ENVIRONMENTAL TRAINING & MANAGEMENT IN AFRICA (ETMA)

ENVIRONMENTAL MANAGEMENT IN THE SUDAN

EL KHUWEI - MAZROUB - TINNA STUDY AREA
NORTH CENTRAL KORDOFAN
&
MESSERIYA STUDY AREA
SOUTHERN KORDOFAN

Final Report

Edited By

M. O. El Sammani, Ph. D.

INSTITUTE OF ENVIRONMENTAL STUDIES

UNIVERSITY OF KHARTOUM

SUDAN

SEPTEMBER 1985

Prepared for :
The United States Agency
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PREFACE

PREFACE

This volume contains the findings of ETMA PROGRAM/SUDAN on environmental monitoring, baseline and trend analysis on the two study areas of El Khuwei-Mazroub-Tinna in North Central Kordofan, and Messeriya Humur in Southern Kordofan. The volume consists of three reports. The first two were produced in December 1983, and contain the findings of the baseline and trend analysis studies on the two areas. The third one was completed in March 1985 and embraces the results of the monitoring study based on a survey of community perception of ecological degradation and environmental change.

As explained in the introductory section of the last report on the perception study findings, the two study areas El Khuwei-Mazroub-Tinna and Messeriya were tackled separately by two separate research teams during the baseline and trend analysis phase. A decision was taken by the coordinators of the two research teams to combine the two areas into one at the monitoring study phase for a number of reasons. First, the adjacent location of the two areas to each other which justifies studying them as one transect extending from about the lat. of Tinna in the north to Muglad in the south. Second, the opportunity this location avails for comparability of the state of environmental change reached in the two areas which grades from a severe degree of degradation in the northern part to better conditions in the southern one. Last, by conducting one study it was foreseen that research costs could be reduced as compared to spending on two researches.

The perception study is founded on the two areas reports of the baseline and trend analysis findings. The parameters selected for testing are outlined in the opening section of the perception report. In this way the perception study has managed to integrate the results obtained from the two areas though they were tackled separately and by two different research teams who differed in their approach and emphasis.

In editing the findings from the two areas it is thought more practical to keep the three reports as separate entities. Hence they shall be presented in the following order:

Report I: El Khuwei-Mazroub-Tinna Study Area,

Report II: Messeriya Humur Study Area, and

Report III: the Community Perception Study Report.

Though kept separate, we emphasize again that the findings from Report I and II are integrated in Report III.

Following this volume and as recommended by the perception study, a fourth and final report shall be prepared as an annex to the volume The report shall contain an intervention plan, whereby one of the twenty villages covered by the perception study shall be selected for designing an action programme in consultation with the village population. The objective of the programme is to improve the environmental conditions there

PART ONE

EL-KHUWEI-MAZROUB-TINNA STUDY AREA

1. INTRODUCTION

The present document furnishes base line data on environmental change; and contributes a scheme of potential physical and socio-economic indicators for environmental monitoring.

It concentrates on north-central Kordofan Region where a study was undertaken under ETMA 1/ Project. The Study area embraces El Khuwei - Mazroub - Tinna, which occupy a rectengular stretch of country, partly located in the Savannah low rainfall belt and partly in the Semi-desert belt Fig.(1).

The study has chosen as its central theme the physical and socio-economic environmental impacts of water supply centres on the areas and populations served by such centres.

2. BACKGROUND OF STUDY AREA

The area under consideration has recently shown symptoms of environmental distress and lack of capacity to support of its human and animal population. In the last two decades, both human and animal population, increased rapidly. Water yards and bore holes also increased, health and veterinary services improved relatively, and part of the area (Khuwei), was much affected by the lorry traffic from Port Sudan-Khartoum - El Obeid, En Nahud - El Fasher road and back. Increasing deterioration is shown by disappearing species from the vegetational cover (both grass and trees) and the wildlife, longer distances travelled by nomads in search of pasture, declining fertility and productivity of soil, and frequency of crop failures. A few years back, this was not the case.

1/ Environmental Training and Monitoring Programme for Africa.

The team would like to acknowledge the efforts of Dr. D.L. Johnson, The Project Co-ordinator from Clark University, in editing parts of this document.

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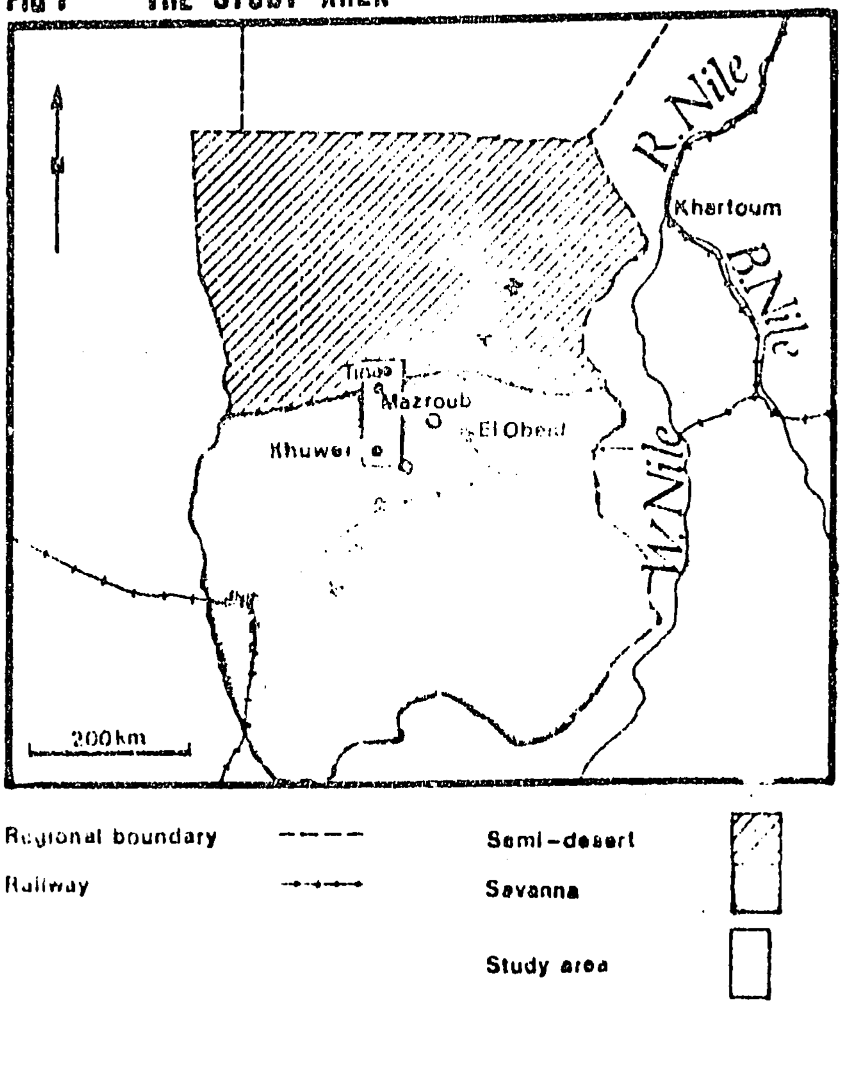
In the past, this part of Northern Kordofan region has accommodated many tribes and communities. Different tribes with different life-styles were able to live near each other without much conflict between themselves, or much pressure on the environment. Economic activities that were practised most were mainly traditional agriculture (shifting cultivation) and nomadism. The two were complementary in many ways and together they represented perhaps the best utilization of that type of environment. As time went by, however, this rather isolated region came into more contact with the rest of the country, and accordingly, became more exposed to external effects as well as internal dynamic changes that were bound to take place. As a result, the ecosystem that was once able to accommodate different communities and different economic activities, showed all the signs of a stressed ecosystem, and one that is on the verge of collapse - if left to itself. Let us see how this process took place.

We can divide people living in the region broadly into two main categories, nomads and settlers. On the one hand, nomads spend most of their time rearing their animals, moving around with them from one place to another, thus intuitively making a rational use of available land through rotational grazing. But although animal-rearing satisfies most needs of the nomad, it does not satisfy all. Some needs would have to be satisfied through selling. Thus, since most nomads do not grow <u>dukhun</u> (millet) - the staple diet - themselves, it has to be bought from adjacent villagers. Together with millet, other types of food (e.g. wheat, macaroni, tea, sugar) and salt (<u>natroon</u>) for watering animals constitute needs that can be met only through exchange of some livestock. Yet another claim on nomads' herds is the annual animal tax on herds. To satisfy their needs, livestock would have to be sold. The rate of withdrawal (off-take) from the animal population to satisfy such needs was therefore quite substantial.

On the other hand, villagers (settlers) grow crops for their subsistence, <u>dura</u> (sorghum), millet and some cash crops,

FIG I THE STUDY AREA



mainly oilseeds such as groundnuts and simsim (sesame) seed. These cash crops and 'excess' millet are sold to meet other needs like clothing, tea, sugar and dried meat. Savings that are made in bumper years are then turned into livestock which can provide milk (cattle, sheep, goats) or to be used as transport (camels, donkeys, horses), or perhaps be sold when the need arises, implying that sheep, cattle (and perhaps camels) can be considered liquid enough to be kept in absence of better (hoarding or investment) alternatives.

This dual nature of the system made it something of a self-sufficient one. One activity complements the other and satisfies the needs of people practising it. The carrying capacity of the environment was not exceeded - for a long time - and no man-made deterioration was observed. The reason was perhaps not so much the conscious good use of the environment, but rather the relatively limited intensity of its use and isolation from numerous viable market opportunities.

A multitude of factors, both external and internal, disturbed this fine balance and contributed to the present situation. It is, perhaps, both difficult and too artificial, to assign (attribute) environmental deterioration in this area, to specific factors (natural and man-made) in a neat and segmented manner. Both natural (climatic) and human, external and internal factors overlapped for such a situation to result. The degree by which the two main activities responded to and interacted with environmental changes were rather different.

3. METHODOLOGY

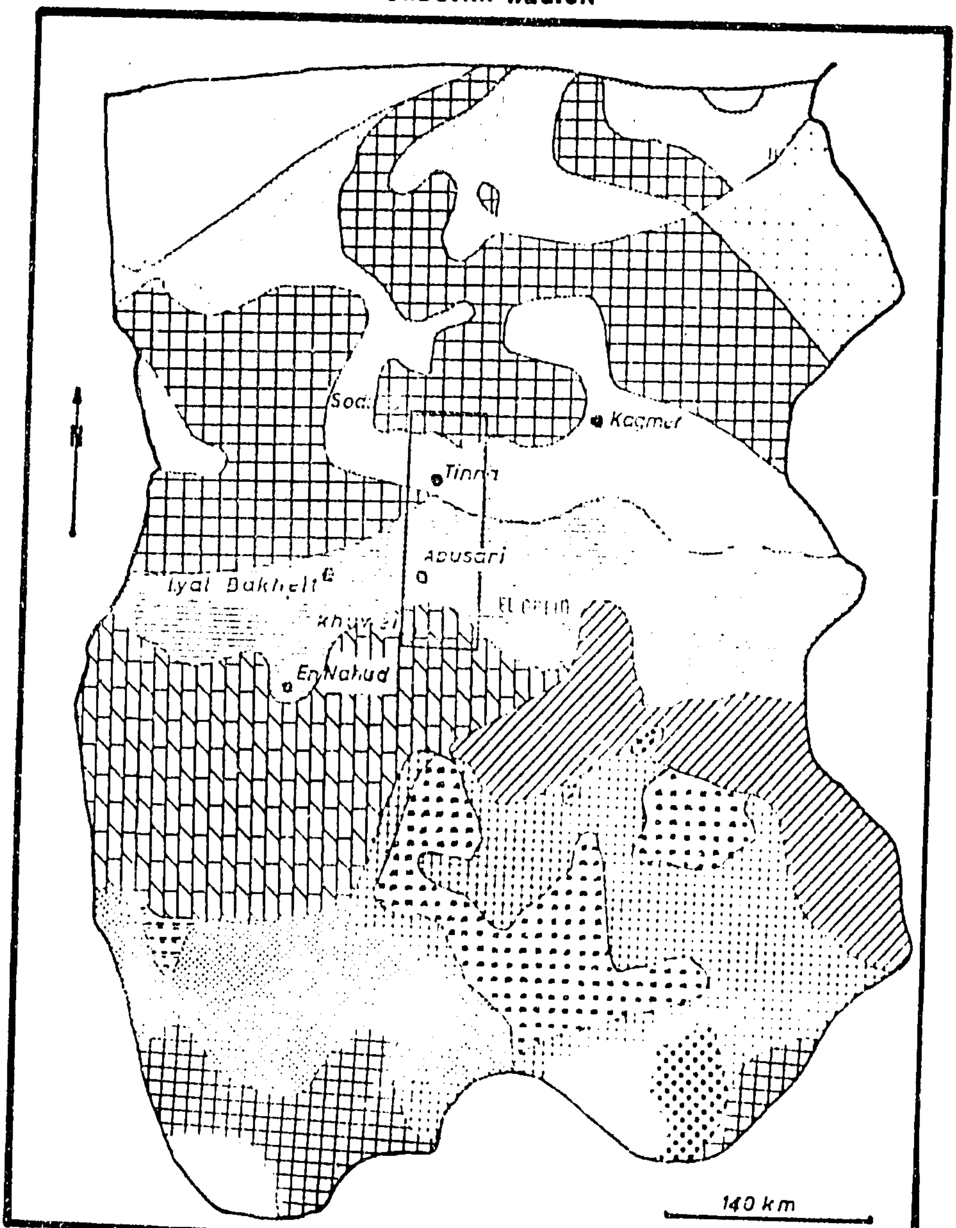
In Khuwei Area the sources of water supply are bore holes. Transects from Khuwei to nearby wateryards and their surroundings were traversed by the Survey Team. In addition to general observations to detect change in ground cover, interviewing of local inhabitants as individuals or groups was carried out to gain better understanding of the questions investigated and the environmental changes that have resulted from the construction of wateryards.

The same exercise was repeated north of Khuwei on the way to Mazroub at the village of Qubet Abu El Sari. The road from Khuwei to Qubet Abu El Sari was studied as a second transect, and this was extended further north some distance on the way to Mazroub. Qubet Abu El Sari is one of many villages located in a water supply problem area to the north of Khuwei. Here villages depend during the dry months on supplies carried for considerable distances from centres with reliable year round water supplies. In this respect, Qubet Abu El Sari was chosen as a control locality, less affected by environmental changes, in contrast to places like Khuwei and Mazroub.

Mazroub, including the site of Tinna to the north, was the last area studied. The two places are located on edges of depressions that are filled during the rainy season by the floods of wadis that replenish the sub-surface ground-water. From October to early July the populations of the two sites dig wells that reach this subsurface water which constitutes the only dependable water source for humans and livestock up to the end of the dry period.

In addition to well fields, Mazroub has 3 hafirs. However, its water potential is less than that of Tinna. In most years, the latter supplements the supply of the former by quantities carried by trucks throughout the dry months. It is noteworthy that both sites lie in a region which is devoid of water supply sources. This factor leads to over concentration of human and livestock population of settled and nomadic origins around the two sites every dry season. Khuwei and Mazroub are located at opposite ends of an ecological gradient, the former in the low rainfall savanna, the latter in the semi-arid zone. In both areas a considerable amount of environmental change is taking place.

FIG. 2 THE VEGETATION OF KORDOFAN REGION



Desert.

Semi-desert grassland on sand.

Semi-desert. Acacia mellifera commiphora desert scrub.

Semi-desert. Acacia tortis-Maerua crassifolia desert scrub

Low rainfall on sand Acacia senegal savanna

Low rainfall woodland savanna on clay, Acacia mellifera thornland.

Special area of low rainfall woodland hill catena.

Low rainfall woodland savanna on clay Acacia seyal balanites savanna.

Low rainfall woodland savanna on sand terminalia sclerocaryea anogeissus prosopis.

Aspecial area of low rainfall ragaba repealing pattern.

Low rainfall on sand, combretum cordofanum dalbergia albizzia sericocephem.

Tow rainfall woodland savanna on clay anogeissus combretum hartmannianur

Flood region.

High rainfall woodland clay anogeissus khya isoberinia deciduous woodland.

4. PHYSICAL AND BIOLOGICAL INDICATORS

4.1. VEGETATIONAL TRANSECT STUDIES

4.1.1. Transects in the Khuwei Area

Fig. (2) gives the vegetation of Kordofan Region and the Study Area.

As shown in Table (1) the first five vegetation samples were taken west of Khuwei village along a transect of 15 kilometers employing the loop and the square meter methods.

The soil along this transect is sandy pediplain which is dominantly covered by *Boscia senegalensis* and *Zornia diphylla* in a range of three kilometers from Khuwei. *Boscia senegalensis* is gradually replaced by *Dalbergia melanoxylon*, *Albizzia sericocephalla* and *Lanea humelis* further away from the fringes of Khuwei up to 15 ilometers, but *Zornia diphylla* persists throughout the transect length.

The soil cover and forage production indicate low values which could be a result of animal grazing. However, in many parts of the area considerable pockets of *gardud* soil can be observed. This is basically known as a poor forage-producing soil because it is characterized by a hard, truncated, bare surface that does not absorb water.

Termite attack is another factor that affects forage and soil cover seriously. In the Khuwei area, a mass destruction of woody vegetation has occurred. This seems to have taken place about 1970 at the height of the drought. The reason for the death of trees is obscure, but it does not appear to be linked directly to the drought or to cutting and lopping for firewood and fodder. One possible explanation is that termites are responsible for much of the widespread tree mortality. In this scenario, failure of pastures to regenerate for several years in succession would have deprived the termites of their preferred source of food. In this case, they would have turned to the woody perennial vegetation as

Table 1

Vegetation sampling along selected transects near Khuwei.

Sample No.	Average Percentage of under story Cover	Average Percentage of bare soil	Average percentage of forage Production Lb/feddan	Average number of trees/feddan	Average number of dead trees/feddan.	Remarks
1	52	48	80	10		The samples had been taken west of Khuwei village up to 15 Kilometers. Interval of sampling being 2-5 kilometers apart.
2	60	40	65	12		
3	62	38	72	15	3	
4	58	42	60	14	3	
5	60	40	60	17	5	
6	85	15	440	15	2	Samples taken at 20 kilometers from Khuwei, taken at 10 kilometer interval in the southwest direction.
7	80	20	300	14	1	
8	90	10	600	20	6	Samples taken at 10 and 20 kilometers from Khuwei in the northward direction.
9	85	15	700	16	5	

Source: Data collected in the field by the writers.

substitute. Changes in location of termite mounds, when combined with widespread death of trees, would then be an indicator of serious environmental deterioration. For with both perennial and annual vegetation seriously depleted, increased soil erosion could be anticipated.

The second transect studied was the southwest of Khuwei village. The soil in this area is composed of flauvio-lacustrine deposits and sandy pediplain. Acacia mellifera, Acacia nubica, Grewia tenax, Adansonia digitata, Scoenfoldia gracilis, Dactyloctenum aegyptium and Crotalaria sp. are the common vegetational cover in the clay lowland. The sandy soil is predominantly occupied by Guiera senegalensis, Dalbergia molanoxylon, Albizzia sericocephalla, Eragrestis tremula, Cenchrus biflorus, and Zornia diphylla.

Soil cover and forage production are relatively high due to the dense cover of grass on the clay lowlands and sandy soil areas. Heavy grazing has not yet started, because this area is almost completely surrounded by shifting cultivation. The cultivated areas protect the fallow zones from the animals of both farmers and nomads, since the possibility of stray animals damaging growing crops is too great to permit them to remain in the area. Real grazing will start after harvest of the crops which eliminates this risk and makes both stubble and fallow grazing available to the animals.

The third transect studied was to the north of Khuwei. The samples (8 and 9 in Table 1) were taken in sandy pediplain and sand dune soil respectively. The sandy soil is covered by Guiera senegalensis, Lanea humilis, Albizzia soricocephalla, Cenchrus biflorus, Aristida pallida, Zornia diphylla and Eragrostis tremula. The vegetational cover of the sand dune is Guiera senegalensis, Lanca humilis, Combretum kordofanum, Cenchrus biflorus, Aristida mutabilis, and Eragrostis tremula.

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Vegetation cover and forage production are considerably higher. The area lacks adequate groundwater resources for borehole development and, although several hydrological investigations had been carried out to try and solve the problem (Land and Water Use Survey in Kordofan Province, 1967), as yet modern technology has been unable to improve on traditional practice. Consequently much of the forage produced in the area is not grazed, but is only destroyed by fires. These are very frequent and may continue for two or three days before they are put out. Perennial grasses and herbs are damaged and the grazing resource at present is largely based on annuals.

The tree mortality in this transect is as high as 20-25 per cent. The losses are concentrated mainly among Dalbergia melanoxylon and Albizzia sericocephalla. Seeding regeneration is actually very small in comparison to the loss. This phenomenon should also be interpreted as a direct result of fires and drought.

4.1.2. Transects in Abu El Sari and Mazroub Area

The first part of Table 2 exemplifies Abu Sari area. The soil is mainly sand dunes covered by Acacia senegal, Guiera senegalensis, Comboretum Kordofanum, Sclerocarya birrea, Cenchrus biflorus, Odladia senegalensis, Aristida pallida, and Eragrostis tromula.

Forage production and soil cover are well maintained due to the area's location in the thirstiest part of the district where water selling is a remarkably profitable investment. Fire problems are still in existence. Perennial grass and tree loss is commonly observed because this area is just a continuation of the transect line north of Khuwei village.

The second part of Table 2 indicates a clear devastation of Mazroub to a radius of 15 kilometer due to the presence of a number of surface wells run by villagers from around Mazroub. The soil is mainly sand dunes covered by Acacia tortillis,

Table 2/

Vegetation transects in Abu Sari and Mazroub Areas.

Sample No.	Average Percentage of Under Story Cover	Average Percentage of Bare Soil.	Average Percentage of Forage Production Lb/feddan	Average Number of Trees/ feddan.	Average number of dead trees/ feddan.	Remarks.
1	80	20	700	25	5	Taken at 15 Kilometers south of Abu Sari.
2	70	30	650	28	7	Taken at 7 kilometers east of Abu Sari.
3	75	25	650	24	3	Taken at 20 kilometers east of Abu Sari.
4	50	50	100	10	-	Taken at 5 kilometers west of Mazrub.
5	50	50	80	13	2	Taken at 10 kilometers west of Mazrub.
6	60	40	120	16	4	Taken at 15 kilometers west of Mazrub.
7	60	40	140	9	-	Taken at 5 kilometers north east of Tinna.
8	65	35	200	12	8	Taken at 15 kilometers northeast of Tinna.

Source: Data collected in the field by the writers.

Leptadenia pyrotechnica, *Acacia senegal*, *Cenchrus biflorus*, and *Eragrostis tremula*. In the first five kilometers out of Mazroub, the main tree cover is *Acacia tortillis*, which is smashed down by browsing. It is replaced further out by *Leptadenia pyrotechnica* and *Acacia senegal*.

Fire incidence is readily observable beyond a grazing radius of 10 kilometer from Mazroub. Pure stands of *Leptadenia sp.* and *Aristida pallida* are seriously damaged and a poor cover of annuals prevails in most of the area. Group interviewing of villagers showed that in the past fire lines were usually constructed and vegetation was protected from damage. Organizing the construction of these barriers to the spread of fire was a characteristic feature of the rural colonial administration. Work on the barriers was carried out annually at the village level. This system has broken down completely and the new system of subcontracting the work out to private contractors does not seem to work particularly well. Frequently the fire lines are constructed, if at all, after fire damage has occurred. Fires are frequently set by nomads to remove the dead vegetation and stimulate new growth. The exact role that such burning plays in dryland ecology and range management, for good or for ill, is uncertain, it elicits strong opinions from both scientists and local inhabitants, and merits detailed investigation before fire can be considered to be an indicator of environmental decline.

The last two points in Table 2 are taken from the Tinna area. Tinna is a natural reservoir near which nomads camp in the dry season. The soil of this area consists of two main features, the clay soils and the sandy soils. The clay soil is vegetated by *Acacia mellifera*, *Acacia nubica*, *Commifera africana*, *Shoenfeldia gracilis*, *Aristida funiculata* and *Cymbopogon sp.*, while the sand dunes are covered by *Leptadenia pyrotechnica*, *Acacia senegal*, *Cenchrus biflorus*, *Eragrostis tremula* and *Cyperus munditti*. The area shows signs of overuse by animals around the water source. Further out on the dune areas where good grass coverage is available, fire incidence is disastrous in eliminating trees and perennial grasses.

As far one travels to the north of Tinna, trees are very sparse and reasonably thick tree cover is only observed in streams and depressions where drainage water collects seasonally. However, the death of trees in this area is very high, approaching 60 per cent. The exact time of tree mortality is not known. Vast areas are covered with remnants of weathered rocks and termite mounds are common characteristics of this area. The mounds are usually built on tree trunks and ultimately the trees die and leave only the mound body.

It is clearly noticed that most of the mounds are accompanied by living trees in the southern part of the area while in the further north the mounds are accompanied by dead trees. So from this it could be projected that the termites are a cause of deterioration, and that the destruction is sweeping southwards where vegetation is richer. With regard to termite feeding habits, it is observed that they depend on grass in rich cover areas but they turn to trees when grass cover is seriously denuded.

4.2. SUMMARY OF BIOLOGICAL AND PHYSICAL INDICATORS

There are a number of possible indicators of environmental change in biological and physical systems.

1. The domination of *Zornia diphylla* around Khuwei shows the non-diversity of the vegetation and the poverty of the pasture.
2. The disappearance of palatable annual and perennial grazing species, such as *Blepharis sp.*, *Dactyloctenum aegyptium*, and *Stylosanthes fruticosa* around the study area shows clear degradation in grazing capacity in radii ranging from 2,5 and 14 kilometers in

Khuwei, Mazroub and Tinna, respectively.

3. Severe land use pressure has led to the domination of such shrubs as Boscia senegalensis and Calotropus procera around Khuwei and Acacia nubica around Mazroub and Tinna.

4. Overcultivation and overgrazing hastened the elimination of mature trees, and the increase of noxious undesirable herbs such as Acanthazoarmum hespidum around Khuwei.

5. The mass mortality of trees and shrubs is another sign of deterioration, especially the disappearance of Dalbergia melanoxylon around Khuwei, Acacia senegal and Leptadenia pyrotechnica around Mazroub and Acacia mellifera and Comm_phora africana in Tinna.

6. It is very rare to find young plants of Adansonia digitata in the study area and that indicates the ultimate elimination of this huge tree which is very important in some villages for water storage during crop harvest time.

7. Leptadenia pyrotochnica is known as a semi-desert plant but about 3 kilometers north of Khuwei it can be observed growing. This is a sign of change in the environmental conditions around Khuwei which is climatologically in the Savannah belt.

8. Termite mounds are seen appearing in the area around Khuwei and Mazroub, but the greater number is observed in the north part in the semi-desert region. We believe that this shows a progressive degradation that is spreading from the northern to the southern part of the area.

5. SOCIAL AND ECONOMIC INDICATORS

5.1. Human Activity

Of the total area of Kordofan Region of 52,650,000 feddans, 3,891,497 feddans are used for shifting cultivation. 2,619 feddans for mechanized farming, 1,063 feddans for irrigated farming, 64,177 feddans for reserved forests and 21,660,000 for natural grazing.

Most of the crops are grown in the sandy areas. The arable land comprises 24,000,000 feddans, but 25 per cent of it is hard, truncated clays known locally as gardud. The actual utilized land for crop production is only 20 per cent. The main crops produced are sesame, groundnuts, watermelons, sorghum, millet and gum arabic. The total areas under these crops and the production of each for 1974 are indicated in Table 3.

Table 3

Major Crops and Crop Output in North Kordofan in 1974

Crop	Area in feddans	Production
Sesame	556,756	12,815,388 kantars
Groundnut	928,720	27,049 Tons
Watermelon seeds	444,352	19,765 Tons
Sorghum	660,326	89,913 Tons
Millet	150,266	98,667 Tons
Gum Arabic	1,000,000	12,000 Tons

Source: First Agricultural Conference, 1975. Report on North Kordofan.

5.2. The Impact of Water Supply Programmes

The major challenge to land and water use planning in the areas covered by the present study and those of similar nature has been how to promote development without leading to an unbalanced ecosystem. This demands that the renewable natural resources continually maintain sustained yields to meet the present and future requirements of the dependent population. There are signs that the ecosystems in the two areas studied are failing to meet the growing needs of the total populations and are showing many signs of stress, as shall be better revealed by the list of indicators arrived at by the present study.

From interviews conducted at the sites visited, a picture of the ecological conditions in the two areas, 15 years and more ago (i.e., prior to the massive programs of water provision) is being established.

In the two areas, during the pre water development era there was a better vegetation cover. This better quality vegetation included both more perennials and greater diversity in the composition of the upper and the lower story. All those interviewed confirmed the prevalence of highly valuded tree and grass species. Many of these prized species, especially those grasses valued for their palatability and nutritional value as fodder, no longer exist or have diminished in area.

Similarly, the local population reports that both areas were rich in wildlife including many species of deer, hyenas, foxes, rabbits, ostriches, guinea fowl, etc. These are no longer seen except in a few spots out of reach of human influence.

Also, both human and livestock populations were smaller in the past with limited geographic distribution, and migratory movements. Khuwei was established at the turn of the last century, when the founders returned from Omdurman following the collapse of the Mahdiya. Qubet Abu El Sari is also a village that has come after the Mahdiya. El Magroub and Tinna were old water centres that were in use prior to the Mahdiya, the former by the Maganeen nomads, and the latter by the settled Katul communities plus some of the Kababish, Diweih and Beni Gerar nomads.

The growth of Khuwei illustrates how each of these centres developed in time. The village was founded on a "rahad" (i.e., water that collects in a depression and that lasts for a short time after the rainy season) and on rain water that was stored in tebeldi (Adisonia digitata) trees. The art of excavating tebeldi for the purpose of conserving rainwater for use during the dry months was discovered some time about the beginning of the 19th century, when the Hamar occupied their present territory. Therefore the distribution of tebeldi and its intensity influenced to some degree early habitation in this area. Khuwei is an illustrative example. Tebeldi run from north to south following the bed of a depression which is possibly a buried drainage system.

At the time of the rise of Khuwei, the site had 6 small villages, including Khuwei itself. Each ofthese was composed of the descendants of the same ancestor. Soon the other 5 villages (El Roza, Wad Aseil, Fakaki, Kideer, and Ablag) moved to separate locations outside Khuwei to secure adequate agricultural land for their crops and abundant grazing for their animals. The maintenance of separate identity by the sheikhs of these villages was also a motivation behind breaking away from Khuwei. This is an important factor that leads to the rise of new settlements and colonization of land in many parts of traditional Sudan.

Khuwei remained a small village up to 1938 when two bore holes were drilled at the site. This marks a new era in the development of the site. The bore holes began attracting human and animal populations to Khuwei from its surroundings. However, this did not lean to heavy concentrations and severe deterioration, as is presently the case, due to a number of factors. Among these factors we mention:

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(1) the small sizes of animal populations, since the rise in animal numbersbegan in the late 60's; and (2) the restriction of tribal nomadic movements as much as possible to the administrative boundaries of each tribe. Those migrations were managed through annual tribal conferences in which the chiefs were present. The purpose of these conferences was to direct movement and minimize conflicts. One exception to the above picture was a massive movement of population from Dar Hamid Area, particularly from the surroundings of Mazroub, and Umm Shugeria Area to the west of Mazroub that led to the rise of a number of villages of Maganeen origin, and other Dar Hamid minorities, to the south of Khuwei.

In those days prior to the expansion of water programs, villages used to cultivate within a short walking distance from the village. Livestock grazed in the surroundings of the settlements. The few cattle at Khuwei used to drink water every day. Women carried firewood on their heads from the outskirts of villages. If we are talking of a balanced ecosystem judged from the standpoint of intact physical environment (good vegetation cover, limited soil deterioration, rich wildlife, well spaced cropping cycles, active regeneration of hashabs, etc.) we can refer to the period prior to the mid-sixties as reflecting all the essential features of that system. However, it was a period of less human activity and development. A few comparisons between 1964 conditions and the situation in 1981 for Khuwei and Mazroub might help to illustrate the impact of an increasing human influence on the ecosystem of an area.

In terms of water-supply sources, Khuwei had 3 bore holes in 1964. Presently these have increased to 4, raising the capacity by 25% in 18 years time. This greater water supply is a strong attraction for more livestock and human population. The same is true for Mazroub and Tinna. The former had one hafir in 1964, presently it has 3 hafirs.

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Moreover, a new well field area has been developed in the inlet area of the new hafirs to the north of the settlement. Tinna up to 1976 had a limited supply that barely met the requirements of its village population. From that date on, and because of the embankment constructed by Rural Water and Development Corporation which retained the flood water for a longer period, the water table at the site has risen considerably. As a result, the place has become a reliable water source for its population and for the nomads visiting it from distant areas.

Population also exhibits dramatic change in both size and distribution. Khuwei in 1964 had about 1350 inhabitants, while Mazroub had about 1500. The estimated population for each of the two centres in 1981 is in the range of 5000 persons. To this should be added the population of those dependent villages to which water is carried by trucks from Khuwei and Tinna and from which many families migrate to spend the dry period at the two latter sites.

As for livestock, it is estimated that about 500 head of cattle, 500 head of sheep, and 200 camels water daily at Khuwei water yard, compared to 700, 2000, and 500 respectively, at Mazroub during the dry months.

In terms of social development, judged from the range of services, the two areas have witnessed some changes comparing the 1964 situation to that of 1981 (Table 4).

It is apparent from the comparisons in Table 4 between the mid-sixties and the 1981 conditions that the balanced ecosystem that existed under limited human influence, has been stressed by expanding human activity. The cause of this stress is referred to a number of factors, the cumulative effects of which are reflected in a number of environmental indicators, which we shall attempt to discuss in the following pages.

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Table 4

Services Provided at Khuwei and Mazroub

A) Khuwei

1964 Services	Services Added by 1981
3 bore holes	1 general secondary school for boys
2 primary schools for boys	1 general secondary school for girls
1 primary school for girls	1 bore hole
1 dispensary	1 local government council
1 public health office	1 plant protection office
1 police post	1 co-operative
1 court	1 flour-mill
1 veterinary dispensary	
1 market place	
1 co-operative	
1 flour-mill	
10 coffee places	
1 mosque	
1 club	

B) Mazroub

1 hafir	1 primary school for boys
2 primary schools for boys	1 primary school for girls
1 primary school for girls	1 intermediate school for boys
1 dispensary	1 intermediate school for girls
1 public health office	2 hafirs
1 police post	a new well field site
1 court	1 hospital under construction
1 veterinary dispensary	1 local government council
1 market place	3 co-operatives
3 co-operatives	2 flour-mills
1 flour-mill	
4 coffee places	
1 mosque	

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5.3. The Socio-Economic Indicators

5.3.1. Improper Planning and Management of Water Supply Centres:

The environmental impact of wateryards can be detected through indicators that point to environmental change and degradation. Many of the environmental impacts stem from the existence of wateryards under uncontrolled conditions. Two concepts are implied by an uncontrolled development of water resources, and both are worthy of investigation: (1) the first is the operation of water centres without control of land use and the natural resources around them; and (2) the second is the need for monitoring which implies effective planning.

A water source in operation in the two areas studied is the first point at which indicators of environmental degradation will appear. This micro level of site indicators can be generalized to the meso level of the region, if similar sources exist in the vicinity. This is basically due to:

i) The planning philosophy and approaches that have directed the water provision program during the last 30 years;

ii) The communal use of grazing under the open nomadic system of livestock raising; and,

iii) The bad management of wateryards especially during the last 5 years. This consistently results in irregular performance and reduced supplies. The frequent failure of water supply at any given water site leads to the confusion of the established patterns of dry season distribution of livestock and human population.

For the location of new wateryards certain criteria are applied to guide the preparation of the regional and national programs of water provision. Aspects such as existing supply centers at the local level, general physical

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environmental conditions of the proposed area, settlement distribution and expected future demands on the site, the seasonal load, if any, that might be put on the resource by nomads, the human and livestock population sizes, etc., are surveyed for every site proposed for water provision. These studies are carried out by interdisciplinary teams, mostly formed of agriculturists and socio-economic specialists. Based on the findings at each site, the different proposals are rated, and finally the program is prepared.

It is a planning process with a monolithic objective, identification of sites for drilling, hafir excavation; or digging of open shaft wells, and the process stops at that objective. By virtue of its philosophy and procedures it is an incomplete exercise. It does not intend to provide an overall land use plan for the area. It starts from the basic assumption that providing water is desirable, and that only the specific site is unknown. Anticipated impacts of development that might be negative are seldom systematically assessed. Efforts to ensure that wise use is made of the water once it is available are rarely applied consistently. Partial planning produces unbalanced ecological change. Since the otcome of the exercise is site selection, only one of many variables that need to be catered for, the environmental degradation that follows is a logical consequence of improper planning. That is why, in time, circles of evident environmental deterioration have surrounded most wateryards. Most serious in this respect is the absence of comprehensive land and water use plans at the site and locality levels. This makes it impossible to monitor the environmental degradation that appears later. To rectify the situation requires a fresh evaluation of present conditions around the supply centres.

Just as water planning has been defective, so too has management of water supply centres, particularly wateryards, proven to be poorly conceived and executed. The effect of bad wateryard management at the local scale has been known to spread disruptive impacts widely through the dryland ecosystems of Kordofan. The field visit to Khuwei Area has revealed the bad conditions of many of the wateryards. This can be judged from the fact that most of them are operating below capacity. Failure to produce at designed levels can be attributed to a number of shortcomings. These include: 1) the system of management adopted in the last 8 years for running wateryards; 2) shortage in spare parts; and 3) lack of fuel. This has its direct effects on the use of the resources around each water point and at the macro level comprised of many water points. When all the wateryards in an area are functioning efficiently, that means that the load of human and animal populations utilizing that area is comparatively better distributed than is the case when some of these wateryards are out of order. In the latter instance, which is happening with most wateryards, the ecosystem adjacent to the functioning wateryard experiences an increased level of pressure. This is a situation that requires environmental monitoring, and one that is very much related to issues of planning discussed earlier.

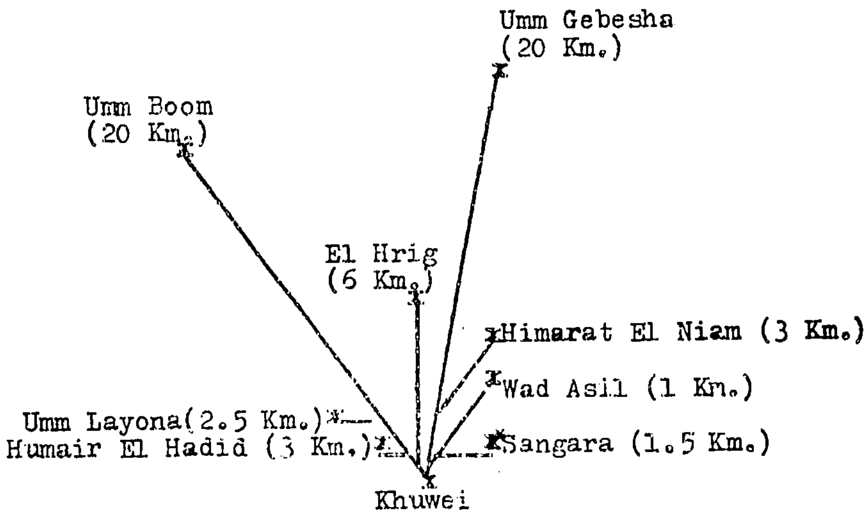
5.3.2. Location and Its Impact on the System

The size of the population depending on a water supply centre is determined, among other factors, by the geographical location of that centre. The effect of location applies to both settled and nomadic populations. The impact of location is illustrated by the two cases of the Khuwei and Mazroub - Tinna areas, and by the two categories of populations.

The two sites have village populations depending on them. This can be broken into: 1) the close villages reached on foot or by donkeys; 2) the distant ones to which water is carried by trucks. There are about 8 villages under the first category depending on Khuwei, and about 13 villages in the same category depending on Mazroub.

The ones of Khuwei, for illustration, are shown in Fig.(3).

Fig. (3) Khuwei and dependent villages



The people from these villages visit the wateryard daily or every other day to obtain their supplies. Water is carried in a variety of containers and by different means (donkeys, camels, and carts) to these villages. It is estimated that on the average about 400 women, 100 donkeys (carrying big skin bags 6-10 tins capacity), 300 other donkeys (carrying two skins - the usual type) and 200 camels (carrying big skins) take water daily from the wateryard to supply Khuwei, the 8 surrounding villages, and some of the nomadic camps in the vicinity. This average increases towards the end of the dry season. Both Khuwei and Mazroub constitute focal points in the local water distribution system. The dependence of both traditional animal and modern motorized water distribution technologies on Khuwei and Mazroub enhances the dominant role these centres play in water management. Their wateryards experience very heavy use, and the vicinity of the towns and the approach roads to them are exposed to concentrated human, animal and vehicular pressure.

This is further exacerbated by the fact that from the beginning of the dry season, as from December and on, much of the population of these thirsty areas desert the villages. People move to Khuwei and Mazroub and the similar bore well sites to spend the rest of the dry period. The migrant population is of two types: 1) poor families whose resources to spend on water from trucks is diminished with the progress of the dry months; and 2) large livestock owners who find the required water for their herds in these wateryards during the dry period. These populations are referred to as the "damara". The poorest among them usually make a living from petty jobs, such as hut construction, cleaning of agricultural land, digging of cesspools, selling of firewood and grass for fodder, etc., which they undertake in these water supply centres. They put pressure on the existing services available in the centre, as well as on the food supply offered by the market. It can therefore be stated that the presence of the "damara" at a water supply centre is an indicator of an ecosystem presently experiencing or soon to be exposed to considerable environmental strain.

Finally, there are the adverse impacts that result from the relationship of water centres to the movement of nomadic populations between their dry season and wet season pastures. Up to the mid-sixties, both Khuwei and Mazroub acted as dry season centres of nomadic concentrations. Here the migrations of some Hamar and Maganeen ended respectively. At that time they were the most southern points on the migration routes for some sub-tribes.

