ENVIRONMENTAL TRAINING & MANAGEMENT IN AFRICA (ETMA)

ENVIRONMENTAL MANAGEMENT IN THE SUDAN

GEDAREF DISTRICT STUDY AREA

Final Report

Edited By

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INTRODUCTION

The resource management component of the ETMA (Environmental Training and Management in Africa) programme, which started in 1981, aimed at the study and identification of the degradational trends of the ecosystems of eight study areas of which the Gedaref District is a significant one. The five-year-long study of the area is not long enough to identify the details of all aspects of the ecosystem. However, it has been possible to trace the major changes in and to identify the main trends of the evolving and dynamic physical and human environments of the District.

This report falls into three parts. The first part is based primarily on secondary sources although field data were used to fill in some gaps. It is divided into two sections: baseline data and trend analysis. The baseline report sets the year 1940 as the base year. Justifications for the selection of the Gedaref District and the base year are stated. Indicators used to identify and monitor environmental change are summarized. The section then moves to a description of the physical and human environments: climate, geology, soils, vegetation and wildlife as the main constituents of the former, and population dynamics, modes of livelihood and land use systems as the major components of the latter. A study conducted in 1948 about one of the villages is used as a base to study the changes which have occurred since then. The section is concluded by a brief attempt to look into causes of change during the base period, 1940-50.

The second section focuses on the identification of trends which had developed between 1950 and 1980 in the physical-biological and human components of the local environment. The first component includes climate,

water resources, soils and vegetation. Of all climatic aspects, only rainfall is significant and critical for all forms of life in such a marginal area. The second component comprises the social and economic conditions in the mechanized rainfed agricultural sector, the traditional peasantry -,pastoral nomadic sector and the urban sector of the Gedaref Town.

Part Two, The Monitoring Report, is entirely based on field survey and field data. Visits to the same monitoring sites had been reported between 1982 and 1984 to observe the up-to-date situation of the already identified trends. The selection of the monitoring sites, which represent all types of land use and most of the economic activities, was not random. The first of these monitoring sites were mechanized schemes. The selection was based on the type of management, i.e., ordinary private schemes, [illegible] state schemes, [illegible] schemes and, recently, a foreign (Canadian) scheme. Emphasis here is made on productivity and soil changes.

Rural and urban settlements constitute the second group of monitoring sites. Four villages and a transect were selected to see the changes which have occurred in aspects like rural land use patterns, economy (particularly agriculture), and population. The study of the major urban centre, Gedaref, covers areas like historical evolution, morphology, land use, economy and population. Urban services, especially medical and educational, together with urban problems, like crime and fire, have also been discussed.

Of the physical aspects, soil and water had been monitored. Soils have been analysed to determine their suitability for crop production and to see the changes taking place therein as a result of different forms of land use and cropping. Analysis of water samples was inhibited by lack of reliable equipment; hence, the study

of water is confined to its availability for mechanized scheme workers and for the urban population of Gedaref, the relatioonship between water points and overgrazing, and the depth of water table in some surface wells.

The section on livestock, grazing and nomads deals with the vegetative cover, movements of the pastoral nomads, and the relationship between the available forage and the feed requirements of livestock to determine the degree of over-stocking and hence the degree of overgrazing. The last section of this part sheds some light on the urban and rural refugees and their contribution to environmental degradation, especially deforestation and urban crime.

The third and final part of this report is made up of two sections. The first of these is a summary statement describing the workshop organized in April, 1984, at Gedaref Town on "Environmental Degradation in Gedaref District." The section is a translation of the main opening addresses, titles of papers presented, and the recommendations made during the closing session of the workshop. Based on the main findings of the study and on most of the recommendations of the workshop, the second section of this part is a feasibility study of two pilot projects. These projects, if proved successful, may be replicated to improve the quality of the natural ecosystem and to enhance the productivity of the two main economic activities, namely mechanized rainfed agriculture and livestock raising, together with contributing to the satisfaction of some needs of the local people, viz., fuel wood, charcoal, building poles and/or cash revenue.

PART ONE

BASELINE DATA AND TREND ANALYSIS

SECTION I

INTRODUCTION TO THE STUDY AREA

BASELINE DATA

1. INTRODUCTION TO THE STUDY AREA

A. CRITERIA FOR SELECTION

The Gedaref area has been an economically important region to the Sudan since the early 1940's. Gedaref is the second largest grain and animal market in the Sudan. Rail and a new highway connect the region to Khartoum, Port Sudan, New Halfa, Gezira and the external markets.

Because of relatively fertile soils and moderate to sufficient rains, the Government of Sudan has developed several large mechanized agricultural schemes in and around Gedaref district. Traditionally the people of this region have been either semi-nomadic pastoralists herding cattle, camels, sheep and goats of subsistence cultivators raising dura (sorghum).

The large scale mechanized schemes pushed the pastoralists and small farmers out of some of their areas. Although the schemes produce the much needed dura and sesame, they have contributed to the degradation of the region in several ways.

As a result, many of the subsistence farmers became wage labourers and gave up their land. This change from land owner to landless wage earner has brought about changes in the social structure of the region.

Pastoralists squeezed out of their traditional grazing area have had to change their migration routes in some instances, while in others they bring their animals to graze on the agricultural schemes themselves. In still other instances they cross the border into Ethiopian grazing lands. This situation is getting worse as evidenced by the increasing number of confrontations between farmers and pastoralists. The pastoralists have

also been increasing their herd sizes to protect themselves against losses due to further expanding cultivation and due to natural factors such as drought or disease. In many parts of the region the stock carrying capacity of the pastures has been greatly exceeded even to service the capacity. Overgrazing is a severe problem. Palatable and nutritious plants are disappearing and grazing areas are being lost to desertification processes. Adding to pastoralists' problems is a scarce water supply. The region has no subsurface water and deep aquifer wells are expensive to drill. In bad years animals have to walk over three miles between grazing areas and watering centers.

From an agricultural viewpoint the Gedaref area offers an interesting array of agricultural practices.

There are traditional smalll farmers, state-owned farms, state experimental farms, guided farms, private farms, and over a million feddans of farms established on unauthorized land.[1/] This rapidly expanding agricultural sector is contributing to desertification of large areas of land. After a piece of land is farmed continuously for five or six years until the soil is depleted it is then abandoned and the farmer moves on to a new piece of land. In the past 8 to 10 years production has also been declining. Among other reasons, poor management, lack of infrastructure, dura monoculture and soil impoverishment have contributed to declining yields.

The town of Gedaref itself is growing fast, and infrastructure and services have not been able to keep up with the burgeoning population. Gedaref has been receiving many refugees, from nearby Ethiopia, whose presence is adding to Gedaref's socio-economic problems.

1/ Unauthorized land is land that has not been demarcated by the Government for scheme owners.

This region was selected as a monitoring site because it is crucial to Sudan's economic well-being and has a multiplicity of human practices pertaining to environmental degradation. The quick changes taking place in Gedaref's environment must be monitored and analyzed carefully so as to produce meaningful recommendations about the future of the area to regional and national decision-makers.

B. LOCATION

Gedaref is located in the southern part of Kassala Province in Eastern Sudan. It stretches between 34^{0} and $36^{0}30'$E longitudes, and $12^{0}30'$N and $14^{0}30'$N latitudes. It lies between two major tributaries of the Blue Nile, the Rahad River and the Atbara River. The Gedaref - Gallabat ridge also crosses thrgh the southern portion of the region. The region is about 600 meters above sea level (See Map 1).

The town of Gedaref is the region's main urban centre; however there are villages scattered throughout the area. Outside of these villages the region is sparsely populated because of the shortage of water and because most roads are dirt tracks that become inaccessible during the wet season.

C. MAIN INDICATORS USED

The categories of environmental indicators we selected to study are:

a. land use
b. desertification
c. urbanization
d. social indicators
e. economic indicators
f. water related indicators

We felt that by monitoring changes in these six categories we could begin to develop an understanding of

the cause of the environmental and socio-economic problems mentioned earlier. A detailed list of indicators is attached to this report.

D. CRITERIA FOR BASELINE SELECTION

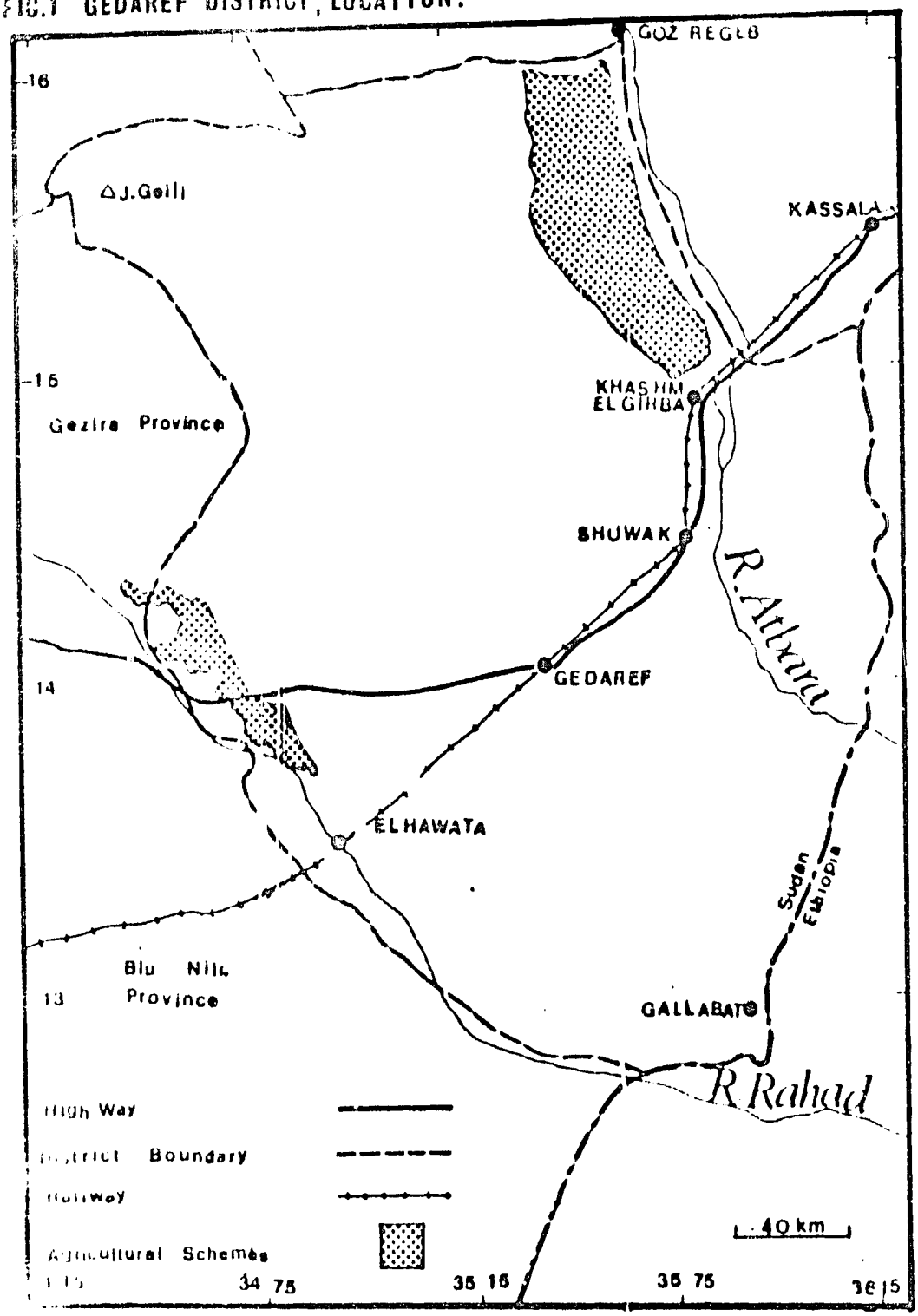
The 1940's have been selected as the baseline period to which changes, in the six categories listed above, will be compared. There are two main reasons for choosing this period.

First, it was just at the end of World War II that the economy of the Gedaref region began to change. Around 1943 the British recognized the region's potential to feed the colonial army in East Africa, and by 1947 mechanized crop production schemes were introduced in the Gedaref District. Mechanized agriculture and commercial prosperity gave rise to a high rate of in-migration. The town of Gedaref, which had been slowly expanding since the railway was constructed in 1928, saw a spurt of growth.

The second reason for choosing this time period as a baseline is that there are several data sources that were prepared in the mid- to late forties that present a good picture of the region during this time. Tothill in his book Agriculture in the Sudan has a chapter on Kassala Province. In that chapter he discusses soil features, vegetation, population, water supply, animal husbandry and cropping patterns. Harrison and Jackson developed a vegetation map of the area in the same period. The map and description are part of M.N. Harrison's Report on a Grazing Survey of the Sudan. Although it was published in 1956, much of the work was done in the late-forties. This seminal work not only discusses the vegetation of the ecological divisions of Sudan, but also talks about the nomadic grazing practices and stock carrying capacity.

There are probably other accounts of the area from the 1940's that we have not discovered.

FIG.1 GEDAREF DISTRICT, LOCATION.



SECTION II

PHYSICAL ENVIRONMENT

II. PHYSICAL ENVIRONMENT

A. CLIMATE

The Gedaref District borders the Central Butana Clay Plain, and lies in the Southern Butana Clay Plain. The Gedaref District gets between 600 and 800 mm of rain annually. This amount is crucial because most of the mechanized agricultural schemes are dry land farms.

Between 1941 and 1950 the rainfall varied by 19.42%. The mean rainfall for those 10 years was 584.36 mm. Gedaref has a dry season for about eight months of the year. Most of the rain falls between June and October. Planting, weeding and harvesting are all centred around these four to five months. The nomadic pastoralists also migrate seasonally according to the rains.

The following two tables present the rainfall statistics for Gedaref between 1941 and 1950.

(These rainfall figures will be compared to the 1950's, 1960's and 1970's data in the trend analysis report.)

Although the majority of rain falls during four or five months, within each month the total rain can vary greatly from year to year. In the month of March, between 1941 and 1950, rainfall varied by 287.88%. During the rainy season, rains are more constant from year to year.

Temperatures in the Gedaref District range from 15.29°C in January to the low 40's during the month of April and May.

The tables below summarize the temperature data from 1940 to 1949.

Table 1.

Mean Monthly Rainfall - Gedaref, 1941-1950.

	Jan.	F: March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
Mean Rainfall(mm)	0	0 1.98	3.65	45.53	86.52	130.3	194.43	98.08	23.57	1.18
Stand.deviation	0	0 5.7	5.11	21.9	46.89	39.13	50.70	20.36	20.45	2.1
Coef. of variance	0	0 287.88	140.0	48.1	54.2	30.03	26.08	19.74	86.76	177.79

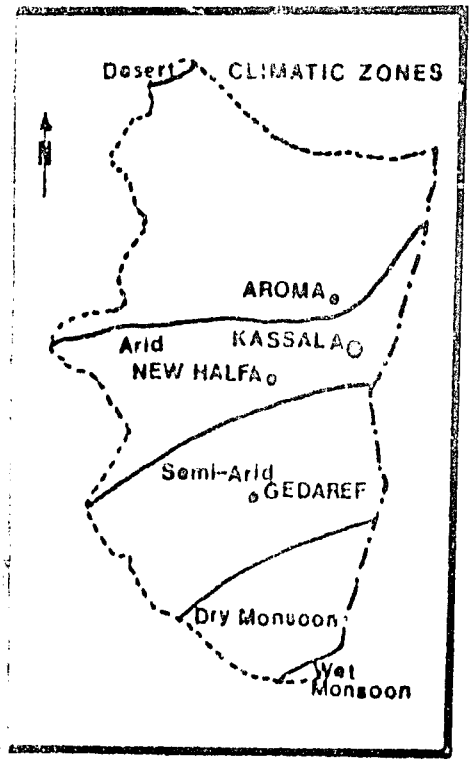
Table 2.

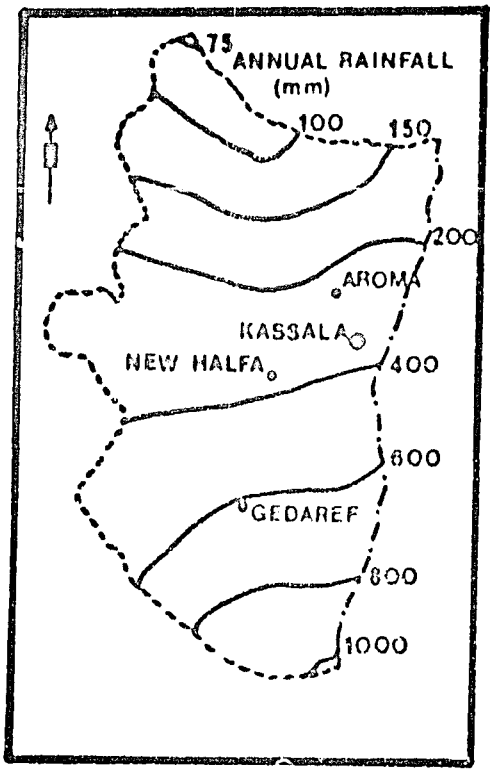
Annual Total of Rainfall - Gedaref, 1941-1950.

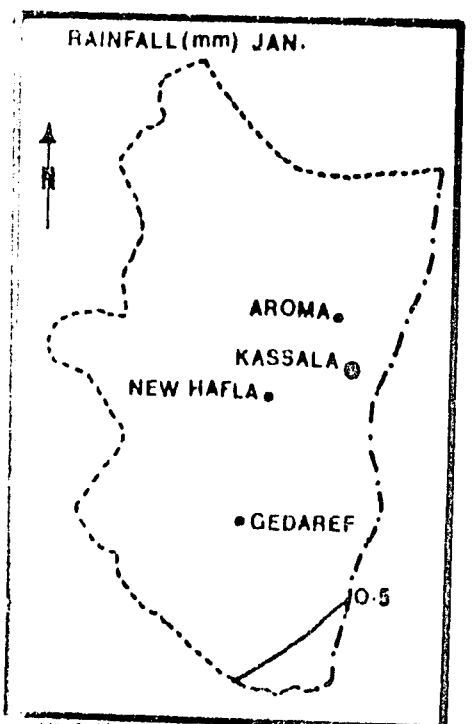
Year	Rainfall(mm)
1941	563.7
1942	611.7
1943	427.4
1944	570.5
1945	495.2
1946	553.0
1947	864.1
1948	487.0
1949	656.0
1950	615.0

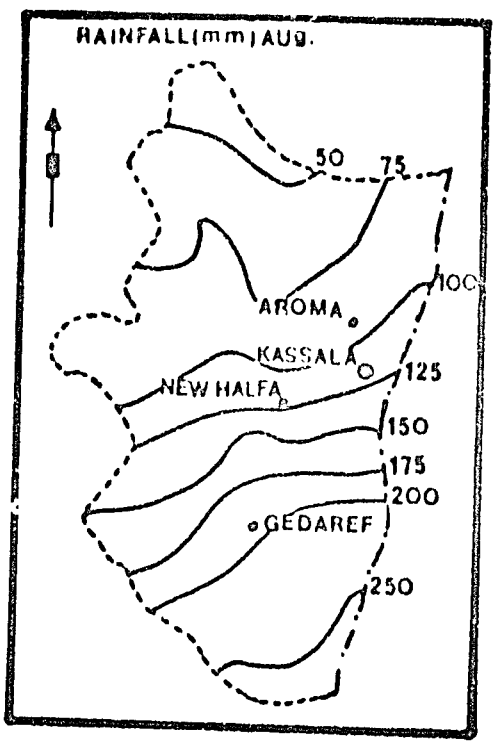
10 year average: 584.36 mm
Highest rainfall: (1947) 864.1 mm
Lowest rainfall: (1943) 427.4 mm
Standard deviation: 113.46 mm
Coef. of variance: 19.42%.

FIG. 2 KASSALA PROVINCE, CLIMATIC ZONES & ISOHYETS









SOURCE: Kassala Province profile

40km

Table 3

Monthly Mean Temperatures (^{o}C) - Gedaref, 1940-49.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean monthly $T^{o}C$	26.3	27.1	29.1	31.6	31.6	29.9	27.14	26.3	26.9	28.4	28.9	26.8
Stand.deviation	0.55	1.17	0.89	0.83	6.09	0.84	0.04	1.23	0.53	0.62	0.48	0.99
Coef.of variance %	2.09	4.32	3.06	2.62	6.96	2.81	2.20	4.67	1.97	2.18	1.66	3.73

Table 4

Annual Mean Temperature (^{o}C) - Gedaref, 1940-49.

Year	Mean $T^{o}C$
1940	28.7
1941	28.2
1942	28.6
1943	28.5
1944	28.5
1945	28.2
1946	28.3
1947	28.6
1948	28.1
1949	28.1

10 year mean $T^{o}C$ = 28.4 ^{o}C

Standard deviation = 0.205

Coefficient of variance = 0.72%

Temperatures in the Gedaref area are fairly steady, as can be seen from the low coefficients of variance. During the 10 year period not only did monthly temperature fluctuate little, but the 10 year coefficient of variance was less than 1%.

The other weather station in our study area is Ghadambuliya, west of Gedaref. Here there is only a rainfall gauge. The Meteorology Department began collecting data there in 1945 (Table 5).

Again, it can be seen that rainfall within a month varies greatly from year to year. In some years the month of May can bring as much as 72.6 mm of rain; in other years no rain was recorded.

During the rainy season fluctuations stablize somewhat, as can be seen by the lower coefficient of variance. Annual rainfall totals varied by 23.8 between 1945 and 1949 (Table 6).

