by Local Population in the Last 5 Years

Year	For Cultivation Practices		For Grazing Practices	
	Adequate	Inadequate	Adequate	Inadequate
1980	14.2	85.8	48.7	51.3
1981	8.8	91.2	41.2	58.8
1982	6.7	93.3	36.6	63.4
1983	14.6	85.4	43.0	57.0
1984	21.7	78.3	51.9	49.1

Source: Own investigation, 1984

It seems that cultivation practices in the area were far more affected than grazing practices. The majority of respondents (74.5%) stated that rainfall amount 15 years before was quite sufficient for both practices.

2. Period of Drought as Perceived by Local Population:

Nearly half of all respondents (47.2%) have heard

of a previous drought period in the area but they could not recall with precision its exact duration. For the rest the present drought condition was totally unexpected since they had not witnessed or heard of an equivalent prolonged drought period. Despite this lack of knowledge or information more than two thirds of all respondents (67.5%) believe that the prevailing drought conditions will not last forever. They were still waiting for a return to normal conditions sooner or later. Such expectations, however, are of crucial importance in defining the tendency of people towards exploiting the available resources. The insistence of people to continue the adopted agricultural practices, despite the decreasing amount of rainfall was and is a reflection of great expectations of normal conditions.

3. Effect of Inadequacy of Rainfall as Perceived by the Local Population:

The effect of inadequacy of rainfall was perceived quite differently by different groups among our respondents, (Table 4).

Table 4

Effect of Inadequacy of Rainfall as Indicated by Different Groups of Answers among Respondents

Effect	No. of answers	% of all answers
Crop failure	77	32.7
Insufficient pasture	77	32.7
Drying up of trees	73	30.5
Livestock decrease (deaths)	72	30.0
Drinking water decrease	60	25.0
Sand movements	137	57.1
Combination of all effects	149	67.2

The above table indicates that drought was well felt by the indigenous people through its effects.

4. People's Response to Drought Conditions:

The local inhabitants seemed to respond differently to drought conditions: 65% of all respondents have resorted to expansion of cultivated area to augment crop failure; 16% to giving up agricultural practices; 10.8% adopted livestock rearing; 2.9% turned to quick maturing crop varieties; 4.6% adopted other occupations such as wood cutting, hay gathering, and seasonal migrations.

Out of all above mentioned responses, expansion of cultivated area is by far the most dangerous one since it adds to the expansion and intennification of the prevailing drought conditions. This means that cultivation is extended far beyond the agronomic line which had been reached a number of decades before the commencement of the present drought period. Agricultural practices seemed to remain in the area as the main economic pursuit, since only a small proportion was convinced of its non-feasibility. Livestock rearing was gradually acquiring momentum but still not regarded as the main pursuit suitable for the local ecological conditions. Paradoxically, only a small number resorted to migration to other areas to escape the drought conditions, contrary to what was reported in other parts of Northern Darfur.

2. Monitoring Indicators of Soil Degradation:

The ordinary farmer in the country generally recognizes soil degradation only when land productivity decreases. In his words the soil then becomes "cool" and should be left for sometime to recover its fertility. For monitoring purposes we attempted to test the changes that occure to the soil as perceived by the local inhabitants and as appeared in the results of our soil analysis.

1. Soil Monitoring Based on Own Observation and Analytical Investigations:

Generally, the area constitutes part of the Qoz country of Western Sudan. It is located on a gently undulating plain which is partly erosional and partly depositional.

The elements observable on the recent LANDSAT imagery which were used for identifying the present landscape units were mainly tone, colour, vegetation cover and drainage pattern.

The landscape units have been identified and mapped (Fig.9):

(a) the sand sheet and dune complex, (b) the low hills and ridges. Divisions of these two units that were observed in the field could not be separated and mapped because of the scale and resolution limitations of the LANDSAT imagery. The two landscape units and soils developed on them are briefly described as follows:

a) The sand sheet and dune complex:

This unit constitutes more than 60 % of the area. It is a complex of two sub-units which are: (i) the stablized and nearby flat sand sheet and (ii) the undulating and relatively high dunes.

Within the sandsheet are scattered clay hollows where natural water pools (rahads) are located.

Surface drainage is absent in the dunes and limited in the sand sheet.

The soils on the sand sheet are very dark, yellowish brown and dark brown. They are non-calcareous, excessively drained, have low water holding capacity and low organic matter. They have a loamy sand texture.

Analytical data of the soil from auger borings 1 and 2 (Table 5 and 6) represent these soils.

The dunes are mostly oriented NE-SW. The soils developed on them are deep. Their texture varies from sand to loamy sand. Though less fertile, they have similar properties to the soils on the sand sheet. Analytical data of the soils from auger borings 3 and 4 (Table 7 and 8) represent the soils of these dunes.

Table 5

Results of Soil Analysis

Auger Boring No. 1

Location: Flat Spot, 8 Kilometres S.W. of Umm Naddada.

Sample No.	Depth cm.	PH Paste	PH 1-5	PCI	EC mmhos cm.	Ca CO_3 %	Mechanical Analysis 2mm	CS	FS	S i	C	Sat. %
1	0-26	6.6	7.1		0.17			59	32	3	6	34
2	26-45	7.0	7.3		0.14			51	36	[illegible]	7	23
3	45-71	7.2	7.3		0.13			30	46	17	7	23

Sample No.	N %	C %	CN %	Exchangeable Cations MEQ/100 G. Na	K	Ca	Mg	CEC	Base Sat.	ESP	SAR
1											
2				0.0	0.1			3		0.0	
3				0.0	0.1			3		0.0	
				0.0	0.2			5		0.0	

Sample No.	Soluble Cations and Anions MEQ/L in Saturation Extract Na^+	K^+	Ca^{++}	Mg^{++}	CL^-	SO_4^-	HCO_3^-	CO_3^-
1	0.4	0.2	0.8	0.2	0.6		0.6	0.0
2	0.5	0.2	0.9	0.1	0.4		0.7	0.0
3	0.5	0.3	0.8	0.1	0.4		0.4	0.0

For definition of abbreviation see p. 52.

Table 6

Results of Soil Analysis

Auger Boring No.2.

Location: Nearly flat, 2 Kilometres S. of Ahayad's Waterwyard.

Sample No.	Depth cm.	PH Paste	PH 1-5	PH NCL	EC mmhos cm.	Ca CO3 %	Mechanical Analysis 2 mm	CS	FS	S i	C	Sat.
1	0-22	7.4	7.7		0.22			55	36	4	5	25
2	22-35	7.6	7.9		0.24			59	34	3	4	24
6	35-51	7.5	7.7		0.21			50	41	4	5	24

Sample No.	N %	C %	CN %	Exchangeable Cations MEQ/100 G. Na	K	Ca	MG	CEC	Base Sat.	ESP	SAR
4				0.0	0.2			3		0.0	
5				0.0	0.3			2		0.0	
6				0.0	0.2			3		0.0	

Sample No.	Na^+	K^+	Ca^{++}	Mg^{++}	CL^-	SO_4^{--}	HCO_3^-	CO_3^-
4	0.3	0.3	1.4	0.1	0.8		0.8	0.0
5	0.2	0.2	1.5	0.1	1.0		0.9	0.0
6	0.4	0.2	1.4	0.3	0.8		1.0	0.0

For definition of abbreviations see p.52.

Table 7

Results of Soil Analysis

Auger Boring No.3

Location: Dune Crest, 2 Kilometres W. of Arais Waterward.

Sample No.	Depth cm.	Paste	1-5	PCL	EC mmhos cm.	Ca CO3 %	Mechanical Analysis 2mm	CS	FS	S i	C	Sat. %
7	0-16	7.3	7.5		0.22			56	36	4	4	21
8	16-62	6.8	7.3		0.20			49	41	4	6	21
9	62-84	6.9	7.2		0.18			55	36	3	5	22

Sample No.	N %	C %	CN %	Exchangeable Cations MEQ/100 G. Na	K	Ca	Mg	CEC	Base Sat.	ESP	SAR
7				0.0	0.0			2		0.0	
8				0.0	0.0			3		0.0	
9				0.0	0.0			2		0.0	

Sample No.	Soluble Cations and Anions MEQ/L in Saturation Extract NA^+	K^+	Ca^{++}	Mg^{++}	CL^-	SO_4^{--}	HCO_3^-	CO_3^-
7	0.25	0.2	1.4	0.21	0.8		0.9	0.0
8	0.27	0.1	1.6	0.16	0.7		0.6	0.0
9	0.27	0.2	1.5	0.11	0.7		0.6	0.0

For definition of abbreviations see p.52.

Table 8

Results of Soil Analysis

Auger Boring No.4

Location: Dune Crest, 3 Kilometres S. of Abu Humera Waterpond.

Sample No.	Depth cm.	PH Paste	PH 1-5	PH KCL	EC mmhos cm.	Ca CO_3 %	Mechanical Analysis 2mm	CS	FS	S i	C	Sat. %
10	0-15	7.2	7.5		0.24			49	40	6	5	23
11	15-38	7.3	7.7		0.26			55	28	12	5	24
12	38-62	7.2	7.7		0.22			63	21	10	6	24

Sample No.	N %	C %	CN %	Exchangeable Cations MEQ/100 G. Na	K	Ca	Mg	EC	Base Sat.	ESP	SAR
10				0.0	0.1			2		0.0	
11				0.0	0.0			2		0.0	
12				0.0	0.1			3		0.0	

Sample No.	NA^+	K^+	Ca^{++}	Mg^{++}	CL^-	SO_4^-	HCO_3^-	CO_3^-
10	0.1	0.3	1.3	0.21	1.0		1.0	0.0
11	0.1	0.1	1.5	0.17	0.8		0.9	0.0
12	0.3	0.3	1.6	0.12	0.8		0.8	0.0

For definition of abbreviations see p.52.

DEFINITION OF ABBREVIATIONS IN TABLES 5, 6, 7 and 8

(pp.48-50)

PH	:	The negative logarithm of the hydrogen ion activity of a soil.
PH at 1:5	:	The PH of the soil solution obtained by mixing one gram of soil with 5 grams of water.
E.C.	:	Electrical conductivity of the soil solution measured in mmhos/cm.
$CaCO_3$%	:	Calcium carbonate percentage.
CS	:	Coarse sand.
FS	:	Fine sand.
S i	:	Silt.
C	:	Clay.
N	:	Nitrogen ions.
C	:	Organic carbon.
C/N	:	Carbon nitrogen ratio.
Na	:	Sodium ions.
K	:	Potassium ions.
Ca	:	Magnesium ions.
C.E.C.	:	Cation exchange capacity.
E.S.P.	:	Exchangeable sodium percentage.
SAR	:	Sodium absorption ratio $= \dfrac{Na}{\left(\frac{Ca + Mg}{2}\right)^{\frac{1}{2}}}$

The following are the main conclusions derived from the data depicted in Tables 5,6,7 and 8.

i) The reaction (PH) of soils developed on the sand sheet and dune complex is slightly acidic, i.e., the PH generally ranges from 7.3 - 7.7. This slight acidity generally favours activity of most soils' microbiological organisms and availability of most plant nutrients.

ii) The electrical conductivities (E.C.) of all the soils fall below the lower limit for soil salinity which is 4 mm hos/cm. The exchangeable sodium percentage was invariably zero per cent. Therefore these soils are neither saline nor sodic, and thus they do not interfere with water and nutrient uptake by plants grown on them.

iii) All the soils are generally infertile, i.e., they have a low cation exchange capacity (C.E.C.). This property is mainly due to the low clay content of the soils and their high proportion of sand particles.

iv) Although organic carbon, nitrogen and phosphorous have not been measured, it is expected that these elements are deficient in these sandy soils. The main reasons for the low organic carbon content are the poor vegetative cover, frequent fire occurrence and removal of vegetation through overgrazing and over-cultivation. Most of our soils had a low nitrogen content. Phosphorous content is expected to be low because of the low clay and organic matter content. This is because phosphorous is found in the clay and organic matter complex.

b) The low hills and ridges:

This unit is of less importance than the sand sheet and dune unit. Its coverage was thought only necessary to complete the picture. It consists of an undulating and dissected surface with scattered remnants of Nubian sandstone outcrops. Among the outcrops are areas where aeolian sand has accumulated. The soils developed in these recent sand deposits have a coarse texture.

The outcrops are bare of vegetation, but the interspersing sands and pediments maintain some tree and grass species. The whole unit is predominantly used for grazing.

Other minor landscape units that could not be mapped separately are the clay hollows within the sand sheet and dune complex and the alluvial deposits of the seasonal water courses. Soils of the clay hollows have a clay loam texture. They are, therefore, expected to be more fertile than the sand and dune complex soils. They are used for production of locally consumed vegetables. The alluvial soils along the water courses are heavy clays. They are thickly covered with vegetation.

2. Soil Monitoring Based on Local Inhabitant's Perception:

1. Knowledge of the dominant soils in the area:

Dominant soils of the area were described by 97.5% of all respondents to be composed of sandy loams and sand Qoz. Clay loams seemed to be known by only a small number of inhabitants.