With the extensive provision of more wateryards and the continuous degradation of range land to the north, some of the "Aballa"(*) nomads of northern and central Kordofan (namely Kababish, Kawahla, Hamar, Dar Hamid, Maganeen, and Shanabla) began pushing further southward then had previously

(*) Camel-raising nomads.

been usual. As a result, Khuwei and Mazroub assumed the additional role of watering places on the route to dry season grazing areas in the Nuba Mountains to the south. Not only does this influx of nomadic herds place increased pressure on local rangland, but also it increases social conflict. The inhabitants of Khuwei, for example, are not in favour of nomads entering the area. They view the nomads as outsiders whose animals consume pasture that otherwise would be available to support local herds. These conflicts increase as a function of declining pasture quality, increased water availability, changing environmental conditions elsewhere in the region, and expansion in the size of herds controlled by settled populations. Niches once available for exploitation are rapidly becoming filled, and activities that were symbiotic have become increasingly competitive and tense.

The influx of the nomadic population, besides that of villages reaching out for their daily supply and the "damara" spending the dry months in the vicinity of watering centres, can be ascertained from the rise in the daily income of the wateryards. This is exhibited by the example of Khuwei (Table 5).

Table 5

Daily average income (LS) by month for Khuwei Wateryard - 1980

January	15
February	20
March	25
April	30
May	35
June	30
July	15
August	6
September	6
October	15

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This shows a marked increase in income toward the end of the dry season, followed by a precipitous decline once the rainy season begins. The revenue is raised by a series of rates levied on wateryard users based on the volume of water consumed for each user (Table 6).

Table 6

Wateryard consumption rates

Unit	Official price (%s)	Self-help contribution collected from buyer (%s)
1 tin (4 gallons)	5	5
1 skin	20	20
1 big skin	30	30
1 camel (to drink)	40	40
1 donkey (to drink)	10	10
1 cow (to drink)	10	10
1 sheep (to drink)	10	10
1 goat (to drink)	10	10

The official prices are doubled in order to raise income for the local self-help scheme. These self-help schemes are limited at present to running the wateryards. It is the self-help money that purchases the spare parts and the diesel fuel required to maintain and run the wateryard pump. The figures given in Table 11 on daily income represent half the actual amount raised. This is the part received by the Local Government Council, excluding the self-help funds, and these funds are not necessarily committed to promoting wateryard operations.

The average daily income figures are self-explanatory. The income of LS 6 during August and September is indicative of the size of human consumption for Khuwei village only, since during these months no population from nearby villages or livestock visit the yard for water. The income from October to January reflects Khuwei plus nearby villages'

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human and livestock consumption. That of the period February up to June stands for the total water requirements of all categories of population: Khuwei village, the nearby village, the "damara" and the nomads.

5.3.3. An Increase in Population without a Crorresponding Increase in Yields

The dominant economies in Kordofan are traditional shifting agriculture and livestock raising. These two livelihood systems have so far depended on the inherent fertility of the natural resources with no modern technological inputs whatsoever. The yields from resources exploited in this fashion of necessity are limited. Population growth places traditional livelihood practices under increasing strain, particularly if there is not a corresponding improvement in technological inputs, landuse intensification, and yields. If inputs remain constant, environmental degradation appears inevitable.

Increases in human and livestock population are evident in both Khuwei and Mazroub Areas. We shall limit this section to increases in humans, and discuss those in animals in the coming two sections.

Khuwei Area had a very small population prior to the drilling of the first bore hole in 1938. Before modern water development began, Khuwei's population depended on rain water stored in Tebeldi trees and shallow wells. When this supply was depleted, people obtained their water by camel from Umm Defeis and Khamas to the south. Both of these sites had bore holes prior to Khuwei. The population increased from 200 to 1400. Presently it is 6000 persons. The same is true for the other wateryards surounding Khuwei. They show an analogous increase in population between 1964 and 1981. At that time each had a population of 2[illegible]0-500 persons; present population are indicated in Table 7 as is the size of the population found in the surrounding hinterland of each major bore hole centre.

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Table 7

Population of Major Settlements in the Khuwei area

Place	Size of population	Size of other population dependent on place
Khuwei	6000	1500
Masharbo	1500	2500
Dodiya	1500	3000
Ankoosh	1500	1000
Daw El-Beit	500	500

The increase in population has come about as a result of one of three factors:

1) Natural growth in population size;

2) emigration from other areas and resettlement near centres of water supply, and,

3) progressive settlement of nomadic families.

All three factors exert more pressure on the existing resources. They lead to expansion of the cultivated areas, increase in numbers of animals, expansion in the amount of land under grazing, cutting of trees to meet new housing needs as well as the domestic fuel supply, and provision of human communities and livestock.

The situation can be summarized as follows: increase in human population through natural growth and migration leads to expansion of the use of the ecumene which, if not coupled by raising the yields of the ecosystem, produces environmental degradation. The evidence that the system is not yielding adequately is indicated by the fact that: 1) the area is not producing enough staple food crops and is importing from other parts of the country, 2) milk and meat supplies are only occasionally available, 3) incomes are very low, the general standard of living has not changed substantially during the last 20 years, and the two areas are experiencing some migration to central Sudan and the oil states.

5.3.4. Increase in Animal Numbers, Especially Cattle and Sheep

Populations in this area have distinctive systems of breeding: villagers breed cattle and goats, while nomads breed camels, sheep and cattle. All animals have increased during the last 10-15 years. Sheep and cattle have witnessed the highest rise in numbers. The reasons given by those interviewed for these increases include the following:

1) Expansion in water supply programs which have enabled both villagers and nomadic groups to base their economic activities on reliable water sources.
2) The progressive resettlement of population from the northern areas to near the southern bore holes, as well as the settlement of nomadic families, has resulted in increasing the number of cattle around these wateryards.
3) The risk of agricultural failure has encouraged people to invest in livestock as a more profitable enterprise.
4) Livestock, particularly cattle, provides the family with milk, and is a ready source of cash to which the family can resort in times of need.
5) Furthermore, in this society, which has its origin in nomadic cultures, breeding animals is prestigious, and is valued as a way to achieve social distinction.
6) People invest capital generated by other activities in animals; many claimed that up to 1967 hashab (*Acacia senegal*) was productive and the surpluses raised from gum were invested in building herds.

The savings of those permanently employed in government is mostly invested in sheep which have great commercial value. Finally, these areas witnessed recently investments in both cattle and sheep from savings raised in Libya, and the other oil states.

7) Breeders have become familiar with the administration of vaccines and medicines. Veterinary drugs have been used since the beginning of the fifties. Drugs are not only available from the Administration of Animal Resources, but also are obtained from the local merchants in the major local market centres.

Different animal species are increasing at differential rates. Those interviewed emphasized that sheep are increasing at higher rates compared to cattle. There are several reasons for this:

1) It is less costly to invest in sheep. The value of one cow is equivalent to that of many sheep;
2) There are more investors among the nomads than the settled cultivators, and the former tend to invest more in sheep;
3) Under declining grazing conditions, especially around wateryards, sheep are less difficult to maintain since they graze over a wider area compared to cattle and require less fodder to maintain one unit than is the case for cattle;
4) Sheep reproduce more rapidly than cattle because the duration of pregnancy is shorter and the number of offspring per year, as well as the frequency of multiple births, is greater.

However, whether sheep or cattle, the increase in numbers of livestock and the concentration of herds close to all operating water centres has led to the degradation of the range lands around these centres. The severe pressure placed on the ecosystem by a continually increasing number of animals is an environmental indicator that needs monitoring.

5.3.5. Opening of New Land

With the natural increase in population, the provision of new water sources, the rise of new settlement and the expansion in old ones, more lands are brought under cultivation. This entails removing the vegetation to make room for the newly added agricultural areas. This is normally carried out in two types of land: (1) the Qoz which is sandy soil; and (2) the Juraba or Sisa which is a sandy clay soil. The average farm size in the Qoz is about 10 makhamas, while it is in the range of 3.5 makhamas in the juraba. A makhamas as a unit of measurement varies from one part of the country to the other. In Kordofan it is 6300 M^2, nearly 1.5 acres.

The crops grown in the Qoz are dukhun (Pennisetum spp.), groundnuts, sesame and watermelons. Those grown in the juraba or Sisa are sesame, sorghum, ladyfingers, peas, and cucumber. The latter is a kind of house wife vegetable garden crop grown in close proximity to the house. Different cropping patterns are adopted depending on the combination of crops grown and the general soil fertility. Because the most common cropping system is a form of shifting cultivation, soil fertility depends very much on the length of the fallow period.

In the past, land was plentiful and the fallow rotation which set aside exhausted land was a lengthy one. Individual families owned cultivable lands ranging from 30-100 makhamas in the Qoz areas and about 10 makhamas in the Juraba or Sisa areas. At any one point in time, average area cultivated was 10 makhamas in the former and about 3.5 makhamas in the latter. Since the most common cropping pattern adopted rotated the same piece of land under two crops for 4 years, and than left it fallow for another 4 years, the production of the area actually put under cultivation in relation to the total land property of the family allowed a reasonable margin for carrying out an efficient system of shifting cultivation.

Although this fallow rotation system is still observed in villages away from water supply centres, it is no longer practiced in the water development centres and the villages in proximity to them. To meet increasing demands for agricultural land for establishment of new farms, or for expanding of cash crops areas, distant lands that formerly were under grazing have been brought under cultivation. For similar reasons, fallow rotations have been cut considerably and land is being subjected to continuous cropping for longer periods.

These changes in the shifting cultivation practices applied for years have strained the ecosystem. This is evident in the clearing of natural vegetation cover to open land for cultivation. One measure of this change is the decline of areas under <u>hashab</u> (gum arabic). <u>Hashab</u> is an important cash crop that comprises a fallow cycle in the shifting cultivation regime. So important is it in the traditional local economy that its regeneration has been effectively integrated into the cropping cycle. The general decline in the soil fertility because of the overcropping of the land has seriously reduced regeneration of <u>hashab</u> and has reduced the yields from those <u>hashab</u> plantations that remain in cultivation. Coupled with economic changes in the gum arabic idustry itself, these alterations in traditional landuse practice have been sufficient to throw the gum arabic industry into a serious state of decline.

5.3.6. <u>Declines in Yields</u>

To use the declines in yields as an indicator, especially in old agricultural areas, needs to be proven by

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research findings, comparing production in those areas to newly opened ones. The yield of such crops as <u>hashab</u>, sesame, groundnuts and so on can be an indicator on the premise that putting the same piece of land under cropping for many years leads to decline in soil fertility and a drop in yields. Interviews held with the local communities in the areas studied confirm the above observation especially around old water centres like Khuwei, Mazroub and Tinna.

Yields vary from one crop to the other depending on a number of factors. One variable is the type of land, whether it is old or newly opened, steeply sloped or flat, water retentive, etc. Yields also fluctuate considerably from year to year depending on rainfall. Equally important are the effects of pests and diseases. Table 8 provides estimates that give some idea of the variation in yields between old agricultural areas and newly opened ones.

Table 8

Yields per Makhamas in sacks for different crops

Crop	Old area	Newly opened area
Dura	2	5
Dukhun	2	4
Groundnuts	4	10
Sesame	1	[illegible]

Usually a newly opened plot which was fallowed, if adequately prepared by "cleaning" off the regenerated native vegetation, is put under groundnuts and then alternated for four years between this crop and dukhun. In cases where the land is less adequately prepared, it is put first under dukhun which is then rotated with groundnuts for the same period. Also land that was under watermelons is followed by dukhun, since there is a general belief among farmers that a watermelon crop increases soil fertility

The diseases affecting yields are Senta (fly attacking i.e. Sesame) Buda, (striga hermonthica), smut and worms. As for pests, these include locusts and birds. The last two cause more damage to agricultural produce compared to diseases.

5.3.7. Number of Tankers Carrying Water from a Bore Hole to Nearby Areas

Tankers are an important source of water supply in many parts of rural Kordofan. They carry water from Khuwei and the other nearby wateryards to the "thirsty" areas to the north of it that are deficient in ground water. A few tankers also operate from Mazroub immediately after the rainy season to supply the area to the west of Mazroub, i.e. the Daleil villages. However, with the progress of the dry season Mazroub itself soon must supplement its internal supply with additional amounts of water carried to it mainly from Tinna. The latter has assumed an important role as a supply centre especially to the areas lying to its west and south.

Up to the mid-1950's no trucks carried water to villages. The introduction of lorries running on diesel fuel marks the beginning of the water trade in the area. Before lorries reached these villages, most of the population of the water-deficit area between Khuwei and Tinna and to the west of Mazroub and Tinna, used to migrate immediately after harvest to spend the whole of the dry season at the nearby wateryards.

Provision of water by tankers can be considered as an environmental indicator that points to negative as well as positive environmental impacts. Of the latter is the fact that areas that are served by tankers experience limited use of their natural resources, since the populations inhabiting such areas are existing on very meagre sources of water. These are just adequate for the continuity of human habitation in these areas. At the same time, they are not open to heavy grazing for two reasons. First, the animals raised by the local population are present only during the rainy season. Second, the nomads do not utilize them except when in teansit between rainy and dry season pastures because of lack of water. In fact, due mainly to water scarcity, these "problem areas" reflect the best environmental conditions in Central Kordofan with the vegetation cover still intact. They give point to the argument that rural areas should be denied sources of water supply unless they come as a component of a total landuse plan.

Therefore, it can be concluded that tankers carrying water to an area indicates that the area has better physical environmental conditions than its surroundings. This is a positive indicator that soils and natural vegetation have not suffered very much. However, it signifies a negative indicator regarding human and animal water requirements since both live under strained supply. It is interesting in this connection to consider the price level as a further qualifying indicator of the degree of degradation. Since the price is lower close to the source from which water is taken, this means that more use of water and resources is occurring. Conversely, a higher price away from the source indicates less use of resources.

On the negative side, the operation of tankers from a source of water supply is an indication that environmental conditions around that source are exposed to some degree of devastation. The dependence of tankers on a source means that the latter offers a surplus that can be transported to other areas. Yet the same source acts as a magnet attracting the poor sector of the population from the "problem areas" that cannot afford to buy water from lorries in the villages. It is also a point of attraction to the large herds and flocks owned by rich families, as it is expensive to pay for their water requirements in the villages during the dry season. Therefore the dependency of tankers on a water centre as a source of supply indicates that the area in which this centre falls is open to environmental degradation due to overexploitation of its resources.

Finally there is the practice of carrying water by tankers to supply livestock with drinking requirements while the herd is grazing in the pasturage areas. Three situations can be cited: (1) livestock owned by rich families near El Khuwei; (2) merchants' cattle on Nyala-Khartoum stock route; and (3) daily cattle near El Obeid. The three imply that grazing conditions at the vicinity of the water source do not support livestock, an indication of environmental decline.

5.3.8. Number of Charcoal Burning and Wood Cutting Permits

Fifteen years ago very few people obtained permits to cut wood or burn charcoal. First, wood was available from dead trees around most settlements, and consumption was much lower than what could be collected annually. This wood supplied the material for fuel and charcoal. This situation still prevails in the area to the north of Khuwei. This is illustrated by the cases of Mazroub and Tinna where no permits for wood cutting are applied for.

Secondly, there was no flourishing fuel wood and charcoal trade in the mid-sixties, compared to present time. Many factors are involved in the activation of this trade, particularly from El Khuwei-En Nahud area and the region around Babanusa. The most important of these is the increased demand for wood and charcoal in the urban centres of the province, particularly the big town of El Obeid. With time, production from the local woods in proximity to these centres has continually diminished and more distant sources have been souht. It would be interesting to study El Obeid's fuel wood and charcoal supply to determine what proportion comes from distant sources. The rate of environmental degradation resulting from the depletion of the wood cover in the areas of supply depends very much on the geographical location and accessibility of supply areas to centres of demand.

Khuwei exhibits this principle since it falls on the active, all season En Nahud-El Obeid road, about six hours by lorry from the latter. Therefore, fuel-wood and charcoal production and trade have assumed important positions as sources of cash for many families in the area, which is not the case at Mazroub and Tinna.

As reported by a number of informants, charcoal production for export has been practiced extesively during the last seven years. Apart from the increasing demand for the commodity, some attribute expansion in production to continuous agricultural failure. Bad harvests have encouraged poor cultivators with no source of earnings other than agriculture to turn to charcoal burning.

Permits for charcoal burning are issued by the Administration for Forestry at En Nahud. Usually the application for the permit does not specify the purpose as cutting wood for charcoal burning, but as requesting permission for clearing land for agricultural purposes, and indirectly using the cleared tree cover for the production of charcoal. Very often people exceed the area allowed. A well known case in the area is that of a merchant who violated the license issued to him to clear a limited area, by denuding a whole tract of country in Umm Layouna Area, producing 2000 sacks of charcoal.

Khuwei consumption of charcoal is estimated about 4000 sacks per annum, of which about 2400 sacks are used by the 20 coffee places, and the balance of 1600 sacks by the village population. Wood consumption is difficult to estimate. The village obtains its supply from cart owners who collect dead wood from distant places and sell it to the villagers.

5.3.9. Number of Lorry Loads of Charcoal from an Area

Besides the amounts that are consumed locally, there are those produced for export to El Obeid and the other centres outside the province. The Forestry Clerk at Khuwei collected in 1980 a sum of Ls. 600 as local taxes on forestry products, including items such as charcoal, fuel-wood, ropes, palm leaves, wooden handicrafts, and so on. Of this amount about Ls. 400 are believed to be the royalties from charcoal. Divided by 11 p.t., the tax per sack, this indicates a local production of 4,000 sacks for which taxes were paid at Khuwei. This does not include that amount for which taxes were paid at En Nahud, and other places like Babanusa. Nor does it account for the possibility that some producers avoided paying taxes altogether on some portion of their output.

In 1980 about 40 lorries (each with a load of 120 sacks) travelled through Khuwei carrying charcoal to El Obeid. This charcoal was produced in the area between Khuwei and En Nahud. 1980 is not a good year to measure production from the area, since in that year charcoal export outside Kordofan Province was banned by a local order. Under normal conditions, more than 40 lorry loads of charcoal are annually taken from En Nahud-El Khuwei area to partially meet the supply requirements of El Obeid, plus other distant centres as far as Khartoum.

Lorry owners do not produce charcoal themselves, but normally obtain the license to export charcoal after paying a nominal tax of 1 p.t. per sack It is the producer who must pay the much more substantial 11 p.t. per sack tax. The shipper buys from the producer at any average price of Ls. 1.000 per sack, which indicates the profit margin open to him, when he sells at El Obeid or Khartoum.

5.3.10. Selective Use of Plant Cover

The local population has developed selective habits in utilizing the vegetation cover in an area for different purposes. Some examples illustrate the preferential uses to which certain species are put:

(i) Construction Purposes:

a. The type of wood preferred for poles for huts in the Khuwei area is Subbagh (Comboretum hartmennianum). In Mazroub and Tinna areas the one used is Kitir (Acacia mellifera).

b. That used as supports for carrying the roof of the hut is Kedad (Dichrostachys glomerata) in the Khuwei area, and Kitir and Inderab (Cordia creanata) in Mazroub and Tinna.

c. The ones used for supporting the fence wall in Khuwei area is Kedad, compared to Kitir, Inderab (Cordia spp.) and Merikh (Leptadenia pyrotechnica) in Mazroub and Tinna areas.

d. The light branches used for keeping the straw material together are Baashoom (Grewia spp.) and Gabeish (Guiera senegalensis) in Khuwei, while those used at Mazroub are Inderab and Shuheit (Combretum aculeatum).

e. For thatching Mahareib, Nal (Cymbopogon nervatos) and Dukhun stalks are used in Khuwei area, compared to Mahareib, (Cymbopogon spp.) Dukhun stalks and Merikh in El Mazroub and Tinna areas.

f. Finally, for fastening together the different structures, in El Khuwei the bark of Layoun (Lannea humits) and Tebelid trees is used, while in El Mazroub and Tinna areas they use the bark of Laot, (Acacia nubica), Seyal, (Acacia tortilis) and the young Merikh plants.

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It seems reasonable to assume that when indigenous builders are no longer able to locate adequate supplies of preferred traditional construction materials, they will shift to alternative material. Thus, any shift in preferred construction components is an indication of diminished environmental resources in both quantity and quality.

(ii) Fodder Purposes:

The nomads, when moving in and out of dry season grazing areas, immediately after the rains and during late dry season, cut the branches of trees to supply green fodder to their herds. The species preferred are: Subbagh, Humeid, (Selerocarya birroa) Daroot, (Terminalia brownil) Hashab, Layon, Hegleig (balanites aegyptianca), and tebeldi. This lopping, if repeated too frequently or carried out too comprehensively, affects the life and the reproduction of these species. It is probably one of the factors behind the failure of tebeldi trees in the area to regenerate. It reduces seed propagation, since at flowering time buds are cut by the nomads to feed their animals. When this is repeated, it results in the tree failing to produce fruits. This has been the case with most of the tebeldis that are distant from settlements. The ones owned by families are in a better shape, since the owners protect them from the lopping activities of the nomads. This illustrates the effectiveness of individual rights to the use of resources as compared to communal rights, since under individual ownership conditions tebeldi has fared better than other species. Nonetheless, even under individual ownership tebeldi is not reproducing, a fact that appears to result from other pressure mechanisms that prevent seedling establishment.

(iii) Perfume Purposes:

The wood from Subbagh is very aromatic. When it is burned it gives off a nice odor which is considered to be a form of perfume. The wood is used locally, and is also exported to other areas.

(iv) Handicrafts and other special purposes:

a. There is El Halfi (Cyperus mundti) grass which is collected by women, and sold to local merchants who export it to Khartoum. There it is used in making baskets and brooms.

b. Ummsimoma (Aristida pallida) is another grass that is used for Sharganiya. These are a type of grass mat. Ummsimoma is also used to supply a local type of broom.

(v) Production of charcoal:

The most preferred species for the production of charcoal is arad (Albizzia sericocephala) and next it is Kedad (Dichrestachys glomorata), then Hegleg (Balanites aegyptiaca), and finally Hashab (Acacia senegal).

These are the traditional community preferences. The present state of the plant cover, especially around Khuwei area as compared to Mazroub and Tinna, suggest that these preferences are no longer fully met from the nearby surroundings.

Species like Subbagh and Kedad are decreasing in the area. Instead of obtaining them from the vicinity of the village, people travel for them for about a distance of 20 km. Basshoom has disappeared completely from the area, and instead people are using Gubeish. Even the latter is decreasing in frequency and is obtained from distant areas.

5.3.11. Increasing distance from settlement one must travel to obtain specific products:

Nearly all of the preferred species mentioned in previous sections once were obtained from close to settlements. This is still the case in Mazroub and Tinna areas in comparison to Khuwei. The location of Khuwei on the main road to western Sudan has encouraged depletion of the resources in its immediate vicinity. In particular, the traffic travelling eastwards carries wood and wood products from the area. Presently the village depends on distant resources because the woody vegetation adjacent to the settlement has been seriously depleted. Subbagh and Kedad, important as construction material, are good examples of this process. Once found close to Khuwei, both now are obtained after travelling 5 hours from Khuwei by carts. Fuel wood and charcoal used to be available close to the settlement. Now they are brought from a distance of about four hours by carts. Again, the same is true for the straw material required for buildings, and the grass fodder for the animals, which were discussed earlier.

The need for transporting products from a distance has encouraged the introduction of carts in the area and the multiplication of their numbers in a short period of time. Up to 1974 there were only about 20 carts in Khuwei. Now there are about 100, all of which are owned by natives who are permanently living at Khuwei. The main sources of employment for these carts are to carry water from the water yard to houses, crops from the fields, fuel wood, charcoal, wood for building, straw and grass for thatching, and fodder grass for the animals. It is evident that the rise in number of charts in the area is in response to meeting the requirements of the Khuwei population, and that as this population grows its demands for these products must be met from a continuously increasing distance from the village.

5.3.12. Presence or Absence of Purchased Fodder: Cotton Seed Cake, Dura Straw or Hay

Fifteen years ago the livestock owned by the village, or that coming with the nomads, used to find adequate grazing at one hour's walking distance from Khuwei. This has changed since then, and good grazing can only be found at present at about six hours travel from the village. The same phenomenon is present around Mazroub and Tinna, but to a lesser degree.

Usually, as the dry months progress, the fodder shortage becomes more acute, and the peak of scarcity is reached between March and June. During these three months people resort to many sources of fodder including hay, dura straw, dura, cotton seed, and cotton seed cakes.

In the Khuwei area from the beginning of March, the village livestock's natural grazing must be supplemented by one or the other of the above feeds. Dura, cotton and cotton seed cakes are purchased locally in the village. Hay is brought by carts and on donkeys and sold to animal owners. A car load of Shelini (Zornia diphlla) fetches up to Ls. 4.000, while a donkey load of the same grass sells for Ls. 2.000. People prefer Shelini, but Haskaneit (Cenohrus spp.) is in wide use as well.

In Mazroub and Tinna, hay is not readily available, and families normally depend on their children who regularly travel to the surroundings of the settlement and bring grass on donkeys for the animals. However, the purchase of dura, cotton seed, and cotton seed cake as feed is widespread in the two areas. The practice began about 10 years ago. To many breeders, these fodders are essential to reduce herd mortality at a very critical grazing period, i.e. late dry season. Many of those investigated speak of selling a number of animals annually and of using the return to buy fodder to sustain the rest of the herd throughout the dry period.

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The northern area (Mazroub and Tinna) has the advantage of being closer to Omdurman Livestock Market with its continuous demand for slaughter animals. The main selling period is September to January; but again livestock raisers also sell in March. The main animals supplied by the area are sheep, besides a limited number of cattle. The numbers sold in March are wholly made of sheep, which are transported by trucks to Omdurman. The cash return from the sales in March are mostly used in purchasing feed to carry the animals throughout the rest of the dry period.

6. A FUTURE STRATEGY

In the process of development, and the dynamics of socio-economic changes that accompany it, environment is bound to be affected. All human and natural resources are utilized to effect development. In particular, efficient utilization of natural environmental resources is called for, both because they are scarce and because of the right of future generations in their costs. Unplanned development and/or unawareness of the importance of minimization of environmental degradation in the process could be expected to result in damages that are either unduly high and/or irreversible. Thus shifting (traditional) cultivation, unplanned mechanized farming, wood cutting and burning, fires, over-grazing, etc. are proper and effective ingredients of environmental degradation, and, in the particular case of poor Savanna, also desertification.

The physical, biological, social and economic indicators identified above point clearly to the occurrence of many processes of environmental degradation which have drastically changed the conditions of the ecosystems of these two vast belts. The changes observed at present started at variant dates. There is much evidence to indicate that their effects have accelerated with the programme of water supply launched in the last 30 years, more specifically in the period after the mid-1960s. An attempt to assemble

The indicators examined in a time scale, according to the year each phenomenon is believed to have started affecting the ecosystem points to the strong relationship between the expansion in water provision and the state of deterioration reached (Tables 9 and 10 and Fig.4).

Table 9

Indicators effect in time prespective time scale, traced back to

Indicator	First Time indicator began operating	Time the effect accelerated
1. Change from a balanced to a stressed ecosystem	1950	1967
2. Improper planning and management of water sources	1956	1967
3. Location and its impact on the system	1938	1960
4. An increase in population without a corresponding increase in yields	1960	1970
5. Increase in animal numbers, especially cattle and sheep	1950	1967
6. Opening of new land	1955	1967
7. Decline in yields	1960	1967
8. Number of tankers carrying water from a borehole to nearby area	1955	1967
9. Number of charcoal burning and wood cutting permits	1960	1970
10. Number of lorry loads of charcoal from an area	1970	1970

Cont..

FIG. 4. BORE-HOLE DISTRIBUTION IN THE STUDY AREA WITH DATE OF ESTABLISHMENT GIVEN

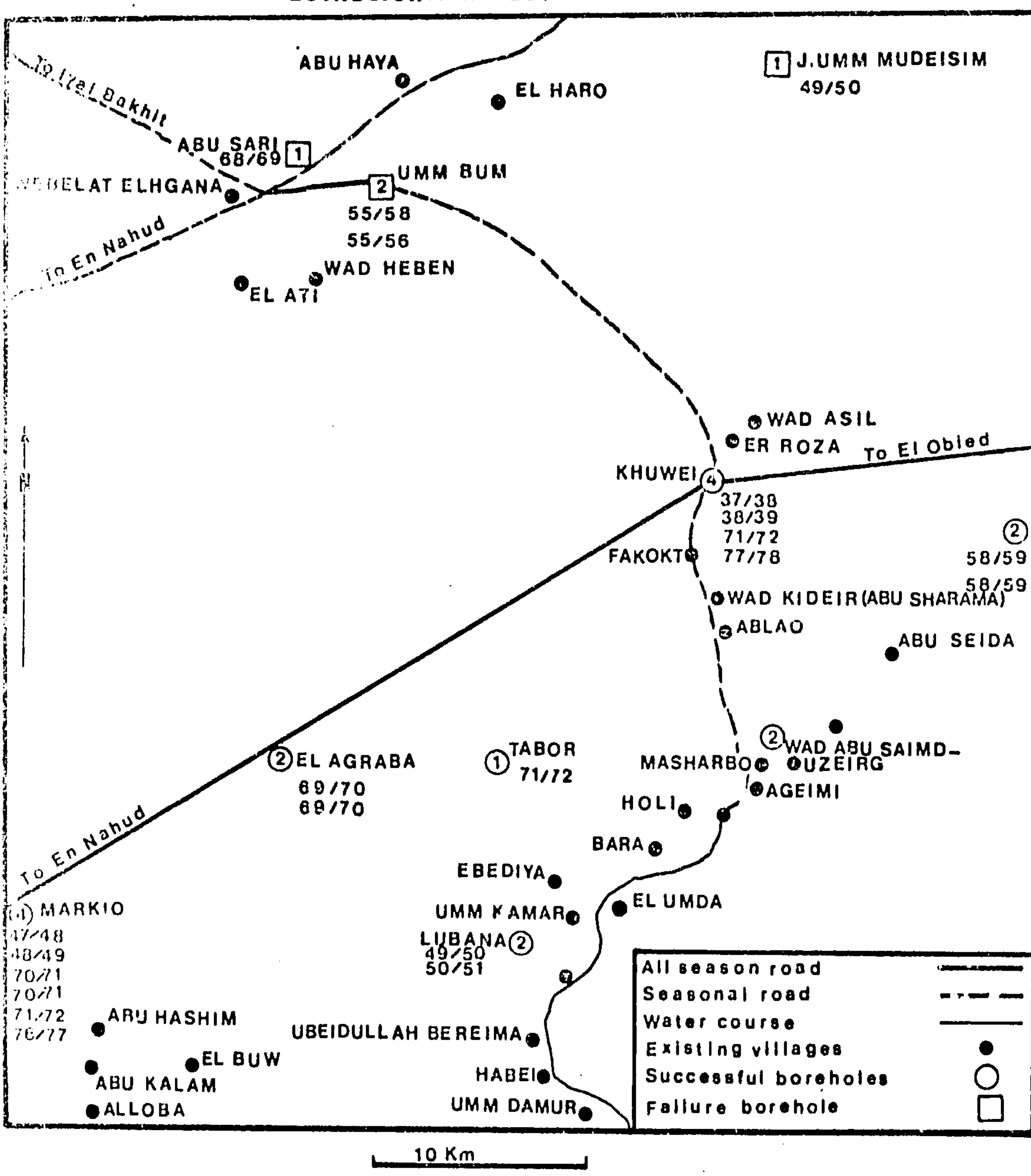

Table 9(Cont.)

Indicator	First Time Indicator began operating	Time the effect accelerated
11. Selective use of plant cover	1900	1960
12. Increase in distance from settlement - one must travel to obtain specific products	1960	1970
13. Presence or absence of purchased fodder: cotton seeds cakes, dura straw, or hay.	1970	1970

It is apparant from the above mentioned dates that the period 1960 and on is the time during which change has accelerated. This coincides with the time during which massive programmes of water supply have been executed, especially as from 1967. This is well exhibited by the following figures giving the number of boreholes drilled at different periods:

Table 10

Total number of boreholes

Period	Sudan	Kordofan Region	The Study Area
1950-60	548	111	7
1961-70	1783	455	3
1971-82	1393	191	7
Total	3724	757	17

Total number of boreholes prior to 1950:

Sudan	Kordofan Region	The Study Area
138	059	004

It will be inaccurate if all the causes of degradation are attributed to the launching of water supply programmes as the sole factor behind the increasing vulnerability of the two ecosystems. There are the evident impact of forces such as the continuous expansion of the ecumene, the increase in population, in cultivated areas, in the number of animals, and in the usage of the renewable resources for different purposes which act on the ecosystems. However, the water programmes enter into the on-going processes as the activator of the forces of degradation.

This raises the important issue that water programming should be approached in future in the context of ecosystems, and not as a service to meet isolated needs e.g., adequate and hygienic supplies for rural communities, expansion of the agricultural production base, development of human settlements, and the like. Such targets, for a long time, dominated the philosophy and the planning processes that guided water programming. Consequently they emerged as the terms of reference of those government departments(*) concerned with planning the utilization of ecosystems. Though most of these units claim that they realize the necessity of achieving balanced utilization of renewable resources when they implement their projects, in practice the outcome is monolithic, adding to the confusion and stresses experienced presently by the ecosystem.

Therefore a new approach to water programming is highly needed, and now. This approach should embody one basic

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(*) Such as: (i) The Soil Conservation Section (1946-56), (ii) The Department of Land Use and Rural Water Supplies (1956-66), (iii) The Rural Water Development Corporation (1966-69), (iv) The Ministry of Co-operation and Rural Development (1969-73), (v) The Ministry of Natural Resources (1973-74), (vi) The Rural Water and Development Corporation (restored) (1974-76), (vii) The Administration for Land Use, Soil Conservation and Water Programming (1976-83), (viii) The Natural Corporation for Water (1981-82) plus, of course, the other units which remained for a long time affiliated to this activity including: (ix) Animal Resources, (x) Pastures and Range Management, and (xi) Local Government Councils.

concept not given priority in the current planning of water sources: the control of the use of the renewable resources through more comprehensive planning and monitoring of the ecosystems at the macro, meso, and micro levels. This will require adopting the following strategy of action, especially by the newly created regional governments:

At the Macro Level

1. Develop land use plans to direct the usage of the renewable resources at the regional level.
2. Integrate the programmes of the units functioning at present in the area of renewable resources utilization, in accordance with the objectives set by the above plan.
3. Draft the essential laws and regulations which assure the effective usage of resources.
4. Train senior personnel in the field of ecosystem handling.
5. Increase awareness at all levels (formal-informal) about the importance of maintaining balanced ecosystems.

At the Meso Level

6. Apply zonation to ecological units with the purpose of defining different types of uses.
7. Initiate development projects based on the balanced utilization of ecosystems.
8. Build capacities of institutions dealing with ecosystems at this level.

At the Micro Level

9. Develop village land use plans that aim at organizing the usage of the land resources around the villages and enable rehabilitating affected areas.

10. Introduce strict tenure rights so as to define village land property for different uses, and as well meet the grazing requirements of the outsiders.
11. Specify kind of use for different water points i.e. strictly for settled population; for local villagers' animals, for nomads, for commercial livestock, etc.
12. Separate the water supply requirement for humans from that for animals through effective distribution systems.
13. Adopt a system of alternating use of water points to enable the closing down of those centres which show signs of deterioration of the ecosystem.
14. Involve the local communities in the planning and running of the water points and in the management of the ecosystem affected by them.
15. Re-educate the local leadership and thevillage communities in management aspects.
16. Raise the water prices and use the revenues generated in financing ecosystem management projects.
17. Improve the maintenance and the running of water yards through further disintegration of the regional and sub-regional maintenance centres to enable this service to function effectively at village level.
18. Work towards diffusing maintenance technology to be assimilated in time as part of the local technical know-how.
19. Up-grade the prevailing traditional economies through improved inputs to raise the levels of production so as to meet the basic requirements of the population: food, fodder, fire wood, charcoal, etc. which consequently lead to improvements in the standard of living of the local population.

The scheme outlined above may not be easily implemented as it is conceived. Many obstacles can be immediately spotted. To mention a few examples, there is the complete or partial lack of understanding of policy-makers as well as many of the technical people of how ecosystems function. To re-educate both is a matter which is resource and time consuming. The problem is further aggravated by the ever present competition over the limited available resources, between urgent needs and those that can be deferred for sometime. Unfortunately, ecosystem planning falls under the category of the latter. Definitely, there is also the impact of the local politics which can scale priorities in such ways as to match immediate gains which may again work against integrated land resource planning at all identified three levels. The nomadic tribes shall be among the first population groups to be affected by the implementation of any control measure; and in response are expected to react strongly against any kind of land use planning. Over and above, there is the important question of the availability of the means to implement such a strategy, being finance, technical know-how, personnel or equipment.

Despite all above repercussions, a start should be made, since the only foreseen alternative is more devastation of the ecosystem.

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PART TWO

MESSERIYA HUMR STUDY AREA

MESSERIYA HUMR STUDY SITE

Introduction:

The Messeriya Humr Study Site has been selected for environmental monitoring because of environmental changes that are taking place there. Increases in human and animal population within the site put pressures on natural resources, leading to environmental change. Government provision of limited medical and veterinary services in the area has contributed to local increases in human and animal populations. These increases were accompanied by a concomitant increase in human and animal water supply sources. Ignored in the construction of additional water supply sources was the necessity of balancing needs with environmental carrying capacities. These interventions produced new water supply distributional patterns which are mainfested, in particular, by high human and animal population densities around many of the newly created water sources. Of course, in the absence of proper planning and policy measures to ensure protection and rational use of resources, overgrazing and deforestation are expected to occur, especially around large centres such as Muglad, Babanusa and Ettboun. Such degradation can so endanger future prospects that the Messeriya Humr homelands will be incapable of sustaining and supporting human life.

The recent expansion of agriculture within the study site is no less serious in its environmental impact than the above mentioned factors. Messeriya pastoral nomads are progressively learning to engage in agricultural production. This process, in addition to the improved water supply situation, has spawned spontaneous settlements of the nomads in new villages. Settlement has necessitated clearance of extensive tracts of land for farming purposes and large scale cutting of trees to obtain wood for home construction and fuel needs.

In addition to the above factors, livelihood patterns within the study site have been influenced by the recent discovery of petroleum near the study site in another Messeriya inhabited area. This discovery has introduced a new factor into the process of environmental change in the study site. As a result of the discovery more people are moving into the area, particularly to the towns, adding to local demand for building material and fuel. Also of significance is the fact that prospecting companies are initiating environmental changes as a consequence of a road opening programme, clearance of drilling sites, and extensive (but accidental) fires set while conducting their prospecting operations.

Although the Messeriya Humr area is located in the Savanna belt where rainfall ranges from 500 mm to 800 mm per year, the aforementioned factors have led to many changes in the fauna and flora of the area. Of more importance the same factors have accelerated resource degradation and desertification in some parts of the region. Because processes occurring at the Messeriya Humr site are representative of those occurring in the region, it has been selected as a site for monitoring environmental change. Monitoring data will provide a base upon which to analyze environmental trends.

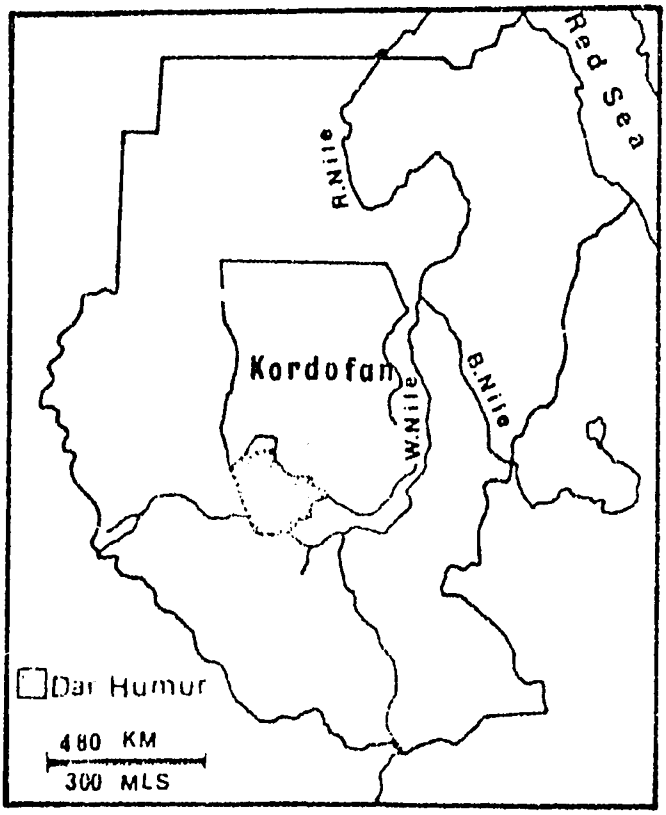
Location of the Study Site:

Geographically the Humr site is located in the Savanna belt of the Sudan bounded by Latitudes 9^{o}, 30'N and 12^{o}N and Longitudes 27^{o}, 30'E, and 29^{o}, 30'E (Fig. 5).

Administratively the Humr country is located just west of Lagawa Rural Council in the Western District of Southern Kordofan Province. The Humrs' rural council has its headquarters at Muglad but is supervised from Regl el-Fula, the capital of the Western District.

Historically Humr grazing rights extend beyond their own administrative boundaries into Bahr el Ghazal Province to the south, Southern Darfur to the west, and to Lake Abyad east of Lake Keilak in the east. The latter sites extend deep into the dmaring (summer grazing) sites

FIG. 5. DAR HUMUR



of the Messeriya Zurg. But as a result of recent conflicts over grazing and water with other groups, such as the Dinka Ngok, the Rizeqat and the Zurg, the Humr today are confined more or less to the boundaries of their rural council. In fact their Dar or homeland has contracted, particularly along its southern boundaries, as a result of continuous warfare with the Dinka Ngok.

The Humr area is a flat plain, with minor geomorphological variations producing four broad zones. These are: the northern Qoz around Babanusa; the alternating Gardud and Qoz of Muglad; the central Qoz mainly west of Muglad; and the alluvial deposits of the Bahr el Arab region. In these areas variations in vegetative cover, soils and drainage are noticeable and to a great extent influence the nomadic migration system and land use patterns.