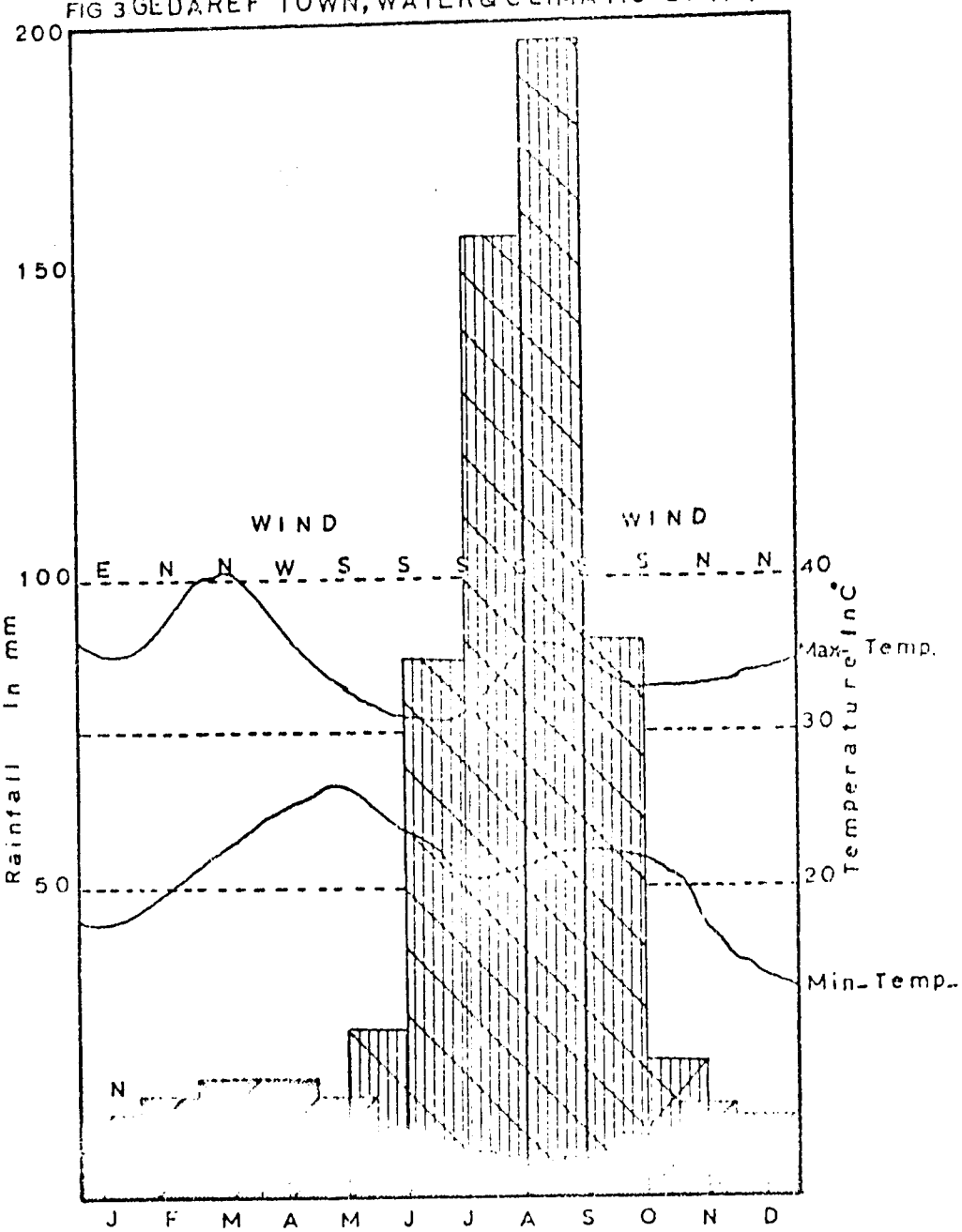
B. GEOLOGY

1. SUBSTRATA:

We have no detailed geological information from the 1940's; however, the Soil Survey Administration published a detailed soil survey of Kassala Province in 1976.[1/] Since geological formations change only over thousands or millions of years, we are assuming that the geological conditions that existed in 1976 existed in the 1940's.

1/ Some of the geological information presented in the 1976 survey was compiled from previous work done in 1956 (Ruxton) and 1964 (Sudan Geological Survey).

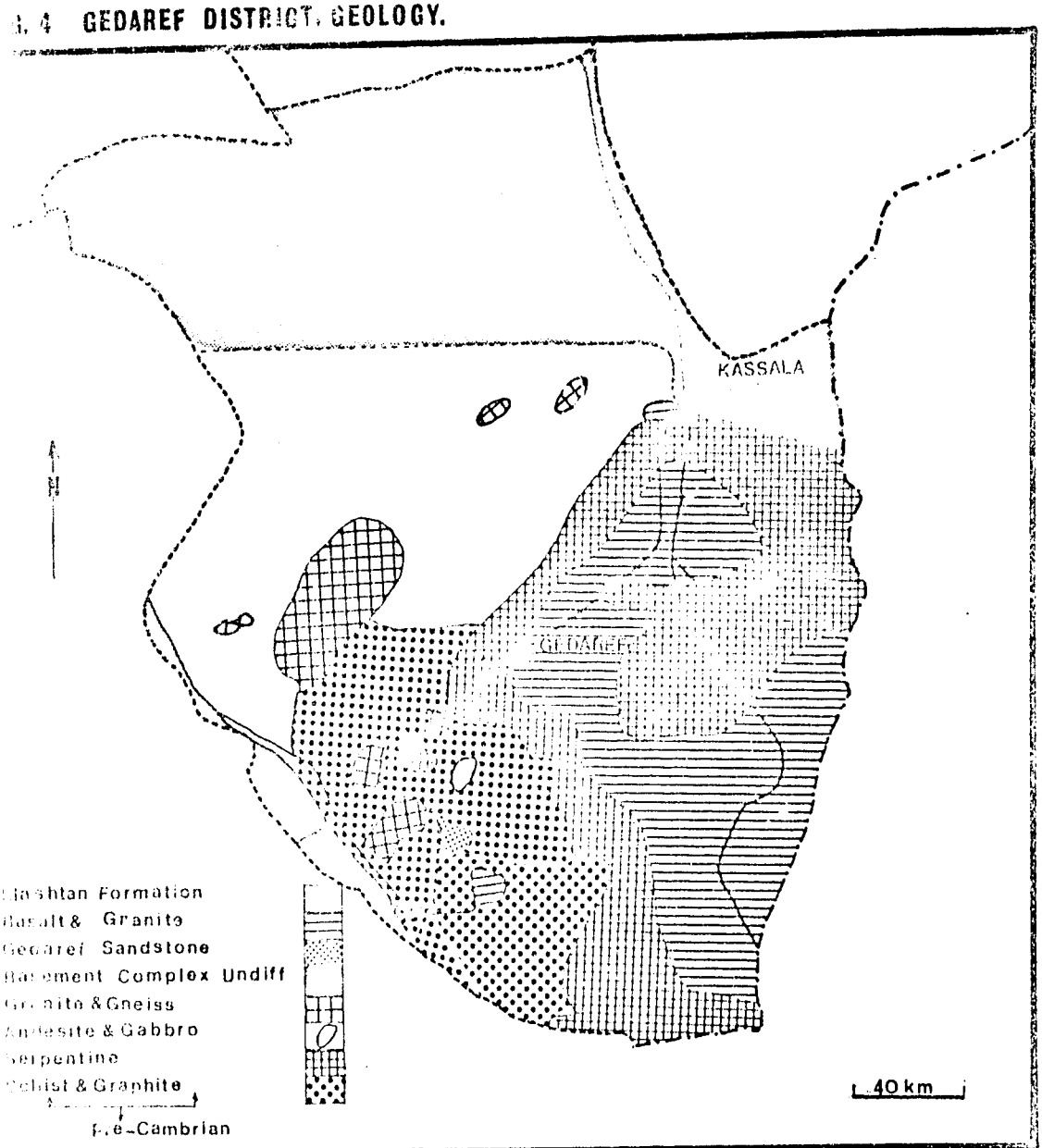
FIG 3 GEDAREF TOWN, WATER & CLIMATIC DATA.



SOURCE:

Kassala Province Profile 1980.

3.4 GEDAREF DISTRICT, GEOLOGY.



SOURCE: SOIL SURVEY, WAD MEDANI, 1976

Table 5

Mean Monthly Rainfall - Ghadambaliya, 1945-1949

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Rainfall (mm)	0	0	0	0	23.4	43.32	79.28	181.42	112.9	36.0	6.8	0
Stand.deviation	0	0	0	0	18.93	36.62	25.68	47.59	46.2	29.19	9.7	0
Coef.of variance %	0	0	0	0	80.9	84.5	32.39	26.23	40.92	81.02	142.4	0

Table 6.

Annual Rainfall Totals - Ghadambaliya, 1945-1949

Year	Rainfall(mm)
1945	472.5
1946	475.9
1947	267.8
1948	497.7
1949	611.0

Standard deviation = 110.86 mm

Coefficient of variance = 23.54%

The Gedaref District lies within the South Central Clay Plains area. The elevation of the undulating plains is from 550 metres to 650 metres. Flatter plains slope away from the Gedaref-Gallabat Ridge down to 450 metres.

The predominant formation in the southern part of Kassala Province (The Gedaref Region) is a large area of tertiary basalts surrounded by Mesozoic sandstones or mudstones of the Gedaref formation. The rocks of these formations are covered by thick layers of Quaternary elastic material which is mainly heavy clay in the Gedaref region. Outcrops of the rock formation are found on the Gedaref-Gallabat Ridge.

The Gedaref Formation:

The Gedaref formation, made of quasi-horizontally bedded sandstones and mudstones, is from the Mesozoic age, but is somewhat older than the Nubian Sandstone formation.

These Gedaref formation beds consist of conglomerates, sandstones, sandy mudstones and mudstones. The sandstones are often silicified and are similar to quartzites found in small jebels, such as those west of Jebel Simsim. There are only a few other surface outcrops.

Tertiary Basalts:

The Gedaref-Gallabat Ridge at an elevation of 600 to 700 metres consists of mud-tertiary basalts and crinnites sitting on top of the Gedaref formation. These

basalts are very dark grey to black, very fine-grained ultra-basic lavas. Some are highly vesicular with zeolite infillings and are called crinanites. The thickness of the basalt is variable, but is more than 200 metres in some places, e.g., ErRawashda.

2. HYDROGEOLOGY:

We have not found any sources discussing the hydrogeology of the Gedaref area in the 1940's.

We have two documents which discuss the hydrogeology of the area: Groundwater Resources of Sudan, published by the Rural Water Corporation (1976); and an M.A. Thesis by O.M. Kheir (1980).

The Gedaref basin mainly consists of Nubian Sandstone formations and basalts. The basalts are multiple sheets and irregular intrusions of Jurassic age, which are extended over the Nubian Sandstone formation. The Nubian Sandstone in the Gedaref area has proved to be older than the Nubian Sandstone in the east of Sudan. The formations are classified as "Gedaref formation," constituted by sands, sandy mudstones and mudstones which sometimes contain conglomerates.

The base of the Gedaref formation varies according to the variation of pre-Gedaref topography or past Gedaref earth movements, represented by large scale warping and faulting.

Water chemistry is good with low values of total dissolved solids, ranging from 500-400 ppm in the Gedaref formation, and in the basalts the salinity ranges from 1000 to 3000 ppm (parts per million). The water of the Nubian and deep basalt aquifers is of the sodium bicarbonate type, while the shallow basalt aquifer is of the magnesium bicarbonate type. The groundwater of the Gedaref basin may be classified as "fresh" water

since the total dissolved solids in all wells is less than 1000 ppm. (Water from wells no. 83 and 121 is brackish, with total dissolved solids exceeding 1020 ppm). Depth of the static water levels ranges from 23 ft (7.0m) to 400 ft (122m) in the Nubian aquifer, and rarely exceeds 100 ft (30m) in the basalts. The saturated thickness of the aquifer ranges from 200 to 500 metres. The groundwater is moving in a N.W. direction with a velocity of 0.3 to 3 metres per year.

The water is found to be under artesian and semi-artesian pressure locally. It also occurs in weathered, jointed, and fractured tertiary lava flows, mainly under free water table conditions. Recharge is mainly from water seeping into the mudstone formations from the River Setit (a branch of the Atbara River), and through seasonal stream beds. The basin is receiving some underflow from adjacent basins around its borders. This accounts for about 12 million cubic metres per year.

The basin's storage capacity is approximately 700 million cubic metres per year, and the abstraction rate is 1.2 million cubic metres per year.

Table 7

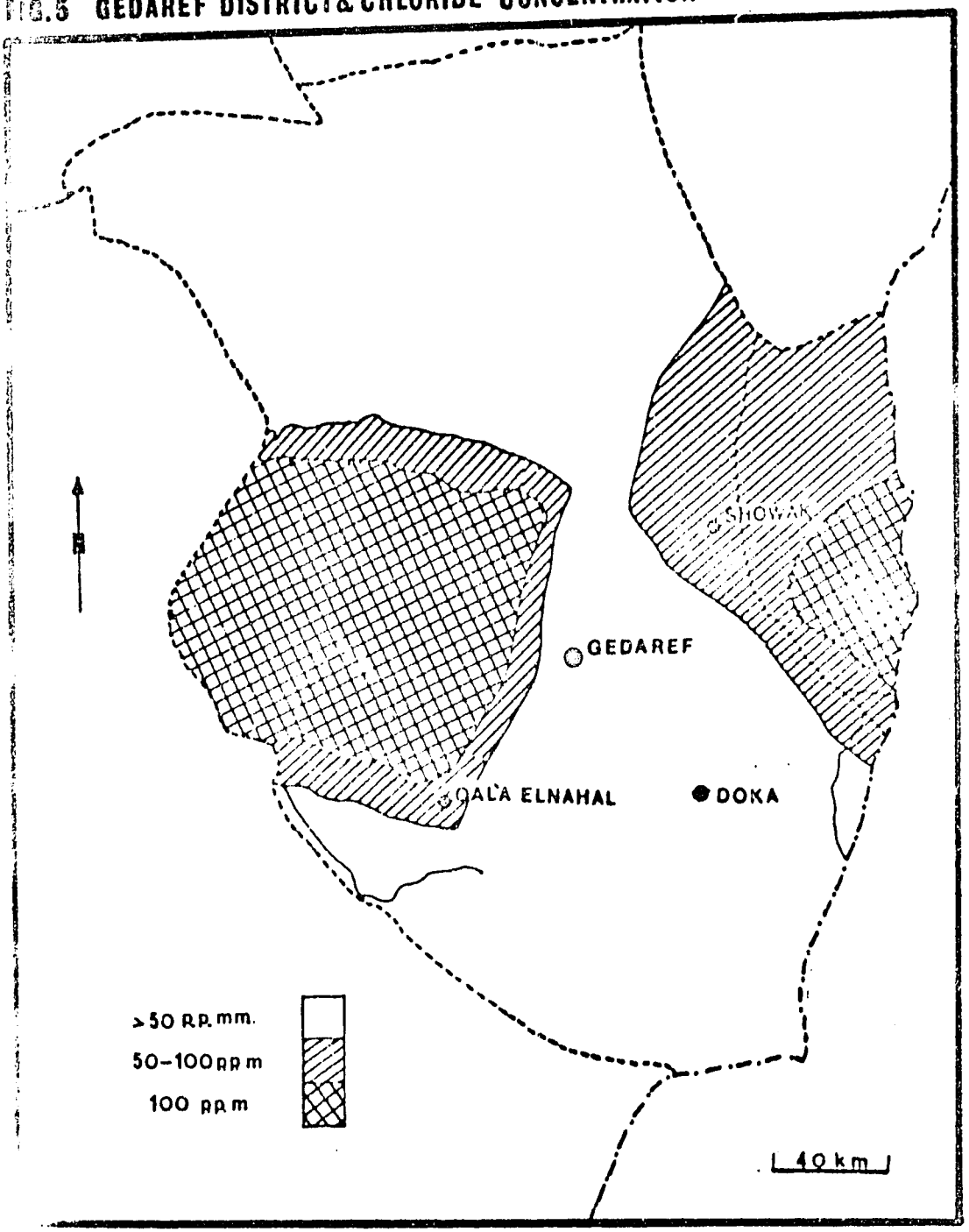
Groundwater Potentials of the Basin

Basin	Underflow Mill.m^3/yr	Recharge Mill m^3/yr	Basin Storage Mill.m^3/yr	Abstraction Mill.m^3/yr	% of Abstraction: to Recharge
Gedaref	12	41.7	700	4.2	10.14%

Groundwater Resources of the Basin

Present State	: Developed
Management	: Required
Future Potential	: Poor
Areas for Future Development and study	: None

FIG.5 GEDAREF DISTRICT& CHLORIDE CONCENTRATION



G. 6 GEDAREF DISTRICT, DRAINAGE.

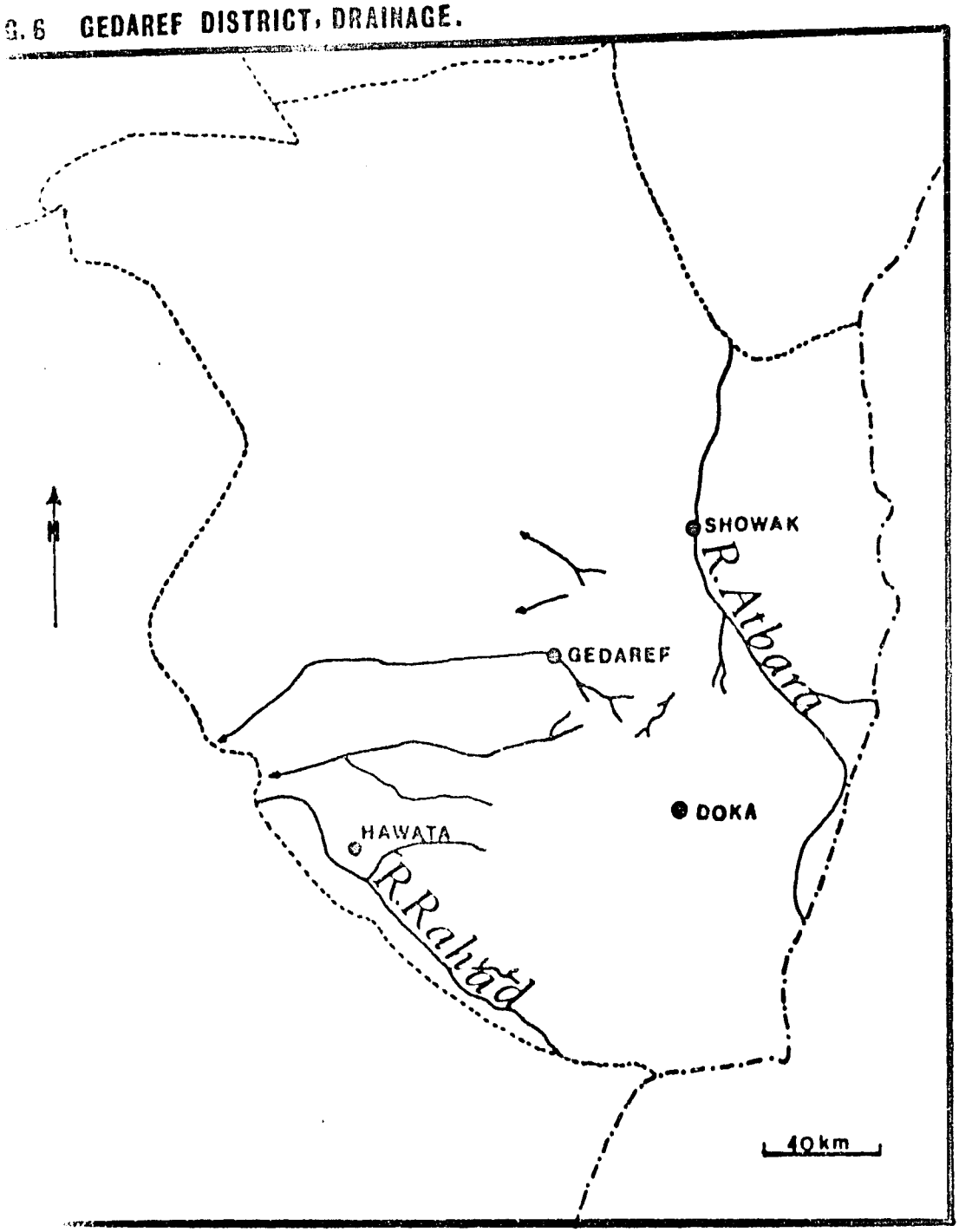
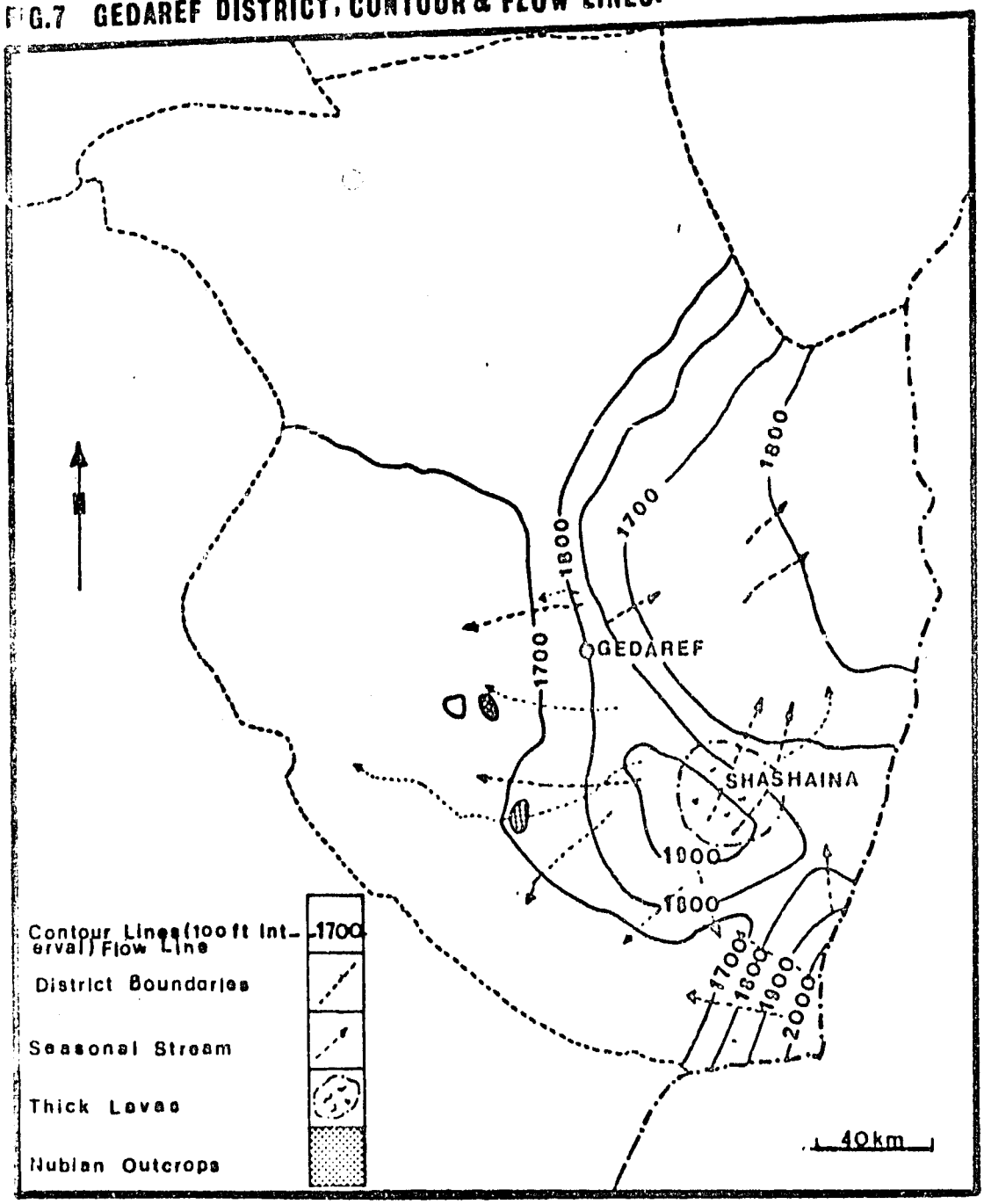


FIG.7 GEDAREF DISTRICT, CONTOUR & FLOW LINES.