Sandy Qoz soil was reported by 95.4% of all respondents as the only soil used for crop cultivation since early times in history. Clay loams in Wadi beds were reported to be rarely used for crop cultivation due to lack of irrigation water and difficulty of working.

2. Perception of Signs of Degradation:

Almost two-thirds (65.2%) of all respondents reported to have observed signs of degradation in soil. They expressed these signs in decreasing productivity, decreasing vegetation cover, wind storms, bare land surface, attack of termites, disappearance of well-known plant species and appearance of new species.

Signs of degradation were reported by 58.3% of all respondents to be mainly concentrated in the sandy Qoz soils rather than sandy loams and clay loams in depressions.

Signs of degradation have been observed by the majority of respondents, 57.2% since the mid-seventies.

3. Perception of Causes of Degradation of Soils:

Causes of degradation were perceived by 61.7% to be the prevailing drought conditions, by 16.7% to be the removal of vegetation cover, by 6.7% to be increased overgrazing and by 11% to be the combination of a number of factors.

The best soils were reported to be presently found at a distance ranging from 10 to over 15 km from the village surroundings. Soils in the immediate village surroundings was reported by 62.7% of respondents to be no longer as productive as a few years before. For a small number of people (6.5% of respondents) good quality soils are to be found nowhere at present. The good quality of loamy sands and loamy clays and sandy loams in Wadi beds seemed to be little perceived by the local inhabitants.

4. Perception of Results of Degradation of Soil:

The results of soil degradation are perceived by 73.5% of all respondents to be reduced land productivity, by 61.8% to be reduced grazing area, by 82.1% to be sand movements and by 37.4% to be abandonment of cultivated lands.

5. Response to Soil Degradation:

Different responses to soil degradation have been reported by different groups of respondents; 61.2% of all respondents have responded to soil degradation by expanding the cultivated area 9% by practicing land rotation, 8% by adopting crop rotation, 10.4% by resorting to animal rearing, 3% by giving up the practice of cultivation, and 8.4% have reported no response at all.

The above findings reflect the awareness of the local inhabitants of the prevailing soil conditions. Such awareness is of significant importance in evaluating the recent socio-economic changes in the area, an issue to be treated in the conclusion of this monitoring study.

3. Monitoring Natural Vegetation:

1. Natural Vegetation Based on Previous Knowledge:

The following brief review of the ecological zones in the area and their divisions is based on information mapped at scales larger than 1:400,000.

According to Harrison and Jackson (1958), and Lebon (1965), two principal ecological zones are described in the area, which are correlated with climatic sequences from north to south: the semi desert and the low rainfall woodland savanna on sand (Fig.11).

Some differences occur in the composition of the vegetation within each zone. These are largely due to changes in rainfall and soil. The character of each zone together with its divisions are summarized as follows:

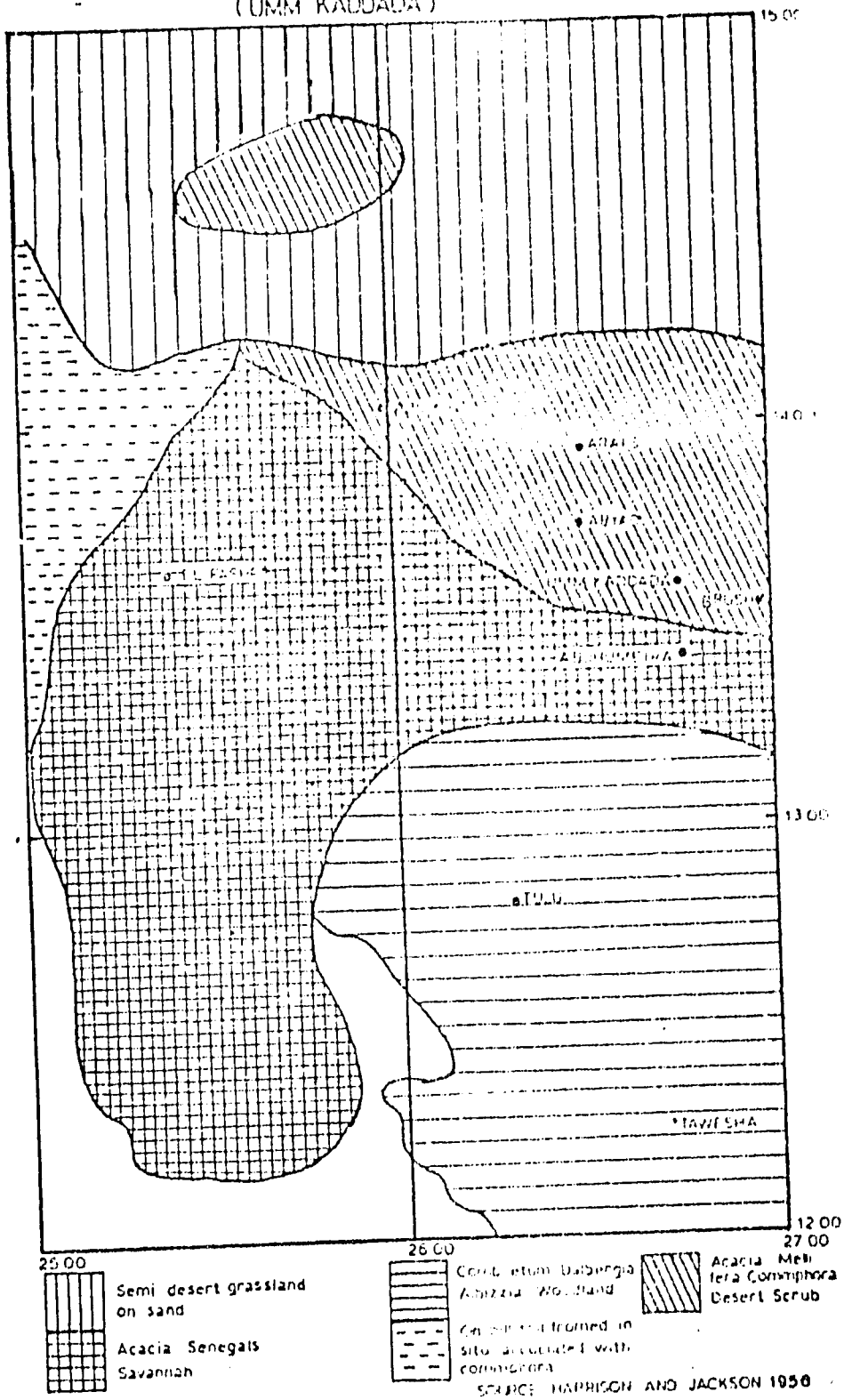
i) The semi-desert (rainfall 75 mm - 300 mm):

This zone occupies the extreme northern part of the study area. In general the vegetation is a varying mixture of grasses and herbs either without any woody vegetation or, more usually, with variable scatter of shrubs interspersed with bare areas. The semi-desert has been divided into the following:

a) Semi-desert grassland on sand.

This division is either without trees, shrubs, or contains only limited scattered individuals of Acacia raddiana (Ar. Sayal), Acacia mellifera (Ar. Kitir) and Commiphora Spp. (Ar. Gafal). The first mostly occurs near hills and drainage courses. The other two are frequent in hollows. The dominant mixture of grass and shrub species includes:

Fig.11. NATURAL VEGETATION OF THE STUDY AREA
(UMM KADDADA)



Latin Name	Arabic Name
Cenchrus biforus.....	Haskaneet
Eragrostis tremula.....	Banu
Schmitdia spp.	Mamleiha
Aristida spp.	Gau
Blepharis spp.	Boghail
Monsonia senegalensis.....	Gurn

b) Acacia mellifera - Commiphora Desert Shrub:

Acacia mellifera (Kitir) is the dominant shrub of the desert. In some places it is accompanied by Acacia radiana (Sayal) and Commiphora africana (Gafal). These large shrubs are associated with annual and perennial grasses, which include Aristida spp. (Gau, Bayad), Schoenefeldia gracilies (Umm Fereedo), Tetropogon spathcem (Fert el Arnab), Chrysopogon aucheri (Egarab) and Panicum tergidom (Tumam). Blepharis spp. is abundant only in places where grazing is not too severe.

ii) Low Rainfall Woodland Savanna on Sand:

This belt comprises two divisions, though the line of demarcation between these is not sharply defined as there is considerable variation due to the position on the slope of the dunes and past landuse practices, within each division. The two divisions are:

a) Acacia senegal Savanna (rainfall 280-450 mm):

The tree Acacia senegal (Ar. Hashab) occurs widely in stands in this zone, rarely accompanied by other trees. Adansonia digitata (Ar. Tabeldi) is found in depressions where the soil is more clayey.

The understory cover consists of:

Latin Name	Arabic Name
Aristida paltida.....	Gau
Eragrostis tremula.....	Banu
Cenchrus biflorus.....	Hashaneet
Cenchrus catharticus.....	Kureit

b) Combretum-cordofanum-Dalbergia-Albizia cerococephala Savanna woodland (rainfall 450 - 600 mm):

The principal tree species which are non-thorny are:

Latin Name	Arabic Name
Conbratum cordofanum.....	Habil
Dalbergia melanoxylon.....	Babanos
Albiza cerococephala.....	Arad
Guiera senegalensis.....	Gubbeish
Sclerocarya birrea.....	Humeid
Commifora pedunculata.....	Luban
Lanea humitis.....	Leiyun
Terminalia laxiflora.....	Duroat
Terminalia brownii.....	Daroat

The understory vegetation is similar to that of the Acacia senegal savanna.

As regards the best grazing plants of the semi-desert zone, Lebon (1965) emphasized the usefulness of Aristida (Gau), Blepharis (Bogeil), and Monsonia spp (Gurn).

Browse bushes were only heavily utilized in over-grazing areas. The best of these bushes were Acacia raddiana (Seiyal), Acacia mellifera (Kitir) and Maerua crassifolia (Sereh).

Some leguminous shrubs, e.g., Indigofera spp. (Kushein), were also important in the browse.

The Low Rainfall Woodland Savanna Sand had little grazing potential. The poor quality of the grazing was attributed to the lack of "saltiness". The few cattle kept by cultivators throughout the year were fed with salt.

2. Natural Vegetation as Perceived by Local Inhabitants:

The following tree and grass species were reported by respondents to be still present in the area:

TREES		GRASS	
Mellifera	(Kitir)	Aristida	(Gau)
Maerus crassifolia	(Sereh)	Ceuchrus bilforus	(Haskanit)
Balanites aegyptiaca	(Higlig)	Eragrostis termula	(Banu)
Boscia senegalensis	(Mukhet)	Echinochola colonom	(Difra)
Acacia radiana	(Seyal)	Stipagrostis papposa	(Bayad)
Acacia tortilis	(Samar)	Tribulus terrestris	(Dressa)
Acacia nubica	(Laot)	Blepharis persiea	(Bogeil)
Acacia senegal	(Hashab)	Cymbopogon proximus	(Marhabab)
Commifora africana	(Gafal)	A. pubitolia	(Kureb)
Grewia tonax	(Goodem)	Acanthospermum herp.	(Hurab Hausa)
Adansonia digidata	(Tebeldi)	Rhynchosis minima	(Adan Far)
Lannea humilis	(Leiyun)	Trianthema pentanchra	(Rabaa)
Ziziphus spina christi	(Sidir)	Sesamum alatum	(Semsem al Jamal)
Guiera senegal senegalensis	(Gobbesh)	C. Occidentatis	(Kaual)
Albizzia amara	(Arad)	Aristida motabilis	(Dubelab)
Cordia gharaf	(Indrab)	Panicum turgichum	(Tumam)
Dichrostachys glomerata	(Kadad)	Solanum dubium	(Djubbin)
Acacia nilotica	(Sunut)	Striga hermonthica	(Buda)
Acacia seyal	(Talih)		
Acacia albida	(Haraz)		
Azadirachla indica	(Niem)		
Calotrophis procera	(Uchar)		
Combretum cordofanum	(Habil)		
Cordia abyssinica	(Gambil)		
Salvadora persica	(Arak)		
Copparis decedus	(Tunduh)		
Scherocarya birrea	(Humeid)		

The following tree and grass species have been reported to be either decreased in number or to have disappeared completely:

Tree Species		Grass Species	
Melifera	(Kitir)	Cenchrus bilforus	(Haskaneit)
Acacia nubia	(Laot)	Echinochola colonom	(Difra)
Acacia senegal	(Hashab)	Stipagrostis papposa	(Bayad)
Commifora africana	(Gafal)	Blepharis persica	(Bogeil)
Scherocarya birrea	(Humeid)	Cymbopogon proximus	(Marhabeb)
Adansonia digitata	(Tebeldi)	Monsonia senegalensis	(Gurn)
Lannea humiles	(Leiyon)		
Guiera senegalensis	(Gobbosh)		
Albizzia amara	(Arad)		
Cardia gharaf	(Indrab)		

Decrease and disappearance have been noticed mainly in the last five years; 75% of all respondents stated that all the above mentioned trees and grass species had been dominating 15 years ago in the village surroundings. Presently, they are scattered in distant places.