The area has few naturally occurring perennial water sources. Most significant are: 1) Bahr el Arab, 2) The Ragabas (meandering channels and ox-bow lakes connected to Bahr el Arab during the rainy season), and 3) Lake Keilak. Seasonal water sources are numerous and include: 1) Rahads and Butas (both are clayey deprssions where rain water collects and stands until shortly after the rainy season); and 2) seasonal wadis such as Shallengo, el Ghalla and el Hagiz. Seasonal wadis contain flood water after rains, but during much of the year, when they carry no surface water, provide subterranean water supply sources in their beds and along their banks.

Indicators of Desertification which were Selected:

A tentative list of indicators used for Humr area includes:

1. Biological indicators

   a) Change in the distribution and frequency of Dalbergia melonoxylon, Anogeissus Leiocarpus and Terminalia Laxifora.

b) Distribution and frequency of fires.

c) Canges in rangeland plant communities.

2. Physical Indicators:

a) Changes in the size and distribution of seasonal surface water.

b) Rilling on gardud and clay soils.

3. Social indicators:

a) Increase in the number and sizes of rural and urban settlements.

b) Changes in herd sizes and herd composition.

c) Changes in grazing habits and traditional migration routes.

d) Changes in crops and areas cultivated.

e) Industrial development (for example in the forms of oil factories, milk factories and traditional manufacturing processes).

General Physical Background to the Humr Area:

In this section a brief account will be given of the geology, climate, soils and the vegetation of the study site.

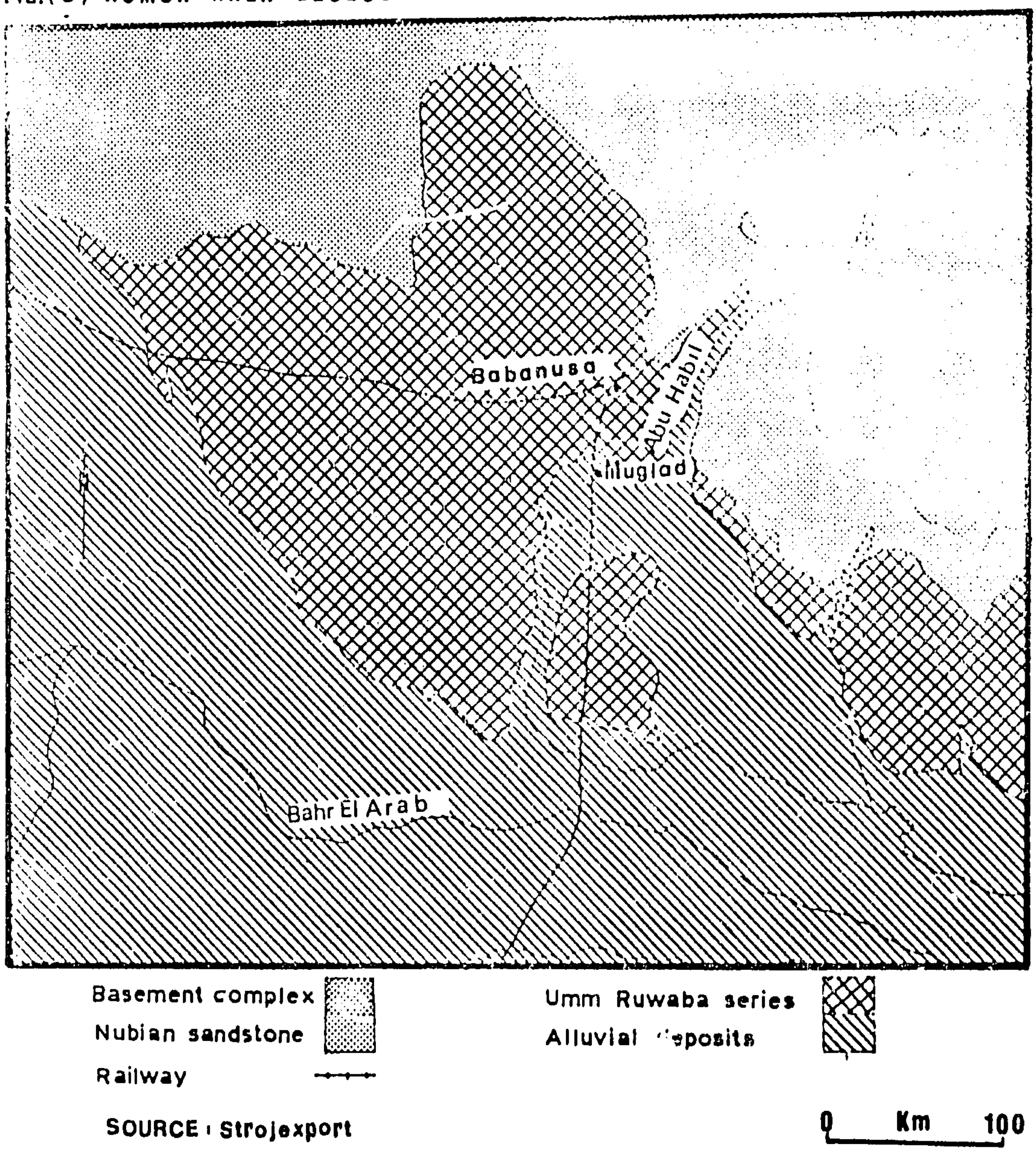
Geology:

The following formations are dominant in the Messeriya area (Fig.6).

a) Basement complex: These are pre-cambrian formations composed predominantly of granites, gneisses, mica. schists, graphite schists, quartzites and crystalline limestone. The Basement Complex rocks hold little ground water and are dominant in the eastern parts of the Humr homeland.

b) Nubian sandstones: These are Mesozoic formations described by Rodis, Hassan and Wahadan (1964) and consist of sandstone, conglomerate and mudstone, compacted into hard ferruginous and silliceous layers. Karkanis (1965) divided the

FIG.(6) HUMUR AREA—GEOLOGY



SOURCE : Strojexport

formation into: basal, middle and upper series. The basal series is made up of coarse and very coarse grained silicified sandstone and conglomerate beds, cemented together with silica. Thus the formation has been rendered very hard and resistant to weathering. The middle series are composed of poorly cemented, friable mud-stone and sandstone beds that weather into undulating surfaces with thick, sandy covers. The upper series are composed of poorly sorted, weakly cemented quartzitic sandstone, in which grain sizes range from clay to medium and fine sand.

These Nubian sandstone formations are mainly found to the west and north of Babanusa town. They are by far the best aquifers and on average the water table in them lies at 300 and 400 feet. Water is usually found in pebble conglomerates and quartzoses sandstones. Rarely is it found in mudstones.

c) Um Ruwaba Formation:

These are plio-pleistocene formations most dominant in the western and southern parts of the Humr Dar. They consist of unconsolidated sands, sometimes gravelly and clayey sands, and clays. The sediments are poorly sorted and are more than 1,000 feet thick in places. Underground water yields are variable, ranging from moderate to low.

d) Pleistocene and Recent Unconsolidated Deposits:

These are mainly superficial deposits consisting of gravels, sands, sandy clays, silts and clays. They occur in a variety of environments in the Messeriya area, such as in Wadi deposits, Qoz and sand sheets, river terraces and alluvium and valley fills. Water potential varies in these different strata, with sands being the least productive.

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Climate:

According to Irland's (1948) division of the climate of the Sudan, South Kordofan Province falls in the Western Savanna region and enjoys a hot semi-arid continental climate. Rainfall is clearly seasonal and is related to the inter-tropical convergence zone. Average annual rainfall varies between 500 mm. in the north and 800 mms. in the south. It is fairly reliable with a variability of 10 to 15% decreasing from north to south (HTS, 1981). The rainy season extends from June to October reaching its peak in August. However the length of the rainy season and the characteristics both of the dry and rainy seasons are the products of the major annual oscillations of pressure and air currents whithin the tropical zone.

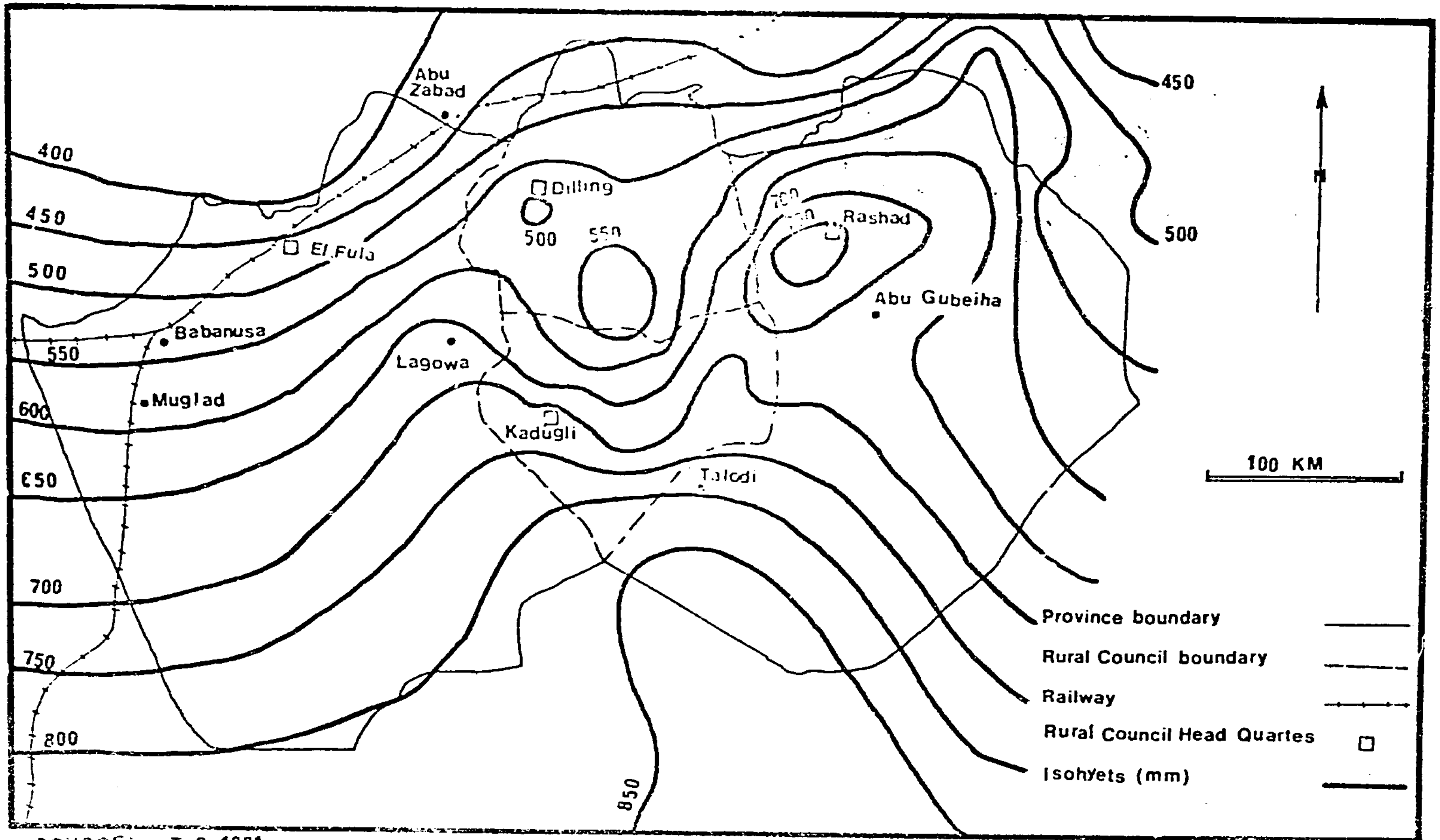
The northern boundary of the Humr country coincides with the 500 mm. isohyet and the southern boundary with the 800 mm. isohyet (Fig.7). The mean start of the rainy season is the 25th of May in the south and the 14th of June in the north. The mean end of the rainy season is the 1st of October in the north and the 21st of October in the south. Since the growing season averages 120-160 days, the study site lies within the boundaries of the area considered safe for rainfed agricultural production.

Temperatures are high with a daily maximum of 35°C in summer and 26°C in winter. Potential evaporation thus reaches its peak in summer where monthly values of around 220 mm can be expected. This is a direct result of maximum insolation and low relative humidity. Potential evaporation declines to about 170 mm per month in the rainy season due to lower temperatures and high relative humidity. It rises again in the post rainy hot season before it begins to fall in the winter season (HTS, 1981).

Soils:

A large part of the Messeriya area is covered by free-draining soils. The parent material and mode of

FIG. 7. STANDARD 40 YEARS AVERAGE RAINFALL



SOURCE: R.T.S. 1981

formation of these soils varies quite widely but they have a number of common features. They are infertile and susceptible to wind and water erosion. They also tend to form surface crust, especially when exposed and they dry out quickly.

The majority of cultivation in the region is on sandy soils which cannot support continuous cultivation successfully more than four to five years. The farming plots require almost fifteen years under bush fallow to recover. Substantial areas are grazed and in some parts (especially the west) overgrazing, trampling and burning has led to crust formation and degradation of sandy soils.

a) Nubian Aeolian and Nubian Residual Soils:

These residual soils are derived from weathering of Nubian sandstone formations and mostly occur in Wadi El Ghalla, Felaita and Fula Catena. They vary in colour from dark red to yellowish red. Textures range from fine and medium sand at the surface, to sandy loam and sandy clay loam at depth. For example one site west of Lake Keilak in the Felaita land system has a high very fine sand content. The very fine composition of these soils may be related to the fact that they overlay Nubian sandstones comprised of sands of fine texture. In the shallow soils, ferruginised sandstone fragments occur.

b) Qoz Sands:

These soils occur along the western margins of Messeriya District and are a continuation of the Qoz soils of the Eastern District. They are highly permeable and have low fertility. Overgrazing in areas having this type of soil has resulted in extensive sand dune mobility.

c) Atmur:

These aeolian soils are found in the alluvial transition zone of the Qoz land system. They are also found as part of the Baggara in the Ghalla fan around Muglad. Atmur soils occur in areas of level to gently undulating shallow sand sheet, or in isolated dune formations.

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d) <u>Qoz Alluvial Soils</u>:

These soils, which contain a higher percentage of silt than the aforementioned soils, lie within the topographic feature called the Ghalla sandy fan.

e) <u>Gardud Soils</u>:

These medium and heavy textured alluvial soils occur on the interfluvial areas between <u>Ragabas</u>. Gardud soils do not have an aeolian mantle; at the surface they range in texture from loam to clay loam.

f) <u>Fula Complex</u>:

The fula complex soils are found on the dissected sandy pediplain of the Ghalla land system. This pediplain has been dissected by numerous streams which drain into the Wadi El Ghalla. Erosion on the interpluves between the streams is severe. Fula complex soils are red, reddish brown, and yellowish red sands derived from eroded Nubian aeolian, Nubian residual and Qoz soils. They have been deposited by aeolian action in a thin mantle over Basement Complex strata and Nubian bed rock.

g) <u>Sandy Alluvial</u>:

Clay soils with high sand content occur within the valleys and flood plains of the three large wadis which drain out through the Felaita sandstone ridge. (These <u>wadis</u> are called Shallengo, El Ghalla and Al Hagiz.)

h) <u>The Ragaba Catenas</u>:

Soils within this classification range from sandy clay to heavy cracking clay varieties. Generally these soils are poorly drained. Frequently deposits of iron and manganese oxides are found in them.

The soils of the Messeriya Humur country were surveyed as part of the Savanna Project by Hunting Technical Service (1981). According to the survey, soils of the Humr area has been provisionally classified into eleven landforms as follows:

	Landform	Soil type	Description
1.	Flat to gently undulating aeolian and locally reworked alluvial sand sheet.	WP_1	Deep aeolian and reworked alluvial sandy soils.
2.	Sandy-plain--flat to gently undulating interluves.	WP_2	Deep coarse-textured residual soils.
3.	Sandy plain (dissected) gently undulating mid-slope.	WP_3	Medium-textured residual soils.
4.	Sandy plain (dissected) flat to gently undulating lower slopes.	WP_4	Fine-textured residual soils.
5.	Alluvial complex (Baggara repeating pattern) sandy ridges.	WP_5	Atmur sandy soils.
6.	Alluvial complex (Baggara repeating pattern) sheet wash plain.	WP_6	Nagga non-cracking medium and fine-textued alluvial soils.
7.	Alluvial complex (Baggara repeating pattern).	WP_7	
8.	Aeolian sand sheet and sandy plain depression areas.	WP_8	Shaqq medium to coarse textured soils.
9.	Flat to gently undulating sand sheet reworked by alluvial processes shallow depression.	WP_9	Baroya-Sandy material overlying medium textured subsoil.
10.	Flood plain complex	WP_{10}	Stratified recent alluvial soils of variable texture.
11.	Jebels and rock out-crops.	WP_{11}	Lithosoils and skeletal soils.

WP_1 soils are deep coarse textured soils developed on aeolian sand. In some areas the sand has been reworked by alluvial processes. Texture is normally sand or loomy sand to more than two metres. Average sand content determined in South Darfur from the same soil type WP_1 was 88% (68 coarse sand and 20% fine sand). Clay content varies from five to twenty per cent increasing slightly with depth. A weak coarse subangular structure is observed below one metre but the upper horizons are unconsolidated and structureless. Colour is variable, commonly yellowish brown in top soil becoming yellowish red in the subsoil.

WP_2 soils are deep sandy soils in which the dominant process of formation is in situ weathering of Nubian Sandstone or Basement Complex rocks. The profile comprised a variable thickness usually 50 to 75 cm of dark red or redish brown sand or loamy sand which overlies yellowish red sandy loam or light sandy clay loam. The top 20 cm often shows evidence of reworking by wind. WP_2 soils are not well documented in the available literature, the only authoritative source is HTS, 1964. WP_2 soils are similar to WP_1 in the low fertility status; they are also freely drained and susceptible to water and wind erosion. The surface has a tendency to crust formation and sealing particularly when cleared of vegetation.

The WP_2 soils have more fine material than WP_1 and therefore can hold more available moisture. The colour of WP_2 soil is redder than WP_1 soil.

The top soils of WP_3 (10-25 cm) are of reddish brown loamy sand overlying brown sandy loam passing into sandy clay loam between 75 and 100 cm. The sandy top soil is moderately alkaline and exchangeable sodium percentage are moderately high (about 10). Top soil fertility is very low but the medium textured horizons have higher cation exchange capacities.

The WP_3 soils also contain medium textured soils formed from the <u>in situ</u> weathering of sandstones and conglomerates of the Nubian series. A thin topsoil of loamy sand is underlain by sandy loam or sandy clay loam, but these soils are less shallow. Coarse angular Nubian sandstone gravel is encountered at variable depths, usually about one metre. In this soil p^H value decreases from around neutral in the sandy topsoil to moderately or strongly acid in the subsoil. The top soilis often lost by erosion.

The WP_4 soils developed on Basement Complex rocks and comprises 60 cm of dark greyish brown sandy clay overlying greyish brown structureless alkaline gravelly clay to at least 1.5 metres. The susoil gravel is largely carbonate concretions, and this, rather than an excessive amount of exchangeable sodium, appears to account for the high subsoil p^H. Cation exchange capacity is higher than in WP_3 soils but phosphorus, nitrogen and organic carbon are very low.

The WP_5 soils are one of the three soil types which occur regularly together as the so-called Baggara repeating pattern. The atmur soil is sandy soil that frequently occurs in the forms of elongated sinuous ridges. Wind action has redistributed some of the sandy material into dune-like formations. The thickness of the atmur sands can vary from a thin mantle less than 50 cm deep to well developed dune-like formations more than two metres deep. In places, sand has been blown or washed over the upper sheet - wash plain giving it a thin sandy mantle five to twenty cm thick. The alluvial deposits of the Baggara repeating pattern have been laid down on top of the aeolian sandsheet. In the Abu Bateikh plain the alluvial fan is discontinuous and the sandsheet protrudes in the form of fairly wide sandy ridge (WP_1 soils). Also in other places subsequent wind action has transported substantial quantities of sand from the surrounding sand sheets which has been deposited on top of the entire Baggara repeating pattern which is quite noticeable in Abu Bateikh.

The WP_5 soils are similar to WP_1 sandy soils except that they are underlain at variable depths by fine textured alluvium. In places the sand is more than two metres deep but normally the underlying alluvium is encountered within the top metre. The WP_5 soils have higher percentage of sand than WP_1 soils. Average figures in the eastern part of Darfur Province are 93% in WP_5 soils and 85% in WP_1 soils.

The WP_5 soils vary from middle to moderately acid (pH 6.6 to 5.7). They are very infertile, the cation exchange, the level of organic carbon, the available amounts of phosphorus, copper, zinc and manganese are all low.

The WP_6 Naga'a soils are a fairly complex group of non-cracking stratified and non-stratified medium and fine-textured alluvial soils with occasionally a thin mantle of sandy material. They form the almost flat sheet wash plains of the Baggara repeating pattern.

In unstratified WP_6 soils clay content almost increases with depth. A typical profile comprises an upper horizon of sandy loam or sandy clay loam with a conspicuous coarse columnar structure and a very hard non-cracking surface crust overlying weakly structured to massive, compact heavy sandy clay loam or clay loam and normally passing in the deep subsoil into clay or occasionally sandy clay. Colours are variable but commonly dark grey, dark greyish brown or olive brown. There are slight variations associated with position on the sheet wash plain. Textures are generally somewhat lighter on the highest part of the plain alongside the atmur sandy ridge. It is these soils which most frequently have a thin surface mantle of sandy material, most it wind blown or ashed from the atmur immediately above. Textures are finer in WP_6 soils on the lower parts of the sheetwash plain. These heavier soils have some vertic characteristic. When dry some cracks develop in the upper horizon, although they are normally covered by tne hard surface crust and slickensides are common in the subsoil.

Moisture availability in WP_6 soils (Naga'a) is strongly influenced by the low permeability of the hard surface crust. A large portion of rainfall flows off as sheetwash in the neighbouring buta depressions. Permeability in individual stratified WP_6 soils but overall profile permeability is normally slow to very slow (0.01 to 0.07 m/day)-AHT, 1976(b). Available moisture capacity also varies according to texture. In South Darfur sandy clay loam, clay loam and light clay horizons in WP_6 soils have an average available moisture capacity of 16% (HTS, 1974(b).

WP_6 soils are generally well supplied with exchangeable bases and micrcnutrients. Cation exchange capacity normally rises with the increases in clay content as moving from top soil to subsoil. Soil reaction in non-stratified WP_6 soils is normally mild alkaline in the topsoil (PH 7 to 8) becoming strongly alkaline in the subsoil (PH 8.5 to 9.3). Salinity levels are low throughout and carbon and nitrogen levels are low or very low.

The WP_7 buta soils have the typical profile, physical and chemical characteristics of montmorillonitic vertisols. The soil reaction ranges from neutral to strongly alkaline but levels of exchangeable sodium do not appear to be dangerously high.

WP_8 Shaqq soils are medium to coarse textured soils in depressions and hollows in aeolian sand sheet and residual sandy plains where they occur in association with soil types WP_1 and WP_2. These hollows act as collecting sites for upslope drainage and colloidal material from the surrounding sandy soils. As a result WP_8 Shaqq soils have higher clay contents and superior physical and chemical properties.

Clay content in this soil is higher than the neighbouring soils of WP_1 and WP_2 and may reach an increase of 5% especially in the deeper subsoils. The texture is mainly heavy loamy sand and light sandy loam.

WP_8 Shaqq soils are generally redder in colour and contain more evidence of faunal activity (insects and animal burrows) than surrounding WP_1 and WP_2 soils. The greater clay content gives the Shaqq soils significant advantages in terms of fertility and available moisture capacity. Plants in such soils rarely suffer from moisture stress during occasional dry periods in autumn, and the soils remain moist for longer periods after rains.

WP_9 baroya soils are polycyclic. A typical profile comprises 20 to 60 cm. of unconsolidated aeolian sand overlying medium textured alluvial material. Occasionally the alluvium reaches the surface. The upper horizon is usually dark greyish brown fine sand or loamy fine sand with a single grain or very weak subangular blocky structure. The subsoil is massive compact greyish brown sandy clay loam. The boundary between the upper aeolian sands and the massive sandy clay loam is abrupt and the presence of mottling immediately below the boundary suggests that the massive subsoil is impeding profile drainage.

Moisture availability in WP_9 soils is much higher than in neighbouring WP_1 aeolian/alluvial sandy soils. Although the sandy topsoil is excessively drained, the finer textured subsoil is much less permeable and water is held back within reach of plant roots for a longer periods. However the sandy clay loam subsoil is very compact and this may impede root development particularly where it occurs at shallow depth.

Fertility is generally low. Cation exchange capacity is very low in the sandy topsoil. Calcium is the dominant exchangeable base but a few profiles have moderately high exchangeable sodium percentages in the deep subsoil. The p^H values is high at depth. Organic carbon, phosphorous and nitrogen are low in all WP_9 soils.

WP_{10} soils which are recent alluvial soils occupy relatively small areas in the Western plains. Fine textured recent alluvial soils are in the Abu Ganuk dissected plain and the Wad Shalengo Valley. Outside these two regions, the only substantial tracts of recent alluvial soils are on the flood plain of the Wad el Ghalla and the lower valleys of its tributaries.

Fine and medium textured stratified alluvial soils appear to occupy most of the flood plains of Wadi el Ghalla.

Stratified coarse textured horizons were encountered with increasing frequency below 100 cm. in the profile. The occurence of sandy material in the subsoil is probably a fairly consistent feature throughout the region. The flood plain contains a number of large backswamp depressional areas occupied by buta cracking clay soils of type WP_7 especially between El Fula and Abu Zabad.

In Wadi el Ghalla flood plain alluvial soils with coarse textured surface horizons are relatively scarce although conspicuous narrow levee like features are identifiable on aerial photographs and wind-blown sand has been deposited over the alluvium in places particularly in lower parts of the flood plain.

Coarse textures are more common in the valleys of tributaries particularly those on the northern side of the Wadi, draining from the eroded Abu Zabad and El Fula dissected plains. Over the years very large amounts of material, mostly sandy, have been washed into the valleys from surrounding interfluves and valley sides.

WP_{11} soils are shallow soils developed on outcrops of Basement complex or Nubian series rocks. Both rock types outcrop occasionally in the Dubeibat plain and the Abu Zabad and El Fula dissected plains. Ironstones and sand stone also form more isolated jebals in the Kodurke and Keilak plains. The total area of such soil is negligible.

3. Vegetation Classification:

According to Jackson and Harrison (1958) the vegetation of the Messeriya Humr country is divided into four broad divisions and eight minor divisions. These classifications are shown in Table 11.

Table 11

Major and minor vegetation divisions of the Messeriya Area

Major division	Sub-divisions
1) Low rainfall woodland Savannah on sand.	a) Combretum Cordofanum-Dalbergia-Albizzia Sericocephalla savannah
	b) Terminalia-sclerocaryes-anogeissus prosopio savanna
	c) Combretum Cordofanum-Albizzia Dalbergia-Acacia Senegal savannah
2) Low rainfall woodland savannah on special areas.	a) Hill Catena
	b) Baggara repeating pattern
3) Low rainfall woodland savannah on clay.	a) Acacia Seyal - Balanites savannah alternating with grass areas
	b) Acacia Mellifera thornland
4) High rainfall woodland savannah.	a) Flood region

3.1. In the first major division of low rainfall woodland savannah occuring on sand, the following associations are found:

a) The Combretum Cordofanum - Delbergia - Albizzia Sericocephalla savannah association exists in a discrete vegetation unit in the Qoz land system around Babanusa. The dominant tree species are Combretum cordofanum, Albizia sericocephala, Dalbergia melanoxylon and Guiera sengegalensis. However in the triangle of Muglad, Fula and Babanusa Albiza sericocephala and Delbergia Melanoxylon show clear dominance over all other species.

b) The Terminalia-sclerocaryea anogeissus-prosopis occurs in deep sandy soils.

The dominant trees in this association are Termanallia brownii, Sclerocarya birrea, Anogeissus Schimperi, prosopis africana, Combretum cordofanum and Albizzia sericocephala.

c) The Combretum cordofanum - Albizza - Dalbergia - Acacia senegal association is found in alluvial soils occurring on the upslope of clay depressions. Acacia senegal and Lannea humilis are the main dominant species in this association (Hunting Technical Services, 1976).

3.2. In the second major division of low rainfall woodland savannah occurring within special areas, two minor subdivisions have been recognized:

a) In the Hill Catena around Lagawa three main zones are found. In zone I the rocky summits of granite and the gneiss Basement Complex hills are usually devoid of vegetation, except for occasional ficus species that have gained a foothold amongst the boulders. In zone II, found on steep rocky hill slopes, a great variety of tree species are found. Frequently pure associations of single species, mainly Boswellia papyrifera occur. Other species observed in this zone include Sclerocarya birrea.

Anogeissus schimperi and Combretum hartmannianum. Zone III, found on the stoney pediments at the foot of the jebels, supports a great variety of tree species. However, rain splash, sheet wash and subsequent surface scaling have given to patchy vegetation distribution. Where soil drainage is rapid, the following species occur: Albizzia sericocphala, Terminalia brownii, Bauhimia reliculala, Lannea humilis, Borassus aethiopium and Acacia senegal.

3.3. The third major division of low rainfall woodland savannah on clay is sub-divided into two minor divisions:

a) In this sub-division, Acacia seyal - Balanites savannah alternates with grassland and both overlie dark cracking clay soils. Vegetation is dominated by Acacia seyal and Balanites aegyptiaca, with scattered Anogeissus schimperi, Combretum hartmannianum and Acacia gerrardii also occurring.

b) In the second sub-division Acacia mellifera is the dominant species. This subdivision demarcates a transitional region between a zone of dark cracking clay soils (where Acacia seyal predominates) and sandy areas. Most common species found in this region are Acacia mellifera, and Acacia nubica. Scattered pockets of Acacia seyal and Balanites aegyptiaca are also found.

3.4. The flood region is used as a fourth major vegetation division. Main trees found within this division are: Anogeissus schimperi, Mitragyne inermis, Acacia siberiana, Hyphaena thebaica. Dominant grasses found here are Hyparrhenia rufa, Setaria incrassata, Echinochloa stagrina, Oryza longistamenata and Penicum spp.

Vegetation Transect Studies:

As shown in Table 12, the first vegetation transect studies have been done in the Southern region of Lake Keilak. Predominant grasses and herbs found there are: Hyparrhenia rufa, Pennisetum spp., and Oldladia senegalensis.

Up to the time of the study animal grazing around Lake Keilak was very light, and the soil was well covered with vegetation. However, further from the lake extensive areas had been devastated by fires. Although Abdel Magid stated in 1975 that fire destroys 60% of range forage in the Sudan, in this area the loss could be more than 60%.

Termites are also observed across much of the area. They are especially common in grasslands, but are very rare in forested areas.

Within the Lake Keilak area, young seedlings of Terminalia brownii have also been observed growing in dense stands under mature trees. This development is a sign of healthy recovery of the ecosystem.

On dark cracking clays east of Lake Keilak, the main grasses are Rottobellia axaltata and Echinocloa spp. The soil cover there is very rich and forage production is relatively high. Very little grazing is done on this range. Fire occurs very frequently over vast areas. Young seedlings of Acacia seyal quickly take over previously cultivated areas and cover all bare land. That this process occurs is a sign that the ecosystem is balanced and healthy. (See Table 12, part II).

Along the northwest part of the lake the study was carried out on two sites. (See Table 12, Part III.) Samples were taken from both hill catena and from dark cracking clay soils. Soils sampled showed little incidence of erosion and forage production upon them was reasonably high. However, fires were common in the area. As a consequence extensive tracts of land had been completely burned, especially tracts where dense stands of grass grew upon clay soils.

As shown in Table 12 Part IV, forage production is remarkably low in the southern part of El Fula area. Vegetation is sparse upon the seriously eroded sandy soils which exist in the area. Vegetation is sparsest where hard pan has formed as a result of heavy erosion.

Heavy grazing is observed at a radius of three kilometers from the town. The only area having a rich ground cover, and hence adequate forage production, is the near Wadi El Ghalla east of the town.

The area extending between the towns of Baggara, Muglad and Babanusa has poor forage production because the soil there is mainly covered by Zornia diphylla, a short-tender, prolific, but low yielding herb. Forage production is nil where an eroded sandy pediplain (which cannot support vegetation) covers a considerable portion of the land surface. (See Table 12 Part V). This area is a wet season grazing range for nomads. But the Range Management Officer at Babanusa stated in 1982 that because of poor grazing material the period spent in the area by nomads during the rainy season is becoming shorter (only two months). Overgrazing is affecting areas immediately around Muglad, Babanusa, and Baggara. It has helped generate an extremely degraded soil cover, approximately 2.5 km. in radius, around each of these settlements. In addition, termites are another agent of destruction. They destroy not only forage, but also trees such as Dalbergia melanoxylon.

In 1969 in order to improve the grazing situation, forty four settlement ranches for nomads were planned in the Babanusa area. Nomads rejected the schemes because livestock movements and number and the total amount of land available for grazing were limited on the scheme.

Consequently all schemes were abandoned, except eight schemes which were downgraded to pilot farm status.

Sibeha, shown in Table 12, Part VI, is one settlement scheme where efforts can be considered successful. At Sibeha, soils are typically sheet sands supporting a Terminolia - Anogeissus Sclerocarya (mixed deciduous) woodland savannah. While the soil cover is reasonably good, forage production is low, especially if we take into consideration government efforts on the scheme. Officers in charge of the scheme claim that they do not have enough equipment and manpower to establish firelines. As a result, frequent fires on the scheme often lead to the elimination of perennial vegetation. In fact, about 80% of the range is composed of annual grasses and herbs. The dominant annual grasses and herbs in the Sibeha scheme are Cenchrus spp., Eragrostis spp., Zoria diphylla and Mitracarpus spp.. Some perennial grasses are found, with Andropogon gayanus being the most frequently seen.

The present plan for settlement of nomads in Sibeha is to introduce families into an area of 10 square kilometers. Each family is to be given 30 feddans for cultivation and allowed to raise 50 animal units inside the scheme. After four years cultivation plots will be shifted. Subsequently the former cultivation plots will be sown to Hashab trees (Acacia senegal). Sale of these trees' products will augment farmer incomes.

Table 12

Transects at the Humr study site.

Part	Sample No.	Average percentage of soil cover	Average percentage of bare soil	Average forage production 16/fed.	Average number of trees/hect.	Average number of dead trees/hect.	Remarks
I	1	97	3	745	89	5	Undertaken at 6 kilometers south of Lake Keilak, at intervals ranging from 1-6 kilometers, on deep sandy soil.
	2	70	30	350	65	3	
	3	100	—	2590	79	4	
	4	100	—	1700	65	2	
	5	96	4	700	127	7	
II	1	100	—	3070	75	—	Undertaken at five kilometers east of Lake Keilak, at intervals of one kilometer for each sample. Soils are dark cracking clays covered with tall grasses.
	2	100	—	3000	70	3	
	3	100	—	3500	68	—	
	4	100	—	3500	60	1	
	5	100	—	3200	51	—	
IIIa	1	100	—	2070	106	6	The study was undertaken at 13 kilometers north-west of Lake Keilak.
IIIb	2	100	—	1550	73	4	The study was made at 23 kilometers north-west of Lake Keilak (in hill catena soils).
IVa	1	60	4	300	76	9	Undertaken 3 Kms. south of El Fula.
b	2	70	30	500	62	8	" 5 " " " " .
c	3	85	15	1200	69	10	" 10 " east of El Fula near Wadi El Ghalla.
Va	1	90	10	350	68	12	Undertaken midway between Baggara and Muglad.
b	2	87	13	380	71	10	" " " " "
c	3	50	50	300	68	11	Undertaken between Muglad and Babanusa.
VI	1	95	5	640	42	5	Undertaken in Sibeha Ranch.

Summary for Vegetation Changes and Indicators of Degradation:

1. Although land around Lake Keilak is not intensively used, additional land is being cleared for cultivation, since villages around Lake Keilak are growing rapidly. Bushes of Guiera senegalensis are speading around villages in radii ranging from one-half to one kilometer. Severely overgrazed land extends in a radius of up to two kilometers from the same villages.

2. Around old settlement centers such as Fula, Babanusa and Muglad, severe land use pressure occurs as a result of high animal densities and continuous cultivation. Heavy grazing radii range from two to four kilometers around these settlements. In addition, large scale destruction of trees has occurred because of a 50% increase in the amount of land cultivated (especially around Babanusa). Consequently, unpalatable plant species, such as Cassia tora, Sida carcofolia, and Acanthospermum hespidum, dominate the immediate vicinities of the above mentioned settlement areas.

3. Because of heavy grazing, palatable perennial species of grasses and herbs, such as Stylosanthes fruticasa and Andropogon gayanus, have disappeared from the surroundings of main settlements.

4. Fifty per cent of the sandy pediplain in the triangular area bounded by Muglad, Babanusa, and Abu Zabad does not support grass or herb growth. This absence of vegetation could be mainly ascribed to heavy grazing in the wet season and to the impact on the soil of active wind and water erosion.

5. Destruction of vegetation by fire is another major agent of degradation within the study area, especially in heavy grass areas such as near Lake Keilak, and between Muglad and Bahr el Arab. For

example fire destroys more than sixty per cent of the annual production of forage in Messeriya District.

6. Termites are also active agents in forage deterioration. They are concentrated in the northern part of the study area, around Babanusa and Fula. Their destructive activities are not limited only to grasses, but extend to trees in the poorer areas of Muglad and Babanusa regions.

7. In the Sibeha Settlement Scheme settlers grow Acacia senegal upon fallowed lands. This is a healthy sign since Acacia senegal will facilitate the recovery of land productivity. Because the scheme is new and experimental, it should be carefully monitored.

Water Resources:

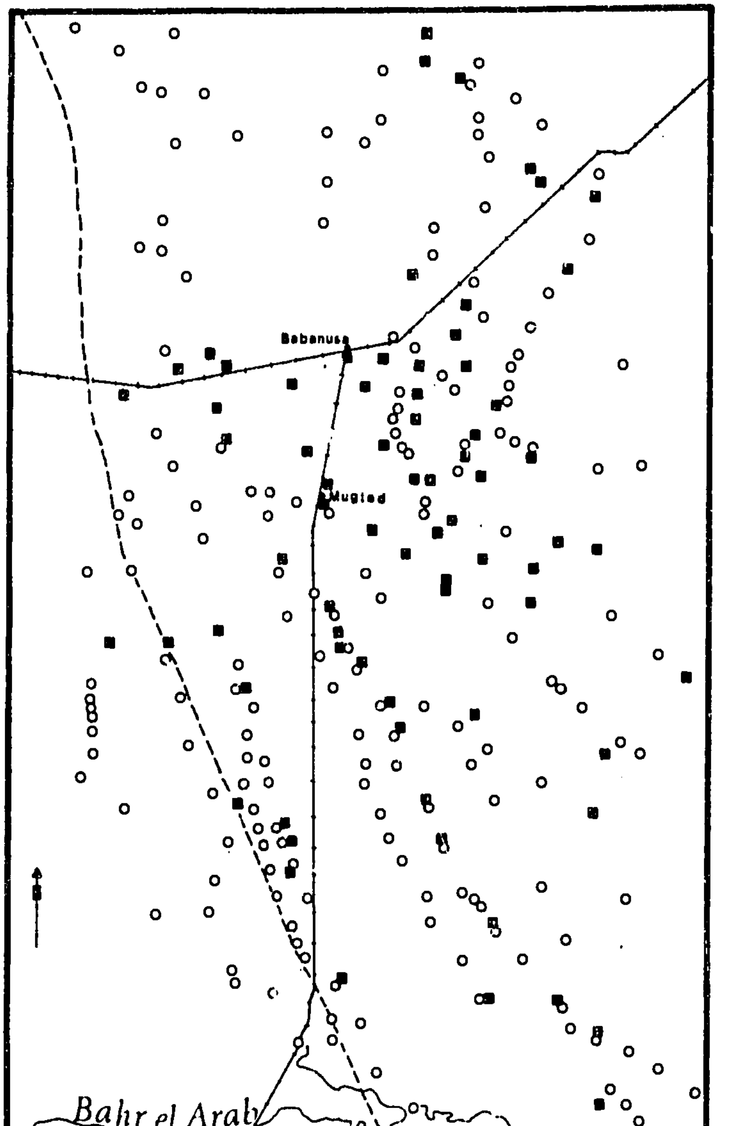
The availability and distribution of water plays a vital role in the distribution of the Humr population, their livestock, their agricultural activities and the pattern and routes of their seasonal movement. Water supply in the Humr area is derived from the following sources:

1. Underground water sources
2. Surface water sources
3. Sub-surface water sources

Underground water:

According to the Geophysical Investigation of Underground Water in Kordofan (1976), rocks taking part in the geologic structure of the Study area represent a highly variable environment in this respect of the circulation and accumulation of underground water, the variability is related to their lithology, structure and texture which are results of post geologic processes. The geology of the Humr land allows to distinguish the following hydrogeological units Basement Complex, Nubian Sandstone Groups and Umm Ruwaba Formation.

FIG. 8 WATER SOURCES IN HUMUR AREA



SOURCE: Savanna Developement Project

Fresh and unfractured rocks of the Basement complex do not represent a favourable environment for the flow and accumulation of ground water. Generally they are considered as impermeable except in areas of fissures and faults.

The Nubian Sandstone formation represents the most important aquifers in the Study area. They form continuous storage areas of a regional extent characterized by pore permeability. Marginal faulting is the decisive factor in the formation of dynamic reserves of ground water, while faulting in the centre of the basin plays a negative role as it disturbs the continuity of the water bearing horizon. Water bearing properties of the Nubian Group depend on the presence of sandstones and conglomerates. Interbedded sandstones are impermeable and represent a barrier for circulation of water.

The Umm Ruwaba formation is also favourable hydrologically and water accumulates in sands and gravel which make it highly capable of water storage.

Development of underground water in the Humr land which is dominated by Nubian sandstone and Umm Ruwaba formations started in 1927-28 when two boreholes were drilled in Muglad. Drilling of boreholes was discontinued since then but was restarted after the Second World War and proceeded at an increasing rate especially during the anti-thirst campaign in 1967. In fact fifty percent of the total 280 boreholes existing in the Humr areas were drilled after 1967.