It is interesting to note that the Rural Water Corporation feels that future development of the basin is poor. Reasons for this were not stated in the report. Detailed specialized study seems to be necessary.

C. SOILS:

The three sources of information about the soils of the Gedaref region during the 1940's are Tothill's Agriculture In The Sud.. (1948), Mechanization in Agriculture In The Rainlands of the Anglo-Egyptian Sudan 1943/1948 by T.W. Clouston, and Harrison's Grazing Report.

The soils in the Gedaref Region have darker colours, higher clay contents and strong vertiselic characteristics. Most soils were formed from weathering products derived from the basaltic rocks of the Gedaref-Gallabat ridge and basement complex rocks.

Tothill describes the soils of the Gedaref Region as chocolate clays. He says that the clay content of the soils increases as one heads south and east through Kassala Province. The average ground slope is 2.5 metres per kilometer. There are limited areas of "chocolate" cracking clays formed in situ from basalt. These areas are found mainly around Gedaref. Areas of clay found to contain quartz stone on the surface are widely spread and are good for cultivation. These soils are called "bashendi". Rainland clay plains crack deeply in the winter and crumble during the dry season. During the wet season they are spongy. As a result of their high permeability, little water is lost to run-off.

Clouston describes the soils of this region as deep, black or greyish black, cracking clays. Toward the western end of this region are large areas of light sandy soils suitable for producting groundnuts.

The two sources give very brief general descriptions ofthe soils in the area. In the trend analysis

there is a more detailed description of the soils done in 1967 by the Soil Survey Administration.

We have no data regarding the soil erosion potentials. However, we can do some educated speculation.

Ahmed Mohamed El Hassan, in a monograph titled The Environmental Consequences of Open Grazing in the Central Butana, Sudan, states that large areas of land in this region (directly north of Gedaref)* have been over-grazed to the point that now they are bare ground. He analysed these bare soils and found that there was a decrease in silt and clay as an area is being over-grazed. Once the soil cover has been lost, the soils are easily carried away by winds and rainfall. This problem of overstocking herds and over-grazing smaller areas of land has developed since the advent of the large mechanized agricultural schemes. If we assume that prior to these schemes there was enough land for all the pastoral groups to graze without denuding large areas, then we can say that there was more cover and more topsoil on the ground and that perhaps these soils were less vulnerable to wind and rain erosion than they are today.

In the first appendix to his grazing report, Harrison (1956) gives a general description ofthe soils in the Gedaref area. The following is his description.

> Dry cracking clay occurs in huge monotonous flat uniform plains in Eastern Sudan. In the Gedaref area it (soils) appears to have been formed in situ. Clay shrinks ../..

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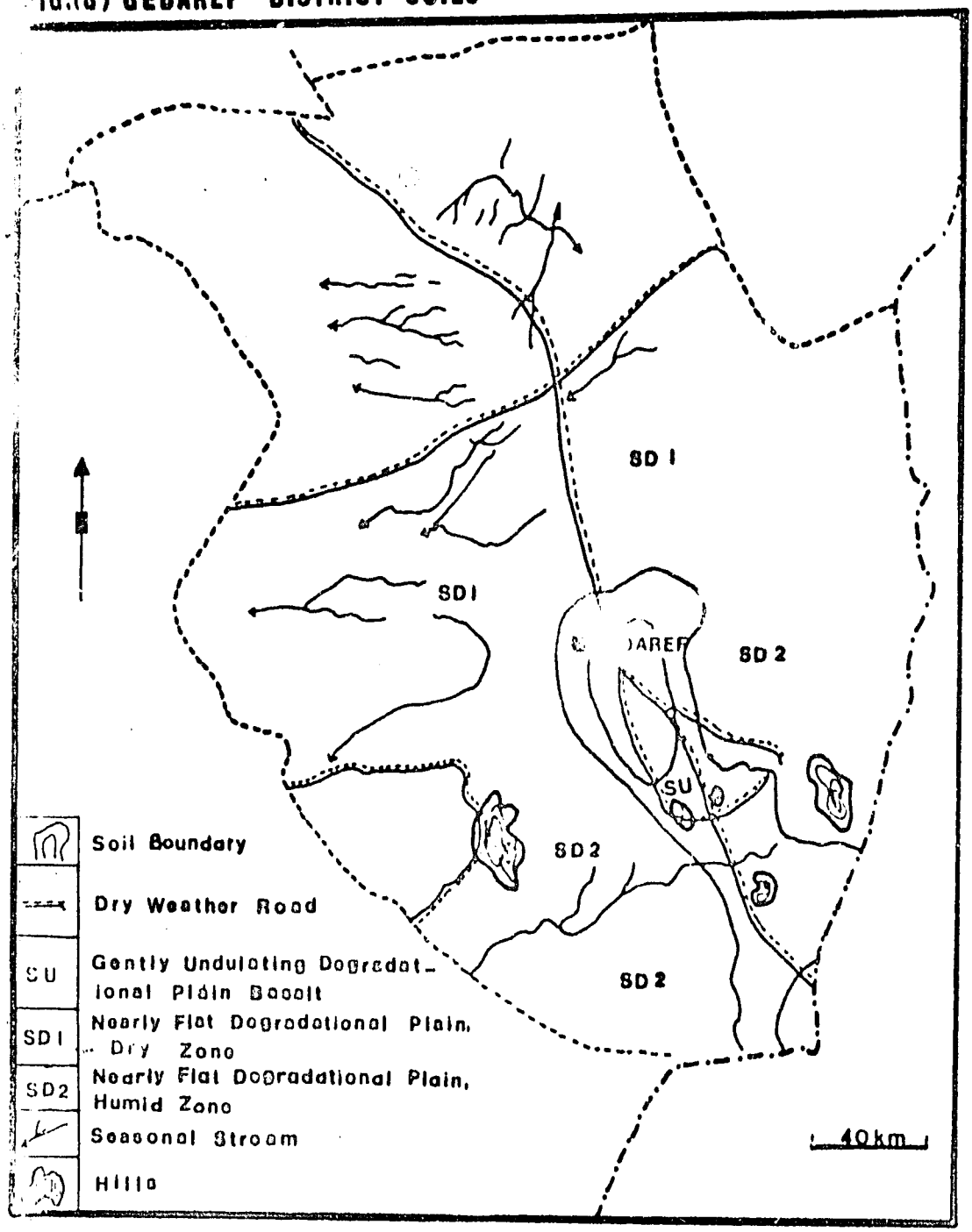
* The Gedaref Region is in the Southern Butana area. Although El Hassan wrote about the Central Butana, the Gedaref region has nearly the same soils and the same problems with regard to nomadic tribes and over-grazing.

10.(8) GEDAREF DISTRICT SOILS



considerably on drying causing soil to crack widely and deeply in the dry season. Water penetration is confined almost entirely to cracks. The cracks close when soil moisture reaches the critical point of 30.25%. The clay then becomes impermeable. There is no sub-soil water table in this area. Not all moisture in the soil is available for plant growth, therefore the cracking clays carry a poorer vegetation than do stabilized sands with equal rainfall.

The top layer of the profile is usually darker than the lower part. The mineral status is good, especially the potash content. Alkaline and calcuim carbonate concretion can also be found.

Above the 600 mm isohyet, crack cannot absorb all the rain and flooding occurs on the level plains. This is evidenced in creeping flows and river spills.

D. VEGETATION:

Harrison and Jackson in their paper on the vegetation of major ecological divisions in the Sudan place the Gedaref District into two sub-divisions of Woodland Savannah. They define Woodland Savannah as "any mixed type of vegetation composed of grass with bushes and/or trees in which the very variable proportion of grass to bushes and/or trees is determined by the frequency and intensity of fires." This type of vegetation is characteristic of the dryish tropics with a monsoon rainfall confined to a few months, followed by a long hot dry season. The following is a summary of Harrison and Jackson's description of the Woodland Savannah and its subdivisions.

The trees of low rainfall Woodland Savannah in the drier parts are nearly all thorn trees of low stature. They are principally Acacia species with some thorn bushes and shrubs, including thickets of Acacia mellifera.

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Broad leaved deciduous trees become predominant in the wetter parts, but there is not as much variety of species as in the High Rainfall Woodland Savannah area.

There are more annual grasses than perennials, and the perennials seldom attain the height and coarseness of the High Rainfall Woodland Savannah grasses.

The Low Rainfall Woodland Savannah is divided into two belts: the dark cracking clays of the east and the stabilized Sand Dunes or "Qazes" of the west. Each soil type gives rise to specific types of vegetation. The clay area is called the Low Rainfall Woodland Savannah on Clays.

The grasses of Low Rainfall Woodland Savannah on Clay often occur in separate patches with each patch dominated by a single grass almost to the exclusion of other grasses. Marked changes from one patch to another take place with no apparent reason.

Acacia mellifera thickets and the drier parts of Acacia seyal-Balanites savannah alternate in time and space with grass-lands area in a grassland Acacia cycle.

The Gedaref region is in two subdivision classes of Low Rainfall Woodland Savannah. From Harrison and Jackson's classification scheme, the two classes are:

III. WOODLAND SAVANNAH, (A) LOW RAINFALL, (I) ON CLAY

a)(I) Acacia Mellifera Thornland, on dark cracking clays alternating with grass area (100-570 mm rainfall), and

b) Acacia Seyal -- Balantites Savanna, alternating with grass areas (570-800 mm rainfall)

a)(i) Acacia Mellifera Thornland

The dominant tree species of this area is Acacia mellifera. It forms dense, nearly pure, thickets which are almost impenetrable and beneath

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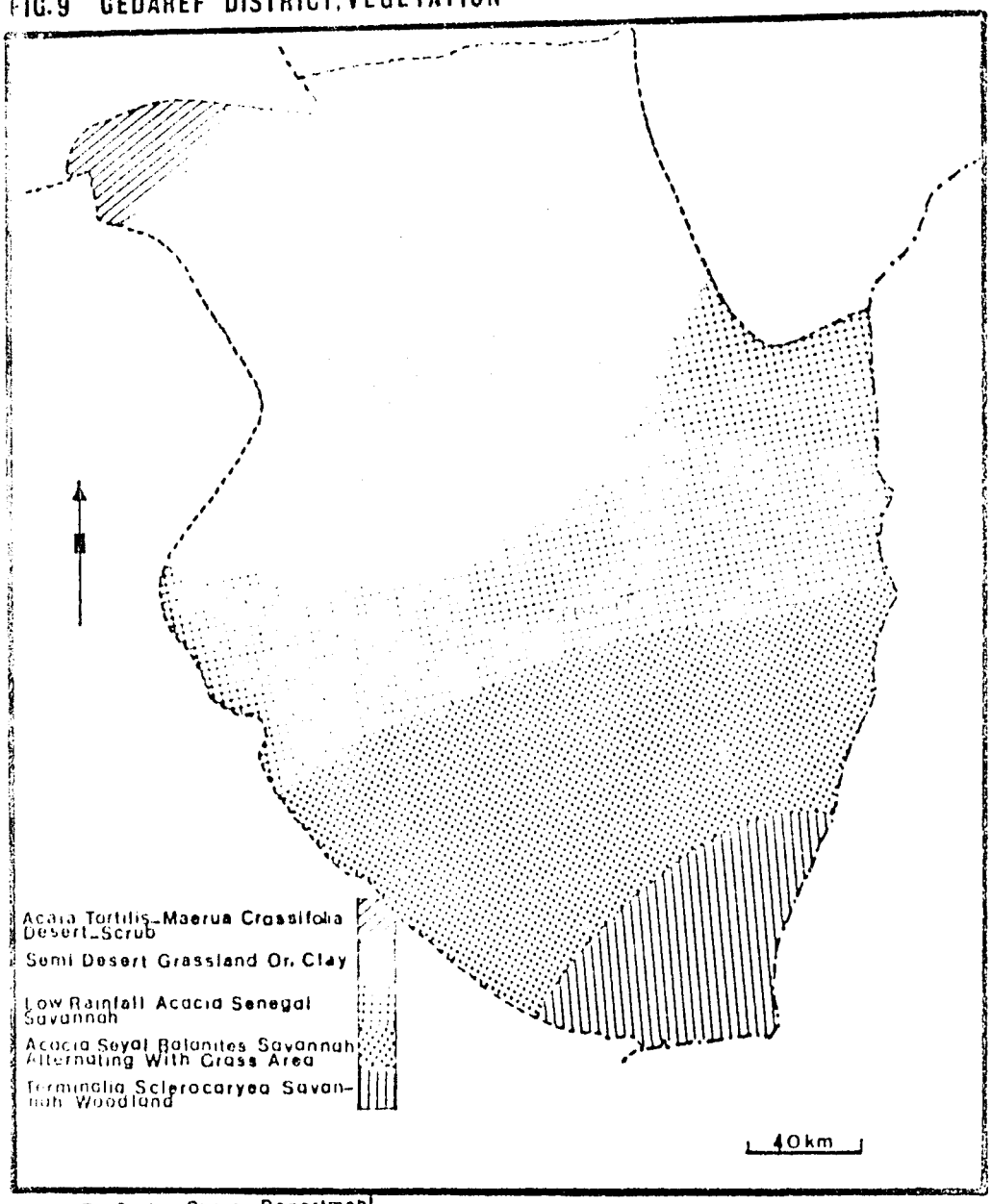
FIG.9 GEDAREF DISTRICT, VEGETATION



SOURCE: Sudan Survey Department

which grass is greatly reduced so that thickets are fire proof. However, as the trees grow older, the thicket is broken by dying trees and the grasses invade and fires follow, killing the remaining A. mellifera. The grassland persists for a number of years before recolonisation by A. mellifera takes place. This is known as the "Grasslands-Acacia Cycle.

Associated with the A. mellifera species are Cadaba glandulosa, Cadaba rotundifolia and Boscia senegalensis. These often persist after A. mellifera have disappeared. Less abundant trees are Dichrostaclup glomorata and Balanites aegyptiaca.

Acacia Seyal begins to occur on water-receiving sites towards the south of the zone, but it is not generally dominant in this subdivision.

The most abundant grasses of the grass areas, usually occuring in separate patches are: Cymbopogon nervatus; Sorghum purpures - sericium; Hyparrhenia pseudocymbaria; and Sehima ischaemoides. Under the bushes themselves is a scatter of Tetrapogon spathaeeus and Setaria verticillata. Dinebra retraflexa is less dominant. Along the Blue Nile and Atbara Rivers are large areas of eroded soil, "Kerrib", which typically have Balanites aegyptiaca, Acacia nubica, Acacia raddiana and Capparis decidua. The grasses are annual Aristida species Schoenefeldia gracilis, Elyonurus reglearis, Seteria archromalaena and Sprobolus species.

b) Acacia seyal - Balanites Savannah

Acacia mellifera thornland passes tradually into Acacia seyal - Balanites Savannah at about the 570 mm isohyet. However, on level sites the Dark Clays on which it occurs cannot absorb more than 700 mm of rain without flooding. As flooding increases, trees disappear to be replaced by open grass plains of Setaria incrassata.

Acacia seyal is distributed throughout, usually more or less mixed with Balanites. After cultivation, the Balanites is often left pure. In dried parts of this belt

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Acacia mellifera are found in slightly wetter areas Acacia senegal, though the Acacia senegal is never as pure or as dense as A. senegal savannah on sands.

In low lying areas Acacia campylacantha (reduced to a straggly shrub not more than 2 metres high) occurs. On areas liable to flooding Acacia fistula and Acacia dreparolsbium are found.

The dominant grasses, which do not differ much from the Acacia mellifera thornland subdivision, are Sorghum purpureo - soriceum, Hyparrheria pseudocymbaria, and Cyborogon nervatus. This last grass is confined to drier parts of the area. On blacker soils there are areas of Brachiaria obtusiflora.

Where Acacia seyal is thickest, beckerorsis species occur. In wetter parts Rottboellia exaltuta is found, and Ischaemum brachyatherur is abundant on water receiving sites. Setaria incrassata with Pennisetum ramosum occurs on low lying areas liable to slight flooding.

For grazing purposes, only Brachiaria obtusiflora is suitable for grazing in the dry season. In the north, in areas associated with Acacia mellifera, short annuals like Sehima ischaemoidas (dunbelab); Tetrapogon (fertil armub) Setaria verticullata (lusseiq) are of good grazing value. Camels browse on whatever trees are abundant, usually Acacia mellifera (kitr), Acacia seyal (talh), and Balanites aegyptiaca (heglig).

E. WILDLIFE:

We have been unable to locate any sources describing the wildlife in the Gedaref area during the 1940's. However Dr. Asim Moghrabi of the Hydrobiological Unit, University of Khartoum, gave a brief oral history.

He said that during the 1940's ostriches, guinea fowl, reedbuck and Dorcas gazelle migrated through the Gedaref area on their way to Dinder. At that time they were rather abundant.

SECTION III

SOCIO-ECONOMIC CONDITIONS

III. SOCIO-ECONOMIC CONDITIONS

A. POPULATION:

Very little data on actual population figures exist for the 1940's. In the 1944 Report of the Soil Conservation Committee, there is a map showing estimates of population of less than 20,000 people. In the surrounding region, the map shows two categories of population densities. To the southwest of Gedaref the population density is 5.50 people per square mile. To the north and in some pockets to the southeast the population density is less than 5 people per square mile. Rasoul, in his M.A. thesis, Urbanization and Town Administration in Eastern Sudan, states that the population of Gedaref Town in 1942 was 7,732 people.

At this point, a brief history of how Gedaref developed would be helpful in understanding Gedaref in the 1940's.

The oldest groups of population in the Gedaref district are the nomads from Arabia and the riverine Arabs from the Nile Valley. The majority of the population however, settled recently and came from Western Sudan and the western frontiers on their way to Mecca.

One of the first tribes to settle the Gedaref area was the Bwadra tribe. Later on the Shukriya tribe defeated the Bwadra and drove them out.

Abu Sin, the Nazir[1/] of the Shukriya (1790-1870) was the first to settle his family in the Gedaref area. He formed the first nuclear settlement, and Gedaref began to grow as a tribal market. Fertility of the soil and

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1/ The chief of the tribe.

sufficient rainfall enhanced growth of the area, and Gedaref began to gain commercial importance, attracting trade from the surrounding countryside.

During the Turkish period (1821-1881) Gedaref continued to grow because it was accessible to Kassala (227 km away), Abu Haraz (233 km away) and Gallabat (150 km away). Gedaref was quickly becoming a meeting centre for traders from Europe, Egypt and India, as well as traders from around Sudan.

During the Mahdist period Gedaref served as a garrison town and headquarters for Mahdist military operations against Ethiopia between June 1888 and March 1889.