Disappearance of trees and grasses was believed by 87.3% of all respondents to be due to the decreasing amount of rainfall and the continuous cutting down of trees. Very few in the sample emphasized the effect of the different landuses particularly overcultivation and overgrazing. The activity of termites had been stated by a considerable number of respondents, particularly in the last few years. The effect of wild fires was not reported in the area.

The partial disappearance of Acacia senegal (Hashab) from the area was reported by the majority of respondents to be the most effective one as regards environmental

degradation. The local inhabitants reported that the study area was known to be among the famous areas producing gum arabic up to early seventies. Prevalence of drought conditions and intensification of tree felling for different purposes have rendered the regenaration of this particular tree species difficult. This has been reflected, as reported by local inhabitants, in the dismantling of the top soil and the enhancement of the removal of the top soil through alien forces.[1/]

The disappearance of some tree and grass species has been acompanied, as reported by 69.2% of our sample, by appearance of new species.

Tree species reported to have been seen in the last 5-10 years included Seyal (Acacia radiana), Haraz (Acacia albida), Marakh (Leptadenia pyrotechnica), and Mukhot (Bosica senegalensis).

New tree and grass species were reported by 64.2% to be of inferior quality compared with the once prevailing species.

The disappearance of some vegetation species was reported to have been recognized through the increased distance of grazing areas. A majority of our sample (83.2%) mentioned the village surrounding to be the place for grazing 15 years ago. Recently grazing areas were reported to be at a distant ranging between 10-25 km from the settlement centre.[2/]

1/ The role played by Acacia senegal in fixing the Qoz soil through its intericating root system has been well documented by forest specialists (Hassan Musnad).

2/ Some high quality grass species such as Bayad (Stipagrostis pappesa); Bogeil (Blepharis persica), and Gau (Aristida) were no longer found in the village surroundings.

3. Measures to Restore the Vegetation Cover as Conceived by the Local Inhabitants:

Restriction of wood cutting and replanting of trees were reported by 62.7% of all respondents to be the best measures to restore vegetation cover. Very few, however, have related the removal of vegetation cover to over-cultivation, though they admitted that overgrazing, as caused by infiltration of some nomadic and semi-nomadic tribes from the northern part of the province in the last few years, had contributed to the decrease of the vegetation cover.

The measures already taken in some settlements like Brush, Abayad and Umm Kaddada to conserve trees in their parameters were perceived by the local inhabitants as successful.1/

The local inhabitants perceive the importance of vegetation cover in regard to two dimensions: as a protector to cultivated areas against moving sands and as grazing potential and sources of fuel and building material.

4. Monitoring Wildlife:

The main wildlife species in the area have been listed by the respondents according to their rate of concentration in the previous time: "Basshoam", rabits", "wild rat", "deer" and "sabar" were reported by 82% of all respondents to be the main types of wildlife in the study area. Other types of less concentration include:

1/ In all three places there has been a guided conservation of trees as shelter belts against moving sands. The shelter belt of Brush is by far the oldest one. It goes back more than 30 years. In three villages, inhabitants were well aware of the usefulness of the shelter belts and therefore they have been observing all regulations which were thought necessary by local authorities for their conservation.

"Fox", "Bagash", "Abu Garbo", "Snakes", "Karay", "Umm Bagnit", "Rats", "Tital", "Abu Shuk" "Neam", "Abu Genfna", "Alkol", "Abu Hussein", and "Abolai".

The main birds reported to have been dominating in the area included Ketew, Gumri, Baloami, Dobas, Hubar, Gidad Wadi, Umm Sheleshik, Zarzour, Umm Mangor, Aweir, Gerig, Ghurab, Sagar el Gidian, Garen Hashash, Abu el-Khutaib, Wezzien, Sogda, Umm Kaglo and Hawa Shernron.

The majority of all respondents (87.5%) stated that the numbers of wildlife in general have decreased remarkably in the last ten years.

Removing of vegetation cover through man's interference and the prevailing drought condition were perceived by 62.7% of all respondents to be the main cause of decrease. Increased hunting practice, due to the increased population number, has been mentioned by a relatively small number of respondents as a cause of decrease in wildlife.

The following wild animals and birds were reported to have disappeared completely from the area since 10-15 years ago:

Wild animals	:	Wild birds
Gazelle		Hubar
Taital		Gidad Wadi
Rabbit		Koria
Daba'a		Sogda
Abu Ndufaf		Neaam
Reil		Segar el Gidian
Zaraf		Wizzien
Abu Shouk		Aoak
Fox		Umm Kagalo
Tiger (Nimir)		Dabas
Marfeen		Zerzor
Giroud		Balcum
Wild cat		Abu Mangar

5. Monitoring Water Resources:

1. Water Resources as Presented in Literature:

Groundwater mostly occurs in the Nubian aquifers. Drilling has shown that reliable water supplies extend to a depth of 700-800 ft. Power is needed to pump water from this depth. Generally, places on basement complex are void of groundwater except in local pockets in the weathering zone and along joints and fractures. Deep bores and hand-dug wells are the main water supply in the dry period. There are a few natural pools (Rahads) in clay hollows that provide water during the rainy period and early dry season. Obtaing water is a problem during the dry period because of the high demand, low rate of water discharge and inadequate fuel supply for pumping.

The study area, being in the rainshadow of the central Darfur highlands, receives very little rainfall compared to its latitudinal position. This is strengthened by the fact that surface run-off is almost absent in the area because of the sand sheet: the depth of sand is enormous and thus all precipitation is being immediately absorbed by the highly porous sand. Water is a critical factor found in very restricted locations which gained fame because of that.

The early sixties witnessed the tapping of the huge underground water basin in the area. Tapping continued up to the early seventies, then stopped for a while and resumed again in the mid-seventies as part of the National Thirst Campaign announced by the Government as part of the whole rural development programme. Fig.(10) and the accompanying table show the progress of the distribution of water points in the area.

regard to the actual grazing capacity has led to a severe degradation of the natural resources. This has been intensified in the last five years by the immigration of some nomadic and semi-nomadic tribes from Northern Darfur districts who had been hit by the prevailing drought conditions. They used to concentrate around water points in the dry period, with the effect of dismantling the top soil by removing the vegetation cover completely, thus enhancing the process of desertification in the area. This could be easily identified in recent air photos and LANDSAT imagery in the form of rings of bare surface in settlement surroundings.

2. Water Resources as Perceived by Local Inhabitants:

Water for drinking purposes was reported by 92.5% of our respondents to be in plenty; 89.2% reported that they cover their needs from water points located within the settlement itself; very few have to bring their water from distant locations ranging between 2-10 km. Water was brought daily, as reported by 68.3% of respondents, or every two days (23.7%) and every three days (8%).

Water bringing used to be the duty of the women in the area. In very few cases, particularly if water is distantly located, the men help in providing the family with drinking water. Donkeys and camels are usually used to transport water to lodgings, but no tankers were reported.

Water amount was reported to be slightly fluctuating throughout the different seasons. Summer was reported to be the most critical season with regard to the water obtained from shallow hand-dug wells.

The majority of respondents (57.5%) stated that water quantity is continuously decreasing particularly in the last few years. Decrease was attributed by 62.5% to increased animal numbers as a result of immigration of semi-nomadic tribes from Northern Darfur districts.

Others attributed the decrease to increased population number and to prevalence of drought conditions. Nearly all respondents (97.2%) stated that water quantity would have been sufficient for the local inhabitants had it not been for the increased animal and population pressure caused by recent immigrations. High concentration of animals around water points for a long period was reported to deplete the amount of water in them. Accordingly, some wealthy individuals among the local inhabitants have been stimulated to dig additional shallow wells to be used as a source of cash earning. Thus commercial water provision started to be a well known practice, particularly in the last ten years. This was quite evident in locations like Umm Kaddada town, Abyad, Brush and Abu Humeira.[1] The effect of this pursuit, however, was reported by 72.5% of respondents to be intensification of the process of desertification in the area. They justified their argument by referring to the relationship between animal concentration around water points and the removal of vegetation cover. They argued that areas without water points are still covered with vegetation despite decreasing rainfall amount. Following this argument, local inhabitants proposed that the best way to restore the natural vegetation is to close down some water points formerly used by immigrant nomadic tribes particularly from Kordofan, i.e., commercial water provision should be stopped. Only then the immigrants would be compelled to leave the area to its indigenous population.[2]

1/ The number of wells operated by diesel pumps in Umm Kaddada town alone was found in January 1985 to be 15, in Brush 3.

2/ This view was documented through an evening discussion organized and guided by the writer among local inhabitants in Umm Kaddada town in August 1984.

From what has been perceived by the local inhabitants as stated above, one can conclude that water availability for drinking purposes was not regarded as a limiting factor for the traditional practices in the area. Only recently, through mismanagement of water sources, water provision started to interact with other factors to affect the ecological status of the area.

SECTION THREE

DEMOGRAPHIC AND ECONOMIC STRUCTURE

SECTION THREE

DEMOGRAPHIC AND ECONOMIC STRUCTURE

I. Demographic Structure:

1. Ethnic Composition:

Table 9

Main tribes as reflected from sample survey

Tribe	No. of respondent	% of total
Berti	72	30.0
Basaa	51	21.2
Dar Hamid	36	15.0
Gawama	22	9.2
Sarari	10	4.2
Bederia	5	2.0
others	44	19.9
Total	240	100.0

As seen from the above table, Berti and Basaa are dominating. Ethnic composition has been considered as one of the indicators of change, and it seems that the traditional composition of the area is still preserved. This finding is of vital importance in regard to the question of population mobility as caused by environmental changes. Of significant relevance is the fact that both dominant tribes are traditionally known as sedentary cultivators, an attribute which is directly related to environmental changes.

The other minor tribes usually practice a sort of transhumant way of life adaptive to the prevailing environmental conditions. Moving the whole family with animals in certain parts of the year was once regarded by the majority of inhabitants of this area as an inferior practice as compared with sedentary cultivation. This attitude is presently undergoing remarkable changes to be discussed in their respective contexts within this analysis. Of significant importance in this context is

the absence of pure nomadic tribes, even at this time of high population dislocation and excessive nomadic infiltration, particularly from northern parts which were recently severely hit by drought hazards. Absence of pure nomadic elements, therefore, is a phenomenon which deserves well grounded explanation in the following discussions. The present population structure, however, resembles in many respects that of 1973, as seen from the following table.

Table 10

Population Structure of Eastern District as Compared with the Three Other Districts of Northern Darfur Province in 1973

District	Urban	Rural	Nomadic	Total
El Fasher District	51,932	141,134	13,469	206,535
	25.2%	68.3%	6.5%	100%
Northern District	4,762	173,480	50,447	228,689
	2.1%	75.9%	22.0%	100%
Dar Masalit	35,424	278,304	72,228	385,956
	9.2%	72.1%	18.7%	100%
Eastern District	4,693	78,015	--	82,708
	5.7%	94.3%	0%	100%

Source: F.N. Ibrahim, 1984, p.101

2. Age Structure:

Table 11

Age Groups

Age groups	No. of respondents	No. of Total
Less than 19 years	00	00
20 - 29	54	22.5
30 - 39	67	27.9
40 - 49	41	17.1
50 - 59	37	15.4
60 +	41	17.1
Total	240	100.0

The majority of respondents falls within the age group under 40 years (50.4%); about a quarter falls within the age group 20-29. These findings suggest that the younger householders are still present in the area, which reflects a sound population structure. The presence of this energatic group, even at a time of continual environmental deterioration, needs further explanation to be touched upon in relation to the question of out-migration. Non-representation of age groups under 19 years suggests that householding is a responsibility of relatively older elements. This is connected with the cultural traits of the people as far as marriage is concerned.

3. Marital Status:

Investigations revealed that 216 (90.0%) of all respondents were married at the time of interviewing, 19 (7.9%) were unmarried, the rest 5 (2.1%) were either divorced or widowed. The majority of respondents (78.8%) have only one wife, 12.9% with two wives, 7.9% with three wives and only 0.4% with four wives.

These findings seem to be strange in a community which emphasizes the role played by a wife in nearly all socio-economic activities of the family. Normally in some parts of Northern Darfur Province a married woman has her own plot of cultivated land and therefore adds to her husband's possessions. This means that polygamy might be quite rewarding for the husband. The small proportion of divorced householders may be interpreted as a sign of social cohesion and a tight family structure. This is of course against expectations at a time of environmental hazards and economic stagnation.

4. Family Size:

The number of children reported by respondents was 996 (459 sons and 537 daughters). This gives an average of 4.1 children/family, which means that the average family size is about 6 persons, still within the norm for the average Sudanese family.

The ages of children were distributed among the following categories as shown in Table 12.

Table 12

Ages of Children

Age group	Number	% of Total
0 - 4 years	373	37.4
5 - 9 "	312	31.3
10 - 14 "	246	24.7
15 - 19 "	106	10.6
20 +	20	2.0
Total	996	100.0

The above table figures reflect the fact that more than two-thirds of all children were under 10 years old. The small proportion of those above 20 years old may be due to the fact that at this age the youths usually get married and are no longer counted as dependant children.