The spatial distribution of boreholes is dictated by the availability of underground water, types of landuse and populatation distribution. As Fig. 8 shows boreholes are concentrated along migration routes and in points of settled population especially larger urban centres like Muglad and Babanusa where twelve and six boreholes were drilled, respectively.

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Surface and Subsurface Water:

Surface water is of varying degrees of quality and reliability. They consist of surface pools (Butas and Rahads), and seasonal streams and perennial water courses. Butas and Rahads are used for both livestock watering and domestic needs during the rainy season. They are usually short-lived but in areas of clay soil they may provide sources of water supply up to the end of December. Seasonal streams include Wadi Shallengo, el Ghalla and el Hagiz with high discharge during the rainy season. The main catchment area of these streams lies in the Nuba mountains. Perennial water sources are Bahr el Arab, Lake Keilak and the Ragabas (Fig.9).

Subsurface water is obtained from Jamams and hand dug wells. Jamams are shallow pits in the stream beds or pools which tap underground water stored in sandy beds or banks of streams. This is relatively clean water and is used for domestic purposes only.

Domestic water supplies are also obtained from hand-dug wells sunk three to ten meters in the clay sediments of wadi-beds and their surroundings. They are most common in the central and eastern parts of the Humr land (HTS 1976).

Utilization of water sources has no serious negative impact on natural vegetation and soils except in areas of nomadic concentration around major centres namely Muglad, Babanusa and Ettibun where indicators of change in quality and species are observed. This is attributed mainly to the misuse of land as a result of expanding cultivation besides overgrazing of pastures by nomads. Around seasonal water sources the intensity of pasture utilization is determined by the amount of water stored. As the amount of water is limited it is observed that pastures are not overgrazed to the ground level leaving bare soils to be subjected to wind and

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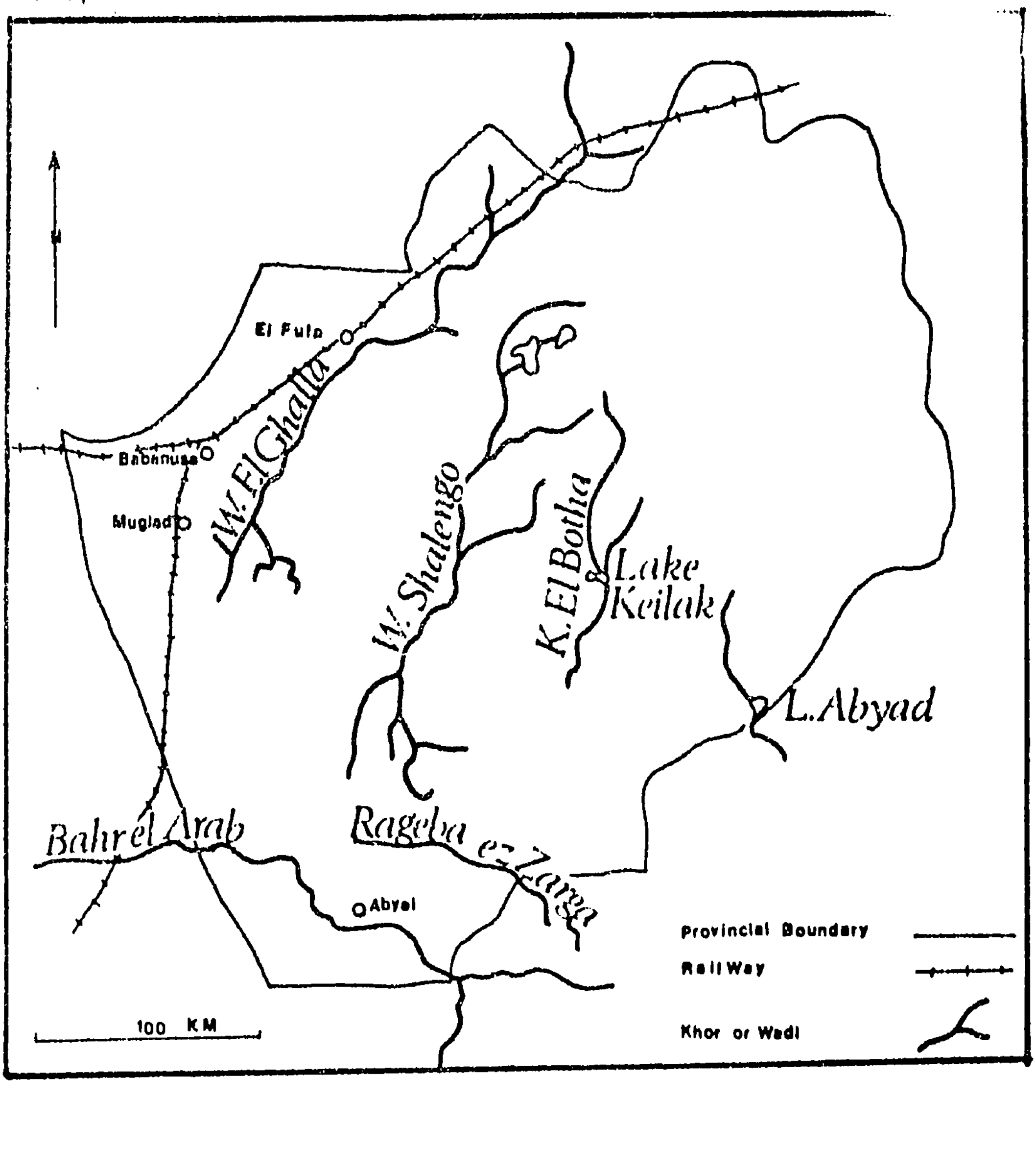
FIG. 9, MAJOR DRAINAGE FEATURES, SOUTHERN KORDOFAN PROVINCE



water erosion. However, the degree of degradation around open water sources is relatively increasing as more and more owners (Hamar) from northern Kordofan come to spend the dry season in the Humr land.

Economy:

Economic activities in the Humr area are basically pastoral nomadism and subsistence farming. According to Cunnison (1966) the Humr before the Mahdiya relied on livestock for most of their requirements and commitments and agriculture was limited to a very small scale. After the reoccupation of the Sudan the area has progressively been drawn into the cash economy.

Since then Agriculture began to expand. Expansion of agricultural activities among the Humr has been enhanced by the development of permanent water sources and the establishment of the railway line along which settlements emerged. However it must be mentioned that the Humr still prefer cattle husbandry to cultivation.

Pastoral Nomadism:

In this section some changes in Messeriya Humr nomadic systems will be considered in the light of recent environmental and socio-economic changes. Social indicators (in the form of changes in patterns of social organization) are evident and can be documented at length. At this point we are just making tentative and simple statements, but the actual situation is reasonably complex.

Cattle Movements and Migration Routes:

Fortunately, the pastoral system of the Messeriya Humr was studied and described in detail by Cunnison in the late 1950s. Cunnison's findings, when compared with present day data, help us detect any changes that have occurred in the system over the past thirty years. The necessity of adaptation to varying environmental conditions is an intrinsic part of the Humr pastoral management strategy. The specific response to these environmental conditions is adoption of a seasonal migration cycle that covers four ecological zones: the Babanusa, the Muglad, the Qoz and the Bahr. From the point of view of the Humr, seasonal cattle movements help them optimally utilize and manage their natural resource base. A combination of the presence or absence of the following factors determines the utilization of each region (zone) during a given period of the year, these are:

1) Water; 2) grazing; 3) flies; 4) mud.

The Babanusa is a northern zone which is utilized during the rainy season. The Muglad is a transitional zone, south of the Babanusa, and contains most Messeriya Humr farming. The Qoz is another transitional zone bordering on the Bahr zone. The latter zone is mainly utilized by herders in the dry season. According to this classification system Lake Keilak lies in the Bahr region and is therefore one of the most popular dry season grazing and watering centres. However it is not important only for its water resources, but also for services which are found there, such as a market, a dispensary, and a court.

In the fifties, herds were driven from the Muglad in December and reached the Bahr in early January. If there was enough water in the pools found at the edge of the Qoz region, herders usually deferred their herd's arrival at the large water sources of the Bahr region until the second half of the dry season. This strategy helped them make optimal use of the grazing and water resources of the Bahr.

With respect to the north-south movement of Humr herdsmen, one can say with confidence that some vertical adjustments have taken place. For example this year we met a group of herders near Keilak who claimed to have arrived there by the beginning of October. Moreover, they

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started to graze near the lake at a time when there was still water in the Ragabas south of Keilak. This change in herd movements was engendered by the increased number of animals brought to the lake, especially aftor the arrival in the area of the Um Bororo and their large herds. (The Um Bororo are a West African pastoral group.) Because the Um Bororo do not cultivate, they quickly move southwards after the rains in order to gain the advantage of being the first to utilize the green pastures near water sources in the Bahr region. The Um Bororo are therefore imposing new demands on the existig system, compelling the Humr to readjust the timing of their herd movements if they are to remain competitive.

Considering the fact that the average number of days spent by the Humr in each region in a complete year used to be as follows (Cunnison 1966):

The Babanusa .... 72 days
The Muglad .... 102 days
The Qoz .... 49 days
The Bahr............... 142 days

it becomes clear that the number of days now spent in the Bahr will have been increased by about three to eight weeks (varying from the different grazing units). One can imagine the adverse effect this change could have on the pastoral system in general, and the Bahr region in particular. The Bahr region is no doubt one of the areas that will need close monitoring, since it undoubtedly will undergo significant environmental change.

Other minor adjustments in herd movements have also taken place. Watering poihs and the so-called "nomad settlement schemes" in the Muglad area have enticed some herders (those with few animals) to stay in this region during the dry season, thus saving themselves the trouble of going to the Bahr. The tendency to adopt this strategy has been frequently observed in the Baggara schemes area. (These schemes lie on the Fula-Muglad road.) One of the

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factors which made such an alternative acceptable to some has been the security risk they would otherwise have encountered in the Bahr, such as tribal tensions that often and in fights that result in deaths. However, the current fuel shortage has rendered this more sedentary alternative a very risky one, since motor-driven well pumps are often shut down for lack of fuel.

Migration of different Humr tribal sections still follows the same general east-west routes (Fig.10). The Ajaira follow the western routes and the Flaita use the eastern routes. There are only a few instances where horizontal adjustments in cattle routes (marahil) shift eastwards.

2. The Interplay Between Cultivation and Pastoral Nomadism. (The Tendency Towards Transhumance)

Traditionally cultivation has been second in importance only to pastoralism within Humr society. However, formerly not all people within the society cultivated, and those who did so were subsistence oriented. Cotton was introduced before the 1950's, but because its diffusion was limited did not alter the subsistence nature of Humr cultivation.

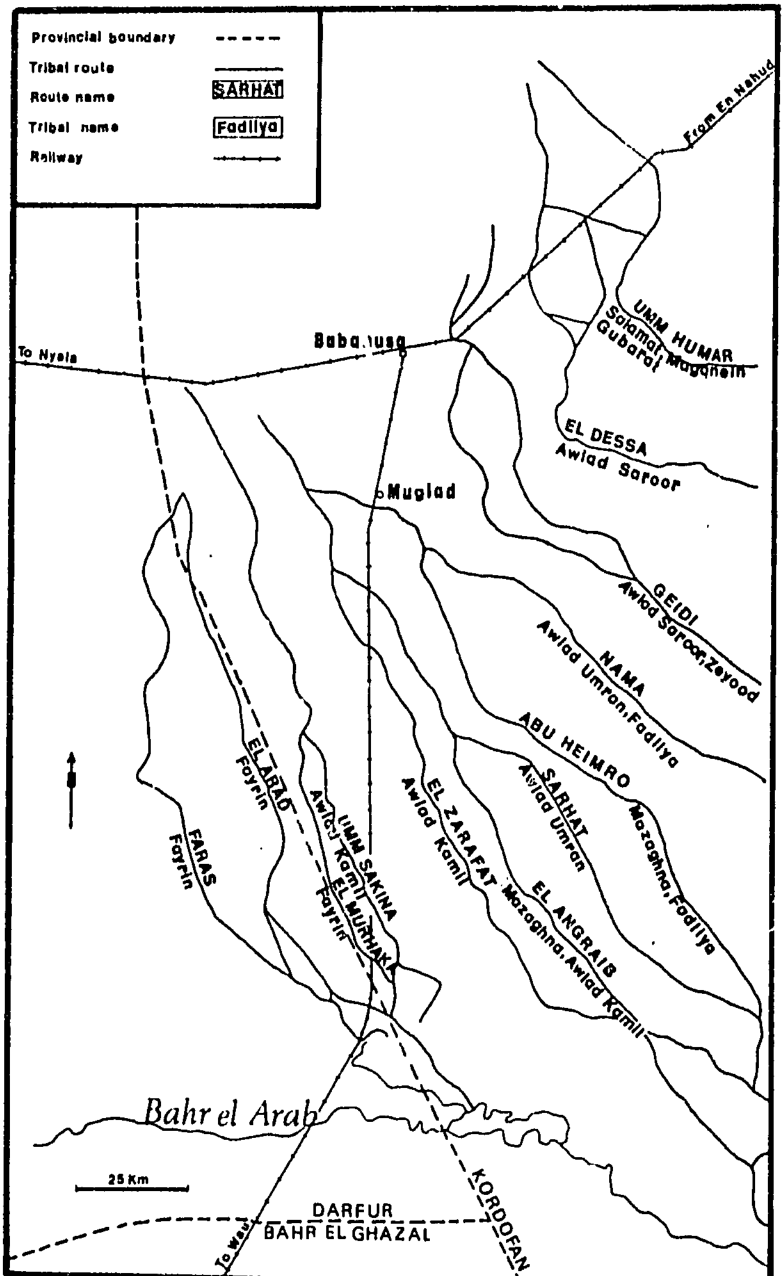
Today, many changes have taken place in the Humr agro-pastoral system. Table 13 shows the range of crops cultivated by a sample of twenty settled farmers from Keilak village.

Table 13

Crops cultivated by settlers around Lake Keilak.

Crop	No. of farmers who cultivate
Cotton	2
Dura (Sorghum)	19
Dukhn (bullrush millet)	12
Groundnuts	7
Sesame	11
Kerkade	2
Vegetables (tomatoes & okra)	3
Rice	3
Bafra (cassava)	3
Maize	3

FIG.(10) TRIBAL ROUTES IN HUMUR AREA



SOURCE: Savana Development project

It is clear from Table 13 that sesame and groundnuts are the third and fourth most frequently cultivated crops, respectively, after the two staples (dura and dukhn). The obvious conclusion that can be drawn from the above table is that for a considerable number of farmers cultivation of cash crops is becoming increasingly more important. However, cotton cultivation actually decreased around Lake Keilak, primarily because of management problems faced by the Nuba Mountains Agricultural Corporation. Total area cultivated by each farmer has increased as a result of greater emphasis on cash crops. For instance, nine of the farmers interviewed admitted to having, over the past ten years, increased the total area they cultivate.

Some former nomads indicated that the rising price of dura has made it difficult for them to rely on sale of animals to obtain money for subsistence needs without seriously depleting their herds. Every pastoralist in Sudan seeks to avoid seriously depleting his herd. In Um-Janah (south of Keilak) we met a 30 year old man who started to cultivate for the first time in his life in 1981. This man acknowledged that he began cultivation in order to give his herd the chance to increase.

Another important observation we made was to observe the spread of agricultural activities around Lake Keilak. In the past cultivation was limited within the Bahr region, since most farms were in the Muglad zone. Today many people cultivate in the vicinity of Keilak. One obvious advantage of this arrangement is that households do not have to wait until harvest time in the Muglad before they can move southwards.

Cessation of the need to migrate is especially important for those households who cannot afford, because of insufficient labor, to operate two distinct production units.

Utilization of Dinka (and now also Nuba) wage labour is becoming more common. About thirty per cent of the farmers interviewed in Keilak village employed wage labour during the past agricultural season. Increases in the production of groundnuts and sesame could well stem from this addition of wage labour to the production process.

The conditions described favour the continuation of a mixed economy, rather than a pure pastoral nomadic one in the area. In any event pure pastoralism was formerly practiced by only a small number of households. But the most important aspect of the new conditions is the spread and increase of cash crop production. One immediate impact upon the pastoral system of this trend toward cash crop farming is the local decrease in the amount of grazing land. Today many disputes brought to court in Keilak concern the damage done by animals to crops.

The two aforementioned trends of (1) spending the dry season around government-provided water sources in the Muglad zone and (2) cultivation of fields in the Bahr have transformed the pastoral system from a nomadic one to a transhumance one. However this is only a tentive observation which will need further qualification in the light of better data. And it should not be taken to mean that transhumance strategies were not utilized in the past within the Humr pastoral system. What is suggested is that formerly pastoral nomadism was the more dominant strategy.

3. <u>Nomadic Competition in the Keilak Area:</u>

Keilak is one of the largest areas witnessing concentration of pastoral activities during the dry season. Concentration around the lake is not a new phenomenon, for it existed at the time Cunnison wrote. There are certain groups which historically exploited the pastoral niche around Lake Keilak. Dry season grazing areas in its vicinity have always been carefully divided among different

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groups. The Zurg mainly utilize Lake Abyad and share it with Awlad Serur (Humr). The Ajaira utilize the Bahr el-Arab, while the majority of the Flaita are encamped at Lake Keilak, with smaller numbers at Abyad and Bahr el-Arab. The dominant groups at Lake Keilak have always been two sections of the Flaita, the Salamat and Jubarat. Although they are not welcomed by the other groups, the Ghazaya section of the Messeriya Zurg also spend the dry season in Keilak.

In December 1981 fighting took place between Humr and Zurg herdsmen south-east of the lake. We were told that fighting near the lake is essentially a yearly business. As a consequence of hostilities, some households from A. Serur (Humr) have abandoned Lake Abyad and resettled near Lake Keilak.

Ideally the Baggara utilize sources of water and grazing in those Ragabas (water courses) which are not near the main dry season water sources. As the dry season approaches, animals can only be watered at Keilak. However, this alternative is resorted to only reluctantly, since, as the following examples show, it adversely affects animal well being. First of all, the concentration of large numbers of animals around a single water source increases the possibility of disease transference between herds. Second, in the latter stages of the dry season water in the lake gets extremely muddy and becomes unhealthy for both human and animal consumption. Third, grazing resources become very scarce near Keilak. This means that animals have to travel longer distances in their journey from pasture to sources of water.

All these difficulties are aggravated by the fact that during the last decade nomadic competition over the natural resources of the Lake Keilak area has increased. Not only is this reflected in the increased tension between Humr and Zurg sections, but also, on a larger scale, in the

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open hostility of the Arab origin tribes with the West African Um Bororo. The use of firearms in these clashes makes them extremely bloody.

Thus, two main factors probably account for the increased nomadic competition around Keilak. The first is a large increase in animal production in the area. This increase results from the operation of many factors. (See also Table 14). The second is increase in tribal conflicts between the Humr and the Dinka along the Bahr el Arab in the Abyei area. Because of increased conflict many Humr households have refrained from spending the dry season along the Bahr el Arab. Keilak, therefore, became the alternative dry season range for these people.

Table 14

Resasons for current problems over grazing resources, Um Janah interviewees.

Lack of water....................	7
Increased animal numbers........	7
Fire..............................	3
Low rainfall.....................	3

4. The Encroachment of West Africans:

The presence of West African people in the Lake Keilak region dates back to the early 1950's. These people are of two origins.

(a) First they are sedentary cultivators who now constitute between one-quarter to one-third of the population of Keilak village. Forty years ago there were only two or three families of West Africans in the area, but new arrivals from West Africa quickly integrated themselves with the original settlers. West Africans now occupy residences just east of the market. More recent West African immigrants settled in a newer part of Keilak village. This extension, called Boboya, is separated by fields from the original village. Founded some thirty years ago, Boboya is now completely occupied by sedentary

West African cultivators. These people are of the Hausa, Melle, and Barno ethnic groups.

West African have introduced new crops such as rice, bafra, tomatoes, and maize into the Lake Keilak area. They also engage in fishing and monopolize commerce at a dry-fish market. Some of them are also engaged in petty-trading. In fact, at least half of the shops in Keilak market are run by them. Other important economic pursuits for West Africans are cash crop cultivation and trade in agricultural produce.

(b) The second group of West African in the Lake Keilak area are Um Bararo pastoral nomads. The Um Baroro are a nomadic tribe belonging to the Fulani nation. If any social organization exists that could be described as pure nomadism, Um Baroro organization would be it. Although records indicate that the Um Baroro visited Keilak during the days of British Administration in the Sudan, there is no evidence that the same households which formerly roamed the Dar Messeriya frequent it today. In fact Um Baroro households usually stay in the area for a few years and then migrate towards the east. Today some Um Baroro graze animals east of the Blue Nile. It is difficult to determine whether Um Baroro pastoral movement is cyclical or a constant movement eastwards. This type of movement is, of course, not new in the history of the Sudan. For example the Baggara Arabs followed the same general route in their migration to Darfur and Kordofan.

In conclusion it must be stressed that West African groups are competing with local populations for the limited resources of the Dar Messeriya. If this continues beyond reasonable limits, it may result in increased friction and eventually in open hostilities at a level that cannot be predicted. Another point worth mentioning here is that the number of new arrivals, both sedentary cultivators and nomadic pastoralists, from West Africa is increasing. Thus, about half the West Africans we interviewed had spent less than ten years in Humr country.

5. <u>The Causes and Effects of Labour Migration in Dar Messeriya:</u>

Labour migration from Dar Messeriya to central Sudan has had a long history. A dramatic increase in the rate of this migration took place in the sixties. In addition this was the period when many young men wanted to join the army. Finally Messeriya youth were among the first to respond to the increasing number of job opportunities available in neighbouring countries.

While the causes of labour migration are generally of an economic nature, it is difficult to say with certainty at this time which environmental factors in Dar Messeriya have supported this trend. It is always safe to assume that the labour requirements of a pastoral economy are less than the available amount of labour. Hence, to supplement household income, excess manpower could be released from the pastoral sector in order to perform local agricultural sector tasks or wage labor tasks outside the region. But, as stated earlier, cash crop cultivation has only recently flourished in the region. Thus, Messeriya youth have only been able to obtain supplementary incomes by working in central Sudan. The present boom in the Muglad job market because of the discovery of oil locally has initiated a reversal of migration direction. If we consider that the oil companies alone employ about one thousand workers, and that many other local jobs are indirectly created as a result of oil exploration, our argument about reverse migration can be acknowledged as nor far fetched.

Migrants, on the other hand, also contribute directly to the Messeriya economy. Of the twenty persons we interviewed at Keilak, five admitted receiving regular money from relatives working in Khartoum. It is clear that the other people receive remittances, but not on a regular basis. In addition, migrants send money to their relatives so that the relatives can buy animals for the migrant. Every young Messeriya migrant has two general aims: (a) to get married and (b) to be able to purchase more cattle. During our trip many stories were told to us describing fierce competition in cattle buying between local youths who had returned from working in Saudi Arabia.

This single-minded investment strategy has now been altered to some extent by a trend toward investment in petty-trading and service industries, i.e., transport, restaurants and so forth. But it will take some time before the cultural preference for investment in cattle is changed.

Meanwhile, the effect of the present investment trend upon the environment cannot be neglected. First of all, it helps generate an increased population of animals in the area, which, as we indicated earlier, puts further strain on local natural resources. Tracing the exact contribution of migrants to the pastoral economy with a small sample household survey would be an interesting exercise. But more than that, an intensive investigation of this matter would enable us to determine the effect labour migration has on environmental change. More precisely it would allow us to look at the interrelationships between labour migration and environmental conditions.

6. <u>The Use of Camels and Lorries</u>:

The presence of camels in the area (functioning as beasts of burden) is an innovation that warrants some consideration and discussion. The long term implications of this experiment are difficult to foretell. However, one possible repercussion from this experiment may be that the camel herders from Northern Kordofan will extend the boundaries of their operations further south. Already the Humr spend the dry season in Baggara country. If Northern Kordofan camel herders actually extend their operations southward, the present pattern and degree of

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nomadic competition within the Lake Kellak region will probably change. Further stress on the natural resources of this zone will aggravate the present situation and result in further tribal tension and environmental deterioration.

Lorries are also being used to carry household luggage to and from dry season camps. While use of lorries does not affect the pastoral system directly, it certainly opens up possibilities for non-pastoral exploitation of the environment. However, this development is dependent upon establishment of good roads in the area. We have noticed that the demand for roads was given second priority by those questioned about primary local needs. (See Table 15).

Table 15

Primary Needs

Service needed:	Number of persons interviewed with a positive response
Water	16
Roads	13
Hospital	6
School	5
Police Station	3
Rural Council	2
Fishing Licenses	1
Agricultural Schemes	1

It is important to note that the demands for a police station, fishing licenses and agricultural schemes were all made by West Africans.

If we consider the fact that Humr cattle cover about 200 miles between dry season (Bahr) and rainy season camps, one can anticipate the future possibility of using trucks for transporting animals over this distance. Presently utilization of trucks is constrained by bad roads and expensive fuel. Nevertheless, with prospects of oil just round the corner, such a possibility may not be far-fetched.

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The use of camels and donkeys (donkeys are also today more frequently used) in the Bahr region is something that requires further investigation from the ecological perspective, since the Bahr environment is known to be inhospitable to both types of animals.

7. Management Strategies and Attitudes in Relation to Animal Types and Number:

With more involvement in the cash economy, the Messeriya Humr have adopted a new strategy regarding herd composition. According to local interviewees, the proportion of small animals sheep and goats in herds has increased significantly. The main reason given for this increase is that selling a small animal is always an easy decision and does not affect the owner's wealth, since the rate of increase of small animals is double that of cattle. The types of goods and services required by nomads have also changed; and today more cash is needed in order to satisfy these requirements.

By and large, cattle are still the favourite animals to keep, and who saves some money will invest it in cattle. The diversification of animal wealth is, therefore, not intended to be at the expense of cattle. A group of those interviewed near Al-Fula expressed the old time Humr attitude by quoting the following proverb:

> "The ploughman died and the
> trader died, but the world
> remains for the cattleman."

This saying is, of course, the expression of a still prevalent pastoral ideology. However, it is not implied here that people remain pastoralists only because of cultural preference or ideology. Ideology is rather used as a justification for the strategies made in management of the pastoral economy. Such strategies are based on realistic considerations of the local environmental conditions, i.e., the economy in the wider sense.

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As mentioned earlier, camels have been introduced in the area as beasts of burden. On the other hand, donkeys are becoming more popular, probably as a substitute for horses. They are used for individual transportation. The disappearance of horses is an expression of social and environmental factors. In the past, tribal raids were common and the horses played a very important role in them. Today, although tribal fights do take place, the use of firearms has made the old style of raiding an obsolete tactic. Horses were also used in giraffe hunting in the past. This activity was a social institution in and of itself. To prepare for it youth of the tribe constantly engaged in training. The initiation to youth-hood, also known as warriorship, was linked to giraffe-hunting. Without question, the folklore of giraffe-hunting is one of the richest of Humr oral traditions, for it symoblizes the glory of the past.

Today, giraffe have disappeared from Dar Messeriya. Their total number in the Sudan has also decreased significantly. It goes without saying that the disappearance of giraffe is a result of social excessive hunting, and environmental changes in the ecosystem or niche factors. Because of their deadly efficiency, the introduction of firearms has been a critical factor in the extermination of the giraffe population. Other factors, like a modification of the climate, i.e., extended drought and an increase in total population of animals on the giraffe's range, have led to the withdrawal of the giraffe to more southern pastures.

Returning to the issue of types of animals kept by the Humr, it is evident that most people own cattle, sheep and goats. But many of them also own camels and donkeys. In Um-Janah, interviewees, in answer to the question of what types of animals they keep, indicated the following pattern: (Table 16)

Table 16

Animals kept by Humr pastoral nomads

Type of animal:	Number of pastoral households herding it
Cattle	8
Sheep	8
Goats	8
Camels	5
Donkeys	3

In regard to total numbers, there is no doubt that the overall livestock population is increasing. Whether this is a result of improved health and water services, or a result of individual household responses to basic economic factors, shaped by wider environmental conditions, is difficult to ascertain. It is safe to assume that both factors are involved. Also remaining to be investigated is whether the total increase in animal numbers is simplu an expression of increases in human population and household units or, in addition, a sign that the number of animals per household has increased. The Humr argue that lack of water and increases in animal populations are the main factors leading to grazing problems.

Nomadic Settlement Schemes in the Messeriya Humr Area:

In 1969 eight area sites (see Table 17) were selected as appropriate for development of nomadic settlement schemes. Development was based primarily on providing water supplies to a group of nomads selected to settle on a 100 square kilometer reserve. Settlers were expected to remain on the site year-round and were restricted as to the number of animal units they could graze on the reserve. While the concept seems to be attractive, the site selection and planning processes for the schemes were poor and this led to the closure of four schemes by 1981. (The closed schemes were: Al Hajiz, Targialla, Buta and Um Dagig.) The remaining four are not without significant problems which lowered their performance. Table 17 summarizes some of the main

(2)

problems which face these schemes. No doubt these problems were planning and implementation problems.

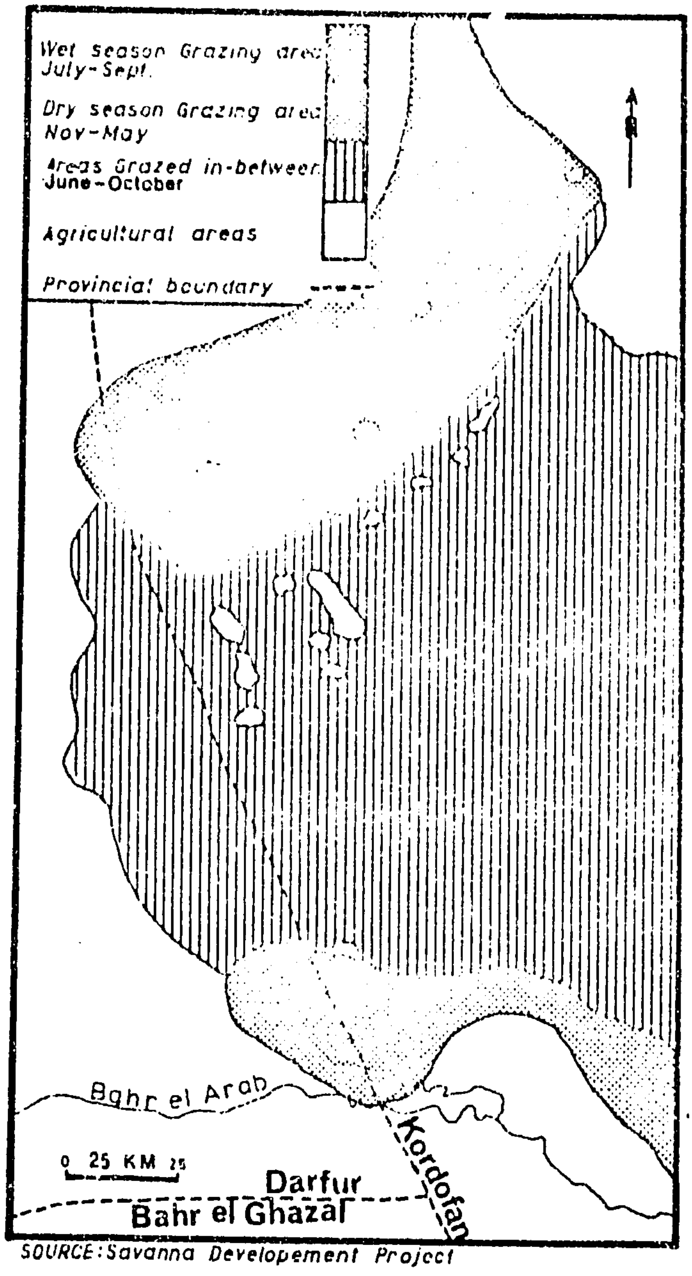
Although these schemes were welcomed as measures for improving social and economic conditions of pastoral nomads, with poor management they engendered severe deteriorat n of surface vegetation. When this happened, as at Buta and Al Hajiz, the schemes were abandoned.

Table 17

Problems of settlement schemes in Babanusa area.

Problem Confronted	Name of Settlement Scheme.							
	Al-Hajiz	Al-Haddadi	Buta	Kilbat	Baggara	Sibeha	Um Dagig	Targialla
1. Lying across traditional migration routes.	X	X			X			
2. Railway line close to site.	X		X					
3. Main truck road crossing site.	X		X					
4. Pools(traditional water sources) inside site.		X	X					X
5. Problems with government constructed water points inside site.	X	X	X	X	X	X	X	
6. Animals seek refuge from flies inside site.				X				
7. Tribal conflicts(local politics).							X	X
8. Fires.	X	X	X	X	X	X	X	
9. Conflict over grazing rights.	X	X	X	X	X	X	X	
10. Conflict over land-owning rights(agricultural land).	X			X				
11. Locals not convinced of the value of the scheme.				X			X	
12. Poor plant cover.			X					

FIG. 11. PATTERN OF PASTORAL & AGRICULTURAL USE IN HUMUR AREA



SOURCE: Savanna Developement Project

Agricultural Activity:

Two types of farming activity can be identified in the Messeriya Humr area: a) Farming by pastoral nomads, and b) farming by settled Humr and other minority groups. The two types are different in terms of land requirements, crops grown, and degree to which farming activity is relied upon to meet subsistence needs.

As mentioned in the previous section, farming by pastoral nomads has the following characteristics:

1. It is mostly geared to subsistence food needs. Therefore, crops grown are mainly dukhn (bullrush millet) and okra.
2. Cropped areas are generally small and range in size from two to ten mukhmas.
3. Traditionally, land was cultivated only around Muglad. However, in recent years expansion of cultivated area has occurred on sandy and clay soils near most permanent settlements of the area (Fig.11).
4. On the clay soils harig (fire) cultivation has become well established.
5. Farming by pastoral nomads is often abandoned when it interferes with the needs of the nomadic system or when it generates sufficient capital for livestock investment needs. At least twenty per cent of people surveyed claim to have stopped farming once their herds reached sufficient size to require their full attention.

This episodic pattern of farming is still dominant among pastoral nomads, but provision of permanent water sources along traditional stock migration routes and in the makhraf (rainy season grazing areas) has led some nomads to consistently produce crops for the market. In fact, permanent water sources have encouraged many pastoral nomads to settle in villages and expand their farming

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activities. This phenomenon has led to a new division of labour within nomadic families. However, the new division of labour has been designed in such a way that different tasks complement each other and help maintain mutual links between the settled and mobile factions of the family. As such when nomadic settlers expand their cultivation areas, they begin to grow commercial crops such as groundnuts, sesame and Kerkade in addition to subsistence crops like Dukhn and Marig (dura).

Agriculture practiced by settled, non-nomadic people is of two types: 1) rain fed Qoz cultivation and 2) irrigated or non-irrigated cultivation on Wadi banks.

1. Rainfed Qoz cultivation has the following characteristics:

   a) Size of areas croppsed ranges from five to twenty Mukhmas, and in a few cases may reach 100 Mukhmas. From interviews we discovered that at least one per cent of farmers around Muglad, Babanusa, and El Fula cultivate 100 Mukhmas. The majority, however, cultivate between three and five Mukhmas of peanuts and two and five Mukhmas of Dukhn. Those farmers growing Kerkade usually grow between two and four Mukhmas of the crop.

   b) Emphasis in the Qoz is on cash cropping. Credit for cash cropping is furnished from household savings or from Sheil loans obtained through local merchants.

   c) Most farmers, whether pastoral nomads or settled cultivators, maintain some livestock around villages all year round. From interviews it can be estimated that settled families own (on average) 20 head of cattle and 15 head of sheep. With reasonable returns from the sale of crops, future averages will

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increase, since an investment in animal wealth is both highly regarded and the only feasible alternative available.

2. The second type of settled farming is usually practiced within and along the main *Wadis* which flow through the area, and near large settlements. Within the region the growth of urban population in the last 20 years has created a market for fruits and vegetables. These items are produced from fields lying near the banks of *wadis*. In most cases no irrigation is required for sustaining fruit trees (mangos and citrus) wherever the water table is at a reasonable depth. Such settled farming along *wadis* has resulted in:

a) Competition between settled farmers and pastoral nomads over watering sites. This competition often leads to bloodshed.

b) Movement of experienced West African farmers into these high potential areas. The presence of West Africans provides an ethnic dimension to potential resource conflicts.

c) Evolution of a system of land tenure based on private land rights. Although for all practical purposes land is privately farmed, as of yet the government has not officially registered land to individuals.

d) Where water pumps are installed ground water levels often drop. This threatens shallow well users in the vicinity of such pumps. Few government controls or regulations govern the installation of pumps.

Farming and Environmental Relations:

As a subsistence activity, agriculture has always been of secondary importance to pastoral nomadism within the area. In a form well-fitted to their mobile behaviour, some Messeriya pastoral nomads have always practised some form of cultivation. Of course, areas cropped have always been small and crops grown have emphasized subsistence needs.

With introduction of cotton in the eastern clay soils west of El Fula in 1924, the Messeriya Humr area entered an era of organized commercial agricultural production. However, in the early years farmers did not readily grow cotton. Cotton demanded substantial amounts of labour and its cultivation was more laborious than cultivation of traditional crops. A water provision programme began in late 1940's was effective in enhancing the acceptance and expansion of cotton growing.

During the 1960's many new settlements emerged along a newly established railway line that passes through the Messeriya Humr country. This line connects central Sudan to the western and subsequently the southern parts of the country. Services offered in these new settlements attracted many, particularly those who had lost their herds and had no real option except to become sedentary. Equally important, markets were developed in these centres. Markets encouraged the evolution of a cash economy in the area. As a result, farming began to expand around these settlements. For example it is esimated that the amount of cultivated land around Muglad and Babanusa increased by over 50% between 1969 and 1981. This expansion was encouraged by the demand created by these settlements and the favourable crop prices that prevailed after 1973. New settlements, in areas previously inaccessible to man, grew up around permanent water centres established during a remarkable (late 1960's and early 1970's) expansion of government-provided water services to the area.

A consequence of the functioning of these processes has been the clearance of forests for farming purposes. Fire has been the main agent used for clearing land, particularly land in those thickly vegetated regions which overlie clay soils. Both manual and fire methods of clearing land have contributed to the destruction of substantial amounts of forest and grazing vegetation within Humr country.

Traditional agricultural practices do not include utilization of inputs to improve soils or fields. These factors, along with the shifting nature of much traditional agriculture, help increase pressure on the resource base.

Fields are generally abandoned every five to six years and new cultivation sites are cleared. As the old sites begin to be overworked, they become overrun by Gibeish. The formation of extensive rings of Gibeish around settlements indicates loss of soil fertility on those sites. The most spectacular spread of this plant has been around Babanusa where it forms a circle no less than three kilometers in radius. Gibeish's dominance in this zone is the result of overgrazing as well as overcultivation.

Low yields of crops grown in the area are common. They encourage farmers to reduce rotation cycles and, whenever possible, shift to new sites. For example, sorghum yields on average are four sacks of grain per acre, millet one and one-half to two sacks per acre, and groundnuts five to six sacks per acre. Some of the farmers interviewed reported cropping their fields for only one year before shifting. Later they cleared new sites using the least expensive method fire. Of course the repercussions of these highly exploitative farming techniques are serious and endanger the vegetative cover and soils of the Messeriya Humr region.

Urbanization and Its Environmental Relationship:

Until 1955/56 Muglad was the only settlement classified as an urban place in the Messeriya Humr region. Its total urban population at that time was 4025. By 1964/65 two new settlements emerged (see Table 18), Babanusa and El Fula which increased the urban population of the region to 15,932, giving an increase in the urban population of approximately 300% within ten years. In 1973 and in 1981 the number places classified as urban remained constant, but the total urban population increased to 24,277 and 51,100 persons, respectively. Between 1955/56 and 1981 the urban population had increased seventeen fold.

It can be argued that the present urban population is small compared with available resources. This would be the case if the surrounding land, wood and range resources were utilized rationally. However, from group field observations and previous studies it has been established that areas immediately around these settlements have suffered the most resource degradation within the Messeriya Humr region. The nature of urbanization in the region is certainly different from that in other parts of the country. Most urban migrants, until very recently (late seventies), were engaged in primary types of production within the urban area, since towns rarely offered them sufficient numbers of wage jobs or opportunities. Emphasis on primary production has increased the density of animals in such localities, since most migrants from the region brought their animals with them, and has boosted the amount of wood cut to use in building homes for the newcomers. Between seventy per cent and eighty five per cent of buildings in the towns are constructed from grass and wood. Very heavy use is made of Dalbergia melonoxylon and Anogeissus leiocarpus wood in construction. Because of heavy usage, these tree varieties are disappearing in the vicinity of towns.

Equally significant is the fact that a recent commercial boom, engendered by the discovery of petroleum in the region, has led to increased commercial building construction and home improvement. Since red bricks are heavily used in this new construction, many new brick ovens have been built. For instance, in Muglad area the number of

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red bricks burning ovens increased from two in 1975 to about twenty in 1980. Each oven produces about 80,000 bricks and uses about 2.3 tons of wood per year. Therefore, the total amount of wood used for brick burning in Muglad alone would total about 44 tons annually. It is possible that within the region 100 tons of wood are consumed annually to produce red bricks. Of course the boom created by the discovery of petroleum will continue to expand the construction of structures. Concomitantly, the accelerated consumption of red bricks will increase the clearance of forests.

Development of towns also increases per capita energy use. Migrants learn to cook differently and use new food varieties which require more energy in the cooking process. Many energy consumptive industries and services also are developed to cater to the needs of the people. Charcoal and wood are widely used in Messeriya Humr towns and represent over ninety-five per cent of the total amount of fuel consumed in cooking. Trade in charcoal is expanding and, for example, Muglad currently has about twenty charcoal dealers, while in 1975 it had only six. Other towns experience the same situation, and consequently, increasing stress is placed on nearby forest resources.

Table 18

Population of towns in the Humr Region

Town	1955/56	1964/65	1973	1981 *
Muglad	4,025	4,709	6,932	26,000
El Fula	--	4,131	5,294	7,000
Babanusa	--	7,092	12,051	18,100
	4,025	15,932	24,277	51,100

Source: First Population Census 1955/56, population and Housing Surveys 1964/65, Second Population Census, 1973.