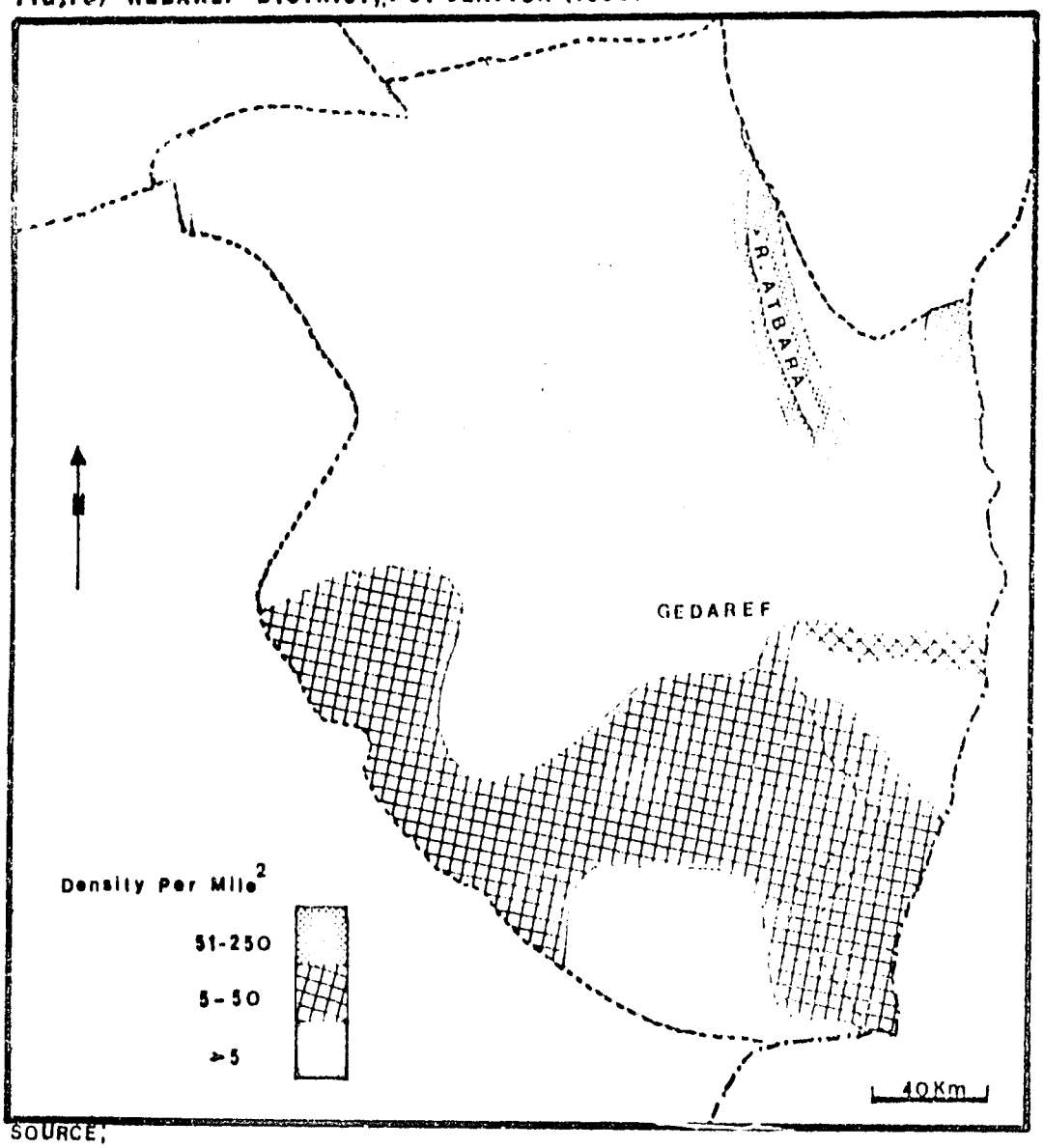
In the early 1900's Anglo-Egyptian forces brought changes to Gedaref. The railway line constructed in 1928 caused further expansion of the town.

In 1947, the British introduced mechanized crop production schemes in the Gedaref District. Mechanized agriculture and commercial prosperity gave rise to a high rate of in-migration for future agricultural schemes. At that time there was a great horizontal expansion of residential areas in the town.

Mackinnon in his chapter on Kassala Province (Tothill's Agriculture In Sudan) describes the Gedaref area as "vast and unpeopled Acacia tall grass forests as well as open grass plains." Writing in 1948 he continues to say, "There has also been a big increase, within recent years, of the Fellata[1/] and western Sudan tribes in the region extending from Doka to the neighbourhood of Gedaref. But on the whole, considering its assets of soil and rainfall, it is carrying only a small fraction of the population the area could support."

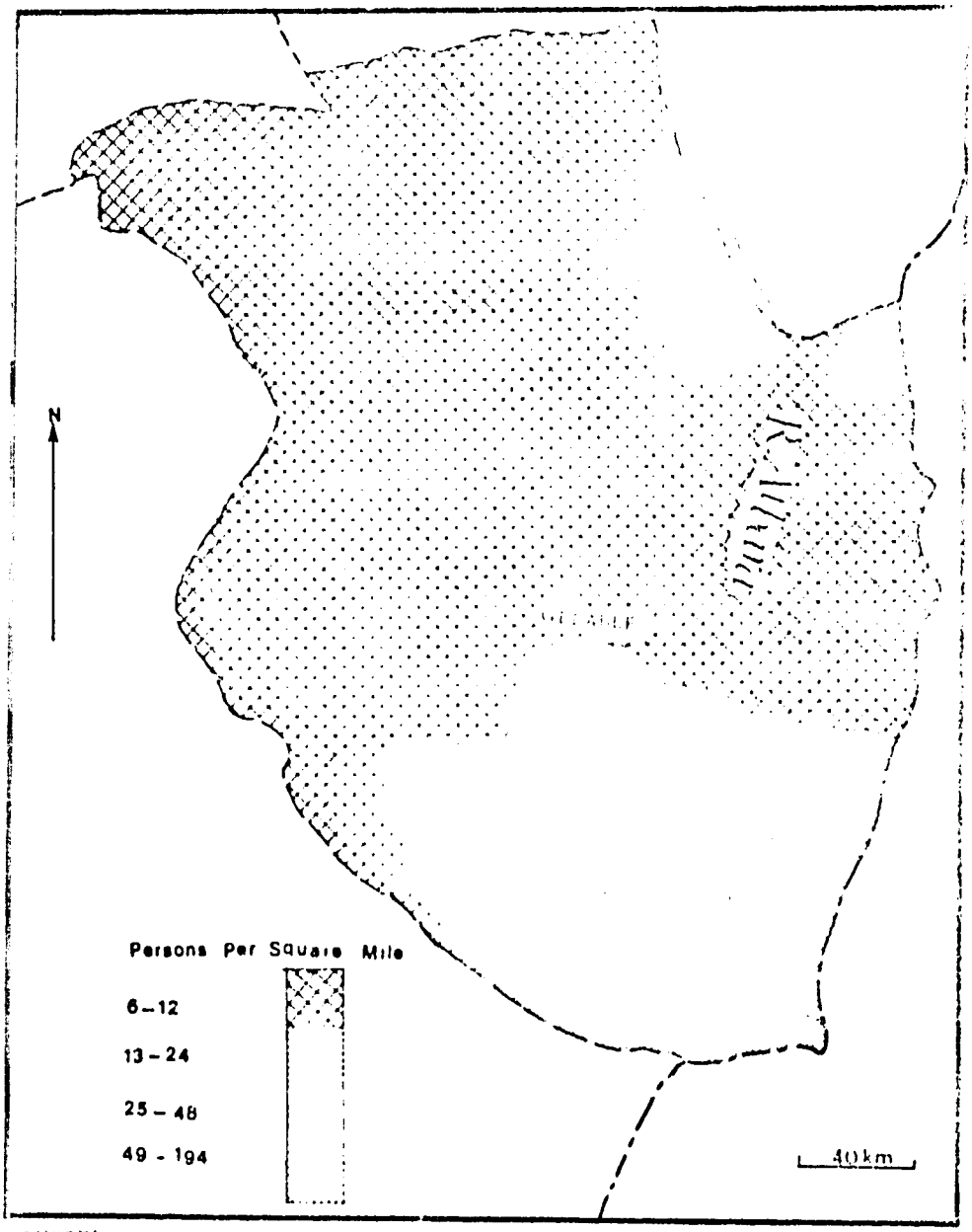
1/ People of north-Nigerian origin.

FIG(10) GEDAREF DISTRICT, POPULATION (1956)



SOURCE:
After Soil Conservation Committee(1956)

FIG.11. GEDAREF DISTRICT. POPULATION DENSITY, 1973.



SOURCE: SUDAN SURVEY DEPARTMENT

Harrison, in his grazing report, talks about the different subsects of Shukriya tribes that have their headquarters in Gedaref. However, he does not give any population estimates. The Eastern Shukriya, their subtribes (Atbara Khut and Butana Khut) and the Lahawin were the dominant nomadic tribes in the Gedaref District during the 1940's. Their migration patterns will be discussed in another section of this report.

In the Gedaref region there are both nomadic pastoralists and settled cultivators. The major land uses in the 1940's were cultivation, grazing sheep, cattle and camels, and urban land uses in Gedaref town and the small villages in the region. There were no major industries in the area. The nomadic pastoralists and their land uses will be discussed in a subsequent section of the report. This section will concern itself mainly with the basic crop complex and related land uses.

B. LIVELIHOOD AND LAND USE SYSTEMS:

1. Basic Crop Complex and Land Use:

Traditionally, two types of cultivation were practiced in the Gedaref District during the early 1940's. These lands which were perennially cultivated around or near the villages were known as "bilad" lands. Lands which were cultivated further from the village and on which dura was cultivated were known as the "hariq" lands. This was done to protect the crop from damage by village animals or to take advantage of good soils and rainfall. "Hariq" cultivation is a traditional practice whereby the land is set on fire to clear and renew it before the crop is seeded. During the early 1940's the plough was not used, ridging was seldom practiced, and the use of "teras" was rare except in the Butana area. Crop rotation was also not practiced.

In bilad lands dura was grown continuously for over 40 years or until the land gave out. Some sesame-dura rotation was practiced.

Before mechanized agriculture Gedaref was a rainfed grain cropping and gum collection area. During the first quarter of this century, the area's main exports were gum arabic, ivory and some limited cotton. By the second quarter of the century the Gezira Scheme was underway and cotton production transformed Sudan into a monoculture export economy. During the colonial period Gedaref was oriented towards grain production for the local market. Gedaref was the most famous "hariq" district in the country in the 1940's because of its extensive prairies and merchant cultivators. In 1943 Gedaref cropped 50,000 feddans under "hariq" cultivation, but in the later 1940's "hariq" began to lose ground to mechanized agriculture.

In 1943, Sudan was faced with a shortage of grain supply so the government started dura production in the Gedaref area with manual labour.

The project was abandoned, however, because the producers consumed the whole crop, leaving no surplus to send to other parts of Sudan.

Also in 1943 the Middle East Supply Corporation proposed sesame production in the Gedaref area. The Government was somewhat skeptical and suggested that dura be planted as well.

By the end of World War II Gedaref was producing 30,000 tons of dura, about 30% of the total dura produced in Sudan.

In 1945 the Ghadambliya scheme was put under production with 12,000 feddans under cultivation; that year the yield was 350 rotls (pounds) per feddan.

FIG (12) GEDAREF DISTRICT LAND USE

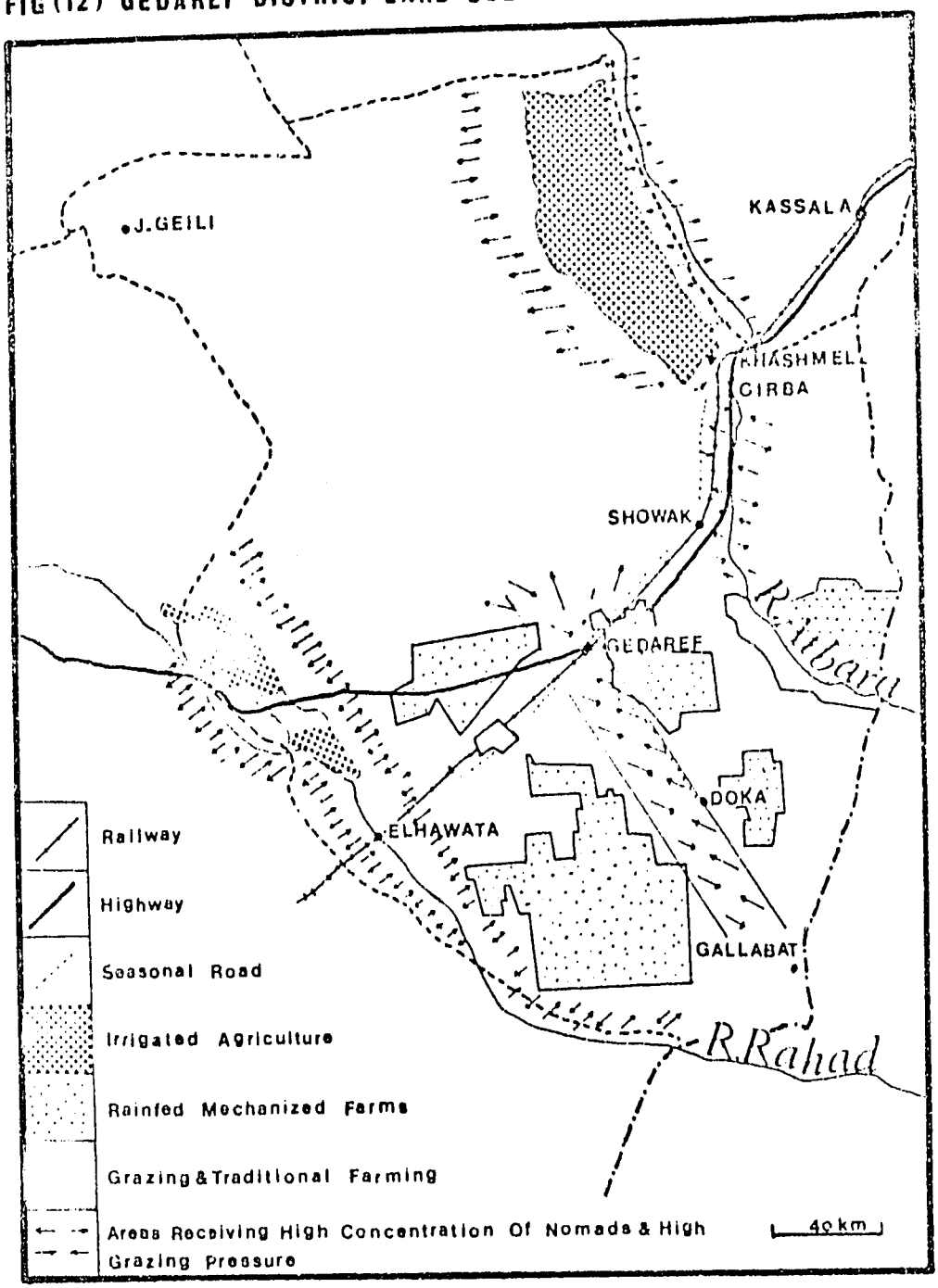
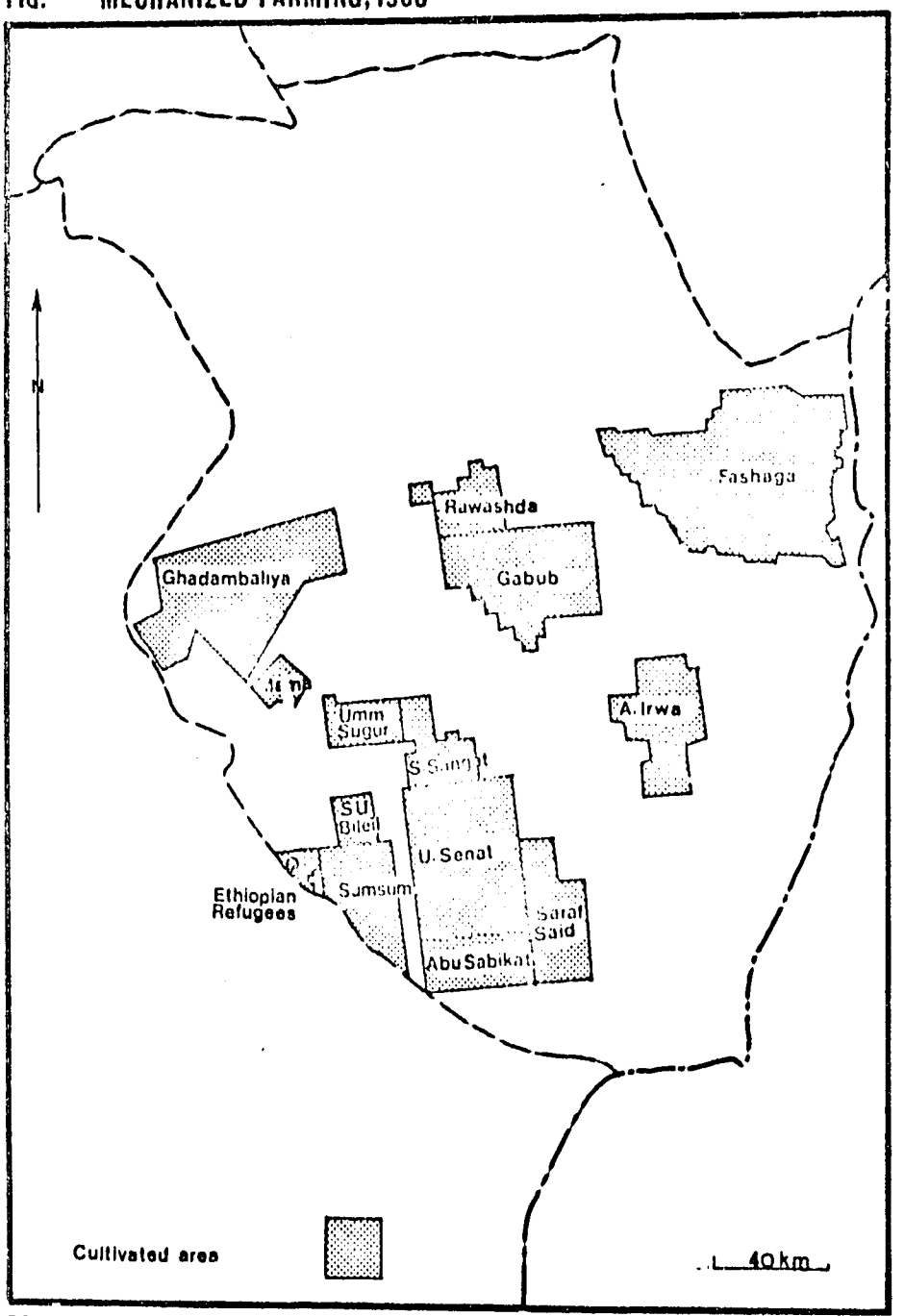


FIG. MECHANIZED FARMING, 1960



SOURCE: Survey Department, Khartoum (1960)

However, a bad grasshopper attack reduced the whole output to 1800 tons. In 1946, 21,000 feddans were put under production, yielding 710 rotls per feddan. The total crop that year was 6,700 tons.

In 1947 the Government expropriated 340,000 feddans for mechanized crop production schemes (MCPS). In the first year of operation the schemes were run as a state farm using direct labour. In the 1948-49 season the Government switched to "participating cultivation." Each farmer was allotted 28 feddans in the dry areas or 20 feddans in the wetter areas. The scheme managers provided the land, farming machinery, seeds, insecticide, water and timber for housing. The farmers also received 3 to 5 feddans for individual gardens. The management marketed the crops and divided the profits among all partners. The "participating cultivators" in turn had to resow areas not sown by machine, weed and thin the plots, harvest, clear the straw at the end of the season, and provide labour for protecting crops from pests. The average yield in the 1948-49 season was 744 rotls per feddan.

Dura and sesame were the main crops grown on a large scale during the 1940's. The dura varieties grown were:

Mugud-the commonest type and the first choice of the "hariq" cultivators,

Wad Akar - also very common, especially along the Atbara River, because of its resistance to bird damage,

Bargowi - a slow maturing Fetarita type, common near Doka, and

Hegeiri and Gassabi varieties - high quality duras grown generally in areas of good rainfall.

Only two types of sesame were grown, the red and the white varieties.

There was a large export of dura and sesame to other parts of Sudan. Also some dukhn (millet) was grown along the Atbara and Rahad Rivers and around Doka.

2. Animals, Sedentary and Nomadic:

Goats, sheep, camels and cattle are the animals kept by both nomads and cultivators in the Gedaref District. Most of the animals are herded by nomadic pastoralists, although sedentary cultivators keep a few animals for domestic use. The specific varieties of animals found in the Gedaref area are:

1. The Northern (or Arab) Cattle. These are a blend of the original African Shorthorn and Asiatic Zebu. Their hump is more pronounced than the cattle found in southern Sudan. Northern cattle have a high degree of resistance to hunger, thirst and movement under desert-like conditions;

2. The Desert or Arab sheep is the hardiest variety and weighs 100 to 150 lbs. The Northern Riverain sheep weighs 60 to 80 lbs. Sheep are more northern than cattle and can exist on poorer lands.

3. The Desert Goat - goats are both browsers and grazers and are very difficult to limit.

4. The one humped Arabian species camel - there are several varieties of this camel used in Gedaref for riding and baggage or cargo carrying.