Regarding other dependants (parents, brothers, sisters, relatives, friends), our inquiry revealed a number of 742 distributed among respondents, i.e., an average of 3/household. If we add this to the family members, then the actual family size will rise to 9 persons.

5. Family Structure:

Our investigations revealed that 94.3% of total households present a nuclear family structure whereby each married couple lives independently from parents in a separate dwelling. Accordingly, each nuclear family has its own cultivated lands and earns its living quite independently. A wife's possession of cultivated lands remains her own, but the returns from it constitute part of all household returns. This may be the justification for the preference of the newly married couples to establish their own dwelling compounds. This finding is

peculiar even within Darfur region itself.[1/]

6. Settlements:

The most decisive precondition for establishing a settlement is the secured supply of permanent drinking water. This is dependent either on the amount of annual precipitation or the hydrological structure of the area. Availability of drinking water has been chosen as one of the indicators of change in the area of study. Settlements have been clustered around water sources since the previous century. Recent boreholes, particularly in the last thirty years in the aquiferous Nubian sandstones, have stimulated increased settlements. This criterion of the area is reflected in the relatively higher settlement density in comparison to other parts of Northern Darfur. Nearly all settlements were found to have been established long ago. There was no sign of recent settlement establishment, as the case in most parts of Darfur, particularly as a result of the recent drought conditions.[2/] The significance of this finding is firmly related to the phenomenon of desertification, which is remarkably observed on the satellite images as rings. The multiplication of the problem, however, is well connected with traditional occupation of millet cultivation in the area, to be elaborated later in this study.

7. Building Materials:

The aspect of building material is of great relevance to the monitoring of environmental changes.

Rural inhabitants among our respondents were all living in dwellings constructed of wood and straw. Even

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1/ In most rural areas and part of urban centres of Sudan it is usual to find an extended family structure, rather than a nuclear one, whereby more than one household live within the same dwelling compound and accomplish the work jointly.

2/ The increase of settlements during the drought disaster in 1970-1973 as observed by F.N. Ibrahim, 1984 in other parts of N. Darfur, was not registered here.

in Umm Kaddada urban centre the majority of dwellings were primarily made of wood and straw. Terrain, type of soil, climatic conditions, availability of wood and straw and the standard of living were the main factors behind the dominant use of wood and straw as building materials.

Wood and straw used to be gathered in the village surroundings with minimal effort and little expense. Even the house construction is carried out collectively, in some instances by women. This finding is directly related to the aspect of desertification through the removal of the plant cover. This was evident from the following presentation:

Besides these tree species there are a number of grass species used for house construction which include sorghum and millet stalks, Marhabah and Simama. Thus we can state that the type of housing in the area contributes directly to eradication of certain plant species, particularly in the village surroundings. This was quite evident from the bare surroundings of all settlements in the area. Our inquiries revealed that 72.5% of all respondents used to meet their demands for timber within a radius of 2 km maximum from the settlement centre. Presently all respondents have to bring their needed timber from places 7-20 km distant from the settlement.

The demand for timber, however, was continuously increasing as a result of population increase in the last 25 years before the recent decreasing trend started. Even at present the demand was found to be very high due to the high frequency of house reconstruction[1/] which was mainly attributed to the recent environmental hazards[2/].

1/ Huts can last for a period ranging between 4-7 years.

2/ High wind velocity due to removal of plant cover, creeping sands on hut edges and the activity of termite and domestic animals, enhanced by drought conditions, are main working factors.

Table 13

Tree Species Preferred by Local Inhabitants for house Construction

Tree Species	High rate of usage	Moderate rate of usage	Low rate of usage
Kitir	+		
Sagat	+		
Arad	+		
Higlig		+	
Sayal	+		
Indrab			+
Hashab	+		
Babanos			+
Sarah		+	
Leyon	+		
Ghebeish	+		
Gafal		+	
Kadad	+		
Hummaid		+	
Mukhait			+
Sidir			+
Ghodaim		+	
Neem			+
Laot		+	
Marakh			+
Habeel			+
Sahab			+
Tebeldi			+

A part from timber as building material, wood has been used to meet energy requirements and the building of fences and enclosures. The average consumption of fire-wood is a donkey-load (rahal hmar) per family of 6 persons per week (F.N. Ibrahim, 1984). This is about 50-70 kg. wood which can be won by the felling of a middle-sized Acacia mellifera (F.N. Ibrahim, 1984) This gives an indication that wood is used as a source of energy quite uneconomically. It has been frequently observed that large pieces of wood were used for cooking one meal, and usually wood is left burning the whole day without any conservation measures. In fact the cooking techniques adopted in the area make use of only a small fraction of all the energy generated by burning a large amount of wood.[1/] The simple tin oven (mangad) known in many parts of the Sudan is rarely used in this area. It burns charcoal and therefore it wastes less energy than open fires do.

Wood use for fuel and building huts, fences and enclosures by farmers and semi-nomads in the area was found to be very high even in comparison with other parts of Northern Darfur. The main reason for this is the sedentary nature of life within the area which continuously increases the burden on the deteriorating plant cover. The estimations of F. Ibrahim in 1979 for the whole Northern Darfur, shown in Fig. 12, could be therefore, taken with some precaution.

The above figures reflect a high wood consumption per family in a year. In fact not only does the rural population use wood for fuel but also the urban population. All of the five bakeries of Umm Kaddada

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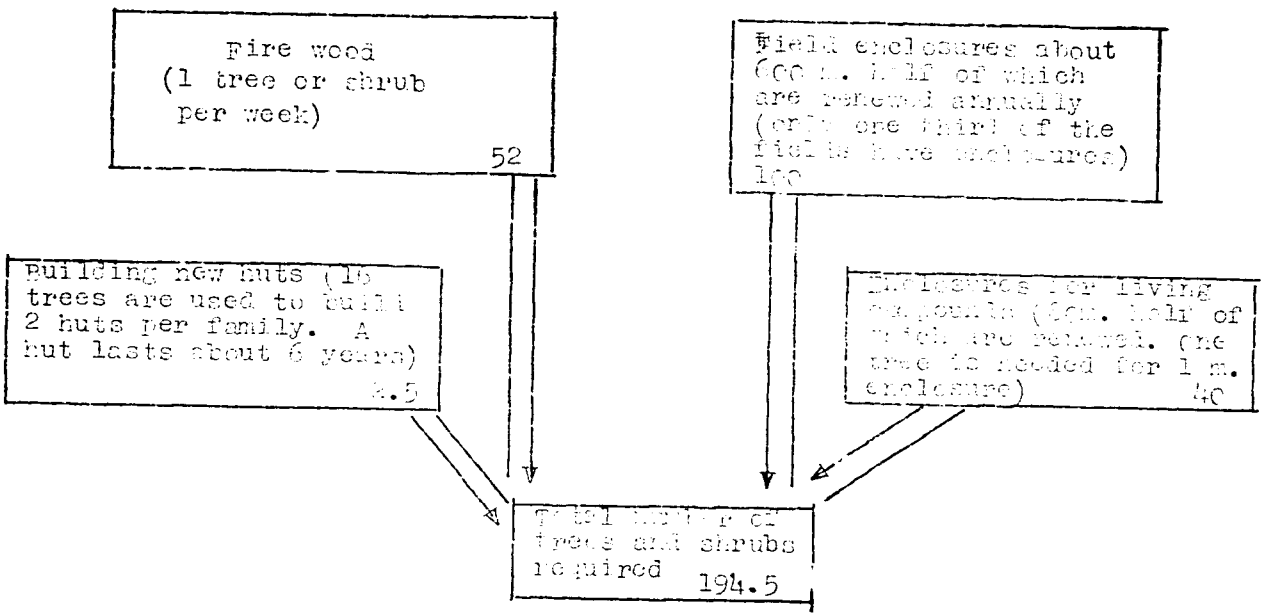
1/ Energy saving ovens, as those known in India or Egypt are not used in this area. Closed mud ovens make use of about 40-50% of the energy produced, while open fires give only 5% energy benefit (F.N. Ibrahim, 1984).

Fig. 12

Annual Wood Consumption per Family
in Northern Darfur



depend wholly on wood as a source of fuel. This is by far the biggest wood consuming enterprise in the area, since other fuel alternatives are either very expensive or completely lacking. Queues of camels were often observed, loaded with timber and firewood, moving towards Umm Kaddada town. Also charcoal collection stations were seen along the roads leading to urban centres, which might be taken as the best indicators that the last remaining plant species have been excessively removed and used as a source of a cash income for the rural population. This trend was reported to be recently activated as a response to the high demand for wood in urban and other large settlement centres and as a response to the decreasing role of other occupations such as farming and pastoral nomadism. This type of correlation, primarily caused by the deteriorating environmental conditions, was found to be well perceived by the local inhabitants, a subject to be dealt with in the succeeding discussions. The following table shows the types of wood consumed as fuel and the rate of usage:

Table 14

Tree Species used as a source of fuel and the Rate of Usage

Tree Species	High rate of usage	Moderate rate of usage	Low rate of usage	Tree Species	High rate of usage	Moderate rate of usage	Low rate of usage
Kitir	+			Mukhait		+	
Sagat	+			Sidir			+
Arad			+	Goddaim			+
Higlig		+		Gasab			+
Seyal			+	Marhabob			+
Indrab	+			Um Simema			+
Babanos			+	Neem			+
Sarah			+	Laot			+
Leyon		+		Marikh			+
Gebesh		+		Falkhosan			+
Gafal			+	Habcel		+	
Kadad			+	Sahab		+	
Hummaid	+			Tebeldi			+

8. Population Movements:

1. In-migration:

To find out the volume of in-migration to the study area the respondents were asked whether they were born in the study area or migrated to it from other places. The result of our investigation was as follows:

Table 15

Place of Birth of Respondents as a Measure for the Volume of Immigration to the Study Area

Place of birth	No. of respondents	% of Total
Born in the village	125	52
Born outside the village but within the study area	84	35
Born within Darfur Province but outside the study area	24	10
Outside Darfur Province	7	3
Total	240	100.0

From the above presentation it is evident that the majority (87%) were either born in the village or within the study area. In-migration from other parts of the province as well as from other provinces was comparatively insignificant.

This finding was found to be quite relevant to the socio-economic pattern of the area characterized by traditional economic pursuits and an affiliated social structure. Communal land ownership and the domination of certain ethnic groups could hardly permit the infiltration of other groups. Moreover, the physical factor of the area was not conducive to creating employment activities which might have attracted people from other areas, particularly in the last few decades. This can be seen from the following table:

Table 16

Distribution of in-migrants according to the period of in-migration

Period	No. of respondents	% of total in-migrants
1950's	46	40
1960's	32	27.8
1970's	21	18.3
1980's	16	13.9
Total	115	100.0

It seems that the majority of the in-migrants have lived in the study area for more than 20 years. The number of in-migrants continually decreased which suggests the decreasing attractiveness of the area, as presented in the Baseline Trend Analysis Report.

According to our investigation, 29.6% of all in-migrants came alone, 39.1% brought their families with them, 26.0% came in company with their parents and 5.2% came as part of a group of the same tribe.

Motivation for in-migration was stated by 33% of all in-migrants to be good cultivable lands, by 22% to be for the sake of escaping deteriorating environmental conditions in their places of origin, by 12.2% to be good pasture, by 10.4% to join relatives, by 8.7% to get married and by 6% to search for paid labour.

2. Out-migration*:

It seemed that the area was comparatively more attractive to people hit by drought conditions in other parts of the province. This has been stated by 59% of

* The question of out-migration needs a further investigation. The figures given in this analysis need further verifications, intended to be updated by the writer in the near future.

all immigrants. At the time of this study conditions were reported to be unattractive, yet the present inhabitants were reluctant to move to other places (65.2%) with the hope of a return to normal conditions. Very few among our respondents have stated their intention to leave the area in the near future. Among those who were intending to leave the area 47% mentioned Southern Darfur as a destination, 35% mentioned other provinces, particularly Blue Nile and Kassala and the rest couldn't state exactly their destination.

To justify their intention to move 32% stated deteriorating environmental conditions in the area, 21% stated a search for better living conditions, 17% a search for paid labour, 9% stated the desire to join relatives in other places, the rest (21%) either stated a combination of one or two reasons or they could not state with precision.

The majority of those intending to move (79%) stated that they would move alone at first, and if conditions there prove to be more rewarding, they would pick up their families. A small fraction (12%) stated that they would move with their families from the beginning. This means that the people were still tied to their home land, but they were longing for a better life. Various sources of information about other places, including our own visit, returning migrants and mass-media, have increased the motivation of individuals to migrate. This has been aided by the increasingly deteriorating environmental conditions in their area of origin. But despite that the majority of those intending to migrate (62%) stated their move to be a temporary one, the length of which depends on the improvement of living conditions in their place of origin. Only 15% of all those intending to move stated an intention to stay permanently in the new destinations given all possible circumstances. The rest (23%) could not forecast what they would do in the future.

It is worth mentioning, however, that 72% of all intending to move stated the desire to give up the idea of moving if conditions in the area return to normal.