* 1981 figures are estimates.

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Some Environmental Implications of the Babanusa Milk Factory:

The Humr country was selected by the government for establishment of a milk dehydration plant. The plant was constructed in the early 1960's and had the following four goals:

1. to improve the regional economy
2. to expand cash transactions among pastoral nomads
3. to encourage nomads to settle around the plant
4. to use resources otherwise wasted.

Although the factory has not been successful economically, it has produced many social and environmental changes. These changes still await full investigation.

Economically, the factory was unable to operate efficiently because of poor handling procedures and milk shortages. Table 19 shows that a sizable proportion (sometimes over 60%) of milk is spoiled and becomes useless before it reaches the factory. The table also indicates that the working season for the factory can be as short as 19 days. Milk shortages and lack of spare parts are mainly responsible for the short working season.. The factory is designed to process 50 tons of milk a day. However, rarely did it average four tons for any working day over the period 1968/69. In 1979/80 the factory stopped producting all types of milk products, except powdered milk.

Table 19

Milk received by Babanusa Milk Factory for the period 1968/69-1977/78

Year	Total work days of factory	Unspoiled milk, in kilograms	% of unspoiled milk to total amount of milk received
1968/69	154	131,900	73.4
1969/70	157	119,845	49.0
1970/71	88	137,194	37.4
1971/72	91	284,271	55.8
1972/73	82	614,852	69.4
1973/74	72	704,808	58.8
1974/75	85	517,077	83.0
1975/76	37	371,254	81.1
1976/77	19	86,620	76.7
1977/78	21	80,585	69.7

Source: Babanusa Milk Factory, Babanusa

Table 20

Kerkede received by Babanusa Milk Factory for the period 1969/70-1979/80

Year	Quantity in Kilograms
1969/70	790
1970/71	340,178
1971/72	179,000
1972/73	498,000
1973/74	173,076
1974/75	146,000
1975/76	---
1976/77	60,644
1977/78	56,041
1978/79	133,867
1979/80	72,730

Source: Babanusa Milk Factory, Babanusa.

The factory has been active in the effort to provide water points in the Humr country. The water development in the late 1960's had three objectives:

1) facilitating nomadic movement, 2) expanding milk production, and 3) encouraging settlement in the Makraf (rainy season areas). As a result of water development, new ragelands were opened and some settlement has risen, both around water points and close to the factory. The actual size of this settlement near the factory has not been fully determined. However, it has grown at a remarkable rate, much more quickly than at any time prior to the establishment of the factory.

The increase in water supply points and the amount of usable rangeland facilitated growth in livestock numbers (especially sheep and cattle) in the area. Thus the usual process of overstocking and eventual overgrazing was begun as well. Unfortunately, increases in cattle numbers did not improve the factory milk supply situation. Humr cattle are generally poor milk producers, averaging three pounds of milk per year. Many cows start production late in life, or never produce milk.

To improve the economic performance of the milk factory, processing of Kerkade (Hibiscus sabdariff)(see Table 20) and gum arabic (into powder) was begun. Consequently, the production of Kerkade boomed in the area; Kerkade became part of the crop rotation in places as far south as the Meram. Most settlers around the factory, and particularly in the Ettboun area, increased the size of their Kerkade holdings to between two and four Mukhmas. It has been estimated that within the region the total area cropped in Kerkade increased from less than 50 Mukhmas in 1969/70 to approximately 8,000 Mukhmas in the mid 1970's. Taking into account the fact that most Kerkade is cultivated using shifting cultivation, the total area grown in Kerkade is estimated to have exceeded 15,000 Mukhmas since 1969. Introduction of Kerkade expanded the area of land farmed and increased the intensity of cropping. Both outcomes put greater pressure on the soil and wood resources of the Humr.

Conclusions:

There is no doubt that environmental changes are taking place in the Humr area. However, the degree and intensity of degradation of the environment is not disturbing except around larger settlements like Muglad and Babanusa and around permanent water sources. Degradation in the eco-potential of the area is attributed to a number of factors which could also serve as indicators of change. Most important among these are:

1. Spread of agriculture.
2. Development of ground water resources (boreholes).
3. Environmental fluctuations.
4. Increase in the size of livestock and human population.
5. Encroachment of significant numbers of camel herding nomads from northern Kordofan especially Hamar.
6. Urbanization.
7. Oil exploration.
8. Improvement in transportation.
9. Fires.

Degradation of the environment around major centres of nomadic concentration is evident in the disappearance of favourable grass and tree species and emergence of vast tracts of Gibeish which is an indication of loss of soil fertility and excessive grazing pressure. However it must be stressed that the Humr area still provides a rich and diversified grazing potential source. The richness of this potential is reflected in the pastoral system which exploits it. Cattle traditionally are the major livestock. Small stock are numerous and migration distances are relatively short and follow well-defined corridors. Until recently camels were unknown. Yet water for animals and humans in the area remains in short supply and retreat to permanent water sources in the south during the dry months of the year is a necessity.

Although the scale of degradation in the Humr area is not high and the vegetation cover in most parts is still intact the area provides a good site for monitoring environmental changes. The study will be more fruitful if comparatively linked to the results of the monitoring study underway in El-Khuwei-Mazroub area which is located in the drier part of north Kordofan Province.

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PART THREE

EL-KHUWEI-MAZROUB-TINNA AND MESSERIYA (MUGLAD) AREAS

COMMUNITY PERCEPTION OF ECOLOGICAL DEGRADATION AND ENVIRONMENTAL CHANGES

INTRODUCTION

1.1. General:

The present document is the second in a series of ETMA findings on El Khuwei-Mazroub-Tinna and Messeriya study areas. It was preceded by two separate documents on the base line and trend analysis findings in each of the two areas, produced in December 1983.

This combined document on the two areas was dictated by a number of reasons which were discussed with the organizers of the project who approved of the integration of the two areas in the monitoring phase. The reasons accepted were:

i. The adjacent location of the two areas which makes them merge into each other as one transect extending from Lat. 14^{0}N to Lat. 11^{0}N. Though not considered in the initial planning of the study, such a location favours comparability of ecosystem changes in a strip of country which ecologically extends from a semi-arid to a high savannah rainfall belt.

ii. There is an established pattern of population migration by both settled village communities and nomads from Mazroub-Tinna area to Khuwei, and by nomads of Hamar district from the latter to the Messeriya area. These seasonal movements create many change processes in the three areas, which add to ecosystems vulnerability and intensify ecological degradation.

iii. The reduced cost element of supporting one field trip to the two areas with one unified team instead of two also encouraged integrating the two study areas at this phase.

iv. This integration solved the problem arising from the immigration of the co-ordinator of Messeriya area whose absence might have impeded the completion of the work. Though not anticipated at the time the decision to integrate was taken, the situation simultaneously worked itself out by having the co-ordinator of El Khuwei-Mazroub-Tinna area accept the responsibility of writing-up the research findings on the two areas.

1.2. Objectives of Present Report:

The present document aims at strengthening the previous findings of the trend analysis study and at covering the monitoring phase. It is based on community perception of ecological degradation and environmental change. It draws its substance from the experiences and knowledge of the population of the study area on the performance of the two ecosystems during the period 1980-1983, extended when necessary to the last 10 to 15 years, i.e., 1970 and on.

1.3. The Indicators Used as Guidelines for Research:

The occurrence of drought conditions which began to show signs in late 1983, the time the survey was planned, directed the attention of the co-ordinators of the two groups in preparation for the community perception study to concentrate on questions related to ecological degradation and environmental change, guided in that by the set of indicators of change identified in the two preceding studies, a list of which is given below:

1.3.1. El Khuwei-Mazroub-Tinna Area:

1.3.1.1. Biological and Physical Indicators:

i. The domination of low quality plant species around Khuwei shows the non-diversity of the vegetation and the poverty of the pasture.

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ii. The disappearance of palatable annual and perennial grazing species around the study area shows clearly degradation in grazing capacity in radii ranging from 2,5 and 14 km. in Khuwei, Mazroub and Tinna respectively.

iii. Severe land use pressure has led to the dominance of low quality shrubs and trees around Khuwei, Mazroub and Tinna.

iv. Over-cultivation and over-grazing hastened the elimination of mature trees and the increase of noxious undesirable herbs.

v. The mass mortality of trees and shrubs is another sign of deterioration.

vi. It is very rare to find young plants of Adinsonia digitata in the study area and this indicates the elimination of this huge tree which is very important in some villages for water storage during crop harvest time.

vii. Leptadenia pyrotechnica is known as a semi-desert plant but about 3 km. north of khuwei it can be observed growing. This is a sign of change in the environmental conditions around Khuwei which is climatologically in the Savannah belt.

viii. Termite mounds are seen around Khuwei and Mazroub but the greater number is observed in the north part in the semi-desert region. We believe that this shows a progressive degradation that is spreading from the northern to the southern part of the area.

1.3.1.2. Social and Economic Indicators:

i. Improper planning and management of water sources.

ii. Location of central places and water sources causes adverse impact on the system.

iii. An increase in population without a corresponding increase in yields.

iv. Increase in animal numbers especially cattle and sheep.

v. Opening of new land, in the form of oil.

vi. Decline in yields.

vii. Number of tankers carrying water from a bore-hole to nearby areas.

viii. Number of charcoal burning and wood cutting permits.

ix. Number of lorry loads of charcoal from an area.

x. Selective use of plant cover.

xi. Increasing distance from settlement one must travel to obtain specific products.

xii. Presence or absence of purchased fodders.

1.3.2. Messeriya Area:

1.3.2.1. Biological and Physical Indicators:

i. Change in the distribution and frequency of some of the plant species.

ii. Distribution and frequency of fires.

iii. Change in rangeland plant communities.

iv. Changes in crops and areas cultivated.

v. Industrial development (for example in the forms of oil factories, a milk factory, and traditional manufacturing processes).

plus other change factors which could also serve as indicators. The most important among these are:

i. Spread of agriculture.

ii. Development of ground water sources (Boreholes).

iii. Environmental fluctuations.

iv. Increase in the size of livestock and human population

v. Encroachment of significant numbers of camel-herding nomads from northern Kordofan especially Hamar.

vi. Urbanization.

vii. Oil exploration.

viii. Improvement in transportation.

With the emphasis given to ecological degradation and environmental change, not all of the above indicators were examined. Selection was limited to those which directly relate to the subject of the study, and of which it is believed local communities have knowledge and could contribute opinions which help in building a trend analysis and in monitoring environmental change.

1.3.3. <u>The Indicators Selected</u>:

In light of the above, the parameters investigated to assess ecological and environmental changes from the community viewpoint are the following:

1.3.3.1. <u>Ecology as Perceived by the Community</u>:

i. Soils.

ii. Vegetation.

iii. Wildlife.

1.3.3.2. <u>Crop Production</u>:

i. The extent farming is practiced.

ii. Physical elements/crop production relationship.

iii. Crops cultivated.

iv. Crop acreage.

v. Production levels.

vi. Staple grain food situation.

vii. The *Acacia senegal* tree.

1.3.3.3. Livestock Raising:

i. The extent livestock is practiced

ii. Grazing systems.

iii. Fire lines as conservation measures.

iv. The use of supplementary feeds.

1.3.3.4. Uses of the Tree Vegetation Cover:

i. Building of human settlements.

ii. Energy uses.

1.4. Organization of the Report:

The report consists of seven chapters. The first is an introductory one. The rest are on the findings of the perception study, covering the following areas: the perception survey, ecology as perceived by the community, crop production, livestock raising, uses of the tree vegetation cover, and a concluding chapter on ecological degradation and environmental change.

The document is well illustrated by tables containing the data obtained from the questionnaire results on the various aspects investigated. The data is presented in percentages of answers received for the various questions asked, with the total responses presented as aggregates at the bottom of each table.

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CHAPTER TWO

THE PERCEPTION SURVEY

CHAPTER TWO

THE PERCEPTION SURVEY

2.1. Introduction

For the purpose of obtaining detailed and measureable information on ecosystem changes guided by the biological/physical and social/economic indicators chosen, a questionnaire was applied to assess and quantify such changes. The questionnaire findings were substantiated by data obtained through interviews and group discussions plus field observations.

The quality and richness of the data in this document, as shall be revealed soon, reflect the fact that the local communities surveyed are knowledgeable of their environment and of the changes they have been undergoing. Their interpretations of various phenomena and the causes of their occurrence very often reflect a rationale which matches scientific analysis and conclusions.

Hence understanding change through community perception studies, especially when the results reached are in line with scientific interpretation, adds to the usefulness of the data obtained as a basis for future planning to correct ecosystem adversities. A major outcome of the ETMA research project is to suggest intervention programmes that check current ecological degradation and create new balances. Therefore understanding how people perceive their environment and feeding this into the planning exercise will increase the chances of participatory action, whereby the concerned communities can take part in effecting the desired changes and thus improving their own conditions.

2.2. The Questionnaire

As mentioned in the section on objectives, the purpose of applying the questionnaire was to substantiate the findings documented in 1983 reports and also to furnish an understanding of how local communities in the two areas view their environment, to what degree they are aware of the ecological changes taking place and the processes and mechanisms behind degradation. The knowledge acquired from the findings of the first phase guided the designing of the questionnaire which included many pre-coded answers.

The period studied was 1980-83. For most of the phenomena examined the investigation covered this time series, however for studying such change impacts that go beyond this period, questions were left open ended to supply the necessary information.

2.3. <u>The Survey:</u>

2.3.1. <u>Team and Organization:</u>

The questionnaire was designed by the group leaders of the two survey areas. Its application in the field was supervised by the two group leaders plus Dr. Mustafa Suliman, a range ecologist. For administering the questionnaire a team of seven research assistants, mostly graduates, was employed. The survey was concluded during the period November-December 1983.

While the research assistants were filling the questionnaires, the three senior researchers conducted interviews with resourceful persons in the area and carried out other field investigations to elucidate the questionnaire findings.

Back in Khartoum the same team of research assistants was employed to organize and tabulate the questionnaire data. The information yielded by the exercise was then computed in percentage answers and correlated by M.O. El Sammani, hence made ready for interpretation and analysis.

2.3.2. <u>Sample Selection and Size:</u>

Based on the previous knowledge acquired on the two areas, the following four centres listed from north to

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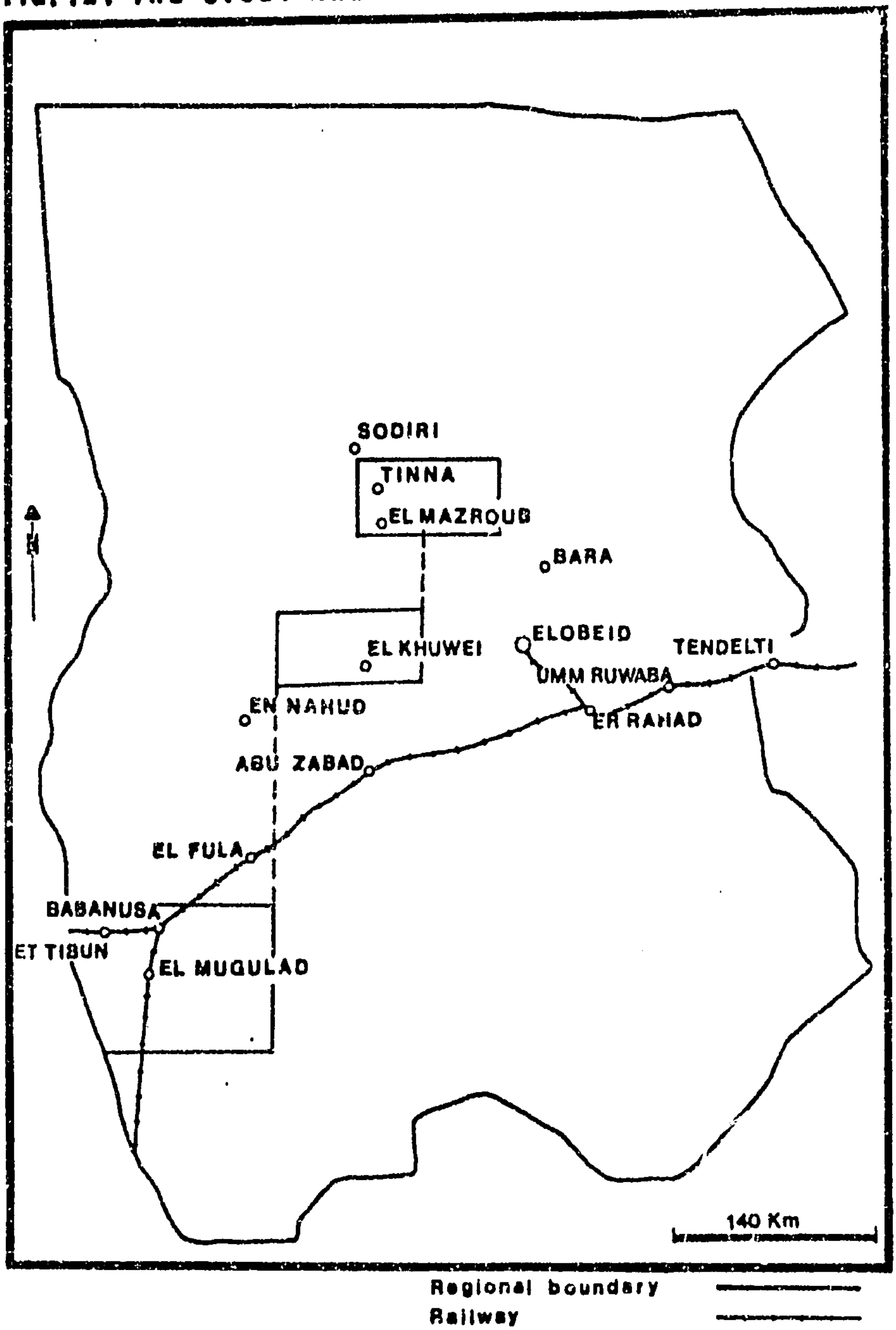
FIG. 12. THE STUDY AREA



south: Tinna, Mazroub, El Khuwei and El Muglad(*) were selected as focal points from which the survey was to be organized with villages chosen in the surroundings of each for the applicantion of the questionnaire, Fig.12.

There were no readily available sampling frames to allow accurate selection of sample sizes, nor time allowed for the designing of such frames. To resolve this problem, surveyors were directed to visit the settlements selected for study, estimate the number of households in the settlement, and then choose a 5% or more sample of all households for questionnaire application. The results of this exercise are presented in Tables 21, 22 and 23.

As could be depicted from the three tables the total sample surveyed was 565, distributed as follows: 142 samples in Mazroub-Tinna area, 224 in El Khuwei area and 199 in Muglad (Messeriya Humr) area. In total it covered 20 villages in the three areas.

2.3.3. <u>Ethnic Composition</u>.

The two first areas Mazroub-Tinna and El Khuwei show ethnic heterogeneity as contrasted to Muglad area where this is not evident. This may be attributed to the fact that the two former areas were more open to tribal movement, because of accessibility and the fact that settlements appeared there earlier in time as compared to the latter one. The Messeriya area up to very recent times was almost a semi-closed district, dominated by cattle pastoralism, with limited water sources to attract outside elements and encourage settlement. However with the advent of the railway line to Nyala in 1962, and the execution of

(*) As from now on Muglad shall be used in the text instead of Messeriya for specificity, since the survey covered the settlements around this centre which comprise the north-central part of Messeriya area.

Table 22

Sample distribution by survey area, village settlement, number of respondents, ethnic composition and occupational structure:
El Khuwei area.

Village	Number of respondents	% of total
1. Khuwei	32	14.29
2. Shalota	25	11.16
3. El Guba	39	17.41
4. Wad Laban	8	3.57
5. Ankosh	32	14.29
6. Kul Yousif	19	8.48
7. Umm Boom	26	11.61
8. El Mafriya	11	4.91
9. Nasharbo	32	14.28
Total	224	100.00

Ethnic Composition of Sample

	%
Hamar	91.84
Dar Hamid	2.57
Ma'aliya	2.15
Bederiya	1.72
Maganeen	.86
Others	.86
Total	100.00

Occupational Structure of Sample

	%
Cultivators (settled)	78.62
Livestock raisers (nomadic)	6.52
Merchants	7.61
Government officials	4.71
Others	2.54
Total	100.00

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Table 22

Sample distribution by survey area, village settlement, number of respondents, ethnic composition and occupational structure: El Khuwei area.

Village	Number of respondents	% of total
1. Khuwei	32	14.29
2. Shalota	25	11.16
3. El Guba	39	17.41
4. Wad Laban	8	3.57
5. Ankosh	32	14.29
6. Kul Yousif	19	8.48
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8. El Mafriya	11	4.91
9. Nasharbo	32	14.28
Total	224	100.00

Ethnic Composition of Sample

	%
Hamar	91.84
Dar Hamid	2.57
Ma'aliya	2.15
Bederiya	1.72
Maganeen	.86
Others	.86
Total	100.00

Occupational Structure of Sample

	%
Cultivators (settled)	78.62
Livestock raisers (nomadic)	6.52
Merchants	7.61
Government officials	4.71
Others	2.54
Total	100.00

Table 23

Sample distribution by area, village settlement, number of respondents, ethnic composition and occupational structure:
Muglad area.

Village	Number of respondents	% of total
1. Izz El Din	27	13.56
2. Et Tibun	38	19.10
3. El Magadama	32	16.08
4. Fisheikh	36	18.10
5. Delam	37	18.59
6. Bagaara	29	14.57
Total	199	100.00

Ethnic Composition of Sample

	%
Messeriya	91.96
Ma'alyaa	6.53
Others	1.51
Total	100.00

Occupational Structure of Sample

	%
Cultivators(settled)	57.05
Livestock raisers(nomadic)	27.24
Merchants	8.01
Government officials	3.53
Others	4.17
Total	100.00

massive programmes of tube wells as from the mid-sixties and on, coupled with the attraction of populations to the area by the petroleum exploration activities in the mid-seventies, the area began to open up. However, it seems that it is still maintaining its ethnic homogeneity at base village level.

2.3.4. <u>Occupational Structure</u>

Occupationally the category of cultivators is dominant in the sample studied in all three areas, with a higher presence of nomadic livestock raisers in Mazroub-Tinna and Muglad areas. Such an occupational distribution is a consequence of locational and ecological factors that have yielded the types of economies practiced in the three areas. Mazroub-Tinna area is part of the semi-arid region of Northern Kordofan which was originally a camel and sheep raising country. Presently it is a marginal farming area growing mainly millet, but still having pockets of population which practice the old camel and sheep nomadic economy, besides receiving the Kababish nomads who annually infiltrate from the north. El Khuwei area lies between Mazroub-Tinna and Muglad area. It enjoys a higher rainfall than the Mazroub-Tinna which lies north of it, and is predominantly settled by cultivators while El Muglad area, as described previously, has only recently attracted settlement and is still maintaining its basic feature of cattle pastoralism.

Examining the occupational structure by area tends to show the presence of the same categories with some variation in percentage distribution which is reflective of the types of economies practiced in Kordofan Region.

2.3.5. <u>Main Demographic Features</u>

Table 24 gives the marital status of respondents which shows that in the three areas studied the survey concentrated on those who were heads of households. Therefore the percentage of those married constitutes about 90% of the sample surveyed.

Table [illegible]:

Respondents by marital status.

Area	Percentage	
	Married	Unmarried
Mazroub-Tinna	90.14	9.86
Khuwei	91.52	8.48
Muglad	92.46	7.54

Total answers received:

Mazroub-Tinna	142
Khuwei	224
Muglad	199

Polygamy:

	Of all marriages: Percentage one wife.	More than one wife.
Mazroub-Tinna	86.82	13.18
Khuwei	85.08	14.92
Muglad	65.02	34.98

The high percentage of household heads in the sample surveyed indicates that the questionnaire answers were obtained from those who were in a decision-making capacity, i.e., heads of families.

Table 25 gives the age structure of respondents. With the majority falling in the age groups 30 and above, the last point relating to the reliability of the data being obtained from those with a decision-making status is further validated.

Table 26 gives the number of sons and daughters in the households surveyed. Based on the information supplied in the table and the data on the number of dependents, an attempt at obtaining the household size was made with figures supplied at the bottom of the table. The average household size is on the order of 9 persons.

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Table 25

Respondents by age groups.

Area	Expressed as Percentage of Sample Surveyed							TOTAL
	15-19	20-24	25-29	30-34	35-39	40-45	46 +	
Mazroub-Tinna	0.69	8.90	13.01	8.90	17.13	11.64	39.73	100.0
Khuwei	2.13	6.81	9.79	14.89	12.34	19.15	34.89	100.0
Muglad	0.48	6.68	10.95	17.14	10.95	14.67	39.04	100.0

Total answers received:

Mazroub-Tinna	:	142
Khuwei	:	224
Muglad	:	199

Table 26

Number of sons and daughters in household.

Area	Percentage of households having											TOTAL
	1	2	3	4	5	6	7	8	9	10	11	
Mazroub-Tinna	7.97	10.62	11.50	13.27	18.58	11.50	7.09	4.43	7.97	2.65	4.42	100
Khuwei	7.50	8.00	13.00	9.50	11.00	15.00	8.50	10.00	8.00	6.50	3.00	100
Muglad	9.36	9.36	11.11	11.11	12.28	4.68	15.79	9.94	2.92	4.68	8.77	100

Total answers received:	Total sons and daughters	Total households	Sons/daughters per household
Mazroub-Tinna	537	113	4.75
Khuwei	1104	200	5.52
Muglad	949	171	5.50

Household size computed from above data plus number of dependents:

			Household size
Mazroub-Tina	200(dependents) ÷ 113(households	= 1.78 + 4.75(sons/daughters + 2 (Spouses)	= 8.53
Khuwei	451 ÷ 200	= 2.26 + 5.52 + 2	= 9.78
Muglad	317 ÷ 171	= 1.85 + 5.50 + 2	= 9.35

CHAPTER THREE

ECOLOGY AS PERCEIVED BY THE COMMUNITY

CHAPTER THREE

ECOLOGY AS PERCEIVED BY THE COMMUNITY

3.1. The Parameters Studied:

The sections on the physical and biological features and indicators in the 1983 reports adequately covered the physical ecology of the study area. These sections were written from a technical point of view, by scientists trained in the related disciplines and in their accounts they drew from the available literature on the two areas.

Initiating and adopting a participatory approach to environmental planning - where scientists, planners and executives would presumably work closely with target groups developing a common understanding to problems - could definitely facilitate the working relationship among the three. Building on this premise, the data collected through the questionnaire method address the question: To what degree are local communities adequately informed about the physical ecology of their area. The parameters investigated were soil types, vegetation types and wildlife.

The information obtained on the above parameters as preceived by the sample studied, when interpreted, follows closely the picture given by the technical accounting as shall be revealed in the following discussion.

3.2. Soil types:

Table 27 and 28 exhibit the main soil types and the main tree and grass species in the three areas as reported by respondents.

Depending on weight of the answers given, the degree of prevalent soil type was ascertained in the frame of the broad generalization of sandy, loamy and clayey, under the categorization of dominant, medium and limited, based on the percentage answers worked out in Table 27.

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Table 27

Soil types ranked according to their areal distribution.

Area	Percentage answers received			TOTAL
	Sandy soils	Loamy soils	Clayey soils	
	%	%	%	%
Mazroub-Tinra	90.45	8.28	1.27	100.00
Khuwei	76.30	11.11	12.59	100.00
Muglad	87.25	6.86	5.89	100.00

Total answers received:

Mazroub-Tinra : 157
Khuwei : 270
Muglad : 204

Table 28

Soil types and identified tree species.

Soil types: S : Sandy
L : Loamy
C : Clayey

Degree of prevalence of soil type: D: Dominant
P: Prevalent
L: Limited

Species	Percentage of answers reporting existence of soil types and species								
	Mazroub-Tinna			Khuwei			Muglad		
	S(D)	L(P)	C	S(D)	L(P)	C(P)	S(D)	L(P)	C(P)
المرخ Leptadenia pyrotchnica	35								
الهجليج Balanites aegyptiaca	38			88	29	18	45	47	97
الهشاب Acacia senegal	19(.)			122	61	26	24	22	
التفل Commiphora africana	15	10		34(.)	6(.)				
السمر Acacia radiana	11(.)								
السرح Maerua crossifolia	23			29					
السيال Acacia tortilis	30								
الكتر Acacia mellifra		32			19(.)			61	45

Cont../..

Table 28 (Cont.)

Species	Percentage of answers reporting existence of soil types and species								
	Mazroub-Tinna			Khuwei			Muglad		
	S(D)	L(P)	C(P)	S(D)	L(P)	C(P)	S(D)	L(P)	C(P)
الاندراب Cordiarothii		15	10						
الطلح Acacia seyal		19						31	156
الميكح Salvadora sp.		18							
الابنوس Dalbergia melanoxylon				51(.)	38(.)		132	59	14
الغبيش Guiera senegalensis				151			131	14	
العرد Albizia amara				109			133	43	
الليون Lanneahumilis				112(.)	30			21(.)	
المخيض Boscia senegalensis				68	40	15			
الحميض Sclerocaryalbirrea				136	30	13	40	19	
الدروب Terminalia macroptera				10(.)			139(.)	12	

Cont../..

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Table 28 (Cont.).

Species	Percentage of answers reporting existence of soil types and species								
	Mazroub-Tinna			Khuwei			Muglad		
	S(D)	L(P)	C(P)	S(D)	L(P)	C(P)	S(D)	L(P)	C(P)
الهبيـــل Combretum sp.				103	11		89	42	
الســـدر Zizyphus spinacristi				13	20		17	35	65
السنـــط Acacia nilotica				12	14	16(.)			62
الصبـــاع Terminalia sp.				40(.)	40(.)				
السعـــات				11	20				
التبلـــدى Adensonia digitata				16(.)	24		20	21(.)	
اللعـــوت Acacia nubica				11	48	16			
القضـــيم Grewiz tenax					12				
الصهـــب Anogeissus leiocarpus							36	54	29
العرديـــب Tamarindus indicus							29	25	46

Cont../..

Table 28 (Cont.)

Species	Percentage of answers reporting existence of soil types and species								
	Mazroub Tinna			Khuwei			Muglad		
	S(D)	L(P)	C	S(D)	L(P)	C(P)	S(D)	L(P)	C(P)
البليلى							20		
ام حمرون							27		
ام سروج Prosobis africana							18		
الشحيط Combretum aculeatum								10	
السلجم Acacia gerradii								24	11
الجوغان Diaspyros mespiliformis									49
انشانو									25
ام سنينة									33
الكوك Acacia sieberaria									29

Cont../..

Table 28 (Cont.)

Species	Percentage of answers reporting existence of soil types and species								
	Mazroub-Tinna			Khuwei			Muglad		
	S(D)	L(P)	C	S(D)	L(P)	C(P)	S(D)	L(P)	C(P)
كركـــز									10
اللبـــان Boswellia papyriefera				(.)	(.)				
الـــزان				(.)	(.)				
ابليلـــى							(.)		
ام ســروج Prosobis africana							(.)		

Note (.) Indicates disappearing species.

Table 29

Soil types and identified grass species.

Soil types: S : Sandy
L : Loamy
C : Clayey

Degree of prevalence of soil type: D: Dominant
P: Prevalent
L: Limited

Species	Percentages of answers reporting existence of soil types and species								
	Mazroub-Tinna			Khuwei			Muglad		
	S(D)	L(L)	C(L)	S(D)	L(M)	C(M)	S(D)	L(L)	C(L)
الحسكنيت Cenchrus biflorous	46+88			206	67	22	87	12	
القو Aristida sp.	19+44	37+48	2	24	60	37	36	33	
الثرايد	10								
[illegible] Trianthema pentandra	13+22								
الضريسة Tribulus terrestris		10							
[illegible] Blepharis Linzriifolia	(.)		2	11(.)	10(.)		55(.)	10	
البنو Eragrostis aspera	12			139	42	10	109	24	
الصمعة Aristida pallida	30			43					
العرقس Chrozophora sp.	12			2					

Cont../..

Table 29 (Cont.)

Species	Percentage of answers reporting existence of soil types and species: Mazroub-Tinna S(D)	Mazroub-Tinna L(L)	Mazroub-Tinna C(L)	Khuwei S(D)	Khuwei L(M)	Khuwei C(M)	Muglad S(D)	Muglad L(L)	Muglad C(L)
الدفرة Echinochloa colonum	77			25			10	15	10
البياض Aristida mutzibilis	7(.)							9	18
الحريش Tephrozia sp.	32								
الضحيان Farsetizi longisiequa	9								
المحريب Cymbopogon proximus		13		(.)					
النال Cymbopogon nervatus	(.)			(.)			(.)		
القرن Monsonia sp.	(.)			20					
اللصيق Zornia dyphella				100	52		154	28	
التيس أبو رخيص Andropogon gayanus				21(.)			19(.)		
الحنتوت Ipomea sp.				16					
عقيق البقر Trianthema portulacaestrum				24					
تمر الفار Acanthus sp.				10					

Cont../..

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Table 29 (Cont.)

Species	Percentage of answers reporting existence of soil types and species								
	Mazroub-Tinna			Khuwei			Muglad		
	S(D)	L(L)	C(L)	S(D)	L(M)	C(M)	S(D)	L(L)	C(L)
الحلفـــا				38(.)					
الشـــير Monachma hispidum				(.)			28 (.)	10 (.)	
الكريب (أبوأصابع) Dactyloctenium aegyptium				(.)			47 (.)	51 (.)	18
حمريـــرة							14	10	19
ام ضنـــب							21 (.)	10	
المحـــلب Hypaesus cancellata							12		
القرجـــوب Polycarpaea sp.							71	15	
ابو جقـــرة Brachiaria sp.							27	14	
ام جـــر Brachiaria obtuseflora								16	107
ام فريفـــرو Schoenefeldia gracilis								42	
ام رجـــو								9	
القولـــة Tristachya superba									

Cont../..

Table 29 (Cont.)

Species	Percentage of answers reporting existence of soil types and species								
	Mazroub-Tinna			Khuwei			Muglad		
	S(D)	L(L)	C(L)	S(D)	L(M)	C(M)	S(D)	L(L)	C(L)
أم نبقـــة Hyperhenia bagirmica								12	
شـــــراب Panicum Subalbidum								15	
ابو طالحـــة Sporobolus sp.								38	
أم شوكـــة Hygrophila auriculata									10
أم بليلـــة Rotobella exaltata									32
البجل البجل									29
الـــــبون Oryza longistaminata									60
الـــــمردى									25

Note: (.) Indicates disappearing species.

Hence in Mazroub-Tinna area sandy soils are dominant while the category of loamy soil is prevalent and that of clayey soil is limited. The last two are localized and found only close to jebels in pediment surface, and associated with the few wadis. In Khuwei area again the sandy soils are dominant while the other two types are prevalent to be found in the loamy and clayey pockets to the east and south of Khuwei, associated with pediplain surface and wadi catchment areas. The same picture is true in Muglad area where loamy and clayey soils prevail.

This very general picture portrayed by community responses coincides with the detailed accounts on soil types and distribution given in the reports of 1983 on the three areas, as could be cited in pp.7-13 in El-Khuwei Mazroub-Tinna study area report, and pages 61-69 in Messeriya Humr area study report.

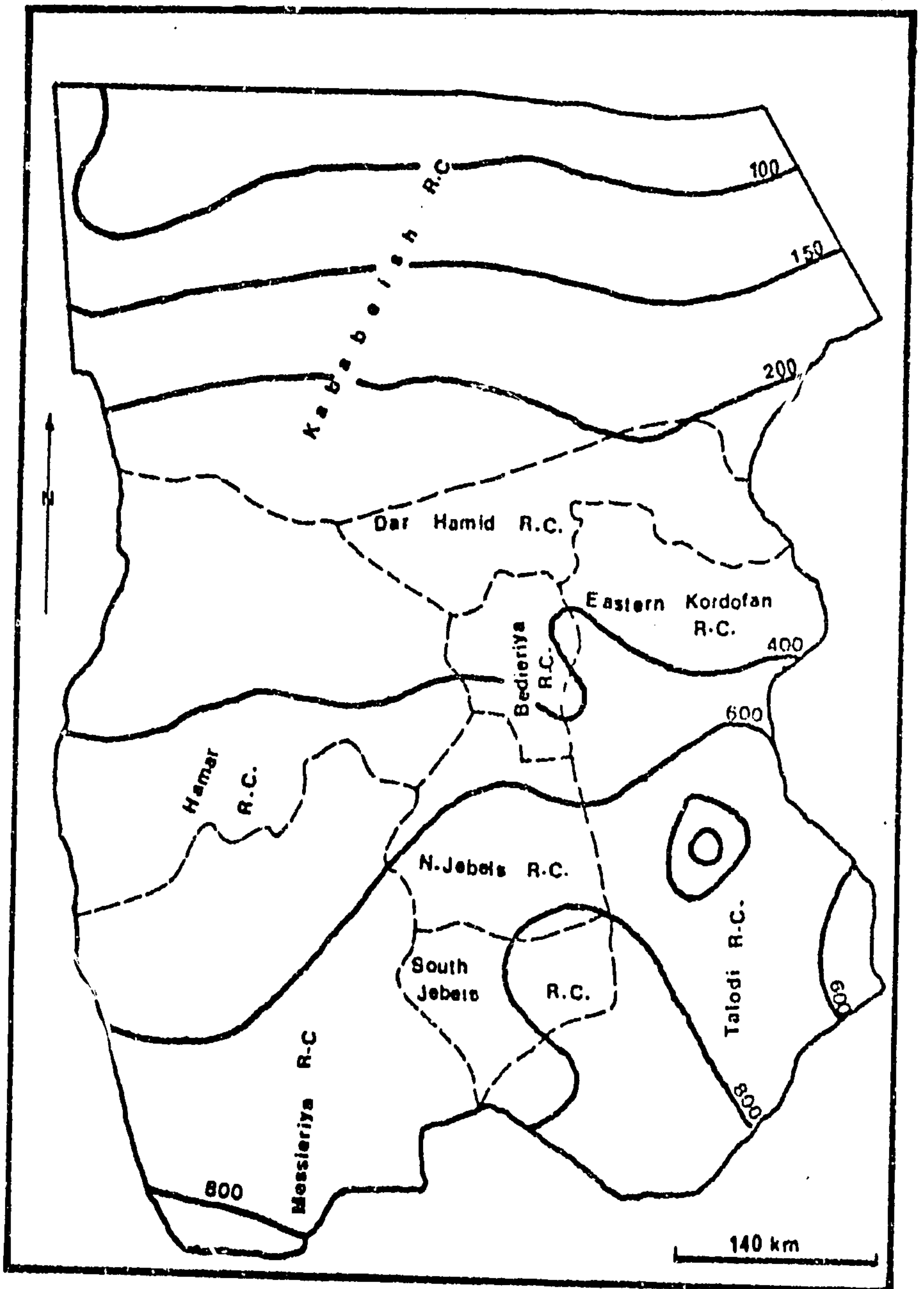
3.3. Vegetation types:

The vegetation types displayed in Tables 28 and 29 were tabulated from descriptions given by respondents. The species listed were the ones accorded more than 15 answers. Species receiving less than this number of answers were discarded.

Names of species were supplied in colloquial Arabic. The final list was supplied to the team range ecologist who identified the species and provided the Latin name equivalent. A small number of species were unidentifiable because of variation in the local terms used or the unfamiliarity of the name. For the benefit of researchers and for future follow-up work it was decided to include in the tables the local name as well to facilitate identification. The same system was adopted in the case of the two tables on wildlife and birds.

It could be depicted from Tables 28 and 29 that the listing arrived at from respondents' answers goes in line with the vegetation descriptions furnished by the 1983 reports on the two areas, the same as in the case of soils

FIG. 13. RAINFALL ISOHYETS IN KORDOFAN



Regional Boundary
Rural Council Boundary
Isohyets

discussed previously. Reference is made in this regard to pages 7 to 14 of El Khuwei-Mazroub-Tinna study area report and pages 69 to 75 of Messeriya Humr report.

It is apparent from the two tables that the variation from north to south in the amount and distribution of rainfall Fig. 13 has its direct effect on the kind of vegetation to be found, the range of species available, the density of the vegetation cover, and the richness of the ecology in the three areas. Arranged according to their occurrence and ecological relationships the listed tree and grass species yield different associations as displayed in Fig. 2 of El-Khuwei-Mazroub-Tinna study area report of 1983 and accounted for in the text.

Based on Tables 28 and 29, while Mazroub-Tinna area has 11 main tree species and 12 main grass species, Khuwei area has 20 and 14, and Muglad area has 26 and 27, respectively. Such variations when related to the use of the resources especially under the absence of conservation measures are indicative of the limited carrying capacity of the northern area of Mazroub Tinna as compared to the central one of Khuwei and the southern one of Muglad. It also explains the accelerating rate of degradation as one moves northwards.

3.4. Wildlife:

Tables 30 and 31 furnished data on wildlife in the study area, with the first giving information on mammals and the second on birds. The same procedure adopted in preparing Tables 28 and 29 on vegetation was applied in the preparation of these tables.

The tables report on mammals and birds that used to be part of the habitat of these areas with many not necessarily existing at present as indicated by the strikes showing the disappearing types

Again if we apply the counting method to the species reported, the north-south variation in ecosystem capability becomes immediately apparent. While there existed 17

Table 30

Mammals of the study area.

Local Name	English Name	Mazroub-Tinna	Khuwei	Muglad
البعشوم	Jackal	x (.)	x (.)	x
ابو الحصين	Fennel	x (.)	x (.)	x
العبلاى	Grivet monkey	x (.)	x (.)	x
المرفعين	Striped hyena	x (.)	x (.)	x (.)
الحلوف	Wart hog	x (.)	x (.)	x (.)
القط	Wild cat	x (.)	x	x
الارنب	Hare	x (.)	x	x
الصبر	Ground squirrel	x	x	x
ابو شوك	Porcurine	x (.)	x (.)	x
الزراف	Giraffe	x (.)	x (.)	x (.)
الغزال	Dorcas gazelle	x (.)	x (.)	x (.)
النمر	Leopard	x (.)	x (.)	x (.)
ام قرنة	Aardvark	x (.)	x (.)	
الثعلب	Fox	x (.)	x (.)	x
الورل	Monitor	x	x	x
ام تنق		x	x	x
التيتل	Hartebeest	x (.)	x (.)	x (.)
الفار	Rat		x	
ابو انضلاف	Aardwolf		x	x
الفيل	Elephant		x (.)	x (.)
ابو عرف	Roan antelope		x (.)	x (.)
الاسد	Lion		x (.)	x (.)
الريل	Addax		x	
الحمرة	Kob		x	x (.)
ام تقدم	Dik-dik		x (.)	x

Cont../..