In the past, animal numbers were controlled by intertribal raids and fighting, disease, starvation or lack of water. After the Mahadiya, the new local Government introduced law and order to tribal conflicts. The number of animals grew very fast until in the 1940's the "safe maximum" had been reached or exceeded (Harrison, Grazing Report). Harrison also points out that the stocking rate at that time was 15 animal units per square mile, and that without grazing improvement

and management this rate needed to be reduced by 20% to prevent deaths from starvation. In the Low Rainfall Savannah on Clay region, which covers approximately 77,000 square miles, the estimated animal units carried at that time were 1,100,000 animal units, which made a stocking rate of 15 animal units* per square mile. In Harrison's estimation this meant that the area was overstocked by 20%.

The distribution of animals according to tribes whose headquarters are in the Gedaref District is given in the following table.

Table 8

Estimates of Tribal Animal Numbers, Gedaref District, Kassala Province

TRIBE	ANIMAL NUMBERS		
	CAMELS	SHEEP	CATTLE
Eastern Shukriya			
- Atbara Khut	21,000	30,000	8,000
- Butana Khut	16,000	30,000	6,000
- Other Khuts	9,000	8,000	20,000
Lahaween	60,000	60,000	5,000

(Harrison, Grazing Report)

Estimates of animal populations of other tribes who migrate through Gedaref and Kassala Province are given in the following table.

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* Harrison's animal units equalled:

1 cattle = 1 unit

6 goats or sheep = 1 unit

1 camel = 1½ units

Table 9

Estimates of animal populations of other tribes

TRIBE *	HUMAN POPULATION	ANIMAL NUMBERS CAMELS	CATTLE	SHEEP	GOATS
Basharin	45,000	35,000	5,000	45,000	18,000
Amarar	67,000	30,000	3,500	50,000	25,000
Hadendawa	110,000	45,000	45,000	85,000	75,000
Beni Amer	45,000	1,000	28,000	70,000	45,000
Rashaida	15,000	25,000	1,000	60,000	30,000
Others	18,000	6,000	10,000	10,000	5,000
TOTAL	300,000	142,000	92,500	320,000	198,000

(Harrison, Grazing Report)

* (These tribes are all branches of the Beja Tribe whose lands are found throughout Kassala Province).

In the 1944 Report of the Soil Conservation Committee, G.M. Hancock (Animal Population of the Sudan) estimated the total animal population in Kassala Province to be 431,000 camels, 179,000 cattle, 598,000 sheep and 671,000 goats. He qualifies these figures with a multiplier for each animal species (cattle 50%; camels 100%; sheep - nomadic 100%; sedentary 50%; goats 60%. This is to allow for failure to count immature animals and probable underlisting.

It was very difficult during the 1940's to get exact numbers or accurate estimates of the animal population. All the above figures are imprecise but are the best estimates available at that time. The figures were taken from animal tax lists, lists of animals kept by local administrations, or animals counted around water centres.

Patterns of Nomadic Migration and Interaction with Sedentary Population:

In the Sudan the movement of pastoralists is a seasonal migration rather than true nomadism. Because

permanent water supplies are scarce in the Gedaref region, the general pattern of seasonal migration of the tribes is "one of congregation during the rainy season and dispersal in the dry season." (Harrison's Report, Appendix V).

In the rainy season the whole region becomes uninhabitable for animals. Clay turns into a sticky morass and the "fly" is a severe problem, especially for cattle. The nomads have to move their herds to the north to find suitable grazing.

In the dry season the tribes revert back to the permanent water supplies on the perimeter of the Butana. Overstocking around these permanent water supplies is serious, and the grazing value of the areas is mostly lost.

Generally the northern tribes in the area move south, for a short time during the early rainy season, where the growing and water supplies come first. During the worst part of the rains they move north to get away from the flies and mud. At the end of the rainy season they gradually move south again. By late October, all the shallow pools dry out and the tribes have to disappear back to their permanent water supplies (see attached map of tribal movements, Fig.14).

The two tribes that have their headquarters in the Gedaref area are the Eastern Shukriya (and their Khuts) and the Lahaween. Some sects of the Beja tribe also migrate through the area.

The Shukriya Tribe:

The Shukriya is the largest tribe in the region, and they are the true owners of the Central Butana. The tribe is divided into two branches: the Eastern Shukriya, who fall back on the Atbara River in the

dry season; and the Western Shukriya who revert to the Blue Nile during the dry season. Each branch has its own Nazir (Sheikh).

Within the Eastern Shukriya, there is the Atbara Khut, the Butana Khut and some small Eastern Shukriya Khuts.

The Shukriya can graze anywhere in the Butana, while a grazing settlement defines a "general grazing area" that can be used during the rainy season by any tribe. This region has no permanent water supply, only shallow ponds and hand dug hafirs that carry water for about two months after the rainy season.

When the temporary water supplies dry up, the southern tribes have to go back south, leaving the Butana to the Shukriya who graze from their permanent water supplies outside the general grazing area. Southern tribes cannot use this water at all.

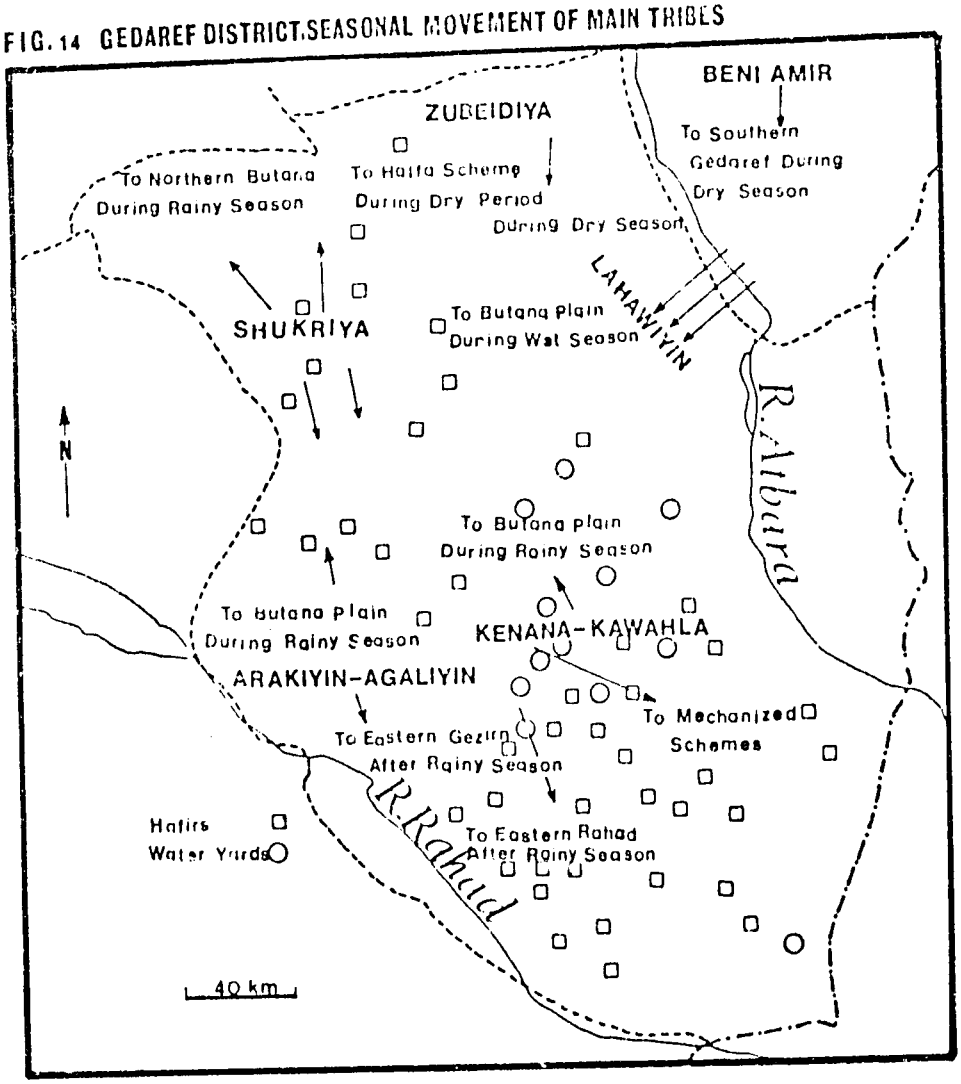
Because the Shukriya enjoy sole use of the permanent water supplies, they can keep many cattle, sheep and camels.

The boundaries of this "general grazing area" are Jebel Qeile, east along the Khartoum-Kassala Road to Jebel on Nasla, then south through Jebel Mundera to Suki. From there the boundary line heads west to "Sin el Luweiga (on the Blue Nile), north to Jebel Lebaitor and back to Jebel Qeili.

Atbara Khut Shukriya

This Khut of the Shukriya has an unusual mix of sedentary cultivators and semi-nomadic camel and sheep owners. The Khut is divided into three "omodias" (sections).

FIG. 14 GEDAREF DISTRICT.SEASONAL MOVEMENT OF MAIN TRIBES



The Northern Omodia of Kawahla have their headquarters in Qoz Regeb. During the dry season they get their water from the Atbara River, all the way up to Baaluk. They graze into Besharin Umm Nagi territory. During the rainy season they graze into the same area as the Lahaween (see description following). This omodia has a little cultivation on Wadi Gigi and Khor Atshan.

The other two omodias are headquartered in El Suedira and Asubri. They have quite a bit of cultivation, just inland from the Atbara River "Kerrib" lands. They also have a large number of cattle plus camels, sheep and goats.

In both the rainy and dry seasons they graze with the Lahaween, however they are more sedentary than the Lahaween and their movements are not as distant.

Butana Khut Shukriya:

The Butana Khut Shukriya have sole use of all the well centres in the central Butana. Most of these well centres have little water and some dry out by the end of the dry season. Half the camel herds get sent to the Atbara River for watering; not many cattle are kept with the camels and sheep because the small size of the water supply limits the extent of heavy grazing.

The largest well centre in central Butana is Es Subagh. It is badly overgrazed. All together there are 12 well centres and 12 hafirs in the Butana Khut territory.

The Butana Khut migrates north, during the rains, to the area around Wadis Ba Hagi, Ruweiyan, Atshan and Gigi, north of the Khartoum-Kassala Road. Some members of the Khut also migrate northeast towards Jebel Mayemba They graze in the area between the Lahaween and the Abu Dellig Khut.

The Butana Khut has some small areas of cultivation along the Wadis just mentioned and along wadi Husheib on the Beira-Rufaa Track.

Other Eastern Shukriya:

A number of other Khuts stretch across the Butana. The Nazir's Khut is based in Gedaref. These smaller Khuts consist of sedentary cultivators and villagers. They herd mostly cattle.

The Lahaween:

The Lahaween tribe came to eastern Sudan in the late 1890's and early 1900's from the White Nile near Kosti. Their headquarters are located in the Gedaref District, but during the dry season they return to the Atbara River to water their animals.

Their territory now extends from Khashm El Girba to Showak on the Atbara River. Along the Setit River they are located between the Atbara Khut Shukriya and the Abu Sin Khut and other Shukriya Khuts to the south.

The Lahaween outnumber the Shukriya in animals, and their grazing migration patterns are somewhat longer.

They have one cultivated area about 10 miles west of the Atbara River, just south of the Khartoum-Kassala Road, and a second area around Nagatta which is their tribal headquarters.

During the short rainy grazing season, the Lahaween set up a temporary headquarters at Jebel Mukheiriq. The tribe moves together, staying 14 to 21 days in one place until the water and grazing are exhausted; then they move on to the next place. They move north as far as Jebel Umm Bettikh or Jebel Mayemba and west as far as Khor Atshan.

In the dry season (about 8 months) most of their camels drink from the Atbara River. They water their camels every fifth day while they continue to graze further into the Butana, searching for areas of Blepharis species. They only go as far as the Butana Khut Shukriya territory (on a line through Jebel Mawasil). In the south they graze as far as Jebel Kasamor and Meganis. As the dry season progresses the Lahaween take some of their camels and the majority of their other livestock and move along the Setit River.

3. Interaction with Sedentary Population:

In the 1940's large scale mechanized farming was just developing so there was plenty of land for both cultivators and pastoralists.

Harrison noted that already in the 1940's there was mutual antipathy between cultivators and nomads. This was partially due to tribal differences; disputes and troubles were frequent when the two would meet.

Harrison in his Grazing Report did note:

> Though sufficient of the vast plains will remain to continue a pastoral economy for some time, the nomads are obviously going to become more and more restricted. (Harrison, Part II, p.17).

Realizing that problems between cultivators and nomads could arise, the Soil Conservation Committee recommended in 1944 that, where nomadic pastoralists were in direct competition for land with settled cultivators, it should be the policy that the rights of the cultivator be considered as paramount, because his crops yield a bigger return per unit area.

4. Land Tenure in Relation to Crops and Herds:

In the 1940's both the nomadic pastoralists and the settled hariq cultivators owned land communally. It was only in the late 1940's when the British introduced large agricultural schemes that another form of land tenure was introduced to the region.

In 1947 the Government put 340,000 feddans in the Gedaref area under mechanized crop production. That year the schemes were run as state farms using direct labour. The following year the Government switched to "participating cultivation" or crop sharing. Each farmer received 20 to 28 feddans which he cultivated while the Government marketed the crop and divided the profits among all the cultivators. "Hariq" cultivation and communally owned farming began to lose ground to mechanized agriculture and a crop sharing land tenure system.

The pastoralists, however, did not change their communal form of land ownership or their nomadic life-style. The climatic conditions of the Gedaref area are such that the pastoralists have to keep moving to find the best pastures and water supplies for their animals.

In his "Note on the Livestock of the Sudan" (Report of the Soil Conservation Committee, 1944), C.P. Fisher states:

> Nomads are not nomads from choice. They are so because they must and for this reason must be accepted as they are. Communal land tenure is the only workable system for them, and with this system nobody can introduce improvement in advance of the slow sense of the mass of his fellows.

One of the pasture management problems that both Harrison and the Soil Conservation Committee were concerned with was that it was very difficult to get

the pastoralists to limit their herd sizes. The pastoralists, of course, want to keep as many animals as possible in order that more animals could survive disease and starvation. One herder would not limit his flock unless everyone in the tribe does the same; this has been an ongoing problem of the communal land tenure system.

As mechanized agricultural schemes grew, the new form of land tenure associated with the schemes began to conflict not only with the pastoral nomads but also with the traditional cultivators as well. This problem was just becoming evident in the late 1940's.

5. Water Resources Use Systems:

In the early 1940's there was little permanent water supply in the Gedaref region. Most of the water was seasonal, except for the Atbara and Setit Rivers, and was stored in shallow ponds or hand dug hafirs. These sources usually dried up within two months or so after the rainy season ended. When these temporary sources dried up, tribes had to move south to look for other water sources. Water for Gedaref often had to be transported from great distances, especially during the dry season. In his Grazing Report Harrison notes that during drought or bad years herds had to walk long grueling distances between grazing areas and water centres. He demonstrated the effects of this problem in the following table:

Table 10

Late Dry Season Conditions in the Low Rainfall Woodland Savannah Area

Animal	Days between watering	Normal year: Radius grazed (mi)	Normal year: Area grazed (Sq. mi)	Bad year: Radius grazed (mi)	Bad year: Area grazed (Sq. mi)
Cattle	1 - 2	8	220	15	700
Sheep	2 - 3	12	450	20	1,300

mi = miles.

The need to develop water supplies, in order to reduce walking distances between water and grazing for animals and to even out the intensity of grazing, can be clearly seen.

In the mid-and late-1940's the government began developing water supplies to relieve the severe water problem in the region. Water was being provided for both pastoralists and for agriculture.

In their 1944 report the Soil Conservation Committee's two top priority projects for the Gedaref area involved water supply.

They wanted to accelerate development of the Gedaref area by providing permanent fire lines and better water supplies, and they were investigating the possibility of constructing a pipeline from the Atbara River to Gedaref. The plan was to drill a line of trial boreholes from the Atbara to the railway at Quala El Nahl, passing through Doka. If the water proved to be insufficient or saline, than the possibility of building a pipeline would be considered.

Everyone concerned with agriculture and rural development at that time was aware that the development and economic growth of the area depended on developing adequate water supplies. Harrison thought that the ultimate aim of providing water supplies for the pastoralists had to be to increase the offtake of animals for each sale, if the costs of water supplies were to be justified. However, Harrison cautioned against putting in unlimited water supplies, saying that this would lead to overgrazing, deterioration of pastures and erosion. Furthermore, he stated that the only way to limit animal numbers, under communal land ownership by tribal tenure, was to limit the water supplies to the amount of grazing available.

By the end of the 1940's and early 1950's, 12 water centres and 12 hafirs had been constructed in the Butana and Gedaref areas. The following is a listing of the locations of the water centres.

Es Sabagh was the largest well centre in the region at the time. (Already then Harrison was noting that the area around it was badly overgrazed.) Nearby along the Gedaref Road were three other water centres: El Sadda, Husheib, and Bereisi. In the other direction were Beira and Sufeiya. Towards Abu Deleig were Gebel Qeili, Umm Ruweishid, El Quleifa and Shagg El Watiya. To the south were Suki and Adeib.

SECTION IV

KABAROS VILLAGE, GEDAREF DISTRICT

IV. KABAROS VILLAGE, GEDAREF DISTRICT

In 1946, K.M. Barbour was conducting field research for his book, The Geography of Sudan, when he wrote the following account of the natural vegetation of Kabaros village, south of Gedaref Town.

> Natural vegetation within some twenty miles of Gedaref has been almost entirely destroyed, having been cleared for cultivation or cut down for firewood. Between Gedaref and Kabaros there are a few stand of Safar (Acacia Fistula Sehwfth) and some isolated heglig, but most of the land is either under cultivation or has been resting for too short a period for more than grass to have grown up. To the south of the railway line and to the west of the ridge there is at first a belt of land partly or wholly cultivated, beyond which lies a region of forest that stretches for miles to the south. In the northern portion the forest consists chiefly of talh, Kitr, hashab and Safar Acacias, with numerous heglig; these grow close enough together for their branches to touch, but even during the rains their small leaves give little shade, and beneath them the grass cover is continuous. Within the forest there are several treeless areas of several square miles extent, where there is only a grass cover, with perhaps a few small bushes; these plains are called Sagias, and their importance today is that they afford obvious sites for locating schemes of mechanized cultivation. (*)

In the field trips and reports which followed we looked at the surroundings of Kabaros village and retraced Mr. Barbour's map to see how much the area had changed in the past 37 years.

(*) K.M. Barbour, Present Agriculture in the Savanna Belt of the Anglo-Egyptian Sudan, University College, Khartoum, 1953.

V. CAUSES OF CHANGE IN BASELINE CONDITIONS AND THE RELATIONSHIP OF ENVIRONMENTAL INDICATORS TO THREE BASELINE CONDITIONS

In the 1940's Gedaref District, with its relatively fertile soils and moderate rains, was beginning to develop economically and to undergo significant changes.

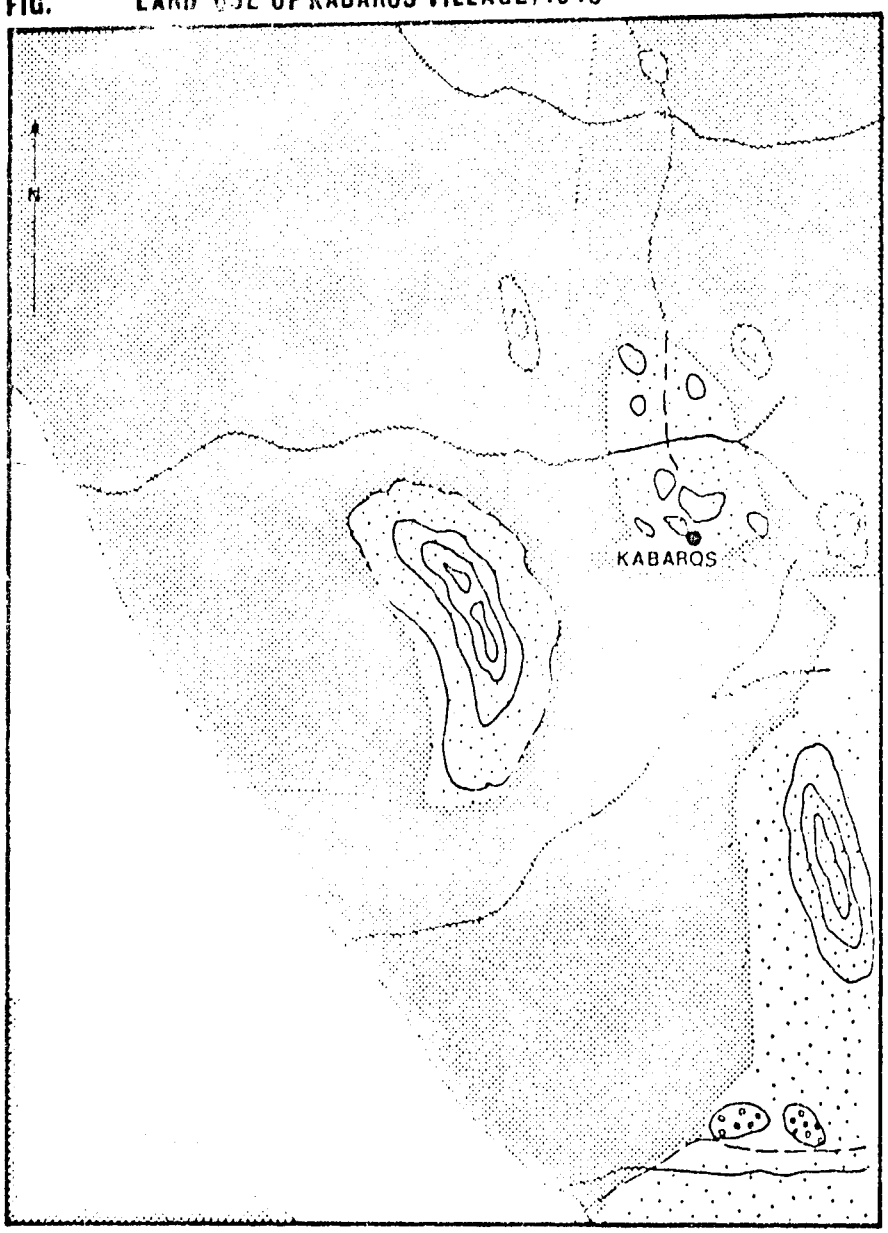
Until the 1940's and during the early part of that decade Gedaref District was a thinly populated area of nomadic pastoralists and settled traditional cultivators. The Town of Gedaref was a small but vital trading centre. Due to lack of developed water supplies, infrastructure and services, Gedaref District remained relatively stable.