Our inquiry about the previous out-migration revealed that 44% of all respondents have participated in seasonal migration streams. Among the family members of our respondents 17% were reported to have participated in permanent out-migration. At the time of our investigation some 19% were reported as absentees. Areas of destinations of these absentees were reported to be within the Blue Nile, Gezira, Kassala, Khartoum, Kordofan, Southern Darfur Provinces and abroad.

As seen, out-migration was directed towards areas still having higher potentials than Northern Darfur. Some of the out-migrants were reported to have participated in the seasonal population movements between western provinces and northeastern provinces as initiated by the expansion in the modern agricultural sub-sector in the latter. The case of Abu Hameira settlement, where a large number of its people have been practicing a sort of chain migration to El Suki area in the Blue Nile Province since many decades ago, was taken as a living example. The migrants from this settlement were reported to have formed a distinctive group confined in a particular quarter in El Suki town called El Basaa, referring to the name of the ethnic group. Contacts between migrants and their home relatives was reported to be still strong. Accordingly the inhabitants of this settlement were found to be highly stimulated and motivated to migrate.

Recently returned migrants were quite negligible in number among our respondents. This might suggest that the flow of information about the prevailing conditions in the area has restricted the return-migration to a minimum, at least at the present time. Presently seasonal migration is restricted to Southern Darfur and Southern Kordofan Provinces, particularly in the rainy season.

Generally speaking, out-migration in this area has been stimulated by the social structure of the population of the area. One of the typical social attributes of Northern Darfur is the role played by women in sustaining the family by providing all its requirements. The woman is actually responsible for everything even millet cultivation. This attitude has released the men and hence stimulated them to join the stream of out-migration.[1/]

II. Economic Structure:

1. Occupation:

Our questionnaire revealed that 57.1% of all respondents were solely peasant cultivators, 30.4% combine peasantry with other occupations, 70.1% were government workers, 1.4% were shopkeepers, 2.5% nomads and 1.2% other occupations.

The above figures are of considerable importance in relation to the question of desertification. The relatively higher number of peasant cultivators compared to other parts of Northern Darfur suggests that the area was once famous for subsistence millet production as emphasized in the Baseline Trend Analysis Report. The numerically small fraction of nomads indicates that the whole area was primarily reserved for millet cultivation and other related occupations.

The significance of adopting peasant cultivation as the main occupation, however, cannot be well understood without reference to the prevailing environmental conditions. It has been proven that excessive rain-fed cultivation is one of the major causes of desertification in the area (F.N. Ibrahim, 1979,1984). Reasons are varied and the processes are rather complex.

1/ For the role played by women in the socio-economic pattern of Northern Darfur See F.N. Ibrahim, 1984, pp. 137-144.

The adopted methods of millet cultivation were believed, even by the indigenous population, to speed up the process of desertification in this area. Cutting down of trees to prepare the land for cultivation and clearing of herbs and grasses dismantle the topsoil layer, thus exposing it to erosional forces, particularly aeolian forces.

Cutting down of trees was reported to be necessary for protection against birds, insects and locusts. This is actually done several weeks before millet is sown. This means that the topsoil is left without any protection and hence becomes vulnerable to erosion. Even during the growth period grasses and herbs are continuously removed, since they compete with millet for the limited soil moisture. The indigenous peasants are well aware of the fact that the roots of the indigenous plants have the ability to absorb every drop of rain which percolates in the soil, contrary to millet which possesses short roots compared to its considerable height.[1/] By digging two holes, one into the sandy soil of a millet field near Abu Humeria (13°20'N, 26°30'E) and the other on a neighbouring fallow field of the same kind of soil but with a cover of grass, the results were as follows:

On the millet field, soil moisture was detected only 7 cm deep, while it occurred at a depth of 75 cm on the fallow field.[2/] This means that, unlike millet, the natural herbs were able to absorb all the soil moisture provided by rain. It has been remarked by F.N. Ibrahim, 1984 that the soil moisture at a depth of 100 cm is common all over the area even in the dry season.

1/ Height of millet stalk ranges between 100-150 cm.

2/ These findings resemble to a great extent the findings of F. Ibrahim, 1984, at a point 14° 15 N, 25° 45 E, where he registered 10 cm deep and 100 cm deep, respectively.

Therefore, we can state that the repeated clearance of vegetation cover, which is usually done by scratching and loosening the topsoil with a native hoe, is the main cause of the irreversible extinction of the natural vegetation species, which are much more adapted than crop plants to the prevailing arid climatic conditions. Moreover, depriving the sandy soil of its natural plant cover will expose it to strong deflation, especially during the long dry season of 8-10 months.[1]

As seen from Fig. (13) the erosion of the fertile topsoil, rather than variability of precipitation, has led to a considerable deterioration of land productivity as reflected in the decreasing trend in productivity of millet despite the continual expansion in cultivated areas.

Another expansion for the deterioration of soil productivity as related to the adopted main occupation of subsistence millet production is the abandonment of the old rotational system of shifting cultivation. Population increase in the last few decades and the utilization of all cultivable areas in the settlement surroundings have reduced the fallow periods.[2] Thus the rational soil regeneration farming system adopted in the past is no longer being practiced at present. Our questionnaire revealed that more than two-thirds of all

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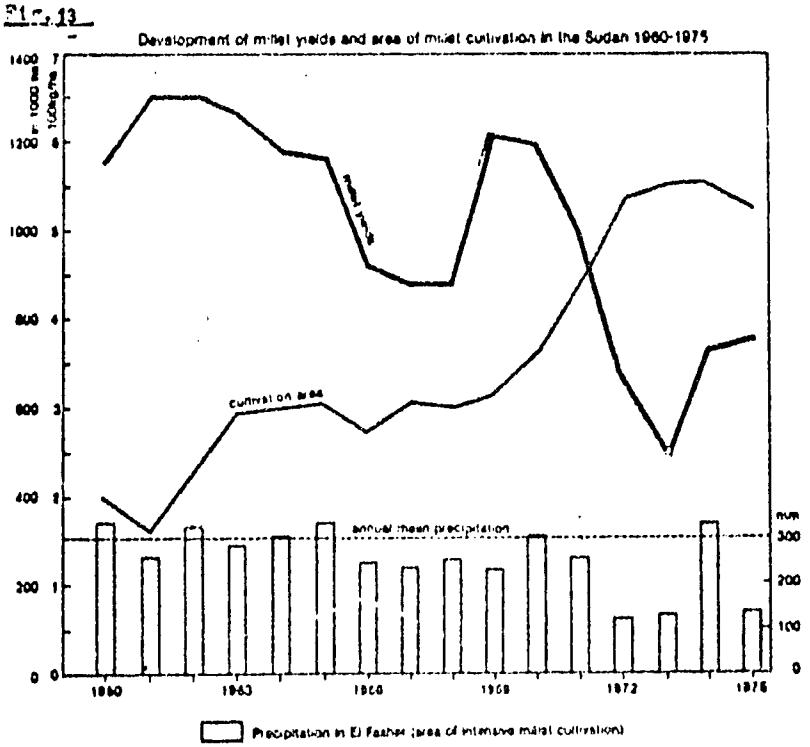
1/ About 200 million tons p.a. of fertile soil are reckoned to be blown away from the Sahelian zone into the atmosphere (Junge, 1977, Quoted from F. Ibrahim, 1984, p.108).

2/ It is not convincing to speak of scarcity of cultivable lands in an area which is known to be sparsely populated. Scarcity of cultivable areas is mostly related to scarcity of drinking water rather than population density which is estimated to be 3 to 6 persons per sq. km.

Fig. 13



SOURCE -- F. N. IBRAHIM , ECOLOGICAL IMBALANCE IN THE REPUBLIC OF THE SUDAN - WITH REFERENCE TO DESERTIFICATION IN DARFUR - BAYREUTH, 1984.

respondents (67.3%) practice permanent cultivation without fallow, 9% leave the land fallow after more than 4 years, 10% after 4 years and 13.7% after 2-3 years. Therefore the sound and rational traditional system of shifting cultivation has been turned into land misuse, and a chain of processes of deterioration of land productivity has been established: Population increase ---> excessive cultivation ---> enhanced soil erosion and soil impoverishment ---> decrease of millet yields per ha.

The fact that the adopted practice of millet cultivation in the area has contributed directly to the process of desertification can well be ascertained by the appearance of bare patches of lands in the settlement surroundings. Air and satellite photos show radical expansion of soil and vegetation degradation from the settlements forming rings of desertification. The idealized scheme of desertification in the perimeters of settlements in the Sahelian zone of Darfur adopted by F. Ibrahim in Fig. (14) was found to be valid in our area of study.

2. Area Cultivated:

As previously stated, cultivated area has been continuously expanded to compensate for decreasing productivity and to meet the demand of the increasing population.

Table 17

Area Cultivated in the Last Five Years and Percentage of Respondents in Each Year

Area cultivated in Mukhamas	% of respond in 1980	% of respond in 1981	% of respond in 1982	% of respond in 1983	% of respond in 1984
3 - 5	88.3	20	12	9	-
6 - 10	7.2	70	14	11	4
11 - 15	4.5	6	61.7	14	22
16 - 20	-	4	8	53.7	35
21 - 25	-	2	4.3	12.3	39
Total	100.0	100.0	100.0	100.0	100.0

Area cultivated was reported by 72.7% of all respondents to be dispersed in different localities, 31% of all respondents owned 1 plot, 57% owned 2 plots, and the rest owned more than 2 plots.

Land ownership was reported to be communal in the majority of cases. Private land ownership was difficult to define. Cultivated lands were reported by 58.2% to be allotted by the settlement Sheikh, 37.5% to be inherited, and the rest by putting a hand on it through several years of continuous cultivation.

Nearly all respondents (94.5%) stated that cultivable areas was still plentiful at the time of investigation. All areas presently under grazing practices are potentially cultivable areas, provided that drinking water is available.

3. Types of Crops:

Throughout the whole area of study millet and sorghum are grown as the main staple crops. They remain constant in all years, despite decreasing yields. The following table shows the different types of crops grown in the area in the last 5 years by percentage of all respondents:

Table 18

Types of Crops Grown in the Last 5 Years by % of All Respondents

Year	Sorghum	Millet	Sesame	G. nuts	Water melon	Okra	Lubia	Fagios	Kerkadi
1980	40	91	50	14	71	46	31	6	18
1981	40	92	51	12	71	43	30	5	18
1982	42	94	49	12	74	40	28	5	16
1983	38	94	49	10	73	39	24	4	12
1984	39	93	39	6	63	31	19	2	9

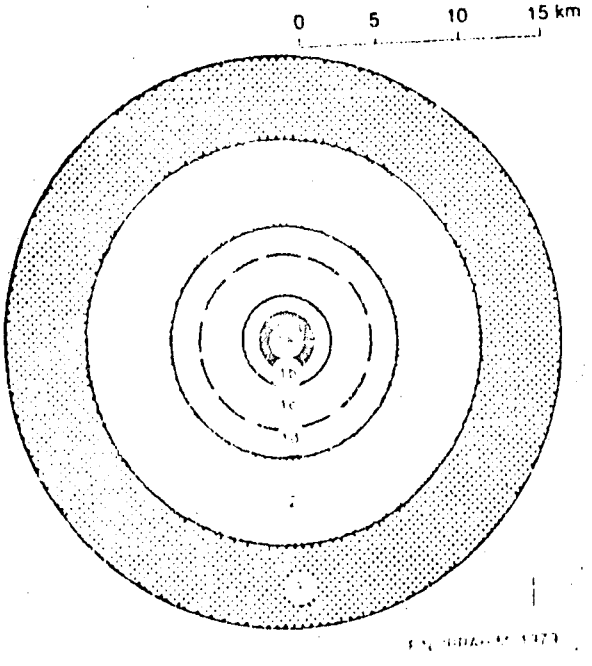


Fig. 14

Idealized scheme of desertification in the perimeter of settlements in the Sahelian zone of Darfur, Sudan

The nearer to the centre, the higher the degree of degradation is

1) Inner ring of excessive cultivation combined with overgrazing
   a) Settlement with old shade-giving trees (*Balanites aegyptiaca*, *Acacia nilotica*, *Zizyphus spina christi*, *Azadirachta indica*)
   b) Settlement fringes, with unpalatable herbs and shrubs (*Cacia* species, *Calotropis procera*, *Guiera senegalensis*, *Albizzia* species)
   c) Ring of excessive cultivation with no fallow
   d) Ring of cultivation interspersed with fallow
      Also overgrazing damages
2) Ring of permanent overgrazing
3) Ring of excessive tree-felling and seasonal overgrazing

Yields attained from all crops were generally reported to be decreasing, particularly in the last five years; 77.4% of all answers stated a yield of less than one sack per Mukhamas in the last year of 1983 which was found to be lower than the years before. Expectations for 1984, the year of investigation, were even worse than ever before. Despite such expectation, the whole cultivable area was duly prepared for cultivation, which suggests that the people were still hoping for better environmental conditions.

Regarding gum arabic production in the area only a small number of people (4.5% of all respondents) owned hashab trees. This finding sounds strange since this area was famous for gum arabic production, and it was, up to only a few years back, part of the central gum area of the Sudan (See Fig. 15). Presently gum arabic production hardly exceeds 1/10 kantar per Mukhamas.