Table 30 (Cont.)

Local Name	English Name	Mazroub-Tinna	Khuwei	Muglad
بقر الوحش	Scimitar horn oryx		x (.)	x (.)
حمار الوحش	Zebra		x (.)	x (.)
ابو جقنة			x (.)	
الذئب	Spotted hyena		x	x
ابو كعيب	Ratel		x	
الكك			x	
السلحفاة	Tortoise		x	x (.)
مناقو	Grivet monkey			x (.)
السمع	Wild dog			x (.)
ابو جماعة				x (.)
ابو قرن	Rhinoceros			x (.)
كنبور	Water buck			x (.)
الخضيرة				x
لوضة	Giant eland			x
الطالح				x (.)
أبو وسيعة				x (.)
الربو				x (.)
الدريان	Ratel			x
ابو سيحان	Red fronted gazelle			x (.)
بوقة	Giant eland			x (.)

Note: For mammals and birds, no scientific identification of species was attempted. The supplied English names were based on knowledge of the prevalent types in Kordofan.

x : Originally found in the area.

(.): Presently not found.

Table 31

Birds of the study area.

Local Name	English Name	Mazroub-Tinna	Khuwei	Muglad
ابو منقور	Hornbill	x (.)	x (.)	x
ام عويدات		x	x	x
ابو امبرام		x	x	x
ام ترج		x	x	x
أم بعيرة		x	x	x
شلنق		x	x	x
جداد الوادى	Guinea fowl	x (.)	x (.)	x (.)
دوه شرول		x	x	x
الـــك	Starling	x (.)	x (.)	x
النعام	Ostrich	x (.)	x (.)	x (.)
الـــور		x	x	x
القمرى	Doves	x	x	x
الصقر	Eagle	x (.)	x (.)	x (.)
الزرزور	Weaver	x	x	x
الانطار		x	x	x
جى جى		x	x	x
الوزين		x (.)	x (.)	x (.)
الكنجى		x (.)	x (.)	x (.)
كرورو		x (.)	x	x
الحبارى	Bustard	x (.)	x (.)	x (.)
الرهو	Crane	x (.)	x (.)	x (.)
السمبر	Abdim's stork	x	x	x
أبو السعن	Marabou stork	x (.)	x	x
الكرنج		x	x	x

Cont./..

Table 31 (Cont.)

Local Name	English Name	Mazroub-Tinna	Khuwei	Muglad
ابو خضير		x	x	x
ام سورج		x	x	x
الهدهد	Hoopoe	x	x	x
الغراب	Crow	x	x	x
الكنيو		x	x	x
اللقيوة		x	x	x
أربد		x	x	x
ام نعجة	Ibis	x	x	x
ام عكار	White-bellied bustard		x (.)	x
كلنق	Vulture		x (.)	x
نامليح			x	x
حميرى			x	x
ام سندى			x	x
ابو مموس	Whydah		x	x
الفرة			x	x
ككوجة			x	x
كدق (كيلو)			x	x
الكوير	Quail		x (.)	x
القطا	Sand grouse		x (.)	x (.)
الكجى			x (.)	x
قدال قدال	Wheatear		x (.)	x
ابو انجلق			x (.)	x (.)
ام دلية			x	x
الفرنوق	Crowned crane		x (.)	x (.)
طير البقر	Cattle egret			x (.)
قدوم حمارى	Sudan dioch			x
جقا				x (.)

Table 31 (Cont.)

Local Name	English Name	Mazroub-Tinna	Khuwei	Muglad
ام حسبر				x (.)
ام جاليلى				x
ود أبو نعلم				x (.)
ود السيرم	Saddle bill Stork			x (.)
ود ابسرق	House sparrow			x
دخز البحر				x
ام قرن				x (.)
الطيرالابيض				

Note: (.) indicate disappearing species.

species of mammals and 32 species of birds in Mazroub-Tinna area, the number of species is 32 and 48 for Khuwei area, and 41 and 57 in Muglad area respectively.

3.5. Conclusion:

The data presented in this section, based on respondents' perception of the local ecology, show that people are knowledgeable of the basic physical constituents of the ecosystems they are living in. They may be short of the essential scientific knowledge to correlate how these constituents interact, to interpret how the systems perform and what internal balances are to be realized to maintain them functioning. Such interpretations and understanding are the work of scientists. As stated earlier in planning future programmes aimed at checking environmental degradation and at the creation of sound economic bases founded on sustained growth, it is essential to involve local communities in the process. A common background of ecosystems characteristics is available to local communities. Therefore this knowledge could be utilized by scientists and planners in participatory action, in training and in environmental extension programmes.

CHAPTER FOUR

CROP PRODUCTION

CHAPTER FOUR

CROP PRODUCTION

4.1. General:

In all three areas staple food and cash crops are annually raised by local communities, plus gum arabic which is extensively produced in the two northern areas. Cultivation is carried out side by side with livestock raising and the two forms of economy exist as complementary to each other, providing family sustenance. While there is a dominance of village based type of livestock raising in the sample surveyed, since the majority of respondents were drawn from settled communities, there is a tendency for prevalence of semi-nomadic and nomadic types of livestock raising in the northern (Mazroub Tinna) area and southern (Muglad) area combined with crop production.

The main aspects that shall be discussed under crop production are the following ones:

i. the extent to which crop raising is practiced in the study area based on the size of population actually cultivating,

ii. respondents' perception of the relationship between the physical elements, e.g., soils, rainfall etc. and crop production,

iii. crops cultivated during the survey period 1980-1983,

iv. acreage put under different crops,

v. production attained for various crops, and

vi. adequacy of staple food crops produced in meeting family needs.

4.2. The Extent Farming is Practiced:

Tables 32 and 33 try to answer the question what percentage of the population of the study area is practicing farming, and to what degree this practice is a regular one, especially so in relation to the adverse climatic conditions and the low production levels that have been prevailing in these areas during the last couple of years.

Based on the date furnished by Table 32, the percentage of those practicing cultivation is in the range of 86 to 93% of the sample surveyed. This indicates clearly that farming is the major economic activity of the study area, among both the settled and nomad communities. For the latter it is undertaken to secure the household staple food supply.

Of the above percentages those who were regularly cultivating during the production seasons 1980 to 1983 were in the range of 92 to 100% in the three areas. This emphasizes that despite the occurrence of inadequate production and crop failure for many years, as shall be elaborated in the forthcoming discussion, farmers in these areas kept trying to raise crops from these lands. Their persistence is backed by the following arguments stated by respondents:

i. that they have limited alternatives within current ecosystem capabilities to shift to other forms of livelihood and employment,

ii. other opportunities outside their areas are not known to them and risky, and

iii. that they relate production fluctuations to one major factor, i.e., rainfall inadequacy, and since they had experienced rainfall havocs before, they carry on trying in anticipation that good rains will come next year.

Table 32

Of all respondents, those who practiced cultivation in the four years (1980-83).

Area	Total sample	Percentage practicing cultivation of total sample	Of those practicing cultivation, the percentage cultivating in: 1980	1981	1982	1983
Mazroub-Tinna	142	85.92	91.80	95.08	95.08	99.18
Khuwei	224	99.10	93.24	94.95	91.89	95.50
Muglad	199	92.96	93.51	93.51	95.68	96.76

Number of respondents practicing cultivation out of total sample:

- Mazroub-Tinna : 122
- Khuwei : 222
- Muglad : 185

Table 33

Reasons given by the minority not practicing cultivation.

Area	As percentage of answers received				TOTAL
	Absent from village	Nomad	Low return from agriculture	Found alternative source of income	
Mazroub-Tinna	11.76	58.82	29.42	0.00	100.00
Khuwei	40.90	0.00	54.55	4.55	100.00
Muglad	30.77	7.69	38.46	23.08	100.00

Total answers received:

Mazroub-Tinna	:	17
Khuwei	:	22
Muglad	:	13

villages, and still others were nomads. Those who indicated a negative attitude towards farming "low return from agriculture" and took decisions to shift from farming because they "found alternative sources of income" constituted a negligible minority.

4.3. Physical elements/crop production relationship:

Two parameters were investigated in this respect: soil suitability for cultivation and rainfall adequacy for crop raising. The results obtained are presented in Tables 34 and 35.

Table 34 indicates the suitability of the three types of soils for cultivation. Sandy soils were ranked by respondents as the most suitable compared to loamy and clayey soils receiving a weight of 85 to 94% of all answers given. Next came the loamy soils which are found in Khuwei and Muglad area. The last mentioned were the clayey soils, with limited usage in Muglad area.

Respondents' reasons for the suitability of sandy soils for cultivation embrace:

i. abundance of this type of soil as settlements are founded on them,

ii. accessibility to settlements,

iii. easy to be work manually using the type of implements available to the farmer,

iv. better moisture efficiency under the amounts of rainfall received in the area, and

v. application of land rotation between annual crops and gum production.

The second parameter examined was rainfall adequacy for cultivation. The data obtained are presented in Table 35. The four years selected for investigation, 1980-1983, were thought to be the ones which respondents remember.

Table 34

Soil types according to suitability for cultivation.

Area	Suitability rated according to respondents: answers: given in percentages			TOTAL
	Sandy soils	Loamy soils	Clayey soils	
	%	%	%	%
Mazroub-Tinna	94.28	2.86	2.86	100.00
El Khuwei	86.00	12.76	1.24	100.00
Muglad	85.17	8.13	6.70	100.00

Total answers received

Mazroub-Tinna	:	140
Khuwei	:	243
Muglad	:	209

Table 35

Rainfall adequacy for cultivation: answers given in percentages.

Year	Mazroub-Tinna		El Khuwei		El Muglad	
	Adequate	Inadequate	Adequate	Inadequate	Adequate	Inadequate
1980	80.92	19.08	80.89	19.11	90.34	9.66
1981	71.32	28.68	77.17	22.83	92.96	7.04
1982	33.08	66.92	65.22	34.78	94.76	5.24
1983	3.08	96.92	6.41	93.59	00.00	100.00

Total answers received:

	1980		1981		1982		1983	
	Adequate	Inadequate	Adequate	Inadequate	Adequate	Inadequate	Adequate	Inadequate
Mazroub-Tinna	106	25	97	39	43	87	4	126
Khuwei	182	43	169	50	150	80	15	219
Muglad	159	17	185	14	181	10	0	194

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The results obtained above show consistency. Out of the four years studied, farmers in Mazroub-Tinna areas had adequate rainfall for cultivation in the two production seasons of 1980 and 81; while in Muglad and Khuwei areas they had adequate rainfall for the three successive produ- tion seasons of 1980, 81 and 82.

It is thought interesting to relate community percep- tion of rainfall adequacy for cultivation to actual rainfall figures in the three areas. The data available in this recpect cover only the two stations of Mazroub and Khuwei, and again partially covering the time series studied, i.e., 1978-81.

The annual averages for Mazroub and Khuwei, which were directly obtained from the station readers there, for the mentioned period are as follows:

Year	Mazroub	Khuwei
1978	449.5 mm	361.5 mm
1979	164.0	456.0
1980	268.5	370.0
1981	234.0	280.0

Two conclusions could be drawn from these figures That the two areas experience rainfall fluctuations in the total annual amounts received, which substantiates a previous judgement that communities in the survy area are accustomed to rainfall inadequacy and annual crop failure. The other point is that since 1980 and 81 production seasons were reported to have had adequate rainfall for cultivation, it could be interpreted that the amounts received in these two years which were between 234 mm and 370 mm are indica- tive of the range of rainfall required for a successful harvest in these areas.

Yet this conclusion needs more qualification since rainfall adequacy for farming can not be judged only on the annual totals received, but on the pattern of distribu- tion and the frequency of rains throughout the season as these relate directly to crop moisture needs. The picture bbecomes more complicated when other physical variables such as soil moisture efficiency are incorporated in the analysis.

The data on rainfall regime for the two stations of Mazroub and Tinna for the period 1978-81 point clearly to the variation in pattern from one year to the other, and to almost the impossibility of predication which are some of the established characteristics of sub-tropical rains.

4.4. Crops cultivated:

Table 36 gives the crops cultivated in the three areas for the period 1980-1983. The crops grown could be grouped under the four categories:

i. Main staple food, crops, embracing millet and sorghum, basically grown for meeting the household needs, however in years of high production surpluses are taken to the market.

ii. Supporting staple food crops, including okra (dried from ladies fingers) and lubia.

The last two are generally interplanted with other crops, or in some cases grown separately on limited areas. Again these are produced for family consumption, however in some cases production is taken to the market.

iii. Staple cash crops, comprising sesame, groundnuts and kerkade, produced mainly for the market.

iv. A multi-use crop, namely watermelons produced as a source of water basically for livestock and to some degree for humans, with the crop sold for cash, first in its green state and later as dry melon-seeds.

The four types of crops are grown in the three areas but with different farming intensity and geographic distribution. El Khuwei area with its intermediate location between the other two shows more dependency on farming

Table 36

Crops cultivated 1980-1983.

Area	Year	Answers in percentages for various crops cultivated							
		Millet	Sorghum	Sesame	Ground-nut	Kerkade	Water melons	Okra	Lubia
Mazroub-Tinna	1980	76.76	38.03	52.11	5.63	10.56	72.54	42.96	40.85
	1981	78.17	37.32	50.00	7.75	10.56	74.64	41.55	34.51
	1982	79.58	38.73	50.00	6.34	11.27	74.64	50.00	36.82
	1983	80.99	41.55	47.89	5.63	9.86	75.35	50.00	40.85
Khuwei	1980	87.05	46.43	74.11	74.11	23.21	69.64	69.64	67.41
	1981	75.89	46.43	73.21	77.68	22.32	74.11	67.41	62.52
	1982	83.48	50.89	65.18	79.91	20.09	77.23	67.41	61.61
	1983	80.80	49.55	68.75	83.04	24.11	79.46	69.64	64.29
Muglad	1980	78.89	32.16	6.03	53.77	7.04	26.13	38.69	26.63
	1981	80.90	30.15	6.03	53.27	3.52	25.13	38.19	25.63
	1982	85.93	32.66	5.03	52.26	4.02	24.62	37.69	25.63
	1983	86.93	32.16	5.03	51.76	4.02	25.13	37.19	24.62

Cont../..

Table 35 (Cont.)

Answers received:

Area	Sample size	Year	Millet	Sorghum	Sesame	Groundnut	Kerkade	Watermelons	Okra	Lubia
Mazroub-Tinna	142									
		1980	109	54	74	8	15	103	61	58
		1981	111	53	71	11	15	106	59	49
		1982	113	55	71	9	16	106	71	52
		1983	115	59	68	8	14	107	71	58
Khuwei	224									
		1980	195	104	166	165	52	156	156	151
		1981	170	104	164	174	50	166	151	140
		1982	187	114	146	179	45	173	151	138
		1983	181	111	154	186	54	178	156	144
Muglad	199									
		1980	157	64	12	107	14	52	77	53
		1981	161	60	12	106	7	50	76	51
		1982	171	65	10	104	8	49	75	51
		1983	173	64	10	103	8	50	74	49

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and a higher intensity of crop production. This leading position could be attributed to a number of factors including: the early settlement of the area, development of water sources, growth in farming population, its location on the main El Obeid-En Nahud transportation axis, access to marketing infrastructure and to some degree adequate rainfall for crop raising. In comparison Mazroub-Tinna and Muglad were originally dominated by nomadic pastoral economies, and recent history of settlement, limited development of water sources (especially so for the former one), less growth of farming population, remote location from primary market centres, and in the case of Mazroub-Tinna a marginal rainfall for cultivation. A more closer examination of the picture in the three areas reveals the following:

a. Mazroub-Tinna Area:

There is a high concentration on millet production in Mazroub-Tinna area where 77 to 80% of respondents grew millet in the period 1980-83. The variety grown is a quick maturing one which gives an adequate harvest in good years of rain. Sorghum is grown too but not as extensively as millet, being raised by 37 to 42% of the sample surveyed. Expansion of sorghum production in this area is limited by two factors, The first is the low amount of rainfall received which does not guarantee a good harvest, so its cultivation is risky. The second is the preference of the population for millet as a staple food. It is interesting in this regard to report that the people of this northern area complain of been forced in recent years due to the drought effect to change to Fetarita, a kind of sorghum as a substitute for millet, their habitual diet food.

The two main cash crops produced in Mazroub-Tinna area are sesame and watermelon. The former was produced during the surveyed four year period by 48 to 52% of the respondents; while watermelons were produced by about 75% of the respondents.

The type of sesame grown is a quick maturing variety locally known in northern Kordofan as el Hirghlue to yield a harvest in sixty days. Watermelons are extensively gown in this area. An elaborate account of the production of this crop is given in Mazroub-Tinna study report of 1983. For the purpose of the present discussion we may highlight the following points. The crop survives well in most years being adapted to the ecological conditions of the area. It is normally grown in late rainy season and produces in December. Because of the shortage in water supply in this area the melons are sold as a water and feed crop to the local animal raisers and to the nomads coming from the north, with many of them depending on it up to the end of March. Animal owners or original producers thereafter sell the dry seeds to local buyers.

Groundnuts and kerkade are procuced in very limited amounts in this zone, being grown by about 6% and 10% of the sample surveyed, respectively. This is a mainly due to the limited amount of rainfall experienced by the area which does not support these crops.

Many farmers grow okra and lubia. Out of the sample surveyed those growing the two crops are in the range of 50% for the former and 35 to 41% for the latter.

It is to be stated in this connection, which shall be discussed in more detail later that there is a great shift in cash crop production in this belt, between the 1960's and the 1980's. Gum was a leading cash crop in the 1960's, and Mazroub at that time was one of the main gum markets of north Kordofan.

Gum production has declined and Mazroub has changed in time into a leading watermelon seed market. The shift has been at the expense of hashab (Acacia senegal) tree which has shrunk in area because of the drought effect as well as the extensive clearance of land to make place for the cultivation of the other crops.

b. Khuwei Area:

Again in this area millet assumes importance as the main staple food crop grown by 76 to 87% of the respondents.

Sorghum is the next established food crop raised by 46 to 50% of the respondents. For some in Mazroub-Tinna area millet is favoured as the main diet food compared to the other types of sorghum. The rise in the percentage of sorghum growers in Khuwei area compared to Mazroub-Tinna area is due to higher rainfall and the presence of loamy soils which are better suited to sorghum production.

Considering cash crops sesame, groundnuts, and water-melons are widely grown with some kerkade produced as well. Farmers who grew sesame ranged between 65 and 74% of the sample surveyed, those who grew groundnuts between 74 and 83%, watermelons between 69 and 79%, and kerkade on the order of 22%. The percentages of the growers of Okra and Lubia are also high on the order of 67 and 62% consequently. The high intensity of crop production in Khuwei area compared to the other two has already been explained, being referred to many factors which have aided the rise of commercialized agriculture and emphasised the role of crop production as the main form of occupation and source of livelihood of the population.

c. Muglad Area:

Millet is the leading staple food crop also in Muglad area with 79 to 87% of the respondents growing the crop in the four year period 1980-83. Sorghum was grown by about 30% of the sample covering those not growing millet plus some of the millet growers combining sorghum as well. Again as in the case of Khuwei area the prevalence of loamy soils and higher amounts of rainfall favour the production of sorghum in this belt.

Being basically a pastoral area with cattle extensively raised as a source of food and cash, cultivation is carried out in this zone for the supply of staple food grains. Hence it is expected that cash crops assume a reduced role compared to the two northern areas, reflected by the given percentages. Groundnut , the leading crop was grown by 52% of the sample studied. It is a recently introduced crop in the area, cultivated as a cash earner mostly by direct hired labour or by share-croppers. In both cases the labour comes from Dinka elements attracted from Abeye area lying to the south of Muglad. Sesame and Kerkade were of limited production grown, respectively, by 5 and 6% of the sample surveyed. Watermelons were grown too but not as a water crop nor for the production of seeds for the market, but mainly as a fruit raised by about 37% of the sample. Okra and Lubia growers were on the orderof 37 and 25%.

One important observation to be concluded from the data in Table 36 is the fact that there is a consistency in the percentage of respondents growing the different crops for the four years investigated in the three survey areas. This can be attributed to a number of factors:

i. That the household in the three areas depends on itself for producing its staple grain food. The majority grow millet, some prefer sorghum and others combine both. Hence meeting the family staple food requirements from the family farm and without resorting to buying imported grains is an established household production strategy.

ii. The household has to produce cash crops for the market to earn money to spend on the other necessities. The range of crops produced is very much determined by the ecological suitability of the area for the production of certain crops, and the other economic alternatives available to the household, e.g., el Hirehre sesame, watermelons and sheep raising in Mazroub-Tinna area, compared to full dependency on commercialized agriculture plus village-based livestock in Khuwei area, and groundnuts production and cattle pastoralism in Muglad area.

iii. Due to the bad pricing policy of cash crops which blocks market increases from the producer there is a negligible shift from one crop to the other in the four years investigated.

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4.5. Crop Acreage:

4.5.1. Annual Crops:

Table 37 exhibits the acreage cultivated in the three areas given in ranges of makhamas(es) for the period 1980-83. Many results could be derived from this table.

The greater part of the sample is concentrated in the range of less than 4 makhamas to 20-24 makhamas, with the majority of farmers cultivating 5.9 makhamas. The percentage cultivating 25 makhamas and more is quite small. This is consistent for all three areas and for the four years studied.

The acreage cultivated is influenced by a number of factors including family needs for food crops and cash, the implements in use which are rudimentary ones, the degree of cleanness of the land available for cultivation, the size of the household which directly affects the labour input in farming, and the food grains supply plus the financial situation of the household during the rainy season. The latter two largely determine the acreage cultivated since poor families normally sell part of their labour to those who could hire them, and hence end up cultivating smaller areas.

The conclusions to be drawn from Table 37, that acreages up to 4 makhamas are mostly cultivated by the small and poor households, 5 to 14 makhmas by average households, and 20 and more makhamas by prosperous household, i.e., those who can manage hiring additional labour from outside the family. Regarding the area put under each crop Table 38 supplies detailed information on the three survey areas for the year 1982. There is a consistency between the total acreage cultivated and the distribution of crops grown in relation to the total farm size. The following results could be reached from Table 38 presented in the established sequence of Mazroub-Tinna- Kuwei and Muglad areas.

i. Millet is the leading crop in the three areas, with the majority of farmers, 49, 31 and 39%

Table 37

Acreage cultivated 1980-1983.

Area	Acreage / Year	Ranges in Makhamas(x) expressed as percentages. Less than 4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50 +	TOTAL
Mazroub-Tinna	1980	9.40	45.30	21.38	9.40	9.40	3.42	0.85	0.85	0.00	0.00	0.00	100.00
	1981	8.62	43.10	18.97	11.21	12.93	[illegible]	0.86	1.72	0.00	0.00	0.00	100.00
	1982	8.62	43.10	18.12	12.07	10.34	4.31	1.72	1.72	0.00	0.00	0.00	100.00
	1983	6.25	47.32	18.75	10.71	8.93	5.36	2.68	0.00	0.00	0.00	0.00	100.00
Khuwei	1980	12.38	26.73	24.26	13.37	12.38	2.48	4.94	0.00	0.50	0.99	1.98	100.00
	1981	9.59	27.27	16.16	14.14	13.64	5.56	6.57	2.02	1.00	0.51	3.54	100.00
	1982	10.89	24.25	24.75	10.40	13.37	4.46	2.47	1.98	0.99	2.48	3.96	100.00
	1983	9.90	25.24	20.79	12.87	12.87	4.95	3.96	1.49	1.49	0.99	5.45	100.00
Muglad	1980	32.02	44.94	15.18	4.49	1.69	1.12	0.56	0.00	0.00	0.00	0.00	100.00
	1981	31.61	44.25	13.22	5.75	2.87	1.72	0.00	0.58	0.00	0.00	0.00	100.00
	1982	37.72	38.93	17.35	3.59	1.20	1.80	0.00	0.00	0.00	0.00	0.00	100.00
	1983	42.07	37.20	14.02	4.27	2.44	0.00	0.00	0.00	0.00	0.00	0.00	100.00

(x) A Makhamas differs in area from one locality to the other. Generally it is about 1.5 feddans.

Cont../..

Table 37 (Cont.)

Area / Crop	Percentage of answers received according to acreage ranges under different crops:											TOTAL
	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50+	
Muglad												
Millet	46.15	39.05	10.66	3.55	0.00	0.00	0.59	0.00	0.00	0.00	0.00	100.00
Sorghum	88.89	11.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Sesame	100.00	00.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Groundnuts	86.52	10.11	3.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Kerkade	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Watermelons	86.20	10.34	3.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Okra	98.31	1.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Lubia	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00

Total answers received:

	Mazroub-Tinna (Sample size 142)	Khuwei (Sample Size 224)	Muglad (Sample size 199)
Millet	104	188	169
Sorghum	47	108	54
Sesame	59	143	9
Groundnuts	8	164	89
Kerkade	4	41	4
Watermelons	84	128	29
Okra	38	103	59
Lubia	29	82	44

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Table 38

Area under each crop 1982 season.

Area / Crop	Percentage of answers received according to acreage ranges under different crops: 1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50+	TOTAL
Mazroub-Tinna												
Millet	20.19	48.08	25.96	2.88	1.92	0.00	C.00	0.97	0.00	0.00	0.00	100.00
Sorghum	82.98	8.50	2.13	4.26	0.00	2.13	0.00	0.00	0.00	0.00	0.00	100.00
Sesame	91.53	6.78	1.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Groundnuts	75.00	12.25	0.00	12.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Kerkade	75.00	25.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Watermelons	20.24	38.10	23.81	4.76	4.76	3.57	0.00	2.38	0.00	1.19	1.19	100.00
Okra	100.00	00.00	00.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Lubia	100.00	00.00	00.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Khuwei												
Millet	37.23	31.91	15.96	8.52	4.26	1.06	1.06	0.00	0.00	0.00	0.00	100.00
Sorghum	72.22	17.59	9.26	0.00	0.93	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Sesame	70.62	20.98	4.90	1.40	1.40	0.00	0.00	0.70	0.00	0.00	0.00	100.00
Groundnuts	71.34	22.56	3.66	1.22	0.61	0.00	0.00	0.00	0.00	0.00	0.61	100.00
Kerkade	87.80	7.32	2.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.44	100.00
Watermelons	32.03	25.00	21.09	9.38	7.03	0.78	0.00	0.00	0.00	1.56	3.13	100.00
Okra	98.06	1.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Lubia	95.12	2.44	1.22	0.00	1.22	0.00	0.00	0.00	0.00	0.00	0.00	100.00

Cont../..

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Table 38 (Cont.)

Total number of answers received under different ranges:

Mazroub-Tinna	1980	117
	1981	116
	1982	116
	1983	112
Khuwei	1980	202
	1981	198
	1982	202
	1983	202
Muglad	1980	178
	1981	174
	1982	167
	1983	164

growing 5-9 makhamas. The high percentage in Mazroub-Tinna area is because millet is the most suited crop to the low rainfall received there, besides many farmers grow it for cash as well.

ii. Sorghum being a support crop to millet and as mentioned conditioned by the ecological factors is grown on limited areas, with the majority of respondents 82, 72 and 89% cultivating less than 1-4 makhamas.

iii. The acreage under sesame and groundnuts is within the range of 1-4 makhamas in Mazroub-Tinna and Muglad areas as indicated by the following percentages of respondents falling within the ranges of 91% for sesame and 75% for groundnuts in the former area, and 100% and 87%, respectively, in the latter area. Khuwei shows some exception with a tendency for increases in the percentages growing 5-9 makhamas for both crops, due to the more commercialized form of agriculture practiced in this area.

iv. In all three areas the acreage under kerkade falls within the range of 1-4 makhamas. Hence the areas cultivated with kerkade tend to be very small.

v. The watermelon acreage is small in Muglad area since it is not extensively grown as in the case of Mazroub-Tinna and Khuwei areas. In the latter two the acreage varies considerably being distributed within the ranges 1-4, 5-9 and 10-14 makhamas.

vi. For okra and lubia in all three cases the acreage is within the range of 1-4 makhamas.

Table 39 provides information on farm location and the number of plots cultivated by the household. In Mazroub-Tinna and Muglad areas the majority of households cultivate one consolidated plot as indicated by 83% of the answers received. In Khuwei area there is a tendency for dispersion with 68% having consolidated plots as compared to 32%

Table 39

Whether cultivated plots are consolidated or dispersed.

Area	Answers given in Percentages		Total %	Percentage distribution by number of plots.				Total %
	Consolidated	Dispersed		One plot	Two plots	Three plots	Four Plots	
Mazroub-Tinna	82.93	17.07	100.00	81.82	14.04	3.31	0.83	100.00
Khuwei	68.33	31.67	100.00	65.71	8.58	12.38	13.33	100.00
Muglad	82.93	17.07	100.00	81.81	14.05	3.31	0.83	100.00

Total answers received for consolidated/dispersed:

Mazroub-Tinna : 123
Khuwei : 221
Muglad : 123

Total answers received for distribution by number of plots:

Mazroub-Tinna : 121
Khuwei : 210
Muglad : 121

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with dispersed plots. The variation is due to the full development of the farming economy in Khuwei area, compared to the other two, which demands a high frequency of rotation of land parcels. The percentage distribution by number of plots in the same table confirms the special situation of Khuwei area where percentages of 9, 12 and 13 among respondents cultivating 2, 3 and 4 plots, respectively, confirms the existence of a dispersed pattern of farming.

The plot rotation period is given in Table 40. For the majority of farmers the time span is 5-9 years, as indicated by 59 to 68% of all answers received. This seemed to be the optimum period for restoring soil fertility if the farming population was smaller and land was left to be colonized by vegetation and then brought back to production at the end of the period. Under the current devastation of the vegetation cover due to heavy use, a shorter period (4 years and less) is desirable for improving soil fertility and definitely longer periods (10 years and more) should be checked. However the farmers' decisions are shaped by many stimuli, such as the level of fertility of the individual plot, the availability of land which determines the rotation period, and the response to family and market needs.

4.5.2. Production levels

Table 41 gives the production levels in total amounts for the different crops produced during 1982. We opted for total amounts because it was easier for respondents to give information on the total harvest attained rather than yields per makhamas. Again 1982 was selected because it was the last harvest season when the survey was conducted, hence could be better remembered by cultivators. The following results could be concluded from Table 41.

i. In Mazroub-Tinna area the first three ranges of production (less than 1 sack, 1-2 sacks and 3-5 sacks) whow the highest frequency for all crops, with a tendency for the first range to dominate.

ii. The same picture is true for Khuwei area, however with more balanced distribution among the three ranges.

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Table 40

Plot rotation.

Area	Period by Percentage of answers			Total
	Less 4 Years	5-9 Years	10+ Years.	
Mazroub-Tinna	12.39	66.37	21.24	100.00
Khuwei	27.45	58.82	13.73	100.00
Muglad	19.31	68.28	12.41	100.00

Total answers received:

Mazroub-Tinna	:	113
Khuwei	:	204
Muglad	:	145

Table 41

Respondents total harvest of various crops from the acreages cultivated in 1982.

/Area Amounts	Millet	Sorghum	Sesame	Groundnut	Kerkade	Water-melons	Okra	Lubia
Mazroub-Tinna:								
Less than one sack	17.44	43.47	50.00	57.14	50.00	21.43	90.91	42.86
1-2 sacks	32.56	39.12	30.00	28.57	00.00	39.27	9.09	42.86
3-5 "	25.58	8.70	6.67	14.29	00.00	17.86	0.00	14.28
6-8 "	8.14	0.00	6.67	0.00	00.00	10.71	0.00	0.00
9-10 "	6.98	0.00	3.33	0.00	00.00	3.57	0.00	0.00
11 +	9.30	9.70	3.33	0.00	50.00	7.12	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Khuwei:								
Less than one sack	20.51	26.31	32.04	3.38	34.38	13.16	42.03	29.79
1-2 sacks	35.90	24.56	31.07	5.41	34.38	15.79	43.48	42.55
3-5 "	22.22	15.79	25.24	10.14	25.00	21.05	11.59	17.02
6-8 "	5.98	12.28	3.88	6.08	6.24	2.64	2.90	8.51
9-10 "	1.71	3.51	4.85	8.77	0.00	5.26	0.00	2.13
11 +	13.68	17.55	2.92	66.22	0.00	42.10	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Percentage of respondents attaining following amounts.

Cont../..

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Table 41 (Cont.)

Area / Amounts	Percentage of respondents attaining following amounts:							
	Millet	Sorghum	Sesame	Groundnuts	Kerkade	Water-melons	Okra	Lubia
Muglad:								
Less than one sack	1.34	2.04	20.00	3.23	40.00	0.00	22.92	23.53
1-2 sacks	3.36	16.33	40.00	9.68	0.00	7.14	43.75	50.00
3-5 "	10.74	20.41	20.00	17.20	20.00	71.43	29.16	23.53
6-8 "	14.76	18.37	10.00	7.53	0.00	14.29	4.17	0.00
9-10 "	3.36	6.12	0.00	4.30	0.00	7.14	0.00	0.00
11 +	66.44	36.73	10.00	58.06	40.00	0.00	2.08	2.94
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Total answers received:

	Mazroub-Tinna	Khuwei	Muglad
Millet	86	117	149
Sorghum	23	57	49
Sesame	30	103	10
Groundnut	7	148	93
Kerkade	2	32	5
Watermelons	28	38	14
Okra	11	69	48
Lubia	7	47	34

Sack/equivalent	Weight in Kg.
Millet	94.35
Sorghum	91.50
Sesame	73.70
Groundnut	45.00
Kerkade	20.00
Watermelons	75.00
Okra	35.00
Lubia	82.00

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iii. In Muglad area there are apparent increase in the frequentcies of the higher ranges of production.

iv. Under the established factors of production which are almost standard in the three areas, the explanation for the rise in levels of production from north to south is higher rainfall plus better ecological and soil conditions.

These conclusions are verified by the data in Table 42. Farmers when asked to identify and rank those factors which are behind good agricultural production, rated adequate rainfall highest as the most critical factor.

4.5.3. Staple Grain Food Situation:

Of all crops produced by the farmer in the three areas the supply situation of millet and sorghum seems to be an important factor in the continuity of local communities and the stablization of population in these areas, as demonstrated by the current drought conditions.

Two aspects were investigated from this angle to assess the staple grains supply. The first related to the storage of grains during the last three years. As a normal practice followed in the three areas, when farmers have a good crop, they store the surplus in the ground in ditches known locally as matmora. The stored amounts are reserved for use during the rainy season. Table 43 indicates clearly that the majority of farmers did not have matmora(s) throughout the period 1981-83.

The above picture is confirmed by the answers received for a more direct question on whether the grains produced in 1982 were adequate in meeting family needs. It is evident from the results in Table 44 that the majority of farmers in the first two areas did not produce enough to meet the household requirements as reflected by the percentage answers given of 88 and 83, respectively, while in Muglad area the situation was different with 60% of the farmers producing sufficient grain crops.

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Table 42

Factors behind good agricultural production.

Area	Answers in percentages:					Total.
	Adequate rainfall	Good agricultural operation	No pests and diseases	No winds at time of establishment of seedlings	High soil fertility	
Mazroub-Tinna	89.05	3.65	4.38	1.46	1.46	100.00
Khuwei	72.82	9.39	14.77	0.34	2.68	100.00
Muglad	72.90	15.15	2.79	0.00	9.16	100.00

Total answers received:

Mazroub-Tinna : 137

Khuwei : 298

Muglad : 251

Table 43

Whether household had Matmoura (dura storage ditch) during last 3 years.

Area	Percentage answers		Total
	Yes	No	
Mazroub-Tinna	21.37	78.63	100.00
Khuwei	19.74	80.26	100.00
Muglad	37.23	62.77	100.00

Total answers received:

Mazroub-Tinna	:	145
Khuwei	:	233
Muglad	:	188

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Table 44

Whether staple food grains produced (1982) were adequate in meeting family requirements.

Area	Respondents' answers in percentages		Total
	Yes	No	
Mazroub-Tinna	11.97	88.03	100.00
Khuwei	16.27	83.73	100.00
Muglad	60.12	39.88	100.00

Total answers received:

Mazroub-Tinna : 117
Khuwei : 207
Muglad : 173

4.6. The Acacia senegal Tree:

Acacia senegal (hashab) as a tree crop producing gum arabic grows in the three areas, with a higher intensity and use in the two norhtern ones. Though the tree grows under natural conditions, its maintenance for gum production needs continuous care from the farmer.

The tree has a production age of up to 18 years and enters into the crop rotation cycle through the shifting cultivation system practiced in these areas. Due to the expansion in areas of annually grown crops and the drought conditions of recent years, the old production and ecological balance that maintained the tree in the cropping cycle is presently shaken; and as a result the areas under hashab are diminishing.

To assess the situation farmers were asked to report on their producing hashab plantations. The results are given in Table 45. Ownership of hashab gardens is confined to Mazroub-Tinna and Khuwei areas with a higher intensity in the latter one. Regarding whether gardens owned are consolidated or dispersed the majority have dispersed plantations which goes with the pattern of shifting cultivation practiced in the area.

In attempting to project the future of hashab in these areas, farmers were asked whether they own young hashab or not. As could be depicted from Table 46, 40% of the farmers in Mazroub-Tinna area own young hashab with the percentage increasing to 50% in Khuwei area which reflects a declining trend, since in the past (early 1960's) the majority of farmers (80%) owned hashab.

4.7. Conclusion:

Farming is extensively practiced in the study area as the main source of livelihood. Of the three types of soils the farmer perceives sandy soils as the most suited for cultivation under the rainfall of the area. Rain efficiency for crop raising is variant from one year to the other, and out of the four years investigated rains were

Table 45

Hashab ownership.

Area	Respondents reporting owning hashab in percentage of answers given.					
	Owning Hashab			Type of Plantation		
	Yes	No	Total	Consolidated garden	Dispersed in cultivation	Total
Mazroub-Tinna	42.65	57.35	100.00	35.30	54.70	100.00
Khuwei	58.87	41.13	100.00	58.44	41.56	100.00
Muglad	15.82	84.18	100.00	15.82	84.18	100.00

Total answers given:

- Owning Hashab:

Mazroub-Tinna	136
Khuwei	231
Muglad	177

- Type of Plantation:

	Consolidated	Dispersed
Mazroub-Tinna	48	88
Khuwei	135	96
Muglad	28	149

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Table 46

Whether owns young hashab.

Area	Answers given in percentages.		Total
	Yes	No	
Mazroub-Tinna	40.52	59.48	100.00
Khuwei	50.22	49.78	100.00
Muglad	17.24	82.76	100.00

Total answers received:

Mazroub-Tinna	:	116
Khuwei	:	229
Muglad	:	145

commonly inadequate for two years in Mazroub-Tinna and Khuwei areas and for one year in Muglad area.

The farmer produces a wide range of crops to meet his staple food needs and for the market to raise cash. In his decisions securing the family grain supply is a priority, hence the emphasis on millet comes very high. Concentration on millet in these areas is also induced by the escalating prices of grains in the country, which with the added transportation costs from production areas shifted the farmer's strategy from diversifying his production to securing his needs from his own farm, especially so in recent years. In this way millet itself has changed to a cash crop, since any surpluses in household production find an active market within the area.

With the increase in population and the expension in agriculture, more land has been cleared for cultivation. This has led to shorter rotation cycles, decline in soil fertilit and low levels of production. Hence farmers are not producing enough to meet the family grain needs. At the same time they hardly raise enough money from the cash crops they grow to augment the shortage in grains by purchasing from the market.

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CHAPTER FIVE

LIVESTOCK RAISING

CHAPTER FIVE

LIVESTOCK RAISING

5.1. General:

Livestock raising is the second important economic activity in Mazroub-Tinna and Khuwei areas, while it assumes a primary role in Muglad area. Even in Mazroub-Tinna area some of the population lead a semi-nomadic or nomadic life, where dependency on livestock raising may match that on agriculture if it does not surpass it in many cases. As mentioned earlier the two economies of crop production and livestock raising complement each other in maintaining the household sustenance. They integrate in many facets. Normally inputs from one fuse into the other, e.g., cash surpluses from crops are invested in livestock, while in times of need animals are sold to spend on agriculture and on family living.

The main points to be covered under livestock raising shall follow the same sequence of treatment of crop production. These include:

i. The extent to which livestock raising is practiced in the area,

ii. respondents' perception of the relationship between grazing and rainfall,

iii. the grazing systems followed,

iv. fire-lines as a main conservation and protection measure,

v. use of supplementary feeds, and

vi. evaluation of the current livestock situation in the three areas.

5.2. The Extent Livestock Is Practiced:

Table 47 gives the percentage of respondents owning livestock in the sample surveyed. It is 73% in Mazroub-Tinna area, 71% in Khuwei area and 88% in Muglad area. This proves the diffusion of the livestock economy in the area as highlighted previously and the primacy of this type of economy in Muglad area.

Adopting the previous categorization of farmers into poor, average, and prosperous, the percentage of those who do not own livestock is 27, 29 and 12%, respectively for the three areas as derived from Table 47. These percentages could be indicative of the size of poor farmers in the three areas, based on the fact that livestock is built on the savings from crop production; therefore those who do not own livestock are not adequately producing.

Regarding the type of animal ownership Table 48 gives the percentage distribution for the sample surveyed. Cattle stand as the main animal in Muglad area because of the type of pastoral economy practiced there, owned by 30% of the sample surveyed, decreasing to 7% in Khuwei and Mazroub-Tinna areas. Sheep ownership is almost the same in the order of 14, 17 and 11%. Goats scored the highest percentage, in the order of 30%, due to a number of factors. The goat is the main source of milk for the family, cheaper to own in terms of cost compared to the other types of animals and needs less care from the owner. Camel ownership is highest in Mazroub-Tinna area being 22%, medium in Khuwei area 16%, and lowest in Muglad area 4%. The percentage is highest in the former one because camel pastoralism was the original economy of that area. Donkey ownership assumes almost the same percentage in the three areas, in the order of 26%, owned by many families as it is the main means of transport to the farm and for carrying water to the homestead. Horse ownership is limited. The

Table 47

Livestock ownership.