The major event that altered Gedaref District, in the 1940's was the introduction and expansion of mechanized crop production. Traditional means of livelihood (subsistence farming and pastoralism) were losing ground to mechanized farming, as was the traditional system of communally owned land. Farmers now became share croppers while nomads began to lose some of their grazing areas.

In an area that had a small but stable population and where there had been plentiful grazing and fertile soils, we began to see in the late 1940's the last Acacia-tall grass forests slowly disappearing. Rangelands which could in the early 20th century sustain all animal life were becoming over-grazed. By the late 1940's most pastures in Gedaref District had reached their life grazing limits, while some were already overstocked by as much as 20%.

As mechanized farming areas expanded conflicts between the pastoral nomads and cultivators increased.

FIG. LAND USE OF KABAROS VILLAGE, 1948



The catalyst for change in baseline conditions seems to be the expansion of mechanized farming. It should be noted that not all the changes associated with this expansion were deleterious. The Town of Gedaref prospered with mechanized farming. More goods and services were provided and a vigorous trade developed in the town.

TREND ANALYSIS

I. INTRODUCTION.

II. PHYSICAL-BIOLOGICAL CONDITION BETWEEN 1950 and 1980.

III. SOCIO-ECONOMIC CONDITIONS BETWEEN 1950 AND 1980.

IV. ENVIRONMENTAL TRENDS AND THEIR INDICATORS.

TREND ANALYSIS

1. INTRODUCTION:

It is apparent that in the late 1940's and early 1950's what we see emerging is the beginning of a development process that puts tremendous stress on the socio-economic and physical-biological environments of Gedaref District.

In the trend analysis we will look at several resources and factors in the Gedaref District that either contribute to or are affected by changes in the environment. The resources to be traced through the 1970's are climate, water, soil, forestry and vegetation. The factors we will examine include population growth and migration, the change in conditions of the nomads, urban problems, lower agricultural productivity, over-grazing, deforestation, etc.

Data for all these points are not continuous during the period of study (1950's through 1980); therefore our picture of the changes which have taken place will be somewhat pieced together. We feel, however, that there is enough data to show that the environment in Gedaref District has deteriorated.

II. PHYSICAL-BIOLOGICAL CONDITIONS BETWEEN 1950 and 1980

A. Climate:

As stated earlier in the baseline report, the climate of the Gedaref District has not changed in the last forty years. The following tables present the mean monthly rainfalls and the annual totals for the periods 1950-59, 1960-69 and 1970-79.

Table 11

Mean Monthly Rainfall - Gedaref, 1950-1959

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean Rainfall(mm)	0*	0	0	6.22	23.31	78.51	155.61	188.4	107.4	17.41	6.18	0
Standard deviation (6)	0	0	0	6.95	3.16	43.86	59.806	38.81	46.29	28.71	10.39	0
Coefficient of variance (%)	0	0	0	111.74	13.54	55.85	38.42	20.6	43.1	164.52	168.12	0

* (0 indicates no rainfall in 10 years during these months)

Table 12

Annual Totals of Rainfall-Gedaref, 1950-59

YEAR	TOTAL (mm)
1950	714.1
1951	469.8
1952	575.4
1953	563.5
1954	557.0
1955	584.7
1956	696.9
1957	473.7
1958	614.3
1959	588.4

Highest rainfall :1950 - 714.1 mm

Lowest rainfall :1951 - 469.8 mm

10 year average ; 583.8 mm

Standard deviation : 71.85

Coef. of variance : 12.31%

Table 13,

Mean Monthly Rainfall - Gedaref, 1960-1969.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean Rainfall(mm)	0	0.16	.96	1.7	95.1	103.4	177.92	179.7	65.4	34.2	3.26	0
Standard deviation (6)	0	0.48	2.9	1.98	8.0	49.73	57.72	54.12	20.55	22.23	5.73	0
Coefficient of variance (%)	0	300	302.1	117.86	84.12	48.11	32.44	30.12	31.42	65.0	177.62	0

Table 14

Annual Total of Rainfall-Gedaref, 1960-69

YEAR	TOTAL (mm)
1960	438.7
1961	599.9
1962	573.7
1963	743.3
1964	551.5
1965	635.3
1966	617.0
1967	662.5
1968	530.5
1969	451.2

Highest rainfall 1963 : 743.3 mm

Lowest rainfall 1960 : 438.7 mm

10 year average : 582.4 mm

Standard deviation : 87.47 mm

Coef. of variance : 15.02 %

Table 15.

Mean Monthly Rainfall - Cedaref, 1970-1979:

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean Rainfall(mm)	0.04	0	41	65.5	26.9	86.3	187.4	167.0	110.6	32.0	4.2	0
Standard deviation	0.12	0	0.87	10.34	21.89	71.04	55.58	60.42	57.22	28.64	9.11	0
Coefficient of variance (%)	300	0	212.19	159.07	81.37	82.32	29.66	36.18	51.75	89.8	215.87	0

Table 16

Annual Total Rainfall-Gedaref, 1970-79

YEAR	TOTAL
1970	518.0
1971	473.7
1972	618.0
1973	598.2
1974	712.0
1975	606.6
1976	642.0
1977	608.8
1978	602.8
1979	775.3

Highest rainfall 1979 : 775.3 mm

Lowest rainfall 1971 : 473.7 mm

10 year average : 615.5 mm

Standard deviation : 81.12

Coef. of variance : 13.18 %

The data in the last 6 tables show that rainfall has not varied in the past 30 years. The 10 year coefficients of variance are small and range between 12 and 15 percent.

The annual distribution of rain has also remained fairly constant during the past 30 years. July, August and September are the three main months of the rainy season. During these three months 75% of the year's rainfalls (see Table 17).

Table 17

Average Rainfall during the Months of July, August and September

Year	10 year monthly average (mm)			Average annual total (mm)	% of annual total
	July	August	September		
1950-59	155.6	188.4	107.4	583.4	77%
1960-69	177.9	179.7	65.4	582.4	73%
1970-79	187.4	167.0	110.6	615.5	75%

One interesting point to note about the rainfall data between 1970 and 1979 is that the Sudano-Sahelian drought of the early 1970's does not appear in the monthly and annual totals. The monthly averages and annual totals during the early 1970's do not vary with any degree of significance from the data of the other 40 years. Although the annual rainfall for 1971 is the lowest for the decade, it is within the normal range for the Gedaref area.

Temperatures in the Gedaref area have been stable during the study period of 1950-1980. This can be clearly seen in the following tables.

Table 18

Mean Monthly Temperatures, Gedaref (^{o}C)

(a) 1950-1959

:	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean temp.(^{o}C)	25.8	27.1	30.2	31.9	32 3	29.8	26.7	26.0	26.9	29.0	29.2	26.6
Standard deviation	1.03	1.54	0.76	0.998	0.715	0.814	0.99	0.564	0.814	0.619	0.413	1.22
Coef. of variance %	4.0	5.68	2.52	3.13	2.21	2.73	3.73	2.17	3.03	2.14	1.4	4.58

(b) 1960-1969

Mean Temp.(^{o}C)	26.8	27.1	30.2	31.9	33.0	30.3	27.3	26.3	27.6	29.2	28.9	26.9
Standard deviation	0.90	1.07	1.04	0.74	0.532	0.887	0.8	0.72	0.65	0.88	1.03	1.08
Coef. of variance %	3.5	3.9	3.45	2.33	1.6	2.39	2.89	2.74	2.37	3.01	3.46	4.0

(c) 1970-1979

Mean Temp.(^{o}C	25.7	28.1	30.3	32.7	32.6	30.2	27.3	26.4	27.5	29.3	28.7	26.7
Standard deviation	0.64	1.11	0.64	0.814	0.481	1.03	0.94	0.59	0.786	0.74	0.70	1.106
Coef. of variance %	2.5	3.96	2.12	2.46	1.47	3.42	3.44	2.25	2.86	2.53	2.43	4.14

Table 19

Mean Monthly Rainfall - Chadambaliya

(a) 1950-1959

:	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean Rainfall (mm)	0	0	0	2.8	17.4	92.65	177.7	(*)	99.2	14.85	0.2	0
Standard deviation	0	0	0	2.6	15.41	58.97	51.98		34.33	12.97	6	0
Coef.of variance(%)	0	0	0	221.4	88.56	63.65	29.25		34.06	87.34	300	0

(*) No data available for the month of August.

(b) 1960-1969

					(*)							
Mean Rainfall (mm)	0	0	0	0	4.5	58.0	107.1	178.4	38.9	17.2	0	0
Standard deviation	0	0	0	0	7.2	46.87	53.32	66.84	32.2	16.4	0	0
Coef.of variance(%)	0	0	0	0	160	80.81	49.78	37.47	82.8	95.3	0	0

(*) Only 5 years of data available for May.

(c) 1970-1979

Mean Rainfall (mm)	0	0	0	4.6	44.8	57.4	141.8	182.3	85.6	20.1	0	0
Standard deviation	0	0	0	5.78	34.52	42.66	57.38	66.3	60.37	40.87	0	0
Coef.of variance(%)	0	0	0	125.7	77.0	74.16	40.46	36.35	70.53	204.36	0	0

Table 20

Annual Total of Rainfall - Ghadambaliya

(a) 1950-59

Year	Total (mm)
1950	621.5
1951	519.5
1952	455.0
1953	589.0
1954	540.0
1955	665.5
1956	669.0
1957	507.5
1958	631.0
1959	625.0

10 year mean rainfall: 582.3 mm
Highest rainfall, 1966: 669.0 mm
Lowest rainfall, 1952: 455.0 mm
Standard deviation : 69.10mm
Coef. of variation : 11.86%

(b) 1960-69

Year	Total (mm)
1960	267 *
1961	406 *
1962	472
1963	464
1964	608
1965	487 *
1966	92 *
1967	540.5

Cont./..

(b) 1960-69(Cont.)

Year	Total (mm)
1968	448
1969	342

10 year mean rainfall:	412.65	mm
Highest rainfall,1964:	608	mm
Lowest rainfall, 1966:	92	mm
Standard deviation :	140.18	mm
Coef. of variance :	34%	

(*) Data not complete for that year.

(c) 1970-79

Year	Total (mm)
1970	491.3
1971	580
1972	556
1973	312
1974	615
1975	661
1976	344.5
1977	558
1978	812
1979	375 *

10 year mean rainfall :	530.48	mm
Highest rainfall,1978 :	812	mm
Lowest rainfall, 1973 :	312	mm
Standard deviation :	146.74	mm
Coef. of variance :	27.66%	

(*) Data not complete for that year.

The rainfall data from the Ghadambaliya area were not complete and not very consistent. Therefore it was more difficult to draw conclusions and to analyze the information. In general, however, the rainfall of the Ghadambaliya area seems to follow a pattern similar to that of Gedaref.

From the above data it can be seen that the climate in the study area has remained fairly constant over the past forty years and does not account for environmental changes in Gedaref District. In 1944, in its report to the Government of Sudan, the Soil Conservation Committee came to the same conclusion. They stated, "The climate had stayed the same (with its normal variations) since the close of the final wet phase of Pleistocene time..." and that "the soil deterioration that has occurred, and which is still occuring, may, therefore, be safely attributed to the work of mankind and to his domesticated animals, rather than to any change in basic climate." (Soil Conservation Committee's Report, Fig.8).

B. Water Resources:

The Gedaref District is traversed by many seasonal water courses. The two major hydrological features are the Rahad and Atbara Rivers which lie respectively, on the southwestern and northeastern boundaries of the district. The major Khors of the district are the Khor Farga and Khor Magadam, which lie near Gedaref Town.

The Town of Gedaref gets most of its water supply from a pump station on the Atbara River at Showak, some 60 miles northeast of Gedaref. Most of the surrounding villages of Gedaref District have village wells or seasonal hafirs.

The expansion of water points is a recent phenomenon. It is most noticeable in the agricultural schemes, such as Rahad and Halfa Gadida Schemes. In

1955, the number of hafirs and wells in these schemes was only 13; by the 1980's water points totaled 250. The most severe environmental problem associated with expansions of water resources is overgrazing. This problem will be discussed in greater detail later in this report. Areas around permanent water points are very heavily grazed because people tend to stay around them longer. Wells open up more areas to permanent settlement. This intensifies the use of pasture around the water points. Although hafirs were constructed to provide the nomads with enough water and pasture for animals, they have resulted in the removal of palatable plants in large areas around the hafirs. In some areas the degradation covers an area of 9 to 39 sq. km.

C. Soils and Vegetation:

In 1976, the Soils Survey Administration prepared a detailed soil survey and land capability classification in Gedaref District. This survey includes meteorological and geomorphological data, along with vegetation classifications and land-use information. The survey team prepared general soils information and analyzed a sample of each type of soil identified.

The Gedaref District and Southern Kassala Province have three main soil types: loamy saline Aridisols, brown cracking clays (Vertisols), and sandy soils (Psamments).

The southern part of Kassala Province (including Gedaref District) is classified as a semi-arid area. The soils are dark, of high montmorillonite clay content with strong vertisolic characteristics, and a high Cation Exchange Capacity.

The terrain units indentified in this survey are as follows:

Table 21

Terrain Units of Southern Kassala Province

TERRAIN UNITS	DOMINANT SOILS (50%)	ASSOCIATED SOILS (20-50%)	INCLUSIONS (20%)
HILLS			
HG Gedaref Gallabat Basalt Hills	Ipu 2	VtcI,ITu3	Rock
PLAINS: VERTISOLS			
(highly cracking soils)			
SA1: Flat Aggradational Plains, Rahad dry zone	VecI,2	VtcI,2	
SA2: Flat Aggradational Plain, Rahad humid zone	Vtc I	Vtp I	Etu 3
SD1: Nearly flat degradational Plain, dry zone	Vtc I,2	Vec I,2	
SD2: Nearly flat degradational Plain, humid zone	Vtc I	Vec I	Vec2, Ath 3
SU: Gently Undulating Degradational Plain, Basalt	Vtc I	Vtc 2	Vec 2

EXPLANATION OF TERRAIN UNITS

Ipu2 = Paralithic Ustropepts - fine clay

VtcI = Typic Chromusterts - very fine clay

Itu3 = Typic Ustropepts - fine loamy

Vecl,2= Entic Chromusterts - very fine clay and fine clay

Vtcl,2= Typic Chromusterts - very fine clay and fine clay

Vtpl = Typic Pellusterts - very fine clay

Etu3 = Typic Ustifluvents - fine loamy

Ath3 = Typic Haplargids - fine loamy

HG: Gedaref-Gallabat Basalt Hills with Qaralithic Vertic Ustropepts, Typic Ustropepts and Typic Chromusterts (area 2450 sq km.)

The Gedaref - Gallabat Ridge has rolling hills, moderate slopes (rarely reaching 20%) and a few rocky outcroppings. The underlying basalts are covered with shallow to moderately deep soils.

The dominant soils are shallow, dark reddish brown Paralithic Vertic Ustropepts with clayey texture. They were formed on basalt and crimonite in situ or on colluvium. The rock underlying the soils, found at 30 to 50 cm., is soft weathering rock which runs to a depth of several metres.

The soils are non—calcareous, nonsaline and nonsodic. They are well structured and friable.

The vegetation found on these soils is grass and la'ot shrubs. The land is mainly used for grazing. It is not suitable for agriculture because it is too dry and too shallow.

SAI: Flat Aggradational south-central Clay Plain, Rahad, dry zone, with Entic and Typic Chromusterts (area: 2470 sq. km.)

The dry zone of the Rahad Aggradational plain is differentiated from the humid zone by soils which have little development of gilgai and are lighter in colour.

The Entic Chromusterts are associated with Typic Chromusterts. Cracking is moderate and other Vertisolic characteristics are also expressed moderately. Their texture is fine or very fine clay.

Kitr Savannah with many open grass areas is the main form of vegetation found on these soils. The land is used for extensive grazing by camels, cattle, goats and sheep.

There is irrigation potential for these soils, and in part of this area the Rahad Irrigated Agriculture Scheme has been constructed.

SA2: Flat Aggradational South-Central Clay Plain, Rahad, humid zone, with Typic Chromusterts and Typic Polluterts (area: 3240 sq. km.)

Generally, this is very flat land except near the river where Khors have dissected the edges of the plain. Along the Rahad River, which meanders widely, there are lower terraces and filled in former meanders which form the flood plain. There are some oxbow lakes in the south.

The soils are well developed Vertisols with a very high clay content. The Gilgai is strongly developed with relief intensities of 30 to 40 cm/2 or 3 metres. This soil cracks widely and deeply (10 to 80 cm deep). The cracks come to 2 cm or more in width at a depth of 50 cm. during the dry season.

Acacia seyal savannah is the typical vegetation found on these soils. Along the Rahad River flood plain there are Acacia nilotica forests.

The land is used for grazing and very limited rainfed agriculture. There is also some irrigation along the Rahad River although there is potential for more irrigated agriculture.

SD1: Nearly Flat Degradational South-Central Clay Plain, Dry Zone with Typic and Entic Chromusterts

These soils have less developed vertisolic characteristics. The Gilgai is nearly absent and the soil textures are less fine than those to the south. The soils are mainly typic chromusterts with considerable areas of Entic chromusterts. The Entics have dark subsoils and a fine or very fine clay texture. The vegetation found on these soils is kitr alternating with grassy areas.

The land is grazed by camels, cattle, goats and sheep. The northern part of the Ghadambaliya Mechanized Agricultural Scheme is located in this area. The main crop is dura. Rainfall is unreliable and yields are low in rainfed agriculture.

SD2: Nearly Flat Degradational South-Central Clay Plain, Humid Zone with Typic and Entic Chromusterts (area: 16,800 sq.km.)

This is the large uniform clay plain in the southern part of Kassala Province. It is dissected by Khors draining the Gedaref-Galabat Ridge. A few low ridges also run through the area.

The relief is very gently undulating. Some Gedaref sandstone can be found at shallow depths. The soils are formed on colluvio-alluvium derived from basalt and other basic rocks.

The Typic Chromusterts are well developed with strong cracking and pronounced gilgai micro-relief.

The cracks are up to 10 cm. wide and 70 cm deep. The montmorillentic clay content is very high (75 to 80%). These soils have a well developed granular surface mulch 2 to 4 cm. thick and are very dark greyish-brown throughout the profile.

Below the surface a 15 to 20 cm. layer has a moderate to strong angular blocky structure overlaying a coarse prismatic layer.

The subsoil is massive, pressure faces are found throughout the soil below the top horizon. Only the subsoil is slightly calcareous. In general, the soils are nonsaline and nonsodic.

Organic matter and nitrogen content are low; however, there is no deficiency of other plant nutrients. The soils are moderately fertile.

The water holding capacity is high, as water seeps through cracks and is stored for use by plants during dry periods. However, these soils have a low permeability when wet and they tend to stay waterlogged for a long period of time.

These soils are hard to cultivate because they are very hard when dry and very sticky and plastic when wet, so they tend to have a very narrow moisture range for cultivation.

Associated soils: Entic Chromusterts :

These brown soils are found on gentle slopes or watershedding sites. They are less prone to waterlogging and have a slightly lower clay content.

INCLUSIONS - Typic Haplustalfs, some Udic Haplustalfs, Udic Rhodustalfs, and Entic Chromusterts.

These soils have a thin sandy surface horizon overlaying sandy clay loam or sandy clay textured B horizon. Their colours range from brown to red. Mottling and iron/magnesium concretions occur in some soils.

Throughout these soils, Acacia seyal (talh) savannah heglig, sefar and other trees are the main types of vegetation encountered. Habil and sahab can be found on higher elevations of this area.

Grazing of cattle, camels, sheep and goats and mechanized dura, sesame and cotton farming are the predominant land use forms.

SU: Gently Undulating Degradational South-Central Clay Plain, with Typic Chromusterts:

This area includes part of the basaltic Gedaref-Gallabat Ridge. The elevation of the plain varies between 500 and 450 metres. A few big Khors drain into

the area towards the Rahad and Atbara Rivers. The relief is geatly undulating with slopes of 0.5 to 2%.

The soils are deep, very fine clayey Typic Chromusterts associated with moderately deep fine clayey Typic Chromusterts, developed on basalt, either in situ or colluvio-alluvium. They are very dark grayish-brown in colour, strongly cracking, with moderate gilgai micro-relief. The soils formed on basalt in situ may have bedrock at 150 to 200 cm. depth. Some of the inclusions found in these soils are brown Entic Chromusterts.