Reasons behind decreasing productivity were readily attributed to the gradual eradication of hashab trees (Acacia senegal) as a result of excessive utilization for construction of huts and as a source of fuel. Moreover, the prevailing drought conditions enhance the effects of wind velocity on old Acacia senegal which has been continuously attacked by termites. It has been often observed that wide areas have been covered with fallen trees which were turned upside down without any sign of man's interference through cutting or felling. This phenomenon, however, is presently dominating the landscape, particularly in localities away from water sources.[1/] It deserves further investigation to determine with certainty whether it is caused by the action of winds, as some scholars advocate, or by the attack of termites.

1/ This feature was quite evident in the area between Jebel Dirra west of Al Abyad and Umm Sunta east of Shog el Sumiat.

In both cases replacement through reforestation becomes increasingly necessary if the previous tree cover is to be maintained and the gum arabic production is to be resumed.

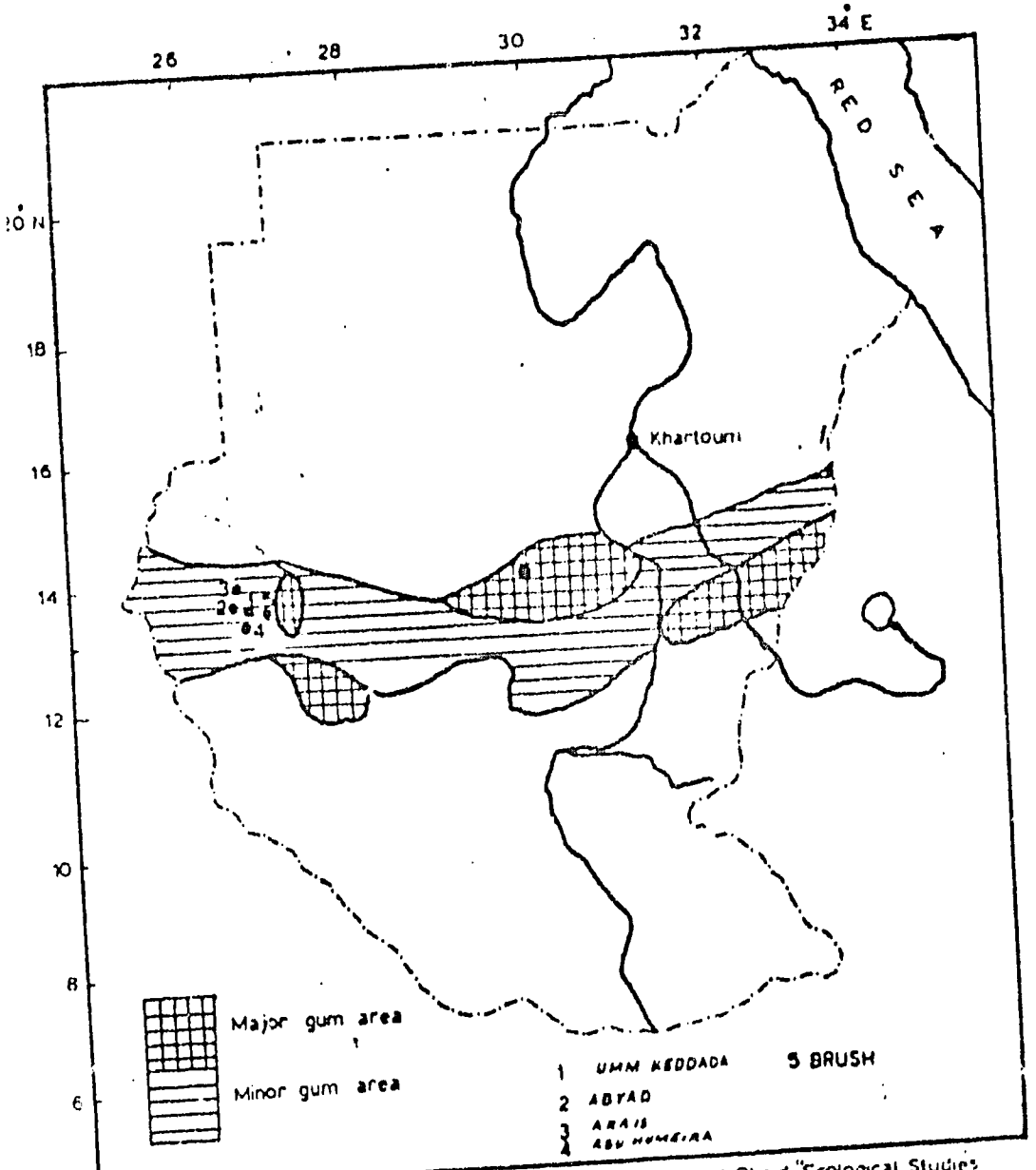
By testing the perception of the indigenous population regarding the reasons behind the decreasing yields of crops we obtained the following results: 96.2% of all answers attribute it to a decreasing amount of rainfall and the short duration of the rainy season; only 3% of all respondents admitted that the degradation of soil caused by over-cultivation is responsible for the decreasing yields. Generally, the inhabitants of the area believe that the Qoz soil is still preserving its initial characteristics and if climatic conditions return to normal, the soil will permit the same yields as prior to the outbreak of the drought conditions. This perception is well reflected in the insistence of the local population on the continuation of cultivation of the same plot of land despite its decreasing yields.

4. Livestock:

1. Monitoring land carrying capacity:

By virtue of its sedentary nature, the area of study is expected to have a relatively smaller animal population than other areas of N. Darfur. Like any other parts of western Sudan, it is extremely difficult to give an account of the real size of the herds, since the owners refuse to give the true figures for fear of being compelled to pay high taxes. Animal statistics are usually collected from taxation lists which are under no official control and are usually made by the chiefs who own most of the animal wealth. Even vaccination figures of the veterinary stations are sometimes far from being dependable since animal owners refuse to participate in vaccination campaigns for fear of being highly taxed (F. Ibrahim, 1984).

Fig.15 THE GUM BELT IN THE KORDOFAN REGION OF THE SUDAN



SOURCE. Redraw from Abul Gasim Seif el Din and Mohamed Obeid "Ecological Studies of the Vegetation of the Sudan, Journal of Applied Ecology, Vol. 7, 1970.

Aerial census is by far the most promising device in such circumstances, but not without limitations. High mobility of herds and the unpredictability of their movements impede the selection of representative samples in a confined area. Therefore, every calculation of the degree of stocking is doubtful as long as no reliable census is available. In Table 19 we attempted to investigate livestock possession among the inhabitants of the study area:

Table 19

Types of Animals, Number of Animals Owned by All Respondents and Average Household

Type of animals	No. of respondents	Total number owned	Average possession per household
Cattle	93	1,483	15.9
Sheep	52	621	12.0
Goats	128	892	7.0
Camels	62	209	3.0
Donkeys	190	588	3.0

The above figures show that the dominant animal species were sheep, goats and cattle, the most typical domestic species for sedentary cultivators. The numerically small representation of camels emphasizes the low representation of pastoral nomads among the inhabitants of the area as reflected in the demographic structure. Such correlation is vital in assessing the degree of stocking in the area, but calculating the exact degree of overstocking is believed to be a difficult task, given the present research facilities. In this respect we depend on the deductions of some scholars (W. Ibrahim 1984) for the whole of N. Darfur:

- The total area of the province is about 340,000 km^2. Only half of it (170,000 km^2) is suitable for extensive (light)grazing; the rest is desert. Owing to the confined water this potential grazing land (85,000 km^2) is actually used.

- One has to assume that the real numbers of animals are at least double the figures given in the census.
- The calculation of the animal stock of Northern Darfur in Livestock Standard Units (1 camel = 1 L.S.U., 1 cow = 0.75 L.S.U., 1 sheep = 0.12 L.S.U., 1 goat = 0.12 L.S.U) gives the following figures:

Table 22

Number of Livestock in Northern Darfur in 1976

Animal type	Census 1976	Taken double	L.S.U	Total (L.S.U)
Camel	226,100	452,200	1	452,200
Cattle	908,100	1,816,200	0.75	1,362,150
Sheep	1,409,500	2,819,000	0.12	338,280
Goats	1,193,000	2,386,000	0.12	286,320
				2,438,950

Following these calculations we can convert our own findings in Table 20 as follows:

Average cattle possession per household in L.S.U						= 11.9
"	camel	"	"	"	"	= 3.0
"	sheep	"	"	"	"	= 1.4
"	goat	"	"	"	"	= 0.8
Total						17.1

Given that the total population of Eastern Darfur District according to the census of 1973 was 82,708 and that the average size of the household was 6, the total number of livestock could be:

82,708 X 17.1 = 235,717 L.S.U.

According to Budget (1975, b, p. 30) 100 kg of living animal weight requires 1,825 kg of plant biomass. To keep a livestock standard unit of 250 kg, 4,562.5 kg of biomass are required ($\frac{1.825 \times 250}{100}$).

For the Sahelian zone Budget (1975 a, p.89) assumes an average annual production of biomass of 1,000 kg dry weight per ha at the surface. Accordingly, the carrying

capacity of the whole Northern Darfur Province can be calculated as follows:

$$\frac{8,500,000 \text{ ha} \times 1,000 \text{ kg}}{4,562.5 \text{ kg}} = 1,863,014 \text{ L.S.U.}$$

Therefore, overstocking in that province is as follows:

2,438,950 L.S.U. - 1,863,014 L.S.U = 575,936 L.S.U.

or in %:

$$\frac{575,936 \times 100}{1,863,014} = 31\% \text{ (F.N. Ibrahim, 1984, p.130)}$$

According to Tothill (1958), the Soil Conservation Committee (1944) had reported that there had been no change in the basic climatic conditions of the Sudan since the beginning of the Egyptian dynastic time. Where erosion had taken place it was caused by man and his domestic animals, and if corrected in time it could be controlled.

Based on the above statement, Tothill claimed that the orderly agricultural practices could proceed with reasonable certainty and that the agricultural land of the Sudan would remain productive in perpetuity so long as reasonable steps were taken to prevent soil erosion. His guess estimate of the carrying capacity of the land at that time was 10 animal units/600 feddans (mile^2) i.e., 60 feddans/animal unit/year. But since that time a remarkable decline in range condition has occurred as a result of overgrazing and agricultural expansion. Tentatively the carrying capacity is estimated as an animal unit requiring more than 60 feddans/year or more than 60 feddans/animal/year (Range and Forage Administration Headquarters, Khartoum).

According to a field survey conducted by Ali Hasab el Karim Sidiq, Range Inspector in Central and Eastern Districts of Northeren Darfur in October 1983, the carrying capacity of the study area hardly exceeds 25 feddan/L.S.U./year.

2. Decreasing trends in animal possessions:

All types of animals have reported to have been decreased enormously in the last ten years in the area of study. The decrease of cattle was found to be higher than that of other animal species. Goats and camels were the least affected. Generally 52% of all respondents stated a loss of 20-40% of their livestock in the last 5 years, 25% have lost 60-90%, and the rest have lost more than 90% of their animal wealth.

This decrease was attributed more to the effect of decreasing feed due to the prevailing drought conditions in the area rather than to an off-take effect. According to our investigations only 32% of all animal loss in the last five years was reported to be sold in the local markets to cover direct needs, the rest either lost through deaths attributed to scarcity of feed (42%) or to diseases (12%) or theft (9%) or slaughtered for different family occassions (5%).

Table 21 shows that the study area exhibits by far the least off-take through local markets compared with other areas.

Table 21

Livestock Market Sales at Umm Kaddada and Other Northern Darfur Market Towns (1976)

Market	Camels	Cattle	Sheep	Goats
El Fasher	12,100	9,800	13,000	5,200
El Geneina	7,410	8,288	7,480	1,460
Mellit	4,264	3,149	21,462	6,233
Toro Burunga	1,430	30,735	6,331	6,124
Umm Kaddada	45	810	645	360

Source: Al Tasahhur Vol.2/1984.

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3. Grazing areas and grass species available for grazing:

Grazing areas in the past were reported by 99.2% of all respondents to be within the study area, i.e., in the village surroundings in all seasons. Presently village surroundings hardly provide sufficient grazing. Animal owners have to search for pasture throughout the dry season in places as far as 50 km. In distant areas, however, grazing potentials are still satisfactory, particularly in places far away from water sources.

The main grass species available for grazing in the study area were: Banu (Eragrositos spp), Gau (Aristida spp) Haskanit (Cenchrus biflorus), Baiyad (Stipagrostis putmosa) Rabaa (Trianthema pentandra), Harisha (Cassia tora), Agig Al Bagar (Aristida funiculata), Al Argas (Horozephora spp) and Bugail (Blepharis spp).