Area	Percentage distribution:		Total
	Yes	No	
Mazroub-Tinna	72.60	27.40	100.00
Khuwei	71.43	28.57	100.00
Muglad	87.83	12.17	100.00

Total answers received:

Mazroub-Tinna	:	146
Khuwei	:	224
Muglad	:	189

Table 48

Respondents by type of animal ownership.

Area	Percentage distribution by type of ownership						TOTAL
	Cattle	Sheep	Goats	Camels	Donkeys	Horses	
Mazroub-Tinna	7.11	13.98	30.75	21.74	25.78	0.61	100.00
Khuwei	7.02	16.67	30.70	16.22	26.75	2.54	100.00
Muglad	29.78	11.41	25.73	3.87	27.08	2.13	100.00

Total answers received:

Mazroub-Tinna	:	322
Khuwei	:	456
Muglad	:	517

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small percentage reported at Khuwei is used for dawing carts, while the ones in Muglad area originate with the cattle pastoral economy where they used to be numerous in the past.

Table 49 elaborates on the above picture giving the percentage distribution of ownership of livestock under different ranges.

5.3. Rainfall Adequacy for Grazing:

Just as rainfall adequacy for cultivation was examined previously, rainfall adequacy for grazing was examined, too, for the years 1980-83. The results are given in Table 50 which show the same pattern revealed for cultivation, i.e., Mazroub-Tinna and Khuwei areas experienced adequate rains in 1980 and 1981, while Muglad received adequate rains in the two mentioned years plus 1982.

The location of Muglad to the south of the other two areas may explain the variation in the amounts received, which being presumably greater were adequate for cultivation and grazing. Our investigation in this regard stopped at 1983. Though we do not have data for the two years which followed i.e. up to 1985, the present drought conditions experienced by the two northern areas indicate that the occurrence of rain failure has continued throughout 1984 to 1985. Successive years of inadequate rain create cumulative deficits in agricultural produce and grazing resources, and since these have actually happened in Mazroub-Tinna and Khuwei areas, they explain the present drought conditions occurring there.

5.4. Grazing systems:

Livestock raising is practiced under two systems in the study area. The first one is a village-based system adopted by the settled communities whereby livestock is kept throughout the year grazing near settlements. The second type is

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Table 49

Ownership ranges by type of animal.

Area / Type of Livestock	Percentage distribution by different ranges of ownership: 1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27	28-30	31-33	34 +	Total
Mazroub-Tinna:													
Cattle	27.27	40.90	4.55	13.64	9.09	4.55	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Sheep	0.00	4.44	6.68	8.89	8.89	2.22	8.89	0.00	4.44	6.67	2.22	46.66	100.00
Goats	16.49	24.74	12.37	15.46	9.29	0.00	10.32	2.06	4.12	3.09	0.00	2.06	100.00
Camels	62.85	5.71	1.43	2.86	1.43	1.43	0.00	0.00	0.00	2.86	0.00	21.43	100.00
Donkeys	90.36	6.02	3.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Horses	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Khuwei:													
Cattle	45.16	22.57	3.23	16.13	6.45	0.00	3.23	0.00	3.23	0.00	0.00	0.00	100.00
Sheep	7.89	7.89	3.95	7.89	13.16	1.32	10.53	0.00	5.26	5.26	0.00	36.85	100.00
Goats	20.71	29.29	10.00	22.86	7.86	2.86	2.85	0.00	1.43	0.71	0.00	1.43	100.00
Camels	68.11	8.70	2.90	0.00	4.35	0.00	10.14	4.35	0.00	0.00	0.00	1.45	100.00
Donkeys	87.18	12.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Horses	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00

Cont../..

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Table 49 (Cont.)

Area / Type of Livestock	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27	28-30	31-33	34 +	Total
	Percentage distribution by different ranges of ownership:												
Muglad:													
Cattle	9.00	11.00	9.00	9.00	16.00	1.00	13.00	3.00	10.00	19.00	0.00	0.00	100.00
Sheep	5.89	11.76	5.89	20.59	8.82	2.94	17.65	2.94	11.76	11.76	0.00	0.00	100.00
Goats	10.07	20.93	7.75	17.05	13.96	4.65	10.08	0.00	0.78	6.20	0.78	7.75	100.00
Camels	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Donkeys	86.23	13.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Horses	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00

Total answers received:

Number of respondents reporting owning:

	Cattle	Sheep	Goats	Camels	Donkeys	Horses	Total
Mazroub-Tinna :	22	45	97	70	83	2	319
Khuwei :	31	76	140	69	117	12	445
Muglad :	100	34	129	20	138	11	432

Table 50

Rainfall adequacy for grazing, in percentage of answers given.

Year	El Mazroub-Tinna		El Khuwei		El Muglad	
	Adequate	Inadequate	Adequate	Inadequate	Adequate	Inadequate
1980	90.91	9.09	85.00	15.00	89.67	10.33
1981	75.35	24.65	85.91	14.09	80.06	19.94
1982	47.92	50.08	60.96	39.04	87.37	12.63
1983	35.47	64.53	52.27	47.73	13.78	86.22

Total answers received:

	1980	1981	1982	1983
Mazroub-Tinna :	146	142	141	140
Khuwei :	224	214	217	210
Muglad :	189	180	182	178

an open range seasonal grazing system followed by nomads and semi-nomads, whereby livestock is driven to distant pastures. Both types are found in the three areas, however, the second one predominates in Muglad area.

Table 51 demonstrates the prevalence of the two patterns throughout the five locally distinguished grazing periods:

- Kharif : rainy season proper, July-September,
- Darat : the period immediately after the rainy season, October-November,
- Shitta : the cool period, December-February,
- Seif : the hot period, March-May,
- Kushash: early showers, June-July, (depending on the onset of the rains).

For village-based livestock herders would look for distant grazing if there is inadequate pasture and water supply around the village, or for fear of damaging crops, and when they have large herds as is demonstrated by Table 51.

It is apparent from Tables 51 and 52 that the livestock of Mazroub-Tinna and Khuwei areas is concentrated all year round near settlements, due to the limited size of village herds and the availability of water in settlements or at nearby centres. Such a concentration is another dynamic factor adding to the causes of ecological degradation of the study area.

5.5. Fire-lines as Conservation Measures:

Fire-lines were introduced by the colonial administration as protection and conservation measures for the range lands. During the earlier periods, the opening of fire-lines and the patrolling of range lands to minimize fire hazards were the responsibility of the tribal administration, carried out through the hierarchy of

Table 51

Place of livestock grazing at different seasons.

Area	Answers in percentages														
	Kharif			Darat			Shitta			Seif			Rushash		
	Near village	Away from village	Total	Near village	Away from village	Total	Near village	Away from village	Total	Near village	Away from village	Total	Near village	Away from village	Total
Mazroub-Tinna	70.19	29.82	100.00	70.19	29.82	100.00	69.56	30.44	100.00	68.56	31.44	100.00	67.65	32.35	100.00
Khuwei	64.08	35.92	100.00	89.33	10.67	100.00	87.92	12.08	100.00	77.71	22.95	100.00	87.34	12.66	100.00
Muglad	21.21	78.79	100.00	51.20	48.80	100.00	33.73	66.27	100.00	41.80	58.20	100.00	82.53	17.47	100.00

Total answers given:

	Kharif	Darat	Shitta	Seif	Rushash
Mazroub-Tinna	104	104	115	105	102
Khuwei	142	150	149	166	158
Muglad	165	166	156	189	166

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Table 52

Reasons for practicing distant grazing away from village.

Area	Answers given in percentages					
	Inadequate grazing around village	Large herd size	Fear of damaging crops	Inadequacy of water supply at village	Others	Total
Mazroub-Tinna	39.73	6.85	13.70	36.98	2.74	100.00
Khuwei	30.17	3.45	21.55	36.21	8.62	100.00
Muglad	32.82	8.49	20.07	35.91	2.70	100.00

Total answers received:

Mazroub-Tinna : 73
Khuwei : 116
Muglad : 259

office holders: nazir, sub-nazir, omda and sheikh. They used to be paid small financial rewards for their effort, which they reciprocated with their village folk. After independence the role of the traditional administration in this activity gradually diminshed and their place was taken by local contractors paid by the local government councils to do the job. Fig. (14) shows the network of fire-lines that used to be annually opened and maintained.

Fire-lines were kept intact up to the early 1970's. Afterwards they suffered negligence due to budgetary cuts, late commencement of execution, inefficient work of contractors, and lately the complete devastation of the vegetation cover in many areas which does not justify spending on protection and conservation measures.

To assess the role of fire-lines in the study area responsdents' perception of the activity was investigated. Table 53 show that fire-lines do not exist as they used to be. The answer for non-existence of fire-lines is 61% for Mazroub-Tinna area, 56% for Khuwei area, and 91% for Muglad area.

While in the past, when the ecological cover was rich, fires were frequent and were estimated to annually devastate 60% of the range lands of the country, presently such a frequency is no longer reported. This corollary is supported by the data in Table 54 on the occurrence of fires during the period 1980-83 in the study area. The data evidently show a decreasing frequency of fires especially toward the end of the period. The only explanation for this, in absence of fire-lines, is the current poor state of the biomass cover.

5.6. <u>Use of Supplementary Feeds</u>:

To assess further the situation of fodder in the study area it was thought essential to examine the extent of use of supplementary feeds. The livestock raiser in

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FIG. 14. THE NETWORK OF FIRE LINES IN KORDOFAN REGION, 1975
(FROM A MAP BY THE ADMINISTRATION FOR RANGE & PASTURE)

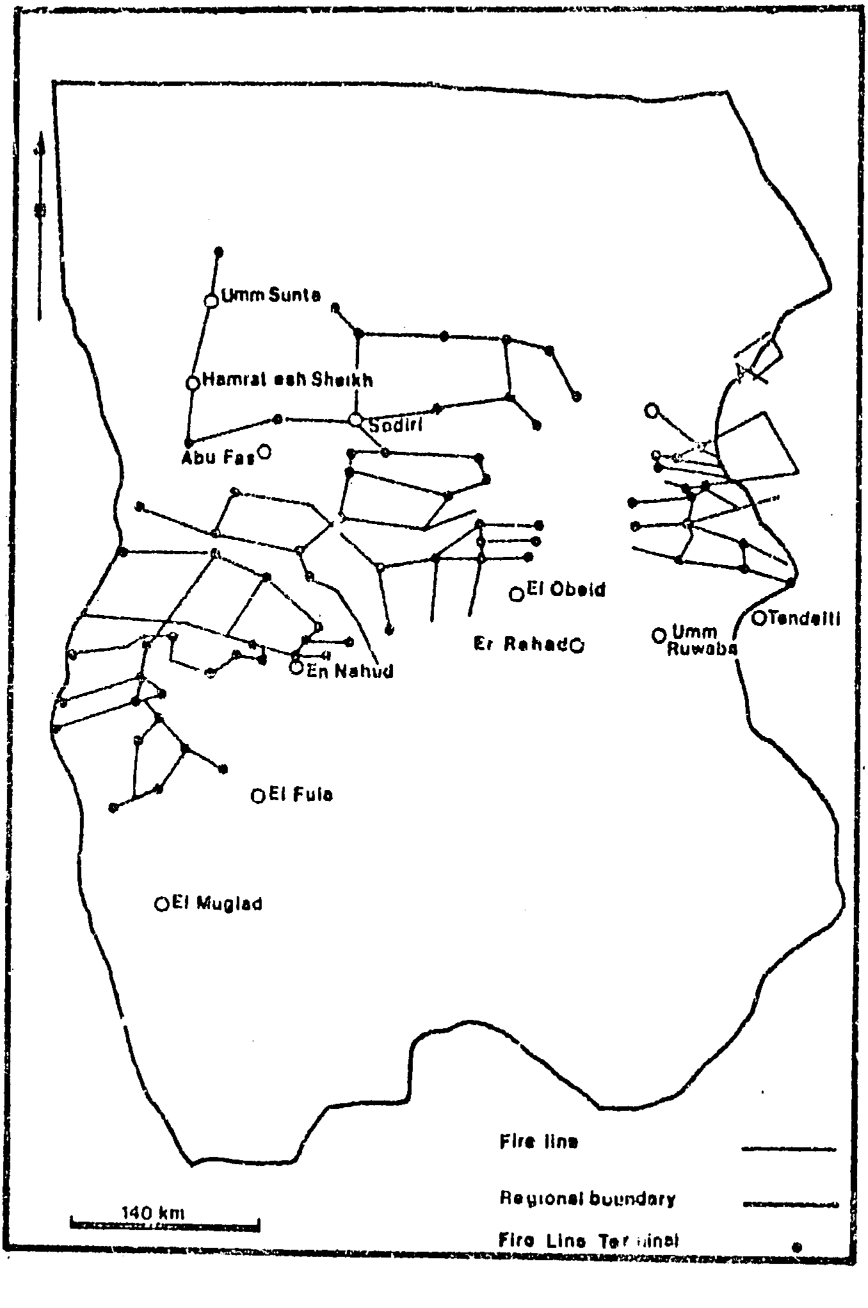

Table 53

Presence of fire-lines in the study area.

Area	Percentage answers stating		Total
	Fire-lines exist	Non-existent	
Mazroub-Tinna	38.89	61.11	100.00
Khuwei	42.74	57.26	100.00
Muglad	8.67	91.33	100.00

Total answers received:

Mazroub-Tinna	: 144
Khuwei	: 234
Muglad	: 173

Table 54

Occurrence of fires during the last four years - 1980-83.

Area	Respondents reporting fire occurrence								Computed for four years.	
	1980		1981		1982		1983			
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Mazroub-Tinna	33.33	66.67	29.08	70.92	13.07	86.93	1.40	98.60	18.80	81.20
Khuwei	47.35	52.65	53.74	46.26	41.92	58.08	10.15	89.85	38.38	61.62
Muglad	59.13	40.87	55.28	44.72	45.58	54.42	11.06	88.94	43.03	56.97

Total answers received:

Mazroub-Tinna	:	569	(for four years)
Khuwei	:	899	(" " ")
Muglad	:	832	(" " ")

Kordofan was not a big user of supplementary feeds in the past, as livestock depended fully on the natural range. Occassionally dura, ferterita type(*) rated as an inferior food grain was purchased from the markets and fed to animals for fattening.

Taking the present degraded condition of the natural range respondents were asked to report on the critical period when they normally experience fodder shortage. From Table 55 the period February to June was identified as the time of fodder shortage with the situation becoming more acute towards the end of the period as could be judged from the same table.

As a consequence of fodder shortage livestock raisers, particularly the village-based type, would fetch hay for their animals as a first resort since this could be obtained from nearby range lands. Table 56 reveals that 56% of the respondents in Mazroub-Tinna area and 68% in Khuwei area fetched hay to feed their animals. The percentage drops to 16% in Muglad area which is illustrative that the open rangelands there were still maintaining the grazing needs of the herds, which is indicative that the same conditions used to prevail in the past in Mazroub-Tinna and Khuwei areas. Among those using hay the majority collected it by themselves as the last two columns in Table 56 point out.

The second resort other than hay under the current shortage would be supplementary feeds. Table 57 illustrates that 63% of the respondents in the two areas of Mazroub-Tinna and Khuwei used supplementary feeds. Again the low percentage of 17 in Muglad area could be explained in light of the reasons given previously.

As for the types of supplementary feeds in use these are detailed in Table 57 with crop residues, dura, water-

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(*) Presently the main cereal grain of the food aid programme to drought-hit areas.

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Table 55

Critical fodder period.

Area	Answers in percentages for following periods				Total
	February to June	March to June	April to June	May to June	
Mazroub-Tinna	6.42	24.77	35.78	33.03	100.00
Khuwei	3.57	17.14	41.43	37.86	100.00
Muglad	2.76	29.66	49.65	17.93	100.00

Total answers received:

Mazroub-Tinna : 109
Khuwei : 140
Muglad : 145

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Table 56

Whether respondents use hay for feeding animals, and whether purchased or collected.

Area	Percentage answering using hay			Percentage answering collecting or purchasing		
	Yes	No	Total	Collecting	Purchasing	Total
Mazroub-Tinna	56.10	43.90	100.00	80.39	19.61	100.00
Khuwei	68.35	31.65	100.00	80.56	19.44	100.00
Muglad	16.45	83.55	100.00	93.54	6.46	100.00

Total answers received:

	Using hay	Collecting/Purchasing
Mazroub-Tinna	82	53
Khuwei	158	108
Muglad	157	62

231

Table 57

Whether livestock is fed supplementary feeds and types of feeds supplied.

Area	Percentage answers feeding supplementary feeds			Percentage answers as to types of supplemtnary feeds					
	Yes	No	Total	Crop residues	Dura	Oil seed cakes	Water-melons	Others	Total.
Mazroub-Tinna	53.22	36.78	100.00	20.96	33.06	12.10	33.88	0.00	100.00
Khuwei	64.24	35.76	100.00	28.83	22.07	18.92	29.28	0.90	100.00
Muglad	16.45	83.55	100.00	32.14	28.57	10.72	21.43	7.14	100.00

Total answers received:

	Whether feeding grown fodders	Types of fodders supplied
Mazroub-Tinna :	87	124
Khuwei :	151	222
Muglad :	152	56

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melons and to some degree oil seed cakes being mentioned.

Regarding the period people began using supplementary feeds on a large scale in the study area, respondents in Mazroub-Tinna and Khuwei areas reported adopting the practice before 10 years as Table 58 illustrates. In Muglad area the use of supplementary feeds was dated back to before five years, which again explains the better ecological conditions of this area as compared to the former two.

5.7. The conclusion to this section shall be based on two tables trying to answer the following question: Taking the evident shortage in the grazing resources of the study area and the constraint of obtaining supplementary feeds with the present day deficit in locally produced dura and the inhibiting prices of imported dura what is the state of the livestock economy at present? The short answer to this question is that the industry is declining especially in the northern two areas Mazroub-Tinna and Khuwei.

Table 59 confirms that livestock numbers are decreasing. Since the two years which succeeded 1983 to date have been worse because of the prevalent drought conditions, it is only expected that the trend of decline has become more established. This is further proven by the data in Table 60 on reasons given by respondents for the decrease in the number of livestock. The two main reasons behind the decline in numbers are animals being sold or died because of drought. The first factor is as damaging as the second one, since people are forced to sell their animals either to get rid of them because of the scarcity of fodders or to exchange their value for grains to meet the household needs.

Table 58

The period when people started using supplementary feeds.

Area	Percentage reporting		Total
	Before 5 years	Before 10 years	
Mazroub-Tinna	37-68	62.32	100.00
Khuwei	39.39	60.61	100.00
Muglad	64.29	35.71	100.00

Total answers received:

Mazroub-Tinna	:	69
Khuwei	:	99
Muglad	:	42

Table 59

Whether animal numbers increased or decreased in the period(1980-1983).

Area	Percentage distribution of answers											
	Cattle		Sheep		Goats		Camels		Donkeys		Horses	
	Incr-eased	Decr-eased	Incr-eased	Decr-eased	Incr-eased	Decr-eased	Incr-eased	Decr-eased	Incr-eased	Decr-eased	Decr-eased	Incr-eased
Mazroub-Tinna	9.52	90.48	25.00	75.00	22.45	77.55	36.67	63.33	42.25	57.75	0.00	0.00
Khuwei	31.03	68.97	42.31	57.69	42.74	57.26	43.28	56.72	44.95	55.05	62.25	37.75
Muglad	17.64	82.36	28.26	71.74	35.65	64.35	40.00	60.00	34.62	65.38	50.00	50.00

Total answers received:

	Cattle	Sheep	Goats	Camels	Donkeys	Horses	Total
Mazroub-Tinna :	21	56	98	60	71	0	306
Khuwei :	29	78	124	67	109	8	415
Muglad :	153	46	115	5	52	2	373

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Table 60

Reasons for decrease in animal numbers

Area	In percentage of answers received						Total
	Sold	Slaughtered	Stolen	Gifted	Died because of drought	Others	
Mazroub-Tinna	46.45	3.23	6.45	3.23	39.35	1.29	100.00
Khuwei	46.56	14.36	7.47	2.31	24.13	5.17	100.00
Muglad	30.48	10.79	6.67	7.31	41.90	2.85	100.00

Total answers received.

Mazroub-Tinna	:	155
Khuwei	:	174
Muglad	:	315

CHAPTER SIX

USES OF THE TREE BIOMASS COVER

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USES OF THE TREE BIOMAS COVER

6.1. General:

Besides crop production and livestock raising, there are other forms of human activity which affect the ecology of the area. A major one in this connection is the use of the tree vegetation cover by the local communities for different purposes including:

i. building of human settlements,

ii. energy uses, and

iii. burning wood for perfume purposes by ladies.

The continuous growth in population and human settlements has been accompanied by an increase in the use of these resources at rates beyond natural regeneration.

To complete the picture on the resource uses of the area, the state of the tree vegetation cover shall be discussed under the three main uses outlined above.

6.2. Building of human settlements:

The population of the study area lives in villages, all built of local material, except for governmental institutions and the housing of some of the well-to-do merchants to be found in the intermediate centres of the three areas.

A general picture of the housing situation in the survey area is supplied in Table 61 which gives the housing composition and reflects the need for local material for house construvtion. The majority of houses are made of 2-3 huts as the percentages reveal. Basic utilities such as latrines and bath rooms are lacking.

The type of local material used, i.e., tree and grass vegetation, is not of a permanent nature like other forms of local material in use in other parts of the country such

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Table 61

House Composition.

Area	Huts: Percentage of houses having						Kitchens % of houses having the facility			Latrines: Percentage of houses having					Bathrooms: Percentage of houses having				
	One Hut	Two Huts	Three Huts	Four Huts	Five huts and more	Total	Yes	No	Total	Private	Shared	Communal	Non-existent	Total	Private	Shared	Communal	Non-existent	Total
Mazroub-Tinna	10.16	32.81	37.50	12.50	7.03	100	63.76	36.54	100	36.22	3.94	0	59.84	100	26.36	14.72	0	58.92	100.00
Khuwei	9.44	24.89	25.33	20.17	20.17	100	79.74	20.26	100	43.86	2.63	0	53.51	100	41.81	9.83	0	38.36	100.00
Muglad	18.59	35.89	25.64	10.26	9.62	100	55.14	44.86	100	23.44	8.59	0	67.97	100	24.8	6.40	0	68.80	100.00

Total answers received:

	Huts	Kitchen	Latrines	Bathrooms
Mazroub-Tinna	128	104	127	129
Khuwei	233	232	228	232
Muglad	156	136	128	125

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as dry earths structures built of vegetation material decay in a few years time and need periodic renewal, Table 62. Hence there is a continuously building demand on the vegetation cover of the area, not only to supply the requirements of new housing but as well for the renewal of what exists.

A household is composed of two structures the hut(s), the main shelter unit which may be conical or square in shape, and the fence enclosing the plot area. Fences are not common to all houses and many are seen unfenced. For the two forms of structures special types of wood are needed. The varieties used are different from one area to another depending on the ecological nature of the area as could be depicted from Table 63. The species mostly used and consequently widely depleted are identified and rated in Table 64 which furnishes data on the source location from which wood for construction is obtained, i.e., from near settlements or from distant sites. Since in their use of wood, people are selective of certain varieties and parts of trees to meet the structural requirements, the tree cover near the villages has become short of meeting settlement needs. Thus, with the exception of thatching and fencing material, for all other types villagers are relying on distant sources of supply.

6.3. <u>Energy Uses</u>:

The population depends on the ecosystem for the supply of the homestead energy needs, just as in the case of wood supply for construction purposes, Table 65. The table reveals that fuel wood is the main source of energy used for cooking and even lighting in all three areas as conveyed by 100% of all respondents. Charcoal is used but by a limited sector of the population, mainly by some of the households in the central villages, 10 to 17% of all respondents. The same is true for kerosene which is basically used for lighting 6-33%. Crop residues and grasses are widely used for light cooking, 16-20% and 14-18% respectively.

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Table 62

Time house is renewed in percentage answers.

Area	Gutiya (hut)				Rakuba (a square shaped hut)				Fence			
	Less than 3 years	3-5	5+	Total	Less than 3 years	3-5	5+	Total	Less than 3 years	3-5	5+	Total
Mazroub-Tinna	37.88	39.39	22.73	100.00	80.87	17.39	1.74	100.00	95.00	2.70	1.80	100.00
Khuwei	20.83	48.61	30.56	100.00	63.04	28.26	8.70	100.00	83.33	12.12	4.55	100.00
Muglad	34.71	63.53	1.76	100.00	52.15	47.85	0.00	100.00	94.66	4.58	0.76	100.00

Total answers received:

	Hut	Rakoba	Fence
Mazroub-Tinna:	132	115	111
Khuwei :	288	230	132
Muglad :	170	163	131

Table 63

Tree species used for construction material.

Area	Species (+ Other materials)	Percentage answers for using species/materials for: Stands (Shiab)	Runners (Kao)	Poles (Gazaz)	Lining material (matarig)	Tying material	Thatching material	Fencing material
Nazroub-/Tinna	Acacia mellifera	41.56	43.67	39.35	--	--	--	9.24
	Acacia senegal	35.54	37.35	23.23	--	--	--	8.15
	Balanites aegyptiaca	13.86	9.49	--	--	--	--	--
	Cordia rothii	9.04	--	10.32	39.57	53.47	--	--
	Leptadenia pyrotechnica	--	9.49	17.42	12.23	--	--	22.83
		--	--	9.68	17.98	--	--	--
	Acacia tortilis	--	--	--	30.22	37.50	--	--
	Acacia nubica	--	--	--	--	9.03	--	--
	Palm leaves(imported material)	--	--	--	--	--	--	--
	Dukhun stalks(locally produced material)	--	--	--	--	--	83.22	51.63
	Dry grass(locally produced material)	--	--	--	--	--	16.78	8.15
	Totals	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Cont./..

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Table 63 (Cont.)

Area	Species (+ Other materials)	Percentage answers for using species/materials for						
		Stands (Shiab)	Runners (Kao)	Poles (Gazaz)	Lining material (matarig)	Tying material	Thatching material	Fencing material
Khuwei:	Dalbergia melanoxylon	69.42	---	27.76	---	---	---	22.47
	Albizia amara	11.68	10.37	6.68	5.75	---	---	4.11
	Terminalia sp.	13.40	55.85	8.03	9.95	---	---	---
	Acacia senegal	5.50	22.41	8.03	---	---	---	4.11
	Guiera senegalensis	---	6.35	35.45	78.55	---	---	9.04
	Acacia mellifera	---	5.02	---	---	---	---	---
		---	---	14.05	---	---	---	---
	Lannea humilis	---	---	---	5.75	100.00	---	---
	Dukhun stalks (locally produced material)	---	---	---	---	---	93.88	56.16
	Dry grass (locally produced material)						6.12	4.11
	Totals	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Cont../..

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Table 63 (Cont.)

Area	Species (+ Other materials)	Percentage answers for using species/materials for: Stands (Shiab)	Runners (Kao)	Poles (Gazaz)	Lining material (matarig)	Tying material	Thatching material	Fencing material
Muglad:	Dalbergia melanoxylon	65.22	34.10	39.01	—	—	—	17.70
	Terminalia macroptera	11.11	10.98	—	—	—	—	—
	Anogeissus Leiocarpus	23.67	43.56	24.18	—	—	—	—
	Acacia nilotica	—	5.68	—	—	—	—	—
	Guiera senegalensis	—	5.68	36.81	88.31	—	—	26.15
	Albizia amora	—	—	—	11.69	—	—	—
	Lannea humilis	—	—	—	—	76.24	—	—
	Palm leaves(imported material)	—	—	—	—	7.73	—	—
	Manufactured material	—	—	—	—	16.03	—	—
	Dukhun stalks	—	—	—	—	—	100.00	56.15
	Totals	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Total answers received:	Stands (Shiab)	Runners (Kao)	Poles (Gazaz)	Lining material (matarig)	Thatching material	Thatching material	Fencing material
Mazroub-Tinna	166	158	155	139	144	143	184
Khuwei	291	299	299	261	224	245	365
Muglad	207	264	182	134	181	146	130

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Table 64

Areas from which wood for construction is obtained given in percentage answers.

Area	Stands		Runners		Poles		Lining material		Tying material		Thatching material		Fencing material	
	Near	Distant	Near	Distant	Near	Distant	Near	Distant	Near	Distant	Near	Distant	Near	Distant
Mazroub-Tinna	43.31	56.69	39.52	60.48	49.22	50.78	44.44	55.56	50.93	49.07	76.23	23.77	72.73	77.27
Khuwei	26.52	73.48	30.60	69.40	38.06	61.94	52.84	47.66	42.15	57.85	77.16	22.84	71.30	28.70
Muglad	53.29	46.71	52.32	47.68	58.44	41.56	62.21	37.79	63.29	36.71	83.22	16.78	80.88	19.12

Total answers received:

	Stands	Runners	Poles	Lining material	Tying material	Thatching material	Fencing material
Mazroub-Tinna:	127	124	128	126	127	122	121
Khuwei :	230	232	268	214	223	232	223
Muglad :	152	151	154	172	158	149	136

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Table 65

Energy Sources used by the Household.

Area	Answers expressed as percentages of sample				
	Wood	Charcoal	Kerosene	Crop residues	Grasses
Mazroub-Tinna	100.00	9.86	6.34	16.20	17.61
Khuwei	100.00	17.86	33.06	20.54	16.96
Muglad	100.00	13.07	16.08	19.10	14.07

	Sample size	Answers received using: Wood	Charcoal	Kerosene	Crop residues	Grasses
Mazroub-Tinna:	142	142	14	9	23	25
Khuwei :	224	224	40	74	46	38
Muglad :	199	199	26	32	38	28

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of all forms of energy used fuel, wood is the most highly consumed. An attempt is made in Table 66 to estimate the household consumption per annum, which comes to 10 to 15 camel loads, roughly equivalent to an average of 25 kantars.

As in the case of construction material there are certain tree species which are preferred by local communities for the production of fuel wood and charcoal. Based on respondents' answers the identified species are listed and rated in Table 67.

Excepting charcoal which is mostly purchased, the majority of households (80-100%) obtain the other locally supplied fuel types by themselves, Table 68.

Similar to the wood supply for construction, fuel wood and charcoal, with some exception in the Muglad area, are obtained from distant sources, as the biomass productivity near villages has markedly diminshed, Table 69.

Another use of the tree vegetation, though of limited extent, is wood for perfume uses by ladies, both locally and for the near-by towns. Since this form of utilization is selective as to what trees are suitable for the purpose, the species used are limited and vary from one ecological zone to another, Table 63. It is to be observed that the range of species is wider as we go south from Mazroub-Tinna to Muglad area.

The household supply of perfume wood is met from differently located sources as Table 70 reveals. With the consumption being limited in amount and selective in use of certain biomass types, there is a fair distribution of the location of the source from which the products are obtained between village vicinity, within survey area and outside survey area as indicated by Table 71.

6.4. <u>Conclusion</u>:

Apart from cultivation and grazing as the two major economic activities, wood cutting for different purposes adds to the impact of man on the ecosystems of the three

Table 66

Wood consumption per annum (in camel load)(*)

Area	Percentage answers			Total
	Less than 10	11-15	16 +	
Mazroub-Tinna	50.59	25.88	23.53	100.00
Khuwei	54.12	30.00	15.88	100.00
Muglad	53.96	23.02	23.02	100.00

(*) A camel load is equivalent to 2 H/W.

Total answers received:

Mazroub-Tinna : 85
Khuwei : 170
Muglad : 126

Table 67

Tree species used for fuel wood production.

Area / Species	Percentage Answers
Mazroub-Tinna:	
Acacia senegal	29.60
Acacia mellifera	27.43
Balanites aegyptiaca	11.55
Leptadenia pyrotechina	10.83
Acacia tortilis	9.39
Cordia rothii	5.78
Acacia seyal	5.42
	100.00
Khuwei:	
Dalbergia melanoxylon	28.54
Albizia amara	25.51
Acacia senegal	17.81
Guiera sengalensis	11.74
Terminalia sp.	9.31
Combretum sp.	7.09
	100.00
Muglad:	
Dalbergia melanoxylon	41.00
Albizia amara	12.97
Anogeissus leiocarpus	12.53
Terminalia macroptera	9.11
Acacia seyal	6.61
Guiera sengalensis	5.70
Combretum sp.	4.33
Blanites aegyptiaca	4.33
Acacia mellifera	3.42
	100.00

Total answers received:

Mazroub-Tinna : 277
Khuwei : 494
Mazroub : 439

Table 68

How fuel material is obtained

Area	Percentage answers											
	Wood			Charcoal			Crop residues			Grass		
	Collected	Purchased	Total	Produced	Purchased	Total	Collected	Purchased	Total	Collected	Purchased	Total
Mazroub-Tinna	85.43	14.57	100.00	14.29	85.71	100.00	93.48	6.52	100.00	88.00	12.00	100.00
Khuwei	85.28	14.72	100.00	17.50	82.50	100.00	91.49	8.51	100.00	97.62	2.38	100.00
Muglad	93.46	6.54	100.00	34.48	65.52	100.00	92.11	7.89	100.00	92.86	7.14	100.00

Total answers received:

		Wood	Charcoal	Crop residues	Grass
Mazroub-Tinna	:	151	14	46	25
Khuwei	:	231	40	47	42
Muglad	:	199	29	38	28

Table 69

Areas from which wood fuels are obtained

Area	Percentage answers					
	Wood			Charcoal		
	Village vicinity	Distant	Total	Village vicinity	Distant	Total
Mazroub-Tinna	63.19	36.81	100.00	13.33	86.67	100.00
Khuwei	46.53	53.47	100.00	32.65	67.35	100.00
Muglad	82.93	17.07	100.00	34.78	65.22	100.00

Total answers received:

	Wood	Charcoal
Mazroub-Tinna :	144	15
Khuwei :	245	32
Muglad :	205	23

Table 70

Aromatic wood vegetation and grasses used by women.

Wood species	Percentage answers by area		
	Mazroub-Tinna	Khuwei	Muglad
Combretum sp.	38.67	34.88	—
Acacia seyal	33.70	4.98	29.47
Acacia mellifera	9.39	—	—
Combretum aculeatum	18.24	—	—
Terminalia sp.	—	22.59	9.05
Terminalia macropetra	—	37.55	32.71
Boswellia papyrifera	—	—	8.35
أبليلى (*)	—	[illegible]	16.94
السعدة (grass species)(*)	—	—	3.48
Total	100.00	100.00	100.00

(*) Species for which Latin names could not be supplied.

Total answers received:

Mazroub-Tinna	:	181
Khuwei	:	301
Muglad	:	431

Table 71

Areas from which aromatic wood vegetation and grasses are obtained.

Area	Percentage answers: Village vicinity	Within survey area	Outside survey area	Total
Mazroub-Tinna	40.97	27.08	31.95	100.00
Khuwei	36.70	31.23	32.07	100.00
Muglad	36.97	40.63	22.40	100.00

Total answers received:

Mazroub-Tinna	:	144
Khuwei	:	237
Muglad	:	192

areas. People's needs for wood are continuously expanding due to population and settlement growth. Biomass production is not expanding equally. Communities are selective in their use of the vegetation cover. When the resources in the vicinity of settlements are depleted they fetch their needs in far located resources. Equally when a preferred species is diminshed they shift to the next best suiting the purpose.

Ecosystems work through their own internal balances. The mass devastation taking place leads to the disfunctioning of these internal mechanism. Accordingly there are evident ecological changes in the study area where valuable tree and grass species are disappearing with their place being taken by invaders of inferior quality. With this trend continuing unchecked, the ecology has been changed and new plant communities and associations are appearing in areas that originally had a richer ecological cover. In this way the future of human habitation in these lands is not only affected by the current drought conditions but by the long lasting effects of desertification.

CHAPTER SEVEN

CONCLUSION: ECOLOGICAL DEGRADATION AND ENVIRONMENTAL CHANGE

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CONCLUSION: ECOLOGICAL DEGRADATION AND ENVIRONMENTAL CHANGE

7.1. Introduction:

The objectives of the ETMA research programme are to study ecosystems in change, assess and monitor the change magnitude and recommend plans to reverse the present adverse trends. One of the outcomes of the exercise is to use the results of the researches carried out under the programme in training at many levels. Training is at least crucial at two levels: that of the planners and technical staff working in the regions, and that of the communities studied being directly affected by change, in preparation for their involvement in any envisaged action programmes to remedy the adverse effects.

The two preceding studies completed in 1983 for Khuwei-Mazroub-Tinna area and Messeriya area furnished the base-line data, identified sets of biological, physical, and socio-economic indicators and attempted some trend analysis of environmental change. As emphasized, the 1983 work was based on the empirical scientific research method, as researchers verified the hypotheses set for testing through field investigations and substantiated their findings with material written about the two areas, while the present study is based on community perception of change using the previous findings as guidelines for more trend analysis and monitoring.

Reviewing the 1983 reports and the present one demonstrates clearly the connectivity between the two findings and confirms that the results derived from the community perception study fall in place with the empirical research findings. This we hope validates the plan that the two researches were designed to dovetail into each other.

In line with the above approach this concluding section is written in an attempt to summarize the issues related to ecological degradation and environmental change based on 1983 findings and the perception study. The main aspects that shall be covered are the following:

i. population perception of degradation and causes of environmental change,

ii. rainfall and ecological change impacts,

iii. ecological change arrested through disappearance of vegetation cover,

iv. soil degradation confirmed,

v. increase in pests which attack crops,

vi. staple grain crops augmented by importation from outside the area,

vii. water supply shortages, and

viii. occurrence of population migration to supplement household income and make-up for the local food shortage.

7.2. Population Perception of Degradation:

The studies carried out on desertification and drought emphatically point out the occurrence of ecological change which accelerates the rate of the former and contributes to the severity of the latter. The 1983 reports on the study area confirmed the same conclusions derived from the current literature. In context of the above which is reached from scientific accounting for the prevalent phenomena, how do local communities perceive ecological changes in the survey area ? Findings from Table 72 convey local communities interpretation of the situation which confirms the occurence of degradation being rated very high in Mazroub-Tinna and Khuwei areas: 97 and 95%, and lower: 73% in Muglad area, respectively. The variation in rating follows the north-south ecological succession of the three areas, which is indicative of the degree of change zone-wise.

Table 72

Whether population perceives that the survey area is ecologically degraded or not

Area	Percentage answers		Total
	Degraded	Not degraded	
Mazroub-Tinna	97.20	2.80	100.00
Khuwei	95.28	4.72	100.00
Muglad	73.33	26.67	100.00

Total answers received:

Mazroub-Tinna	:	143
Khuwei	:	233
Muglad	:	195

Many factors were outlined and studied as the causes behind ecological degradation and change. The most prominent ones among them were put before the sample studied for rating. The results are furnished in Table 73, where respondents ranked the causes of degradation in the following order: drought, expansion of cultivation, impact of nomads, increase in numbers of livestock and the occurrences of pests and diseases causing the death of trees, selected as the major ones with a low rating for the impact of water sources and commercial production of fuel wood and charcoal.

The low rating of the impact of water sources may be due to the fact that such an impact results through a chain effect caused by a complex process, involving many variables such as growth of human settlements, expansion of cultivation, over concentration of livestock, etc., which are not easily related by local communities. Besides, of course, water sources are services badly needed in these areas and highly appraciated. Commercial fuel wood production on the other hand is practiced on a limited scale in the two southern areas, which may explain the low rating received by this variable.

As a further test to community awareness of ecological change, the signs of such a change concluded from the 1983 research findings were similarly put before respondents for rating. The results are summarized in Table 74. The ones which scored high rating are: increase in the area of bare surface, more frequent sand storms, and dune encroachment. The other signs ascertained but rated low are the spread of termite attacks on vegetation cover and the appearance of new water courses.

These signs are the physical evidence or the artifacts of degradation. They are the outcome of the cumulative effects of many ongoing ecological processes that have culminated in their appearance. It is thought to be essential to investigate some of these processes with the local communities, again guided in that by the team

Table 73

Reasons behind degradation.

Area	Percentage answers received							
	Expansion of Cultivation	Increases in number of livestock	Impact of nomads	Impact of water sources	Drought	Commercial production of fuel wood and charcoal	Pests and diseases causing death of trees	Total
Mazroub-Tinna	8.71	11.15	16.72	1.74	46.34	0.70	14.64	100.00
Khuwei	17.92	13.60	17.60	4.16	31.36	5.75	9.75	100.00
Muglad	14.24	16.40	10.76	8.88	33.86	7.53	8.33	100.00

Total answers received:

Mazroub-Tinna	:	287
Khuwei	:	625
Muglad	:	372

Table 74

Signs of ecological degradation as ranked by respondents.

Area	Ranking of signs of degradation						
	Dune encroachment	More frequent sand storms	Increase in bare surface	Appearance of new water courses	Spread of termite attack	Others	Total
Mazroub-Tinna	27.74	30.79	29.77	2.29	9.41	0.00	100.00
Khuwei	20.03	31.58	31.07	5.43	10.36	1.53	100.00
Muglad	17.74	12.95	33.33	11.30	17.74	6.99	100.00

Total answers received:

Mazroub-Tinna	393
Khuwei	589
Muglad	186

findings on the indicators of change, which shall be considered next.

7.3. Rainfall/Ecological Change Impact:

As presented earlier there has been a decline in rainfall as from 1982 and on. The drop in annual rainfall results in many ecological changes. Table 75 traces these changes. Respondents' rating is in the following order: crop and pasture failure (which are two results ascertained by the previous discussions), migration of human population, migration of livestock, high livestock mortality, and death of trees.

7.4. Shrinkage of Vegetation Cover:

An immediate effect of drought in a chain analysis of the ecological degradation evidently seen by local communities is the decline in crops and pastures. The migration of humans and animals follows as the next effect resulting from the collapse of the resource base.

Whether the tree and grass cover, as indicative of the state of the natural ecology and the resource base, has increased or decreased could be assessed from respondents' answers given in Table 76. The results obtained clearly confirm a shrinkage in the vegetation cover in Mazroub-Tinna and Khuwei areas, as reported by 100 and 98% of all respondents consequently. The case is different in Muglad area where 46% of the answers confirmed the decrease in the vegetation cover while the rest were divided between increase and no change in vegetation cover.