Acacia seyal savannah is the dominant vegetation found in this area. In the north, however, there are more broad-leaved trees, while in the southern part kitr is dominant.

The area is used for grazing camels, cattle, goats and sheep. There is some mechanized rainfed agriculture, but traditional dura cultivation forms most of the agricultural activity. This area needs special management to prevent soil erosion.

The following table and explanatory notes summarize current and potential Land Suitability for the terrain units described above. These descriptions are generalized, and there may be specific differences within each unit.

As can be seen from this table the majority of this region's soils are not suitable for agriculture by flush/basin irrigation, pump irrigation, gravity irrigation, or for cotton production.

The best use of this land seems to be grazing and possibly some forestry. Only through major land improvements can modern irrigated agriculture take place.

Table 22

Current and Potential Land Suitability for Terrain Units

Land Use Categories.

(Explanatory notes on next page)

Terrain Unit	Range camels and goats	Range cattle and sheep	Agriculture: Flush/Basin Irrigation	Agriculture: Pump Irrigation	Agriculture: Gravity Irrigation	Agriculture: Rainfed Traditional	Agriculture: Rainfed Modern Dura	Agriculture: Rainfed Modern Cotton	Agriculture: Rainfed Modern Sesame	Forestry
HG	S2 - S2	S2 - S2	N - N	N - N	N - N	S3 - S3	S3 - S3	N - N	S3 - S3	S2 -
SA1	S2 - S2	S2 - S2	N - N	N A S	N B S2	S3 - S3	S3 - S3	N - N	S3 - N	S2 - S2
$SA2_s$	S1 - S1	S1 - S1	N - N	N - N	N C S2	S3 - S3	S3 D S3	N3 - N	S3 D S2	S2 - S2
$SA2_m$	S1 - S1	S1 - S1	N - N	N - N	N C S2	S3 - S3	N - N	N - N	N - N	S2 - S2
SD1	S2 - S2	S2 - S2	N - N	N - N	N - N	S3 - S3	S3 - S3	N - N	N - N	N - N
SD_2S	S1 - S1	S1 - S1	N - N	N - N	N - N	S3 - S3	S2 - S2	N - N	S2 D S2	S2 - S2
SD_2M	S1 - S1	S1 - S1	N - N	N - N	N - N	S3 - S3	S3 D S2	S3 D S2	N D S3	S2 - S2
SU_s	S1 - S1	S1 - S1	N - N	N - N	N - N	S3 - S3	S3 E S2	N - N	S3 E S3	S2 - S2
SU_m	S1 - S1	S1 - S1	N - N	N - N	N - N	S3 - S3	S3 EE S2	S3 E S2	S3 E S3	S2 - S2

Explanatory Notes

* Current suitability.

** Major improvements needed to considerably increase suitability.

*** Potential suitability.

S1 = Highly suitable land (now or after improvements), no significant limitations, yields high benefits.

S2 = Moderately suitable land, moderately severe limitations likely to reduce yield, yields moderate benefits.

S3 = Marginally suitable land, low productivity, many limitations which would lower yields and increase recurrent costs.

N = Unsuitable land, very severe limitations.

Land Improvements

a. Provide irrigation water by pumping from river or wells; flood protection when necessary, land reclamation by leaching soils and sodium may be necessary on saline river terraces.

b. Provide water by gravity irrigation.

c. Provide water by gravity irrigation and drainage systems.

d. Provide water by surface drainage for rainfed agriculture.

e. Soil conservation practices needed to minimize erosion (i.e., contour ploughing, strip cropping).

f. Flood control for depth and duration (canal bunds).

III. SOCIO-ECONOMIC CONDITIONS BETWEEN 1950 AND 1980

A. Development of the Rainfed Mechanized Agricultural Sector

In the early 1950's mechanized crop production took hold and began to grow. During the 1950 to 1952 growing seasons the total area under mechanized cultivation was 30,124 feddans, which produced an average yield of 890 rotls per feddan (440 kg/feddan) of dura.

The system of "participating cultivators" (share cropping), whereby the Ministry of Agriculture managed and supervised the schemes, was not working well for several reasons. The profit margin on 28 feddans was too small to attract settlers. Secondly, profit sharing was not practiced and was unknown in the Gedaref area. Thirdly, much of the profit made by tenants was eaten up by money lenders who lent the tenants money to finance agricultural processes. Furthermore, labour was difficult to recruit and very expensive. Labourers had to work away from their homesteads in areas where water and food were difficult to obtain.

As a result of these problems the Ministry of Agriculture began to turn the mechanized crop production schemes over to private tractor farmers. The government assumed more of an advisory role controlling land use and the management and repair of machines. By 1955 the tractor farmers started to show modest success.

The land tenure system was governed by the "Land Settlement and Registration Ordinance (1925)" and the Ministry of Interior's "Scheme for Disposal of Rainlands (1959)" in the manner and conditions specified under "Land Form 48". The government owned all unregistered land.

A Land Allotment Board, composed of local, regional and national officials, parcelled out land for new schemes. All land had to be compensated for and demarcated before the Land Allotment Board could parcel it out. Allotments for private tractor farmers were 1000 feddans each. National Cooperative Societies could receive up to 5000 feddans while private enterprise and registered companies could receive 5000 or more feddans. The term of a lease on a 1000 feddan tract was one year, but larger holdings had eight year terms. Rent was 1 pt/feddan/year.

To receive land from the government as a private tractor farmer the farmer needed an initial investment of Ls 3,500. This sum was beyond the reach of most farmers and rural communities; therefore, the merchant and contractor class made up the majority of lease holders. These classes had the money but not the agricultural skills or the time to stay on the farm, since this was not their main occupation but rather a side business or investment. "Wakils" (representatives of the lease) were appointed by these "farmers" to manage the farms.

To give the peasants and rural communities an opportunity to benefit from mechanized farming schemes, the Ministry of Agriculture in 1958-59 established farming cooperatives. These cooperatives consisted of a manager and twenty paying members. The cooperatives were allotted 5000 feddans. Each paying member was to contribute Ls 175 for equipment, services, etc. This system also did not find much success because, again, few could afford the Ls 175 fee, and those who did pay it had to work in Gedaref Town to supplement their farm income.

In order to rectify this situation, 700 feddans were granted to 70 tenants to create a cooperative. The cooperative functioned along the lines of the mechanized crop production schemes except that the government gave all the profits to the tenants so that they could raise money to buy shares in the cooperatives. This system was highly successful, and by the end of 1960 more than 70 such cooperatives were organized.

The Land Allotment Board could also allocate land outside of the demarcated area. The Board allotted 100 to 200 feddan plots which were manually cultivated by tribesmen as well as by cultivators from outside of the Gedaref area. No provisions were made to settle the land, register it, carry out soil surveys or even demarcate it. The land was outside of the technical supervision of the Department of Agriculture. Because there were no maps or records of these areas, the Land Allotment Board had little control over the undemarcated land they had parcelled out. Alongside the undemarcated "allotted" land, unallotted undemarcated plots began to spring up.

By 1964/65, undemarcated land under crop production was more than 500,000 feddans. Because the land was unsettled and unregulated, conflicts arose between nomadic herdsmen and the new cultivators. Farmers could not manage 100 feddans manually, so they brought machinery in and used the land in a very extractive manner. This practice resulted in serious erosion and loss of soil fertility.

At this time the role of the Ministry of Agriculture was to regulate crops grown, ensure land conservation, and supervise crop production, equipment, construction of buildings, etc. The one year lease system, however, was creating uncertainties and problems.

Because of the short term of the lease, farmers had a difficult time securing loans to finance the growing season. Farmers were hesitant to construct permanent buildings or invest in equipment because of the uncertainty of lease renewal. This system did not encourage soil conservation and good farming practices. These problems, coupled with a high rate of absentee leaseholders, caused farming to become "extractive agriculture" and the standard of crop husbandry dropped to a low level.

In an article published in Sudan Notes and Records, K.A. Agabawi (1968), suggested several actions that the government could undertake to reduce the problems facing the agricultural sector. The following are his recommendations:

1. Leases for all size allotments should be extended for 8 years and made renewable. This would be done in an effort to eliminate some of the uncertainties of annual leases.

2. Leasees should be encouraged to settle in the area and build permanent structures on their plots.

3. To try and abolish absentee farming it should be made a prerequisite for obtaining a lease that the leaseholder be required to be on the land during land preparation, sowing and weeding.

4. The Ministry of Agriculture should provide leaseholders with alternativies for crop rotation.

5. Rotational and crop lands should be allocated as one piece (2000 feddans). At that time the Land Allotment Board was giving lease holders two pieces of land-one (1000 feddans) for cropping and the other (also 1000 feddans) to be used as rotational land. Often these two pieces of land were far apart, and it was difficult for farmers to move equipment and labourers between the two areas.

Some of Agabawi's recommendations were incorporated into a new authority for governing

Table 23

Area and production of sorghum, sesame and cotton, 1954/55-1974/75

(a) Sorghum

Agricultural season	Total area (Feddans) *	Total production (Tons)	Yield (Tons/Fed.)
1954/55	150,000	60,000	0.400
55/56	300,000	150,000	0.500
56/57	671,663	333,831	0.499
57/58	871,000	413,435	0.474
58/59	637,907	392,050	0.614
59/60	901,192	679,960	0.745
60/61	625,700	131,548	0.420
61/62	874,345	453,508	0.518
62/63	700,000	300,000	0.428
63/64	765,631	233,459	0.304
64/65	941,700	354,653	0.376
65/66	892,755	371,332	0.415
66/67	1,146,700	222,558	0.194
67/68	1,634,495	686,943	0.605
68/69	676,330	181,590	0.268
69/70	1,219,675	314,056	0.257
70/71	1,567,275	447,975	0.286
71/72	1,375,270	417,502	0.303
72/73	1,005,535	180,758	0.180
73/74	1,261,000	391,412	0.310
74/75	1,565,000	426,821	0.272
Average	942,056	340,257	0.398

* One feddan = 1.038 acres = 0.42 hectare.

(Cont../..)

Table 23 (Cont.)

(b) Sesame

Agricultural season	Total area (Feddans) *	Total production (Kantars) **	Yield (Kantars/Fed.)
1954/55	60,000	300,000	5.0
55/56	100,000	500,000	5.0
56/57	208,460	416,920	2.0
57/58	250,000	270,000	2.8
58/59	138,866	927,145	6.6
59/60	133,088	532,352	4.0
60/61	50,660	283,696	5.6
61/62	137,270	343,175	2.5
62/63	75,265	675,000	8.9
63/64	151,866	530,731	3.5
64/65	90,000	188,903	2.1
65/66	71,899	273,216	3.8
66/67	218,750	790,580	3.6
67/68	321,506	964,418	3.0
68/69	298,900	823,538	2.8
69/70	317,045	1,109,388	3.5
70/71	252,055	827,364	3.3
71/72	256,454	1,079,817	4.2
72/73	334,772	1,639,468	4.9
73/74	391,300	1,421,100	3.6
74/75	310,000	465,000	1.5
Average	198,484	683,896	3.9

* One feddan = 1.038 acres = 0.42 hectare.

** One kantar = 100 Lb.

Table 23 (Cont.)

(c) Cotton

Agricultural season	Total area (Feddans) *	Total production (Kantars) **	Yield (Kantars/Fed.)
1954/55	4,000	8,000	2.0
55/56	2,500	11,000	4.4
56/57	5,500	26,000	4.7
57/58	6,000	27,000	4.5
58/59	9,275	68,220	7.2
59/60	1,570	6,680	4.2
60/61	20,400	63,600	3.1
61/62	28,300	86,700	3.1
62/63	33,055	100,915	3.0
63/64	18,650	44,750	2.9
64/65	18,450	55,250	2.9
65/66	21,850	55,750	2.5
66/67	30,000	78,989	2.6
67/68	36,620	79,404	2.2
68/69	34,650	86,300	2.5
69/70	53,800	60,500	2.9
70/71	7,750	14,250	1.8
71/72	2,100	6,200	2.1
72/73	3,750	8,670	2.3
73/74	7,400	29,200	3.9
74/75	5,000	15,000	3.0
Average	16,696	44,385	3.2

* One feddan = 1.038 acres = 0.42 hectare.

** One Kantar = 100 Lb.

mechanized farming. In 1968, the government established the Mechanized Farming Corporation (MFC). This corporation was to set policy for and control rainfed mechanized agriculture in Sudan.

The MFC prepares land surveys, demarcates and allocates land, works with the Agricultural Bank to facilitate credit, and is responsible for World Bank farming projects. The Mechanized Farming Corporation also manages four "state" farms (Simsim, Agadi, Goz Rom, and Habila).

Most of the schemes in the Gedaref District are operated as private tractor farms. By 1974 2.8 million feddans were being cultivated in the Gedaref area. Of these 2.8 million feddans only 122,133 feddans (4%) were State Farms.

Table 23 demonstrates the growth of mechanized farming in Gedaref between 1954/55 and 1974/75. The table also shows the decline in yield during the past 10 years.

B. Development of Gedaref Town

In 1947, the introduction of mechanized production schemes in Gedaref District created agricultural and commercial prosperity which, in turn, gave rise to a high rate of in-migration into Gedaref Town. As new lands were opened for cultivation more people moved into the area to supply the necessary labour.

Gedaref became the commercial and service centre for the agricultural sector in the district. Gedaref provides such services as an industrial area for repair of farm machinery, the Agricultural Bank, markets, and commercial grain silos for storage.

The rapid growth of the population led to the horizontal expansion of existing residential areas and the creation of new ones on the outskirts of the town. Today residential areas in Gedaref Town are highly congested.

Consequently, the town is expanding outwardly in all directions. In 1942 the population of Gedaref Town was 7,732. By 1970 it had grown to 70,355. It is estimated that today (1982) the population of the town is nearly 200,000 people (see Table 24).

The annual rate of population increase in Gedaref Town is 10.1 percent. This 10.1 percent annual rate of population increase can be disaggregated into two components: new births and in-migration. New births have resulted in a 2.4 percent annual rate of population increase, while in-migration has resulted in a 7.7 percent annual rate of population increase.

Table 24

Population Figures for Gedaref Town
(In Selected Years)

YEAR	NUMBER OF PEOPLE
1942	7,732
1955/56	17,537
1964/65	45,080
1976 (estimate)	122,000
1982 (estimate)	195,200

In 1970 the total area of Gedaref Town was 22 square kilometres. By 1976 the town had grown to 41 square kilometres. Today 85 percent of Gedaref Town is unplanned, and neighbourhoods without infrastructure or social services have sprung up as a result of substantial in-migration coupled with lack of planning for settlement of in-migrants.

Several statistics show the change in the human urban environment of Gedaref Town.

Housing

Housing stock has not been able to keep pace with the demands of a rapidly growing population, as the following table shows.

Table 25

Housing Stock in Gedaref Town

YEAR	NUMBER OF DWELLING UNITS	POPULATION
1955/56	933	17,537
1964/65	7,720	15,090
1973/74	8,367	66,200
1976	15,443	122,000

In 1964/65 there were 5.8 people per dwelling unit; by 1973/74 that density had grown to 7.9 people per dwelling unit. In 1973/74, 90 percent of dwelling units were made of straw. Most of these straw houses had been built in the unplanned parts of town. Another indicator of the insufficiency of housing stock is that by 1974 rent took 20 percent of total family income.

Health Services

There has been great pressure on health services as a result of the rapid expansion of the population of Gedaref Town. The result has been inadequate provision of services and concomitantly the spread of communicable diseases. Although statistics are sparse and scattered, they serve to show the serious problem of inadequate health services in Gedaref Town (see the following tables).

Public Health

Like other urban services in Gedaref Town, public health services have also declined. The attached table shows the decline in terms of personnel and equipment.

In 1973, each truck had to pick up garbage for 1,046 people. In 1976, the required number of garbage collectors to do the job adequately would have been 250. Only 85 workers were on the job, one-third of what was actually needed.

Table 26

Public Health Services

TYPE OF HEALTH WORKERS FACILITIES/SERVICES	NUMBER OF WORKERS IN 1969	1973	1976
Health officers	-	2	2
Sanitary overseers	-	20	-
Mosquito labourers	-	1	-
Garbage collectors	-	85	85
Night soil workers	-	101	101
Garbage collection Trucks	9	8	6

Note: In 1976 only three trucks were in working condition

Table 27

Hospital Beds and Number of Patients

YEAR	NUMBER OF HOSPITAL BEDS	NUMBER OF IN-PATIENTS	NUMBER OF OUT-PAITENTS
1964/65	240	-	-
1970	-	193,812	-
1973/74	355	201,378	12,000

Note: In 1973/74 there were 601 in-patients for each bed.

Table 28

Medical Facilities

TYPE OF FACILITY	NUMBER OF FACILITIES (1974)	(1978)
Hospitals	2	2
Health Centres	2	2
Dispensaries	2	10
Dressing Stations	7	6
Maternity/Child Centres	1	1
Mid-Wife Schools	1	1
Nursing Schools	1	1

Water Supply

In 1964/65 only one percent of the population had an inside water pipe, 55 percent had an outside pipe, and 44 percent of the population used other means to obtain water.

Until 1970 Gedaref Town pumped its water from the Abu Nadja deep bore wells at a rate of 1,200 m^3 per day. In 1970 the Showak Pump Station was established on the Atbara River. Since that time the town has been pumping its water from this pump station.

Education

Education services have also not kept up with the demands of a fast growing population. The following table shows the number of schools in the town in 1976.

Table 29

Schools in Gedaref Town, 1976

	1976
Population	122,000
Number of primary schools	46
Number of students enrolled in primary schools	14,638
Number of junior high schools	11
Number of students enrolled in junior high schools	2,907
Number of senior high schools	4
Number of students enrolled in senior high schools	944

Fires

Most residential areas of Gedaref Town are classified as fourth class areas. Ninety to ninety-five percent of the dwelling units in the town are built out of flammable material (straw or wood). Fourth class areas are also the areas where most migrants live.

The number of fires in Gedaref Town has been increasing. In 1978/79 there were 213 fires and in 1979/80 there were 229.

Therefore, it is not surprising that 76 percent of all fires occur in the unplanned, fourth-class part of the town. Because these areas are unplanned, the roads within them are narrow; this creates problems for firefighters. Secondly, the scarcity of water centres in these neighbourhoods compounds the problem of providing adequate fire protection. Lack of electricity and telephone services create delays in the notification of the fire when the fire does break out. Finally, social cohesion is diluted in fourth class areas because a great mixture of ethnic groups reside there. Therefore, people in fourth class areas are not likely to help one another when a house does catch fire.

Urban Crime:

Another strong indicator ofthe degradation of the human-urban environment is the crime rate. Several things have contributed to an increase in crime in Gedaref Town. Between 1967 and 1971 the percent of people unemployed when compared with the number of people registered as working in the labour force went from 9 percent to 28 percent. Migrants in many cases have failed to adapt to the urban environment and have not been successfully integrated into the new community.

Because of poor housing conditions, children often spend their time unsupervised in the street or in public squares where they are liable to learn delinquent types of behaviour.

Most migrants are young males, hence the sex balance in areas of in-migration and out-migration is disrupted. Prostitution has become widespread in the town. The poverty of Sudanese and refugee women has been the major reason why prostitution services have risen to satisfy the increased male demand.

C. Nomads during 1950's to 1980

Forty years ago nomadic society was relatively stable with few social or economic problems. Seasonal migration patterns were regular and rhythmic. Water was scarce, but sufficient for both human and animal populations. Cultivation was done on a small scale and, for the most part, did not conflict with the nomadic way of life. Land was tribally owned, and though an open-grazing system was practiced, most tribes stayed out of each other's territory.

The expansion of mechanized farming and the subsequent increase in population of Gedaref District had a significant effect on the nomadic way of life. The new agricultural schemes were often in or near traditional migration routes. Agriculture was taking up more and more pasture land, and the pasture areas that were left became overgrazed. An influx of migrant tribes (Rahawine, Rufa'a, Kenana and Eritrean pastoral groups) put additional stress on already overgrazed areas. As a result, conflicts arose between settled cultivators and nomads and amongest the nomadic tribes themselves.

Nomads were taking their herds into cultivated areas so that the animals could graze on crop residues and to water them.

An increase in livestock, increased demands on limited water supplies, and lower quality pasture area have created a situation where nomads spend days searching for good pastures. El Hassan (1981) compared the grazing situation during the 1950's to that of the 1970's. He found that in the 1950's palatable plants were close to the nomadic camps. In both the wet and dry seasons herders could find good pasture less than an hour's time away from the camps. In the 1970's conditions had deteriorated to such a point that herders were

spending 2 to 4 days searching for good pasture during the dry season.

New demands and social needs have altered nomadic consumption patterns and lifestyles. As their pastures became overgrazed and as demand for grazing land has exceeded supply, the nomads have been forced into buying dry fodder for their herds. In addition, food and goods not bought forty years ago are today purchased with money obtained from the sale of animals.

The expansion of mechanized farming created a large demand for wage labour. The need was increasingly being filled by those nomads who were finding it necessary to work for wages to maintain their families and their herds. The traditional nomadic family and its social structure was altered by this process. Part of the family had to settle with a few animals and work as labourers on schemes while the rest of the family took the main herd through its traditional seasonal migration.

D. Small Farmers during the 1950's to 1980

Prior to the inception of large mechanized farming schemes, cultivation was done on a much smaller scale. Traditional farmers practiced bilad cultivation near villages and haria cultivation on distant plains. Land was communally owned and acquired through custom. Dura and sesame were the main crops; however Gedaref also produced a good amount of gum Arabic. By the early 1950's traditional farming was losing ground to mechanized agriculture. Today the former practice has nearly disappeared from the area.