Table 22

Grass Species Preferred by Animals but No Longer Available in the Study Area as Reported by Villagers

Grass species	Partial disappearance	Complete disappearance	Grass species	Partial disappearance	Complete disappearance
Boghail		+	Asal el Gumry	+	
Arkash		+	Shilini	+	
Herisha	+		Khal el Shau	+	
Garan		+	Difra		+
Bayad		+	Haskanit	+	
Abu Froa	+		Koraib	+	
Kheshaina	+		Ghabash	+	
Abu Rakheisa	+		Madad	+	
Habat el Ain	+		Argasi		+
Um Geseisah	+		Banu		+
Nadah	+		Simema	+	

The above species were reported by 68.3% of all respondents to have disappeared in the last 5 years, by 23.4% in the last ten years and by 8.3% more than 15

years ago. In all cases it seems that the disappearance has coincided with the prevalence of drought conditions in the area. This was evident from the explanation of the disappearance of these grass species by our respondents: 86% of all respondents attributed disappearance to a decreasing amount of precipitation and 14% attributed it to overgrazing and overcultivation.

To augment grass shortage particularly in the late summer season some respondents usually resort to collecting grasses after the rainy season to be stored as fodder (53.7%). Others (22.2%) resort to cutting branches of trees and collection of fallen leaves and the rest (24%) depend on crop residues as fodder for animals. The lower representation of those who use crop residues as a source of fodder was attributed to the meager quantities caused by deficient precipitation and the need for it as building materials. The practice of cutting branches and felling trees was reported to be a recent one, but the tendency is towards intensification, especially if the prevailing drought conditions continue.

Supplementary feed in the form of grains, cottonseeds, cakes, watermelons and salts were reported to be used rarely by local inhabitants. It was reported by 62.5% of all respondents that giving supplementary feed has started in the last 5-10 years. In the last few years it became a necessity, yet the majority of local inhabitants could not afford to buy it.

4. Prospect of livestock in the area:

Despite prevailing harsh environmental conditions in the area and despite the continuing elimination of animal species through various working forces, the local inhabitants still perceive that investing in livestock is the main safety valve against deteriorating environmental conditions. This perception may reflect the awareness of the people of the decreasing role of crop production for cash and/or subsistence. The majority of our respondents (54.5%) believed that the area favours pastoral

nomadism, if it could be organized, rather than the previously adopted crop production, a conclusion which suggests an ongoing process of socio-economic transformation. but unfortunately neither the present carrying capacity of the grazing areas nor possession of capital favour investment in livestock by the local inhabitants.

In contrast to what has been usually stated about the social position of animal numbers in western Sudan, prestigious animal possession, i.e., animal numbers were no longer seen as a matter of prestige. The economic role of livestock is gradually increasing in the area, a tendency which might help in replanning and reorganizing the system of landuse there.

CONCLUSION AND RECOMMENDATIONS

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The spread of desert-like conditions in the area of study has created a serious ecological imbalance. This situation is mainly caused by the recent environmental deterioration, in terms of decreasing amount of rainfall as well as the rapid increase of human and animal population particularly in the last two decades.

The main purpose of this study was to test the environmental indicators of change, presented in the Baseline Trend Analysis Report, and the various processes which are triggered. The whole study was based mainly on the results of intensive field studies in the area conducted at differing intervals.

The aim of the study was to assess the physical and anthropogenic complex in one section of the whole Northern Darfur Province. The perception of the local population of the ecological and socio-economic factors were analysed; the consequences for the eco-system and for man himself were emphasized.

To attain the aims of the study our approach was an investigation of the ecological potential of the region in the past, at present and in the future. To reflect climatic deterioration in the area, climatic data were assessed; the impacts on the decreasing trend in productivity as perceived by local inhabitants were presented. It was clearly reflected that aridity is an influential factor for enhancing degradation of soil. The quick regeneration of the natural ecosystem under the persistence of man's impact is found to be difficult. Far reaching anthropogenic destruction of soil and vegetation was found to be overwhelming in the area, intensified by the rigid landuse system which does not allow for variability of precipitation. In regard to vegetation cover, both quantitative and qualitative

degradations have been analysed, and the degree of overstocking has been estimated. The relationship between vegetative cover and the distribution of water points as induced by the geological structure has been underlined.

The morphodynamic processes reflected in the removal of the top soil as caused by overcultivation and overgrazing have been well presented and analysed. Reactivation of the consolidated sand dunes and the recently formed sand dunes and sand sheets have been taken as the main cause of the decreasing cultivated lands.

The anthropogenic aspects of the degradation of ecological conditions have been investigated mainly by means of a questionnaire which was carried out among 240 households scattered among 6 settlements. Population structure, economic pursuits, social structure, cultivated areas, water supply problems and consumption, settlement, consumption of fire wood and building timber are among the main items covered by our questionnaire work.

General Remarks and Proposals:

The most far-reaching impact on the natural resources is the practice of rain-fed millet cultivation. Population number, increasing both naturally and through in-migrations, has induced extension of cultivated areas beyond the climatically adapted dry limit. Serious damage in the area is not caused merely by mobile pastoral nomads but rather by sedentary cultivators who usually mix rain-fed cultivation with sedentary animal breeding. This damage is clearly seen in settlement surroundings in the form of bare surfaces with exhausted soils. Deterioration of the ecological resources in the further surroundings of settlements is a product of deforestation through wood cutting for various purposes.

According to the classification of F. F. Ibrahim (1980) the area of study is ranging between moderately to severely affected by desertification by virtue of its

dependence on rain-fed cultivation on the consolidated sand dunes and its higher population density. Only the extreme southeastern portions are less exposed to desertification hazards at present.

The effect of the prevailing ecological imbalance is the drastic decline of the basis of existence of the population. Despite that, inhabitants of the area are still adhering to their native homes, unlike the case of other parts of Northern Darfur Province.

Only a numerically small portion of the population has responded by out-migration. Solutions to the prevailing problems become more and more difficult as deterioration of resources continues. Our recommendations to correct the situation are to a great extent in line with the recommendations given by F.N. Ibrahim (1980) for the whole of Northern Darfur.

1. All areas beyond the agronomic dry limit should no longer be used for rain-fed cultivation. Instead regulated animal husbandry should be advocated and encouraged.

2. In areas with still higher resource potentials, precise knowledge of the soil productivity and the dominant socio-economic conditions should be collected and made accessible for planners and policy makers.

3. Improving livestock husbandry through a controlled use of the pastures. The land carrying capacity should be accurately calculated in terms of L.S.U. (Livestock Standard Unit).

4. Methods of improving pastures should be developed for conservation of available pastures; reseeding and opening of new pastures by ensuring the supply of drinking water. The existing water stations should be relocated according to the carrying capacity of the pastural areas, i.e. water pumping should be practiced in rotation to assure rotation in pasture.

5. The present economic exploitation of drinking water for the in-migrant nomads should be reassessed according to the prevailing drought conditions. Concentration of in-migrant nomads around water points for long periods should be strictly avoided. Some water points in places like Al Arais, Dangdanga, Abyad, Brush should either be closed or restricted to local consumption. New boring of wells should be regulated by the local authorities in accordance with land carrying capacity.

6. Wood cutting in settlement surroundings for various purposes should be strictly avoided. The experience of Brush village for conserving trees in settlement perimeters through the efforts of the inhabitants themselves should be followed in all affected areas. Planting trees and the adoption of new agro-forestry methods are highly recommended.

7. Rehabilitation of the Acacia senegal tree (Hashab) and its combination with millet are urgent measures to reconsolidate the reactivated sand dunes and to contribute to an increase of the farmer's revenue. Some areas should be conserved for at least five years (between Umm Kaddada, Brush, Hilla and Abu Hureira) before any cultivation practice continues.

8. Limitation of wood cutting should go hand in hand with experimentation in energy-saving methods such as introducing charcoal ovens instead of the commonly used open wood fires. Transportation means, both collectively and privately, should be encouraged to bring dead trees from distant areas at an affordable price for urban consumption.

9. Environmental education should be made compulsory for all levels. Teachers as well as students should be engaged in conserving and rehabilitating the

ecosystem. The example of El Sayed Abu Hamad in El Fasher, who engated more than a thousand of his pupils in planting trees in the town perimeters, should be followed in this area.

10. Planting and conserving of trees should be the duty of every individual in the area. Laws and incentives should be announced to ensure continuation of programmes.

11. Planning of the southern zone of rain-fed cultivated areas south of Lat. 13°N to provide for seasonal population movements through expanded cultivated areas and increased land productivity. Only then can promotion of exchange between the northern zone of nomadic livestock breeding and the southern zone of rain-fed cultivation be ensured. This can only be achieved through improvement of infrastructure and enlargement of the market functions of the central places in the transitional zone (Umm Kaddada, El Fasher, Mellit, Kutum).

12. Abandonment of cultivating the Qoz should be accompanied by development projects in Wadi basins at local levels. The presence of a number of Wadis and depressions between elongated dunes with good quality soil provide for irrigated agriculture, particularly horticulture. Availability of underground water in the Nubian Sandstone aquifers assures continuous provision of water for irrigation. The experiment of Umm Eshush near Umm Kaddada should be further encouraged throughout the area. The horticultural practices of Krush by means of private shallow wells should be encouraged and guided by an agricultural extension programme. The potentials of Khor Abu Udam and Khor Al Naim in the eastern part of the area should be thoroughly investigated and planned for development. In both locations

seasonal flow of rain water can be conserved and oriented toward irrigational purposes. Both crop production and fodder supplement are greatly needed in the whole area. In this respect both private and cooperative ownership and management are recommended. The experience from Umm Ushush and Sag el Naam proved the incapability of the public sector to run agricultural projects in the area. Shortage of infrastructure, fuel, spare parts and capital are the major limitations for the local authorities. Private and cooperative sectors should be encouraged and guided to exploit the agricultural potentials of the wadi basins. Proposed projects should adjust themselves more to the local demand and less to the European markets. Larger projects like Sag el Naam and the proposed projects in the southern part should help to act as a regulating factor in drought years, to keep millet prices within the purchasing power of the majority of the local inhabitants.

13. In order to absorb the labour surplus from deteriorated agricultural areas, labour-intensive manufacturing and handicrafts should be encouraged and guided, particularly among women. Availability of high quality raw material in the form of wool, leather, wood and palm leaves together with the tradition of handicrafts in the area favour expansion and improvement. The primitive and unorganized practices in places like Umm Kaddada, Brush and Abu Hummeria should be aided and oriented. In this respect the cooperation of politicians, teachers, and tribal heads is most necessary.

14. Last but by no means least is the establishment of research and training centres particularly for school leavers to investigate specific problems and to train local teams which can take over the

work of desertification control in their native environment. Fortunately for the affected areas, both the central government and the local decision makers show great willingness to encourage the implementation of all measures intended for rehabilitation. What is really lacking are: a dependable resource inventory, suitable plans and the financial means to realize them. This study and the proposed seminar to be organized by the writer are some of the steps being taken to ease the task for planners and decision makers at local and central levels. We hope that our proposed seminar will come out with concrete proposals for implementation of some projects for the benefit of the whole.

We need to conclude this study by stressing the fact that the natural resources in the area of the study are seriously endangered, and if no preventive and corrective measures (in the manner recommended above) are taken soon to rescue the ecosystem from complete deterioration, the whole area would turn to a state of no return and the proper time will be missed for ever.

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PART THREE

SUMMARY OF UMM KADDADA SEMINAR PROPOSALS AND RECOMMENDATIONS

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A) Summary of Umm Kaddada Seminar:

1. Objectives of the Seminar:

As a third stage of the environmental monitoring in Eastern Darfur a seminar was conducted in the period 10-15 May 1985 at Umm Kaddada Town to fulfil the following objectives:

- To make possible the meeting of different users of the environment (including planners, executives, specialists and local inhabitants) in one locality for coordination and exchange of ideas and experience.
- To present the results of the research studies undertaken by PTMA in the area under the guidance and supervision of the collaborators of the IES (Institute of Environmental Studies) of the University of Khartoum.
- To arrange for presentation of other working paper prepared by different groups of specialists within the context of resource conservation and management.
- To help create environmental awareness among the local inhabitants so as to emphasize the need for maintaining ecological balance through own initiation and follow up.
- To help formulate a working plan for resource management and improvement open for participation of the Central Government, the Regional Government, international organizations and the local potentialities.

The seminar was organized by the writer together with a number of dignitaries who participated either by working papers or through discussions. Experts and specialists in the fields of agriculture, ranching and range management, veterinary, forestry, landuse, water resource utilization and management, animal husbandry, environmental management and conservation, drought and desertification rehabilitation and nourishment aid distribution programmes, local government, native handicrafts, social sciences, health, education, security, women's organizations, publicity and information have all actively participated throughout the seminar sessions.

The preparation of the Seminar was a joint effort of the writer, a regional higher committee and a number of local sub-committees. The time for preparation extended for more than five months and passed through a number of difficulties and bottlenecks. Fortunately, the high degree of enthusasm among the regional administration and the awareness of the local inhabitants have facilitated the realization of the Seminar. The support of the Regional Government, both morally and materially, and its continuous encouragement have paved the way towards its accomplishment. The sincere cooperation and active participation of Ust./Yousif A/Rahman - Dept. of Geography - in all stages of the seminar were valuable and useful. In this context one would like to acknowledge and honour the participation of other colleagues from Khartoum University, Gezira University and Abu Haraz College. The coordination of the Director of the Ministry of Agriculture in El Fasher Dr. Ahmed Ibrahim was highly effective and appreciable.