The reasons behind the disappearance of the tree and grass cover are stated in Table 77. Based on the values accorded to each the most highly ranked three are drought, overgrazing and deforestation for fuel wood and land clearance for cultivation.

Under severely affected ecosystems such as the ones being investigated, research may focus on signs which may indicate that the system is compensating in other forms,

Table 75

Adverse effects of inadequate rainfall as rated by respondents.

Area	Rating of adverse effects						
	Crop failure	Decline of Pastures	Death of trees	High livestock mortality	Migration of livestock	Migration of human population	Total
Mazroub-Tinna	31.80	30.10	8.25	8.01	11.17	10.57	100.00
Khuwei	30.67	28.75	9.08	10.73	10.18	10.59	100.00
Muglad	24.32	24.07	3.83	19.87	18.40	9.51	100.00

Total answers received:

Mazroub-Tinna	:	412
Khuwei	:	727
Muglad	:	810

Table 76

Whether tree and grass cover increased or decreased

Area	Respondents rating given in percentages of answers received			Total
	Increased	Decreased	No change	
Mazroub-Tinna	0.00	100.00	0.00	100.00
Khuwei	2.34	97.66	0.00	100.00
Muglad	28.57	45.57	25.86	100.00

Total answers received:

Mazroub-Tinna : 249
Khuwei : 471
Muglad : 406

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Table 77

Reasons behind disappearance of tree and grass cover.

Area	Respondents' rating of causes given in percentages of answers received:								Total
	Over grazing	Over cultivation	Deforestation for fuel wood and cultivation	Felling wood for construction	Drought	Pests and diseases	Wind storms	Fires	
Mazroub-Tinna	11.01	0.00	9.17	0.00	73.85	5.05	0.92	0.00	100.00
Khuwei	10.59	0.64	5.73	0.42	65.25	8.05	3.82	5.50	100.00
Muglad	12.24	22.99	19.70	0.00	33.73	8.67	0.00	2.67	100.00

Total answers received:

Mazroub-Tinna	:	218
Khuwei	:	472
Muglad	:	335

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i.e., such as the appearance of new tree and grass species in place of the disappearing ones. Community observation in this regard is not encouraging as could be detected from Table 78 with the majority of answers given confirming no appearance of new tree and grass species. Even if we take this result as inaccurate based on what is scientifically established in ecological succession, most species which might appear shall be inferior from human use angle to the disappearing ones, being a form of succession under poorer ecological conditions.

7.5. Soil Degradation Confirmed:

All of the signs and causes of ecological degradation identified in Table 28 and 29 lead to the disappearance of the top soil and result in the loss of soil fertility. Table 79 confirms the occurrence of these conditions as reported by respondents. Again the low rating given in Muglad area is due to the fact that the state of degradation there has not reached a degree of severity, whereby a full community consensus could be passed as in the case of the first two areas.

Of the three types of soils prevalent in the study area, the one which is mostly used for cultivation and grazing is the sandy soil, Table 80. Since this type is the one dominant in the study area it could be concluded that soil degradation is widespread throughout the area.

7.6. Increase in Crop Attack by Pests:

Two kinds of pests, rodents and birds, affecting crop production were examined as to whether their numbers increased or decreased in the last ten years. Table 81 and 82 confirm that both had increased in number in the last ten years judged from the majority of answers given. Muglad area being different is because the ecosystem is still retaining its basic features as repeatedly explained before.

The causes behind intensive attacks by pests are listed and rated in Tables 83 and 84. For rodents,

Table 78

Appearance of new tree and grass species in the area during last 10 years.

Area	Respondents assessment in percentages	
	New species appeared	No species appeared
Mazroub-Tinna	3.48	96.52
Khuwei	10.62	88.38
Muglad	00.00	100.00

Total answers received:

Mazroub-Tinna : 201
Khuwei : 452
Muglad : 358

Tree species reported to have appeared include:

مــــرخ

سيــال

هبيــل

تابة بطران ـ هوسة ـ عرقس

Table 79

Whether soil degradation is taking place or not

Area	Those answering "Yes" and "No" in percentages of answers received		Total
	Yes	No	
Mazroub-Tinna	89.29	10.71	100.00
Khuwei	90.07	9.93	100.00
Muglad	54.87	45.13	100.00

Total answers received:

Mazroub-Tinna : 140
Khuwei : 232
Muglad : 195

Table 80

Soils that are mostly affected by cultivation and/or grazing.

Area	Respondents' rating of three types of soils in percentages of answers received			Total
	Sandy soils	Loamy soils	Clay soils	
Mazroub-Tinna	91.89	7.43	0.68	100.00
Khuwei	92.27	7.73	0.00	100.00
Muglad	89.85	7.73	2.42	100.00

Total answers received:

Mazroub-Tinna : 148
Khuwei : 220
Muglad : 207

Table 81

Whether rodents attacking crops increased in number during last 10 years.

Area	Percentage of respondents reporting			Total
	Increased	Decreased	No change	
Mazroub-Tinna	82.96	14.81	2.23	100.00
Khuwei	80.33	15.30	4.37	100.00
Muglad	35.14	3.24	61.62	100.00

Total answers received:

Mazroub-Tinna : 135
Khuwei : 183
Muglad : 185

Table 82

Whether birds attacking crop increased in number during last 10 years.

Area	Percentage answers stating			Total
	Increased	Decreased	No change	
Mazroub-Tinna	64.63	30.61	4.76	100.00
Khuwei	65.65	29.57	4.78	100.00
Muglad	31.08	23.87	45.05	100.00

Total answers received:

Mazroub-Tinna : 147
Khuwei : 230
Muglad : 222

Table 83

Reasons behind increase in rodent population.

Area	Percentage of answers relating increase to				Total
	No use of pesticides	Decline in number of predators	Agricultural expansion	Food shortage under natural conditions	
Mazroub-Tinna	65.45	3.64	12.73	18.18	100.00
Khuwei	61.29	10.32	21.94	6.45	100.00
Muglad	54.05	16.22	5.41	24.32	100.00

Total answers received:

Mazroub-Tinna : 110
Khuwei : 155
Muglad : 222

Table 84

Reasons for increase in number of birds attacking crops.

Area	Percentage answers explaining increase in birds						Total
	No bird control campaigns	Expansion in agriculture	Food & drinking water shortage under natural conditions	Bird migration from distant areas	Drought	Decline in natural vegetation	
Mazroub-Tinna	34.16	10.56	8.70	9.94	31.06	5.58	100.00
Khuwei	32.75	14.04	11.11	10.53	19.30	12.27	100.00
Muglad	23.65	2.70	31.76	29.73	7.43	4.73	100.00

Total answers received:

Mazroub-Tinna	:	161
Khuwei	:	171
Muglad	:	148

given in order of importance, these are: no use of pesticides food shortage under rational conditions, agricultural expansion, and decline in number of predators. For birds the ranking shows this order: no bird control campaigns, occurrence of drought which is affecting food supply under natural conditions, bird migration from outside the area, and expansion in cultivation.

7.7. Staple Grain Crops Augmented by Importation:

The previous findings from the discussion on staple food production in the area confirmed the occurrence of a deficit in grain food as from 1982. This indicates clearly that the study area is short of feeding its population, which is the most evident sign of environmental degradation under the type of economy practiced there.

To make up for the shortage, the area imports grain foods. At the level of the household people purchase the dura needed to augment household production Table 85. Their sources of cash include selling livestock, earnings from casual employment, or other sources such as remittances sent home by family members living outside the area.

7.8. Water Supply Shortage:

Many of the aspects related to water supply in terms of type and number of sources, location and impact on ecosystems were adequately treated under the 1983 reports. Despite the degradation caused by the uncontrolled use of the biomass cover around these sources which was the central theme of the 1983 study especially in Khuwei-Mazroub-Tinna area, there is an evident shortage of water supply for human and livestock in the study area as revealed by the findings of the perception study. This coupled with the food inadequacies ascertained above point clearly to the crisis these areas are undergoing at present.

Table 86 gives the type and location of source in the three areas. It is apparent from the table that there is a high dependency on boreholes in Khuwei and Muglad areas, with the main source being open-shaft wells in

Table 85

Means of meeting shortage in dura.

Area	Answers in percentages: Sell livestock to purchase from market	Earn from casual employment to purchase from market	Other sources of income to purchase from market	Total
Mazroub-Tinna	42.34	41.43	16.23	100.00
Khuwei	19.09	53.27	27.64	100.00
Muglad	76.58	7.20	16.22	100.00

Total answers received:

Mazroub-Tinna	:	111
Khuwei	:	199
Muglad	:	111

Table 86

Water supply: Type of source and location.

Area	Percentage of answers									
	Type of source							Location		
	Bore-hole	Open shaft well	Hafir	Fula	Rahad	Tebeldi	Total	Inside vil-lage	Distant	Total
Mazroub-Tinna	9.46	68.92	4.06	6.08	11.48	0.00	100.00	41.46	58.54	100.00
Khuwei	58.54	2.22	0.95	15.19	8.54	14.56	100.00	52.90	47.10	100.00
Muglad	49.56	0.90	2.70	5.41	37.83	3.60	100.00	41.23	58.77	100.00

Total answers received:

	Type of source	Location
Mazroub-Tinna	148	164
Khuwei	316	259
Muglad	111	325

238

276

Mazroub-Tinna area. As to the location of source the data reveal that almost half the population depends on sources within settlements while the other half depends on distant sources.

Table 87 shows the daily household consumption which reflects that the majority of households consume on the average 2-5 tins per day. This includes households' domestic needs plus a small amount supplied to goats kept at home.

Though massive programmes of drinking water supply were implemented in the last decades, the dependency of the population on natural water sources is still high as could be depicted from Table 88. Hence besides food shortage the population of the study area lives in a situation of scarcity of water supply during the dry season and bad quality water during the rainy season. This is further proven by the data in Table 89 which detect the occurrence of water shortage in the period 1980-83.

7.9. Population Migration to Augment Family Income

Population migration for employment to supplement household income, especially when it is regularly practiced on a seasonal basis is a good indicator of the inadequacies of the ecosystem in meeting basic population needs. As from mid-1960's, and following closely the expansion of the cash economy base and the progress of education in rural areas, coupled with more accessibility to urban and production centres, there has been an increasing trend of population migration from the areas of traditional production of Kordofan and Darfur to central Sudan.

Since the economies of these traditional lands are based on dry farming, with crop harvesting normally finished by December, the farmer finds himself under-employed till the onset of the next rains in July. Hence many are motivated to migrate to central Sudan and recently to south Kordofan to raise additional income during this slack period. This has been an established trend with benefits to the economies of the push and pull

Table 87

Daily household water consumption and how it is obtained.

Area	Percentage of answers							
	Water consumption					How water is obtained		
	Less than 2 tins	2-5 tins	6-10 tins	11 +	Total	Fetched	Pur-chased	Total
Mazroub-Tinna	10.79	54.68	28.78	5.75	100.00	43.24	56.76	100.00
Khuwei	8.65	60.17	19.48	11.70	100.00	21.74	78.26	100.00
Muglad	5.70	40.42	32.64	21.24	100.00	54.59	45.41	100.00

1 tin = 4 American gallons

Total answers received:

	Water consumption	How water is obtained
Mazroub-Tinna:	139	185
Khuwei :	231	230
Muglad :	193	229

279

Table 88

Whether household depends on water from natural sources during rainy season.

Area	Percentage of answers		Total
	Yes	No	
Mazroub-Tinna	82.43	17.57	100.00
Khuwei	75.76	24.24	100.00
Muglad	81.60	18.40	100.00

Total answers received:

Mazroub-Tinna	: 148
Khuwei	: 231
Muglad	: 163

Table 89

Whether experienced water shortage during 1980-83.

Area	Percentage answers											
	1980			1981			1982			1983		
	Yes	No	Total	Yes	No	Total	Yes	No	Total	Yes	No	Total
Mazroub-Tinna	60.69	39.31	100.00	73.78	26.22	100.00	71.33	28.67	100.00	61.81	38.19	100.00
Khuwei	69.40	30.60	100.00	76.39	23.61	100.00	80.26	19.74	100.00	66.95	33.05	100.00
Muglad	65.24	34.76	100.00	71.51	28.49	100.00	62.64	37.36	100.00	62.98	37.02	100.00

Total answers received:

	1980	1981	1982	1983
Mazroub-Tinna:	145	164	143	144
Khuwei :	232	233	233	233
Muglad :	187	186	174	208

areas. However, in recent years and associated with the drought conditions in the push areas, the normal trend described above has taken the form of mass migration, which is resulting in the depopulation of the traditional areas and the overstressing of the economies of the recipient areas.

Focusing more on the study area we find that out of the households surveyed about 18%, 44% and 31% in Mazroub-Tinna-Khuwei, and Muglad areas, respectively, at least one member practiced migration during the period 1980-83, when we relate the total number of migrants in each area to number of households surveyed, Table 90.

Migration is a male population activity undertaken by the head of the household and some of the grown-up sons as indicated in Table 90.

Migrants head to four destinations, Table 91. When rated according to the weight of answers received they come in the following order: within the country to other areas of production, outside Sudan to the petroleum producing countries, within Kordofan mainly to the sorghum mechanized schemes in the southern part, and finally within the survey area.

As mentioned the type of migration practiced is of a seasonal nature which is proven by the data in Table 92.

Among the motives behind migration obtaining employment is ranked highest by respondents, Table 93.

Migrants are saving money from employment outside the area, Table 94.

Of all forms of expenditure of money raised from migration, helping the family stands as the highest item spent on, especially in Mazroub-Tinna-Khuwei areas, Table 95.

Whether migration is an established trend in these areas or not is answered in Table 96 with the majority of respondents showing intention to migrate again.

Table 90

Member migrating within the household

Area	Expressed as percentages of household members					Total
	Head of household	Wife	Son	Daughter	Dependent	
Mazroub-Tinna	53.57	0.00	42.86	3.57	0.00	100.00
Khuwei	49.04	5.77	40.39	2.88	1.92	100.00
Muglad	55.71	1.43	32.86	1.43	8.57	100.00

Total number of migrants:

	Total number of migrants	Households surveyed
Mazroub-Tinna	28	142
Khuwei	104	224
Muglad	70	199

Table 91

Destination of migrants.

Area	In percentages of answers given				
	Within area	Within Kordofan	Outside Kordofan but within Sudan	Outside Sudan	Total
Mazroub-Tinna	14.29	21.42	50.00	14.29	100.00
Khuwei	3.85	48.08	28.84	19.23	100.00
Muglad	4.28	10.00	32.86	52.86	100.00

Total answers received:

Mazroub-Tinna : 28
Khuwei : 104
Muglad : 70

Table 92

Whether migration is permanent or seasonal?

Area	Percentage respondents answering	
	Permanent	Seasonal
Mazroub-Tinna	28.57	71.43
Khuwei	46.61	53.39
Muglad	78.33	21.67

Total answers received:

Mazroub-Tinna	: 28
Khuwei	:104
Muglad	: 70

Table 93

Motives behind Migration.

Area	As expressed in percentages of total answers given						Total
	To obtain employment	Low return from agriculture	Dissatisfaction with life at home	To help family to obtain food	To obtain education	Other	
Mazroub-Tinna	65.22	6.52	13.04	6.52	0.00	8.70	100.00
Khuwei	44.03	15.09	23.27	14.47	1.89	1.25	100.00
Muglad	36.29	12.90	20.97	21.77	5.65	2.42	100.00

Total answers received:

Mazroub-Tinna	:	46
Khuwei	:	159
Muglad	:	124

Table 94

Whether saved money from migration.

Area	Percentage reporting	
	Saved	Not saved
Mazroub-Tinna	80.95	19.05
Khuwei	82.67	17.33
Muglad	84.31	15.69

Total answers received:

Mazroub-Tinna : 28
Khuwei : 104
Muglad : 70

Table 95

Forms of expenditure of money saved from migration.

Area	Percentage of Respondents expending on							
	Investment in livestock	Building or improvement of house	Farming	Trade	Marriages	Helping family	Others	Total
Mazroub-Tinna	0.00	0.00	12.50	18.75	31.25	31.25	6.25	100.00
Khuwei	10.99	2.20	16.48	5.49	7.69	53.85	3.30	100.00
Muglad	23.71	11.34	25.78	15.47	10.30	12.37	1.03	100.00

Total answers received:

Mazroub-Tinna : 28
Khuwei : 104
Muglad : 70

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Table 96

Whether head of household who practiced migration is intending to migrate again in percentage of answers received.

Area	Intending to migrate	Not intending
Mazroub-Tinna	78.57	21.43
Khuwei	71.43	28.57
Muglad	41.86	58.14

Total answers received:

Mazroub-Tinna	:	28
Khuwei	:	104
Muglad	:	70

7.10. A Summary:

The conclusion to the study is given in the following summary points:

1. Though the preceding two reports on Khuwei-Mazroub-Tinna and Muglad treated the two areas separately, the present one through the research layout of the perception study tied the previous findings from the two and derived conclusions common to both.

2. Perception studies are essential for the initiation and planning of action-oriented programmes which involve local community effort and participation, since the findings of such studies reveal to the planner the state of knowledge acquired by the community and their rationale in interpreting situations and reacting to problems.

3. The results reached from people's perception of ecology, farming performance, livestock raising, vegetation cover uses and ecological degradation, and environmental change show conformity with the scientific conclusions of 1983 reports founded on the empirical research method. Hence there is a wide scope for an effective interaction between planners and local communities, geared towards designing programmes of common interest to both, to check the ongoing degradation and improve the environment.

4. An attempt towards achieving this goal shall be made in the forthcoming phase of the research by selecting one of the 20 villages covered by the perception study as a pilot case for an intervention programme. The programme design shall be worked out in consultation with the village population and the plan reached shall come as a separate document to be annexed later to the present volume.

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5. It emerged very clearly from the findings of the study that as one goes south from Tinna to Muglad the ecosystems present better potentials for community sustenance which comparatively reach their maximum in Muglad area.

6. Within the above frame the drastic stage of degradation has already been reached in Mazroub-Tinna area and to some degree in Khuwei area.

7. Compared to the two northern areas, the present ecological conditions of Muglad area reflect the picture of the rainfed production systems of the northern half of Kordofan in the mid-sixties when most of the change impacts were 'small' and there was a balance between the human use of resources and ecosystem rejuvenation.

8. The prolonged effects of desertification and the current responses to grazing and water supply shortages caused by the drought which hit the northern half of Kordofan have forced the nomads and the settled livestock raisers from this area to move into southern Kordofan for refuge, including Muglad area. Unless some action is taken the degradation which already devastated the resources of the north shall be evident in the southern areas in a couple of years.

9. The action needed should encompass both the current systems of production inherent in Muglad area and aim at checking and organizing the invading elements from the north.

10. Considering crop production in the three areas, it emerged very clearly that farmers in these areas concentrate on staple food crops to secure the family food supply with cash crops produced to raise the necessary cash needs. With the growth in population and the inflation which has escalated since 1974 coupled with inefficient

means of production and the bad pricing policies more land has been cleared for farming in a surge for family sustenance.

11. The outcome is a severe environmental change and a repeated failure in producing enough food to maintain the continuity of habitation in these lands. Some drastic measures which question the approaches and practices of the past are badly needed with new alternatives considered.

12. People are fatalistic in their outlook. Rain failure is not new to them and they experienced it many times in their life history. They are presently living in anticipation of good rains next coming season. If rains are the immediate foreseen potential for crop raising, some effective action in terms of new practices, inputs and farming systems is essentially needed to minimize risk-taking in crop production.

13. While this is being sought, long term alternatives should be created. Of the possibilities in this regard is tapping the ground and surface water potential for expanding agricultural production where this is feasible, and the planning of spontaneous settlement schemes in places which offer suitable conditions for this kind of development to attract populations from those parts devastated beyond rectification.

14. In the area of livestock raising both nomadic and village herds have severely declined. It was estimated by some of the heads of the tribes in Mazroub-Tinna-Khuwei areas that about 80%, 25% and 90% of the cattle, sheep and donkeys population, respectively, in these areas had perished. It is becoming evident that the continuity of livestock raising under the traditional open range conditions is threatened. Same as in the case of crop raising, the current practices and systems

have to be assessed. Alternatives which work towards improving and controlling grazing, expanding the fodder base and storing fodders for times of need should be sought.

15. Local communities depend on the tree biomass for many uses including energy and settlement building, for which there are no alternatives at present. Hence development of village wood lots to maintain continuous production should be highly considered.

16. The above recommendations need to be taken as components of an overall strategy which should develop approaches that aim at stablizing the populations of the study area through expanding the food base as the immediate target and reversing the present trends of ecological degradation as the long term objective.

ANNEX I.

KHUWEI VILLAGE INTERVENTION PROGRAMME

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ANNEX (I)

KHUWEI VILLAGE INTERVENTION PROGRAMME

1. INTRODUCTION:

As stated in the conlusion to Part II findings on the baseline and trend analysis studies of El Khuwei-Mazroub-Tinna and Muglad area, the two reports shall conclude with a village intervention programme to be explored in Annex I. This approach is different from how the other ETMA Study groups concluded their final results, which took the form of workshops, in which area research findings were dissemnated to concerned target groups in the places studied.

Instead of a workshop it was seen as a practical alternative, too, in the case of El Khuwei-Mazroub-Tinna and Muglad areas to attempt formulating a village intervention programme, that leads to objectives similar to those attained from convening workshops. i.e., building of environmental awareness and working towards better human and productive ecologies. In this context the goal to be served by workshops and intervention programme is one, and the latter provides an alternative device for effective environmental monitoring and guided ecological change.

With the idea endorsed by ETMA Programme Co-ordinator a field visit was carried out in the period from the 25th of May to the 15th of June 1985 to the study area as a follow-up to previous findings, and with the purpose of selecting a site where the village intervention programme could be outlined and defined. The outcome of the exercise is presented in this Annex, named Khuwei Village Intervention Programme.

2. Site Selection:

Out of the villages studied in the three areas, Khuwei centre was selected as a suitable site for applying the intervention programme, for a number of considerations. The reasons for the selection of Khuwei include:

i. Its central location between Mazroub-Tinna and Muglad areas.

ii. Its intermediate location within the group of surveyed villages in Khuwei area.

iii. It reflects the characteristics of the economies of the two other areas, hence solutions adopted for Khuwei could with minor alterations be extended to Mazroub-Tinna and Muglad areas.

iv. The site receives in normal years fairly adequate amounts of rainfall, which offer better opportunities for ecological recovery and higher crop production compared to the northern area of Mazroub-Tinna.

v. Khuwei is more accessible to El Obeid where the resources and the technical services required for the implementation of the intervention programme could be better secured compared to the two other sites.

vi. Being on the main El-Obeid-En Nahud road the results accomplished by the intervention programme could be extended to villages and other centres on the road, and in this capacity Khuwei could serve as a demonstrative example for effective intervention for environmental improvement.

3. Organization and Financial Capabilities of Khuwei Council:

The basic geographic, ecological, demographic, economic and social features of Khuwei area were thoroughly investigated and accounted for in Parts I and II of the study. Additional information on the organizational capabilities of the site is thought as essential to be furnished in relation to the suggested intervention programme. The past performance of the centre under the People's Local Government rule, which is frozen at present because of April 1985 change in government, is indicative of the potential organizational capabilities of the centre.

Khuwei is a headquarters of a rural council Fig. (11), one of many in En Nahud District. The council has an area of 1283 sq. km. and a population of 55,183 persons. A number of rural service facilities are operated within the council unit. These include:

12 water-yards

14 primary schools for boys

5 primary schools for girls

10 Khalwas (pre-primary religious education schools)

4 adult education classes.

3 dispensaries

4 dressing-stations

1 health care unit

Organizationally and under the People's Local Government (PLG) rule, Khuwei Rural Council comprised 37 village councils with one at Khuwei Centre. A village council was constituted of one village or a number of adjacent villages. A village council was run by an electorate body, an off-shoot of the Rural Council seated at Khuwei.

The Rural Council was administered by a local government executive officer accountable to the district headquarters at En Nahud. The electorate body of Khuwei Rural Council was made up of 30 councilors drawn from the council area. Their occupational and professional backgrounds were as follows:

i.	executive officer	1
ii.	farmers	17
iii.	merchants	5
iv.	public health officer	1
v.	teachers	2
vi.	other business	1
vii.	women representation	3
		30

The council carried out its tasks through five committees namely:

i. finance,

ii. supply and rations,

iii. education and health,

iv. anti-thirst programmes, and

v. agriculture and livestock.

In terms of financial capabilities the rural council has been experiencing a situation of budgetary deficit for the last three years. This is directly related to the effects of desertification and drought which have caused a sharp decline in crop and livestock production which led to a drop in taxes collected. This is well illustrated by the line items of the 1984/85 budget which show an eminent deficit, usually made up from central subsidies as indicated by the following figures:

Item	Actual Expenditure LS
i. Salaries	276,000
ii. Fuel	12,000
iii. Current running costs of services	60,000
Total	348,000
iv. Actual tax money collected	123,000
v. Deficit subsidized from central sources	225,000

4. Programme Justification:

In Part II of the study, 5 villages including Khuwei were covered in the study area by the questionnaire survey. The findings from the survey plus the above account on the rural council organizational and budgetary situation justify designing and implementing the intervention programme. The main point which furnish the justification for the programme are:

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i. The area faces many environmental problems at present that are demonstrative of a real working and challenging situation for programming to reverse the current trends. Such problems include high rates of ecological degradation exemplified in the disappearance of the tree vegetation cover for different uses, shortage in grazing and fodders and in grasses for building materials, crop failure and death of livestock, moving sands burying cultivations and roads, shortage of water supply, dependency on food aid, and a high rate of population migration.

ii. The impact of all these adverse effects has culminated in a general decay of the society and unless some action is taken a final collapse shall come very soon.

iii. Production systems in this area have been operating under traditional means and practices, while there is a scope for the trial of new solutions that have not been attempted before.

iv. People are prepared to support such solutions because of the building up of environmental awareness among the inhabitants of the area, especially that Khuwei centre commands many administrative and social services, with a sizeable enlighted community which could act as an aid to progeamme inititation and implementation.

v. The presence of some societal differentiation; i.e.; farmers, livestock raisers, merchants, [illegible] government officials, plus many varied forms of petty activities, which could enrich the programme; as people with different outlooks and experiences could come with different solutions to problems.

vi. The budgetary performance of the rural council indicates clearly that area and regional economies are financially strained. The council area is not self-supporting, leaving aside financial surpluses for investment in local development. Reducing the burden on the regional and central financial sources dictates taking steps towards building local self-sustenance. This is only feasible through ecological rehabilitation, and the expansion of the food base in those areas affected by drought and desertification.

5. Programme Objectives:

The programme objectives should address the problem and meet the goals outlined previously under programme justification. These may be summarized as follows:

i. To check ecological degradation and improve environmental quality in the area.

ii. To set the ground for a wise and rational use of the natural resources of the area, on bases that assure sustained growth and development.

iii. To expand and diversify the food production base so as to meet basic needs and create a surplus for cash generation.

iv. To channel savings and gainfully employ labour in viable economic activities.

v. To increase employment opportunities and incomes and check out-going migration so as to stablize the local population.

vi. To serve as a demonstrative example that the ecology of such areas could be better utilized for higher production under planned situations.

vii. To demonstrate that local communities have the abilities to change their own lot once they find guidance and the essential requisites. In this way Khuwei intervention programme could furnish the example which can be copied under similar situation.

6. Programme Philosophy:

The philosophy which guides the programme should encompass the following basic planning principles:

i. The programme should be a community-based activity in initiation project formulation and at the implementation stage.

ii. Should be comprised of many components that integrate in finality to serve common goals and objectives.

iii. The community should be assisted by an agency in project identification, community organization, and access to financial and technical inputs which may not be available for the programme from within the community.

iv. Project ideas or programme components should address needs identified by the community. The agency role would be to help in guiding project prioritization and in tailoring projects within feasible technical and financial frames.

v. Project plans should be developed in such a way to maximize opportunities for the involvement of the individual, the family, the groups and the community at large in project selection and implementation.

vi. The programme should aim at sustainable solutions that grow in effect as the programme progresses. Any addition of a new increment or a component should aim at strengthening the programme.

vii. Should be a training and an educational exercise, so that the results achieved can be extended to surrounding areas and the experiences gained can be utilized for more effective solutions of environmental problems.

viii. Should address the various population sectors in the society, i.e., the males, females, the young and the old and the different occupational groups, with the individual and the society seeing meaningful benefits accruing to them from the implementation of the programme.

7. Programme Organization:

The guidelines for programme organization embrace:

i. The programme should be developed as a joint venture between a locally organized community and a regional agency or a group of co-ordinated departments.

ii. The individual, family, group, and community initiatives should be recognized and have a place in the agency scope and assistance activities.

iii. An evaluation of the existing institutions in the community should be made, with the purpose of assessing their credibility so as to initiate the involvement of the most viable ones.

iv. The agency should be a public institution delegating the authority of execution to an appointed director to run the programme.

v. Since the programme shall involve many project components the necessary specializations required for executing the programme should be made available by the concerned departments in an advisory capacity as need arises.

vi. A professional committee representing the concerned departments should be formed to guide implementation and give the necessary backstop service required for the integration of the programme activities.

vii. Execution should be carried out through local community workers who could be selected from the local leadership or could be appointed from the village folk if the latter is proven to be necessary.

8. Procedure of Programme Formulation:

With the above guiding principles explored and developed during the field survey in preparation for the village intervention programme two meetings were held with

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community leadership at Khuwei to investigate and reach conclusions on three basic issues:

i. To feel if there is a need for an intervention programme in the first place judged from the degree of environmental awareness acquired by the community about the current ecological changes and community perception of the kind of action needed to check the on-going decline and reverse the present trends.

ii. To assess the status of community organization, present and potential for initiating action and accepting joint responsibility with an outside agency for intervention.

iii. The list of project ideas that may make feasible components of the intervention programme, as identified by the local leadership.

On the first two points positive responses were ascertained from the meetings held. Community awareness of the ecological changes taking place as a result of the adverse impacts of drought and desertification were readily assessed, as the community had already co-operated in establishing a nursery to provide seedlings for planting this season in Khuwei village and the surrounding villages. The committee set to run the nursery and manage the distribution of seedlings is strong proof of the organizational capability of the community. The nursery project deserves more exploration.

The idea of establishing a nursery began two years back on pure community initiative. A small plot was fenced near one of the bore-holes for the purpose. The shortage of water for planting from that specific bore-hole hampered the full development of the project in that year, hence the nursery failed to produce the required seedlings. Last year the Renewable Energy Project came to know of the interest of the village in developing a nursery, and a grant of Ls. 8,000 was made by the mentioned project to the village for this purpose.

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Accordingly a committee was formed to run the project. The committee is made of 15 members selected in a general meeting which was attended by most villagers. The membership of the committee embraces the following professions and occupational backgrounds:

Farmers	5 members
Government officials	6
Women	1
Other business	3

The committee holds regular meetings to decide on issues related to the development of the nursery and to monitor the progress of the project. The amount of Ls.8,000 allocated by the Renewable Energy Project was received by the committee at the start of the project and is presently under the responsibility of the committee treasurer who spends on the project according to the committee decisions. It is known to the committee that the fund shall be audited by an auditor to be assigned for the task by the Renewable Energy Project.

The committee shifted the site of the nursery to the vicinity of another bore-hole located on the southern edge of the village, for reasons that this bore-hole is less congested by users and allows obtaining water for the nursery any time needed.

The developments accomplished to date include fencing of the nursery lot (50 X 50 M), preparation of seedbeds, building of sheds, construction of a tank for the storage of water, purchase of a two-wheel cart and a horse to carry water to the nursery, and the preparation of 26,000 seedlings planned to be distributed to farmers this rainy season. The seedlings produced are Acacia senegal, however, the committee has plans to diversify production and include Blanites aegyptiaca, Acacia mellifra plus some citrus and beautification trees to be made available to interested villagers.

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The conclusion to be drawn from this experience is that people at Khuwei have already taken steps towards rehabilitating the lost ecological cover in their area. The infra-structure of the nursery, the organizational set-up created to run and monitor the project, and the enthusiasm shown by the people to pick up new ideas and explore further possibilities for the improvement of their lot should be taken seriously as signs of readiness to accept change and to work towards creating a better environment.

9. Identification of Programme Components:

The meetings held embraced the executive officer and staff, members of the nursery committee plus other interested villagers. On discussing project ideas for ecological rehabilitation and expansion and diversification of the rural economy of the area, the following priorities were identified by those present in these meetings:

i. Improved and Adequate Seeds

Seeds for sowing are normally obtained from the harvest of the preceding season. Due to the drought that afflicted the area for the last three years, there is an evident shortage of seeds for sowing. People expressed their interest in obtaining better quality seeds especially quick maturing varieties of dukhun, millet, and sesame to be imported to the area and distributed in adequate amounts. People showed their readiness to contribute to the costs of these seeds.

ii. Fencing of Farm Hedges

The vast stripping of the area of its vegetation has opened the cultivated land to severe wind erosion with the fertile top soil lost to the farmer, resulting in a sharp decline in soil fertility and productivity. Farmers also began to observe a pattern of unequal distribution of moisture in the soil within the same farm plot due to run-off from higher to lower degraded spots. Hence the protection of farm lands from wind action came as a priority in these meetings. The solution suggested by the villagers is

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to grow 2-3 rows of Acacia senegal trees as farm hedges. This device besides checking wind action shall serve in demarcating individual land property, facilitate enforcement of laws and regulations to minimize damage caused by tresspassers especially nomads from the north, and add to the income of the farmer by producing gum from these hedges. The seedlings needed for the farm hedges could be obtained from the nursery and the community views the idea as one that could be easily implemented under the umbrella of food for work projects.

iii. Water Spreading Projects

Khuwei village lies in a depression which runs from north to south from the site of the village down to Nasharbo water-yard to the south. The geological and geomorphological studies of the area ascertain that this depression is a bed of a buried river system. During 1984 rainy season Khuwei was drowned by a torrential flood which damaged most the built-up area of the village. The presence of dense Tebeldi growing in clumps plus the rich and varied tree vegetation in this depression are indicators of a higher soil moisture content which could be tapped for expanding and diversifying crop production through simple water harvesting techniques. There are already three sites in this valley fenced and put by some of the locals under vegetable gardening. Members of the nursery committee took us to a number of sites where they believe that water spreading could be attempted. Hence, the potential is there, and its development would require some agency assistance in ground surveying, design of earth works, and guidance in the construction phase.

iv. Jubraka Farming

Jubraka farming is widely experienced in Khuwei area. A Jubraka is a fenced piece of land of about half an acre in area. It is normally a low spot of land chosen near the home or in proximity to the village. It is a form of a back-door garden usually tended by the housewife with some help from the other members of the family. The main crops

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grown in the Jubraka are quick maturing varieties of cereals namely maize and naged (a kind of feterita) plus vegetables mainly bamia, lubia, cucumber, and sometimes pepper and tomatoes. The cereals being quick maturing types are produced for consumption during late rainy season till the main crops yield a harvest. The vegetables are grown for house supply and for the market as a ready source of cash during the rainy season.

The possibility of improvement of Jubraka farming was raised in the meetings held with Khuwei people. They see a scope for applying water harvesting techniques at Jubraka sites, and of diversifying and improving production through the application of better performing varieties and the introduction of new crops.

v. Ground Water for Irrigation

Khuwei lies on the Nubian sand formation with its rich ground water aquifer. The valley previously described under the water spreading component extending from Khuwei to Nasharbo also lies on this aquifer. People were exploring the possibility of using tube well water for mini-irrigation purposes or for supplementing rain water harvested through water spreading techniques. It seems feasible to utilize the four existing bore-holes for such purposes by increasing their pumping capacity to provide additional water for irrigation, or to drill a series of bore-holes in the valley for the same purpose. The kind of irrigation development visualized by the people is to carry water by animal drawn carts to irrigate small plots of vegetables that could be established during the rainy season to be put under production for the market. They look for outside support to assist in planning the project and providing for the cost of the carts which they agree to repay as a long term loan.

vi. A Village Woodlot

The inhabitants of Khuwei are presently obtaining fuel wood from increasing distances from the village. Those buying fuel wood and charcoal are purchasing both commod-

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ities at higher prices. Hay obtained through free collection from the vicinity of the village as it was the case in the past is no longer practiced, and most users purchase hay imported from distant lands at the village market place. Establishing a village wood-lot shall serve both purposes, provision of fuel wood and hay for the village animals plus protecting the land around the village from ecological hazards. The idea was already there and was not initiated by our meetings, as the nursey committee is considering implementing the project once they find the requisites for that. The basic component needed is the fencing as they believe that it is difficult to develop a wood-lot without putting a fence, since that Khuwei is an important watering centre for many outside populations and livestock, that have to be kept away from the plantation specially during its first years of establishment. The community contribution to the development of the wood-lot would be the provision of the seedlings from the nursery and the mobilization of communal labour in the operation of planting at the wood-lot. The latter could be once more viewed as a possible component under the label food for work projects.

vii. <u>Female Goat Herd</u>

Goats are presently the type of animal widely found in the villages. They are the ones left after the others cattle, sheep, camels and donkeys had either perished in large numbers or some among them migrated south. Their survival is attributed to their tough nature and their ability to sustain on any vegetative material.

The goat is the animal of the housewife. It is kept to supply the home with milk, and is occasionally slaughtered for meat, and often sold for petty cash earnings. The impact of the goat on the village ecological cover as an activator of degradation seems still to be a controversial issue. Some ecologists believe that its role in vegetation devastation is over-exagerated. It is the last left in an area because of its taughest nature. The impact of the goat on the local ecology was a topic discussed at length in one of the meetings held at Khuwei. Though no agreement was reached on the issue it was overwhelmingly accepted that the goat is an important source of milk for the family, and that in future and with the decline in the sheep and cattle numbers the goats may emerge as the only possible source of meat in the village markets. Hence one of the components suggested under the intervention programme is to improve the goat breed in the area by importing a good strain of male goats to be made available to serve the herds of those interested. The wood-lot when fully developed can supply hay for the female goat herds. It was suggested to cut hay from there and transport it to homes, so as to keep the goats under control.

viii. Poultry Production

Again in the search for maximizing the opportunities for raising family income, poultry production as a home industry was suggested. Most families keep chickens and there seem to be prospects for expanding production through the importation of improved breeds, small loans to familites to increase the numbers raised, control of diseases particular to the area, and provision of feeds. Khuwei could take advanage of its location on the busy El Obeid-En Nahud road in marketing its production locally and at the two mentioned cities.

ix. Handicrafts Industry

Again there are possibilities in this respect. Locally woven products from palm leaves and wood are produced by most housewives and sold at the market place or to passengers on the main road. As the skill is there and the material needed is somehow obtained at present some innovative designs and new products could be introduced in this traditional industry to expand the market and create additional incomes for those practicing the art. There was interest from the community to secure the support of an outside agency for this component of the programme.

x. Energy Saving Stoves

Some of the members of the nursery committee seem to be familar with the recently innovated stove sold presently at El Obeid. The efficiency of this energy saving device was explained at one of the meetings and the participants were keen on a demonstration of the stove and on acquiring it if it could be locally manufactured or if the prices could be subsidized. Hence propogating the use of the stove could be another component of the integrated village intervention programme.

10. CONCLUSION:

This last part of the study attempted to outline a village intervention programme for one of the three areas studied. The first sections of the report addressed the basic principles in terms of programme justification, objectives, philosophy and the organization on which the programme should be founded; while the latter sections were devoted to the development components constituting the programme. The way the whole exercise was developed through meetings with the target groups that shall interact and benefit from the programme, if it ever has the chance of being executed, fulfils the objectives anticipated to be served by ETMA study programme. It served in building environmental awareness among those population affected by ecological changes. It provided group training through the extension of new ideas for combating the impacts of drought and desertification. Hence it achieved in one way or the other the goals explored by the workshops convened by the other ETMA study groups.

To fulfil further the objectives of ETMA Programme in building up environmental awareness, dissemination of research findings and provision of training opportunities for target groups, the study co-ordinator organized a meeting with some of the technical staff of those departments at El Obeid which carry out activities related to the programme. The meeting was held on the evening of 7th July 1985 at the office of the Regional Government Secretary and attended by representatives of the Projects Development Unit, Soil Conservation and Land Use, Department of Planning and Economy, Department of Agriculture Services, Department of

Pastoral Nomadic Affairs, and Department of Mechanized Schemes. On discussing the intervention programme report the meeting reached the following conclusions:

i. The intervention programme idea is based on a comperhensive treatment of the environmental problems in the study area and on a proposed action programme which addresses these problems. This research philosophy and methods applied in finalizing the programme are recommended to be adopted in future in the preparation of regional projects, i.e., projects are to be developed in environmental contexts.

ii. The project plan reminded those in the meeting of the Kheiran area plan of development which was formulated on integrated lines of action. The components of Kheiran project embraced: expansion of horticultural production, improvement of poultry, establishment of shelter-belts, and afforestation activities outside the shelter belts by beneficiaries from the project. Of the proposed activities only one component, i.e., horticultural production, is being executed. The main obstacle which faced implementing the other components is one of integration, as to how to organize and involve the other technical units in carrying out their assigned parts of the project.

iii. The meeting devoted much discussion to the question of integration on department and discipline basis at the various stages of project formulation and later on at the implementation stage. The conclusions reached emphasized the need for integration with the mechanisms leading to it institutionalized and the linkage between the fifferent departments formalized.

iv. Arising from the above, the need for training in the region of interdisciplinary work and the team approach was raised as an essential input for enhancing the planning and executive capabilities of the regional technical staff.

v. In discussing the role of community participation in realizing local development it was agreed that the kind of approach to be adopted is guided change, whereby the beneficiaries from the project are to be helped by technicians to formulate their identified projects within acceptable scientific frames. Guidance should also be provided at the implementation stage.

vi. The document was accepted by the meeting as a scheme of project possibilities which requires further work to formulate its findings into costed projects. A promise was made at the end of the meeting that ways and means shall be sought to endorse the document by the regional authorities and look for the necessary finance to turn its recommendations into an implementable project.