To all other colleagues from different governmental departments in El Fasher I wish to express my sincere thanks. I am particularly indebted to the Regional Governor for his moral support and financial help. Thanks to the members of the higher committee and sub-committees under the leadership of El Sayed/El Sadiq

Mohd. Yousif, A/El Gadir Abdalla and Mohd. El Tayeb whose continuous effort and energetic movements have helped to realize the seminar in its scheduled time.

To all inhabitants of the area, who overwhelmed us with their hospitality I would like to express my gratitude and hope our recommendations may help in solving at least part of their perpetual problems.

Finally, I would like to thank all persons who contributed to the preparation of the seminar material including publicity at all levels, typing of working papers, cartographic works, organization and distribution of the results of the seminar.

2. Working papers presented during Seminar Sessions:

It is not our intention to summarize all papers presented. We confine ourselves to the main theme of each paper and the name and profession of the author. Thirteen papers covering different aspects related to environmental conservation and management have been submitted and presented through 6 Seminar Sessions as follows:

- An Ecological and Socio-economic Imbalance of the Area: Past, present and future prospects, by the writer of this report (Hassan A. El Mangouri).

  The paper was intended to present the results of the studies included in Part One and Part Two of this Wrap-up Report.

- Drought Imprints and Efforts to Its Control, by Abu Hamed, a higher secondary school director in El Fasher and a well-informed and experienced dignitary in the whole Darfur Region.

- Agricultural Activities in the Area: Past, present and Future Prospects, by El Sayed Osman Adam Palila, an agricultural inspector in Umm Kaddada area.

- Landuse in Umm Kaddada Area: Past, Present and Future Prospects, by El Sayed Mohamed El Amin, Director General for Landuse and Soil Conservation in El Fasher.
- Land Reform and Water Spreading Techniques and Practices in Eastern Darfur, by El Sayed Hamdon Ahmed Mohamed, Director for Soil Conservation and Landuse Department in El Fasher.
- Ranching in Umm Kaddada Area: Past, Present and Future Prospects, by El Sayed Ali Hasab el Karim Sidig, Range and Ranching Director in El Fasher.
- Animal Wealth in Umm Kaddada Area: Past, Present and Future Prospects, by Dr. Adam Mohamed Ahmed, Director General for Animal Wealth in Darfur Region.
- Forestry in Umm Kaddada Area: Past, Present and Future Prospects, by El Sayed Mustafa Ismail Sirag, Director General for Forestry in Darfur Region.
- Water Sources in Eastern Darfur: Past, Present and Future Prospects by, Engineer El Fadil Abdalla Mohamed.
- Regional Government and Desertificistion Control, by El Sayed Mohamed El Tayeb Mohamed, Top Administrator for Eastern District.
- Rural Handicrafts and Its Effects in the Development of the Area: Past, Present and Future Prospects, by Hawa Mohamed Abbaker, Women's Organization in Umm Kaddada.
- Women's Role in Developing the Area: Past, Present and Future Prospects, by Fathia Mohamed Abbakar.
- How We Contributed to the Perpetuation of Ecological Imbalance, by Dr. Abdalla Osman El Tom, Lecturer at Gezira University.

All papers were presented in Arabic language to facilitate understanding for the local inhabitants who participated actively in all discussions. Their ideas and comments have added to the value of the scientific information presented by the various specialists.

These inputs of the local inhabitants, however, were given utmost consideration by the formulation of proposals and recommendations at the end of the Seminar.

The participation of planners and executives from different governmental departments has added to the wholistic approach to environmental aspects. All groups of participants have benefited a lot from the knowledge and experience of each other. Of particular importance were the experience, awareness and patience of the local inhabitants.

The excursion organized by the writer for all scientists, planners and executives was intended to confront them with the living situation in the area. It was very useful in enriching their knowledge and increasing their awareness about the changing environmental conditions. The excursion was not only confined to the most degraded localities but also to others with comparatively higher potentialities. Throughout the excursion casual meetings and discussions were held for exchange of knowledge and experience on the spot. In some localities meetings were held spontaneously among the local inhabitants to add current information about the prevailing conditions.

The outcome of the whole excursion, however, was used as an earmark for the formulation of the proposals and recommendations at the end of the Seminar.

At the end of the excursion, all participants were divided into small groups according to their respective specialization and experience to help formulate workable and practical proposals. The proposals were intended to

combine the scientific knowledge, experience and results of the previous studies. For this reason, proposals extracted were regarded by all participants as quite realistic and practical. A local committee was immediately formed from among participants for further follow-up.

It is worth mentioning here that all participants were quite enthusiastic and willing to cooperate further to translate all proposals and recommendations into reality. The local inhabitants from different localities in Eastern Darfur have expressed their willingness and readiness to participate in any program for the benefit of the whole area. Being fully aware of their irrational practices in the past they ascertained their determination to reject any sort of individualistic behaviour and readiness to work collectively to overcome the prevailing environmental deterioration.

It remains, then, to be seen whether the policy-makers at the national and regional levels will make use of the positive attitude and response of the local inhabitants to formulate the relevant and realistic policy to correct the situation in the area. Fortunately, the area still possesses some potentialities for development which need feasibility studies, some capital and above all political will to break down the existing vicious circle of development.

B) <u>Proposals and Recommendations:</u>

1. <u>Urgent Measures:</u>

- Grouping of affected people near central villages like Umm Kaddada, Brush, Abu Hemera, Jebel Hilla, Umm Sidra, Umm Gafala, El Karada, Umm Hosh, Tom Bushara or in accessible localities with drinking water potentialities not far from their traditional areas of origin.

- Formulation of a local body to take the following measures:
  * Accurate census among affected people to reveal the number of families affected.
  * Distiction of inhabitants according to their economic pursuits to help planning for them.
  * Distinction between those who need full support and others with partial needs.
- Provision of nourishment aids, medical care and other services in the new grouping areas through coordination of the different regional, national and international working groups.
- Organization of migration streams within and outside the area according to actual needs.
- Resettlement of some migrant people in places with higher agricultural potentialities in Southern Darfur by implementing feasible agricultural projects.
- Organization of nomads' movements within and across Eastern Darfur district by specification of migration routes and "marahil".
- Native tribal leaders should be given defined authority to safeguard the utilization of resources.

2. Medium and Long-Term Measures:

1. In the field of land cultivation:

- Prohibition of land cultivation, for at least 5 years, in all areas north of lat. 13°N, i.e., in all areas with an average rainfall of less than 250 mm. The line Tolo-Abyad Umm Shanqa should be taken as the southern boundary with the exceptions of Gurrabat and Gardoud lands.

- Land quality improvement measures should be taken by the Regional Ministry of Agriculture.
- Offering of other alternatives for affected people within or outside the area (see short-term measures).
- Controlling and regulating land utilization in newly planned areas to avoid repetition of misuse.
- Adoption of water spreading techniques for irrigation water beds and depressions, where environmental conditions are favourable.
- Rehabilitation of existing projects like Western Savanna, J. Verra and Sar el Naam projects to help in solving some of the problems created by drought and desertification processes.
- Agricultural facilities particularly extension programmes, capital and other inputs should be provided in areas with agricultural potentialities.
- Introduction and adoption of cooperative systems in agriculture.
- Creation of agricultural statistics department at the regional level.
- Land and crop rotation should be followed to ensure conservation of the soil quality.
- Preparation of a detailed resource and landuse map at a large scale to help in formulating development plans, i.e., map of environmental context of development for the area.
- Intensification of research particularly in the fields of soil quality, water resource availability, utilization and management.
- Formulation and enforcement of the needed laws and regulations for resource protection and natural utilization.

- Studying the relationship between groundnut cultivation in the area and the intensification of desertification process.
- Development of horticulture in line with the experiment of Umm Ishush and Brush based on underground water and soils of depressions.
- Potentialities of Khor Abu Udam and Khor Al Naiem in the eastern part of the area should be thoroughly investigated and planned for development (See recommendations of the monitoring study at the end of Part Two).

2. In the field of animal husbandry:

- All areas beyond the agronomic dry limit, i.e., all areas north of lat. 13°N should be left for regulated and controlled animal husbandry. Improved livestock rearing should be advocated and encouraged.
- Land carrying capacity should be calculated with a high degree of accuracy in terms of L.S.U. (Livestock Standard Unit).
- Methods of improving pastures should be adopted through conservation of available pastures, reseeding and opening of new pastures.
- Relocation of existing water stations according to the actual carrying capacity of the pastoral areas, i.e. water stations should be used in rotation to ensure rotational pasture, e.g., El Sarafa, Safaha, Umm Talateen water stations should be utilized in rotation.
- Nomadic infiltration from the North, particularly camel herders, should be restricted, at least for five years, to allow rejuvenation of the plant cover. This can be achieved through the demarcation of migration routes among various tribes as stated in Millset Agreement.

- Closing down of some bore holes either partially or completely in affected areas to deprive nomadic tribes from further concentration and to allow for plant recovery, e.g., water station of El Filaiaa, El Hamera and Shag el Shau should be closed down.
- Water stations of Dangdanga and El Higair el Azrag should be used in the period December-June and closed the rest of the year.
- All bore holes in Shag el Sayal should be closed completely for at least five years.
- Implementation of nurseries for the production of seeds for ensuring high quality grasses in areas which have lost their plant cover.
- Maintenance of existing Hafirs like Hafir El Garaia to release exhausted areas.
- Fire lines and ranch control should be provided in all areas through own initiation, laws and regulations.
- Implementation of a centre or a college in the manner of Abu Haraz to improve the quality of the desert sheep to endure environmental hazards and ensure higher productivity. Also the centre should help in improving the quality of the native cattle.
- Measures should be taken to convert animal wealth in the area into rational economic utilization by regulating the take-off and marketing facilities within and outside the region.
- Emphasis on leather production in the area through private sector or cooperative societies.
- Extension of poultry production particularly in or near urban centres.
- Improvement of veterinary services to a higher degree of efficiency.
- Experimental farms for hay conservation and milk production.

3. In the field of forestry:

- All areas north, west and east of Umm Kaddada town should be demarcated as reserved forests.
- Felling and wood-cutting should be strictly prohibited in all affected areas particularly around settlements.
- Reforestation measures should be followed through reseeding and conservation of existing plant cover in village and town perimeters. The experiment of Brush village should be repeated in other villages.
- Need for fire-wood and construction wood should be met by dead trees in distant areas the transportation of which should be the effort of private and cooperative groups.
- Areas still having high forest potentialities should be protected against irrational use.
- Strengthening the forest department with efficient staff for forest protection, forest extension, seed collection and reforestation techniques.
- Implementation of the proposed Gum Arabic Belt Rehabilitation Project Umm Kaddada-El Nuhud.
- Encouraging the local inhabitants to adopt self-help rehabilitation programmes starting from the house surroundings.

4. In the field of water provision:

- Rethinking in the present water points distribution in accordance with the increasing environmental degradation.
- New water points should be based on scientific calculations to land carrying capacity.
- The need for detailed and accurate geophysical and hydrological studies in the area to demarcate aquifers.

- Spare parts, fuel, equipment and skilled staff are urgently needed to elevate the efficiency of the existing water points. To that end a sum of Ls. 896,000 was calculated in May 1985 as urgently needed.
- For the maintenance of 54 water stations, a sum of Ls.982,000 was estimated in May 1985.
- Replacement of 24 overused wells at estimated cost of Ls. 1,392,000.
- For the replacement of 17 water containers a sum of Ls.765,000 was estimated in May 1985.
- Strengthening the existing water stations with another 41 deep wells at an estimated cost of Ls. 4,715,000 in May 1985.

5. <u>In the field of social services:</u>

- Improvement of the hygienic situation of the whole area through educational measures.
- Nutritional measures to reduce child mortality.
- Improvement of preventive and curative medical care as the most urgently needed measures.
- Improvement of educational services in the area by providing the needed financial help.
- Educational curricula should be oriented towards environmental conservation.
- Strengthening the existing security departments in the area to keep law and order.
- Improvement of communication means through road construction, wire and wireless communications.
- Improvement of market facilities for locally produced goods.

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6. In the field of handicrafts:

- Financing a weaving factory in Umm Kaddada for improving traditional handicrafts either privately or cooperatively.
- Training of school leavers particularly among girls to participate in the factory.
- Provision of medium-term loans for native handicraftsmen to enable the initial start.
- Marketing of finished articles should be organized and safeguarded both within and outside the area.

7. General recommendations:

- The whole question of rehabilitation programs should be viewed at a national rather than a regional level.
- Systematic studies should be carried out all over the country.
- Planning measures should be divided into short-term and long-term.
- All matters concerning drought hazards, their impacts and solutions should be the concern of a separate and independant body with sub-units at regional and local levels.
- Nourishment aids and rehabilitation programs should go hand in hand.
- Developmental concepts should be brought to bear environmental conservation and ecological balance.
- Youth potential should be trained and oriented towards a balanced socio-economic development at the regional and national levels.
- Volunteer societies should be encouraged at the local level to lead the process of transformation.
- Information media and publicity should be improved.