Mechanized farming changed the mode of acquiring land. Land became the property of the government and was allocated by the Land Allotment Board. Land ownership patterns changed from communal to individual, and some small farmers lost what for most of them was their

only productive asset, their land. With their traditional means to livelihood gone, small farmers turned to the labour market for work as wage earners on large mechanized schemes or within towns and villages.

Gum Arabic production also dropped because of mechanized farming. Large areas of land were cleared for the 1000-1500 feddan mechanized farms. Valuable Acacia senegal trees were cleared along with all the other vegetation. With the loss of the gum arabic trees many small farmers lost their secondary source of income, gum arabic collection.

IV. ENVIRONMENTAL TRENDS AND THEIR INDICATORS

By the late 1960's /early 1970's the Gedaref District was beginning to show some signs of negative environmental change. Mechanized farming had expanded to nearly 3 million feddans and was contributing to problems such as deforestation and soil degradation. Expansion of mechanized schemes pushed pastoralists and small farmers out of some of their traditional farming and grazing areas. Overgrazing became a serious problem.

The influx of migrant groups created additional social and ecological problems. Resource competition grew worse as evidenced by the increasing number of confrontations between farmers and pastoralists.

The rapidly expanding agricultural sector contributes to desertification of large areas. Often a piece of land will be farmed continuously for five or six years until the soil is exhausted. It is then abandoned and the farmer moves on to a new piece of land. In the past eight to ten years crop yields have been low. Poor management, lack of infrastructure, dura monoculture and soil impoverishment have contributed to low yields.

The expansion of large-scale mechanized schemes has also pushed pastoralists and small farmers out of some of their traditional farming and grazing. As a result many subsistence farmers have become wage earners and have given up their land. This change from land owner to landless wage earner has brought about changes in the social structure of the region. Pastoralists who have been squeezed out of their traditional grazing areas have had to change their migration routes in some instances. In others they have responded by bringing their animals to graze on the agricultural schemes or by crossing the border into Ethiopian grazing lands.

Overgrazing has become a severe problem. Palatable and nutritious plants have disappeared and grazing areas are being lost to desertification processes. Limited water resources add to this problem.

The infrastructure and services of Gedaref Town have not kept up with the burgeoning population. Gedaref has received many refugees from nearby Ethiopia whose presence is adding to Gedaref's socio-economic problems.

These environmental changes and problems are evidenced by indicators such as low agricultural productivity, decline in gum arabic production, overgrazing, deforestation, soil degradation and changes in the human environment.

The literature written about Gedaref in the period from the 1950's through the 1970's is not complete with respect to all the environmental indicators listed above. In some instances there is sufficient data to show the development of a trend; in other cases there are only a few general statements and observations. It is in these areas, where insufficient data exist, that we hoped to obtain more conclusive information during our

field studies. Gaps in information on topics such as overgrazing and overstocking, of water supply and water quality, deforestation, and specific information on urban conditions in Gedaref Town will be supplemented in Part Two of this report.

A. Low Agricultural Productivity

By 1975 the area under crop production in Gedaref was over 2½ million feddans. Of this 2½ million feddans nearly 1½ million feddans were cultivated in unallotted, undemarcated and unregulated lands. During recent years agricultural productivity has been low and in some years showed a declining trend. Of all the major areas under rainfed mechanized crop production, the Gedaref District shows the lowest average yield. This is shown in the following table.

Table 30

Mechanized Rainfed Dura Productivity
(Average Yield) (ton/feddan)

YEAR	AVERAGE YIELD, BY PROVINCE			
	KASSALA (GEDAREF)	BLUE NILE	SOUTHERN KORDOFAN	UPPER NILE
1969/70	0.243	0.342	0.909	0.455
1970/71	0.300	0.486	0.477	0.409
1971/72	0.309	0.426	0.424	0.454
1972/73	0.191	0.313	0.346	0.366
1973/74	0.320	0.550	0.252	0.433
1974/75	0.245	0.265	0.246	0.261
1975/76	0.409	0.305	0.358	0.428
1976/77	0.299	0.338	0.444	0.326
1977/78	0.250	0.329	0.314	0.375
1978/79	0.232	0.264	0.352	0.434
1979/80	0.279	0.308	0.150	0.428

Source: Mechanized Farming Corporation Agricultural Statistics Bulletin.

According to a report prepared by the National Council For Research, (Problems of Mechanized Crop Production in the Gedaref Region, 1975), several factors contribute to low crop yields. These include:

a. Deterioration of soil fertility which is partially due to monocroping sorghum, especially in the northern part of the region. This may have been the result of the present land tenure system.

b. Poor husbandry practices, especially with regard to sowing date, seed rate, poor quality seeds, etc

c. Weak crop protection and extension services.

d. Scarcity of labour which has resulted in delay of agricultural operations.

e. More attention has been given to horizontal expansion rather than investing on practices that would increase production per unit area.

f. Poor drainage in the southern part of the region". (pp.10-11).

B. Decline in Gum Arabic Production

Wood clearance for mechanized agriculture and for the production of charcoal have adversely affected the production of cash crop gum arabic through the large scale removal of the gum-yielding trees, Acacia senegal. Evidence for the decline of gum arabic production in the district comes from data which show a production decline from 232,000 Kantars in 1975/76 to 26,000 Kantars in 1980/81 (i.e., a decrease of about 89% in five years, or an average annual decline of about 18%). It is worth realizing that gum is not only one of the major export crops of the country but is also a major source of supplementary income to a large segment of the rural population.

C. Overgrazing

The significance of the northern part of the district (the Butana) as the best rangeland for camels and sheep largely stems from the occurrence there of

Blepharis sp. (siha), a good fodder plant. In fact Blepharis is by far the best Butana dry season grazing plan (Jackson and Harrison, 1955). When it is eliminated through overgrazing, the plants that replace it are of almost no value for camels or sheep. Camels and sheep are much better equipped to graze Blepharis than cattle, which graze Belpharis only during the rainy season when its spiky leaf heads are still tender.

It has recently been reported that Blepharis is disappearing from and is even extinct in vast areas of the Butana (El Hassan, 1981). As early as the 1950's Jackson and Harrison reported that the species was highly susceptible to overgrazing. This is attributable to the fact that the plant does not shed its seeds in the dry season; the seeds are held firmly in the dried and spiky flowering heads. Being highly nutritious, the seeds are particularly attractive to grazing animals. In the process of grazing and digestion the seeds are eventually destroyed. Therefore if the plant is completely eliminated through overgrazing every dry season, it will quickly disappear.

The southern part of the Gedaref District is predominantly agricultural. Most mechanized rainfed schemes and their subsequent expansion have occurred in this part of the district. As a result, the traditional transhumance pattern of the pastoral tribes within the entire district has been severely disrupted.

Herdsmen are bringing their livestock into mechanized crop production areas to feed their animals on crop residue and to take advantage of water facilities. Although figures on animals units per feddan, feeding requirements, etc. are scarce, it is interesting to note that in 1955 Jackson and Harrison stated that the Gedaref and Butana regions had already reached their carrying capacity and were beginning to show signs of overgrazing.

The increase in over-grazing is also related to the recent expansion of water supply points. This phenomenon is particularly noticeable in the Rahad and Halfa Gediida Schemes. In 1955, the number of hafirs and wells in these schemes was only 13, by 1982 water points totalled 256. The magnitude of overgrazing around these water points is shown in the table below. There is also evidence of overgrazing along the permanent water courses, particularly the Atbara and Rahad Rivers.

The higher spots of the Gedaref District are also becoming overgrazed. Overgrazing occurs during the rainy season when the pastoralists leave their summer grazing areas and head for higher areas. (Higher areas are mainly in the Butana area and include El Subogh Ragab, Jebel Geili and As Sabio.) The main reason that pastoralists concentrate in these areas is that lower lying flats become very muddy and biting flies and insects become a great nuisance to the animals.

Table 31

Overgrazing around water points

Animals	Normal		Maximum	
	Distance walked from water point (Miles)	Area grazed (Sq. miles)	Distance walked from water point (Miles)	Area grazed (Sq. miles)
Camels	30	2,800	45	6,400
Sheep	15	700	25	2,000
Cattle	12	450	20	1,300

Source: Jackson and Harrison, 1958.

Another type of area within the District experiencing overgrazing lies along the transhumance routes (see attached map of pastoral routes). These routes are becoming narrower and shorter due to agricultural expansion. Consequently, a greater concentration grazes a smaller area. This process

occurs at least twice a year, first as the herds come from and second as the herds go to their seasonal grazing lands.

Overgrazing is seen in the southeastern part of the District between Gadaref Town and Gallabat. Pastoralists concentrated their herds in this narrow strip because these lands are relatively better than in other parts of the District and because they have not been disturbed by mechanized farming.

The recent influx of a very large number (around 200,000) Eritrean refugees to the Gedaref area has also contributed to the overstocking and overgrazing problem since these refugees have large herds of animals. Secondly, through the refugee resettlement programme the Government of Sudan has allotted about 50,000 feddans for refugee agricultural schemes (and has thereby reduced the amount of land set aside for grazing).

D. Deforestation

Charcoal production and agricultural expansion are the major causes of widespread deforestation in Gedaref District. Fires, overgrazing, and use of wood for industry are also contributing factors.

As mentioned earlier, planned mechanized agriculture within Gedaref District expanded rapidly, from twelve thousand feddans in 1941 to three million feddans by the late 1970's.

With the introduction of tractors, crawler tractors and machines, large areas of land have been easily cleared of trees and bush. Although the Mechanized Farming Corporation does recommend that farmers establish tree shelter belts on their land, this recommendation generally is not followed.

Acacia seyal had been found in pure, thick stands in Gedaref District. The trees are all about the same age and size (13¼ cm. in diameter), making them easy to cut. When burned Acacia seyal produces excellent charcoal. These characteristics make charcoal production from Acacia seyal very profitable. In fact, illicit charcoal producers have gone deep into forests away from main roads to cut their trees. Profitability of charcoal production is also enhanced by the fact that demand for charcoal in Sudan is limitless. Since other sources of energy are not available to most of the population, charcoal will remain their fuel source for the near future.

E. Soil Degradation

It is not uncommon for farmers, as previously mentioned, to cultivate continuously a piece of land for five or six years until the soil is exhausted and productivity drops; the farmer than abandons the land and obtains a lease to farm more land. In this way large areas of land are being degraded and are left to desertification processes. Degradation thus occurs, whether agricultural development is authorized or not, since vegetation is cleared, shelter belts are not planned, crop rotations are not strictly followed, and fertilizers are not used to preserve the soils.

For the most part, there is a complete disregard of soil conservation practices among the farmers. Failure to use soil conservation practices has lead to widespread soil degradation and erosion. Many rainfed schemes have been abandoned because of weed infestation and poor productivity caused by neglect of soil conservation practices.

Ahmed M. El Hassan, in his 1981 study of the "Environmental Consequences of Open Grazing in the Central Butana," discusses the effects of soil

degradation around water points. He states that overgrazing around water points results in a gradual inability of pasture soils to support rich plant cover because the percentage of organic matter in the soil decreases and the soil becomes dry. Paucity of ground-cover results in increased run-off and wind erosion. El Hassan took samples from soils around water points and found that there was a decrease in silt and clay percentages in the soil, an increase in the percentage of soluble salts because of a continuous addition of urine from large herds around the water points and a decrease in p^H levels as a result of accumulation of acids from urine, and increases in organic matter because of incorporation of animal manure into the soil.

F. Effects of Environmental Change on the Human Environment

Environmental change in the Gedaref District is happening not only to the natural environment but also to the human environment. Nomads and small farmers have experienced major changes which have adversely affected their social and economic structures. Gedaref Town has also experienced many changes since the late 1940's / early 1950's which result from the deterioration of its natural and urban environment.

As mentioned earlier, 40 years ago, nomadic society of the Gedaref area was fairly stable, with few economic and social problems. The effect of expanded mechanized farming, soil deterioration, loss of good pastures and deforestation, on nomadic society has been for the most part negative. Nomads have been squeezed out of many traditional grazing areas and migration routes have been disturbed or altered. There was an increase in conflicts between cultivators and nomads, and amongst nomadic tribes themselves. Due to poor grazing lands, nomads have been forced to supplement their herds' food

by buying fodder. To get money to buy fodder and to maintain their families, nomads found it increasingly necessary to supplement their income by working as labourers on mechanized farming schemes. The cultural, social and economic structure of the nomads has been disrupted by the environmental changes occurring in Gedaref.

The development of Gedaref District and the subsequent environmental changes profoundly affected traditional farming and the small farmer. In the 1940's traditional farming was the main form of cultivation. Gradually traditional farming lost ground to mechanized farming and today the practice has nearly disappeared from the region. Land ownership patterns changed from communal to individual, and small farmers lost their land. Some landless farmers turned to the labour market for work on mechanized farms or in towns and villages while others tried to establish their farms in the northern and eastern parts of Gedaref District. These areas are more fragile because rainfall is less and more variable and because the land is marginal. It should be noted, however, that not all small farmers suffered negative effects from the changes in Gedaref. Some small farmers actually acquired large schemes and changed their status for the better.

Gedaref Town expanded quickly in an effort to meet the demands of the expanding agricultural sector. However, as can be seen from the statistics presented in section III B, the Town could not keep up with the demands of a growing population for goods and services and demands of commercial agriculture.

PART TWO

THE MONITORING REPORT

PART TWO

THE MONITORING REPORT

This part of the Report covers the monitoring activities undertaken during the period 1982-84. The intention here is to continue to identify the nature and magnitude of the environmental (physical and human) changes and trends which have developed in the area, as described in Part One of this Report.

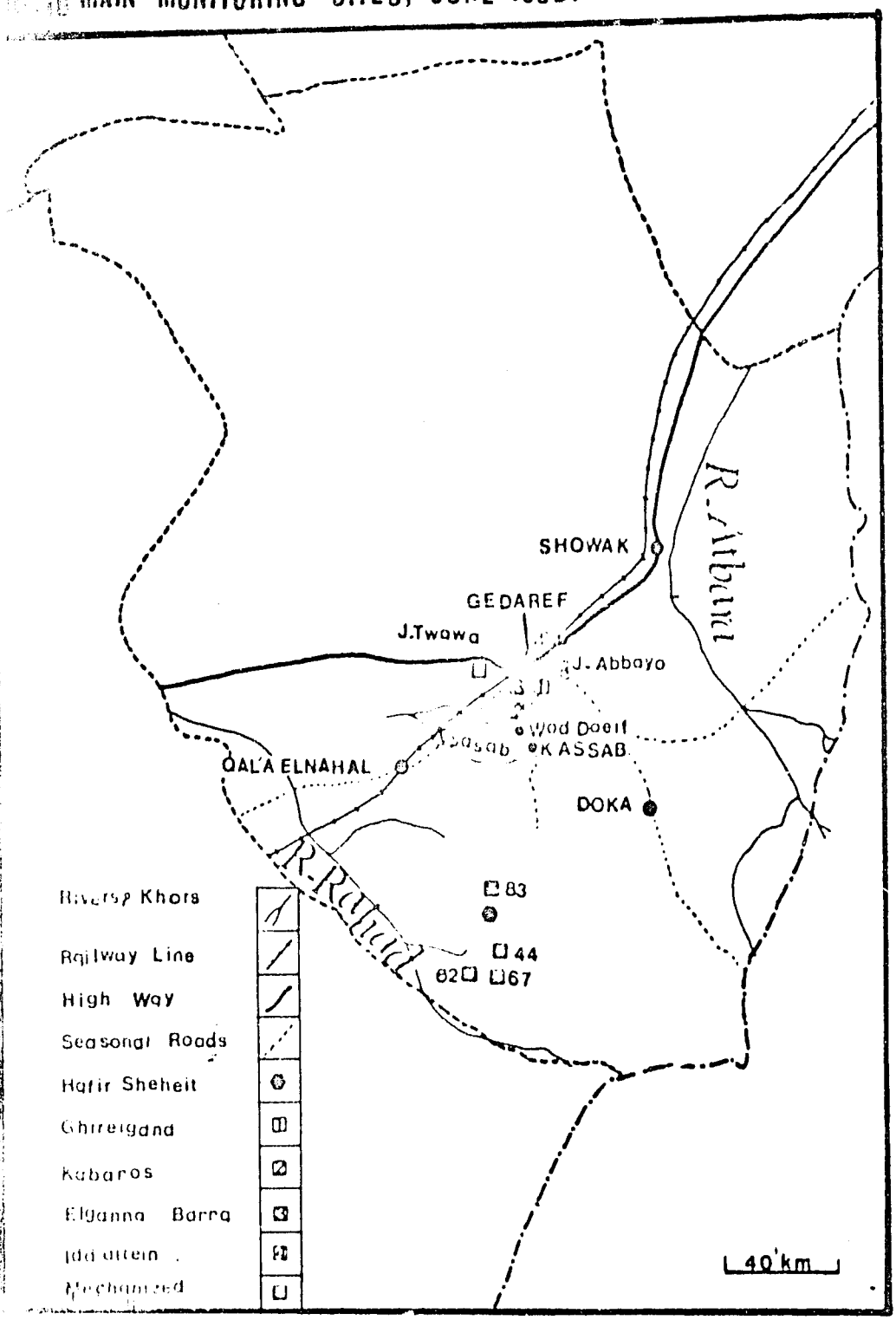
This part of the Report is composed of two monitoring reports: the first covering 1982 and the second covering the 1983-84 period. Each of these reports is based on field visits made to the same monitoring sites both before and after the rainy (growing) season.

The 1982 Monitoring Report.

The visits to the monitoring sites took place in June and December 1982. The reports of the two visits are combined into one because of the complementary nature of data and information collected and because this first year of field activity has been used to fill in some of the gaps identified in the baseline and trend analysis report and to check some of the secondary data already collected. However, some changes had been monitored in some aspects. The report deals with the following general areas of study:

I. Mechanized Farming.
II. Traditional Villages and Hafir Sheheit.
III. Gedaref Town.
IV. Soils.
V. Water.
VI. Livestock, Grazing and Nomads.
VII. Refugees.

MAIN MONITORING SITES, JUNE 1982.



SECTION I.

MECHANIZED AGRICULTURE.

I. MECHANIZED AGRICULTURE

A. SELECTION

The selection of farms has been based on ownership and situation. Thus, five mechanized farms have been selected for monitoring in the first trip. These are;

1. Scheme No. 67, a state experimental farm which has been in production for the last two years.
2. Scheme No.[illegible], a state experimental farm which will be put under production this year after 9 years of fallow.
3. Scheme No.[illegible], a normal state farm which has been in production for a long time.
4. Scheme No.[illegible], a private guided farm.
5. Scheme No.[illegible], a non-guided private scheme.

During the second trip in 1982 two new Canadian schemes were selected for monitoring because they are the only schemes to use deep ploughing. These are:

6. Scheme No.[illegible] put under cultivation in 1981 for the first time.
7. Scheme No.[illegible] to be put under cultivation in 1983 for the first time.

In addition, traditional farming at Kabaros Village will be monitored with the hope of finding out if there are any differences between the environmental impacts of the two types of farming, mechanized and traditional.

B. PRODUCTION:

1. Scheme No. 67 : It lies to the south of the state farms' main camp at Simsim.

It has an area of 1,500 feddans of which 500 feddans are left fallow every year. The rotation is cotton-dura-cotton. The scheme is now running an experiment to test machine efficiency for the coming four years by using three tractors: one for 500 feddans, one for 800 and the third for 1,000 feddans, and by keeping a complete record of each tractor's performance, e.g., number of work hours, break-downs, spare parts, petrol consumption, etc.

1. Scheme No. 67 : Output

Table 32

Season	Crop	Area Cultivated: Feddans	Output	Yield per Feddan
1980/81	Cotton	972	2,602 kantars	2.65 kantars
1981/82	Dura	872	3,501 sacks	4.02 sacks

2. Scheme No. 44 : It lies to the east of the state farms' main camp. It has the same rotation, fallow and cultivation area, and the same purpose of experiment as that of scheme No. 67.

Scheme No. 44 : Output

Table 33

Season	Crop	Area cultivated: Feddans	Output: Sacks	Yield per Fed.: sacks
1981/82	Dura	923	3,793	4.11

3. Scheme No. 62 : It lies about 6.4 Km. to the S.W. of the state farms' headquarters. Its particulars are the same as those of Scheme No.67.

Scheme No. 62 : Output

Table 34

Season	Crop	Area Cultivated	Output	Yield/ Feddan
1979/80	Dura	1064 feddans	7 232 sacks	6.8sacks
1980/81	Cotton	730 feddans	2 290 kantars	3.1kantars
1981/82	Dura	952 feddans	4 654 sacks	4.9 sacks

Note: The decline(28%) in the productivity of dura.

4. Scheme No. 83 : It lies about 3 Kms. to the east of the state farms' headquarters. It has an area of 1500 feddans, and it uses no fixed rotation. It is provided by the Mechanized Farming Corporation with fuel, spare parts and repair of machinery, harvestors and extension services. The former owner discontinued cultivating the scheme in 1979; the M.F.C. terminated his contract and the scheme was allotted to a new owner as of the 1982/83 season.

Scheme No. 83 : Output

Table 35

Season	Crop	Area Cultivated	Output	Yield per feddan
1974/75	Sesame	200 feddans	60 sacks	0.3 sacks
	Dura	250 feddans	750 sacks	3 sacks
1975/76	Sesame	100 feddans	25 sacks	0.25 sacks
	Dura	1000 feddans	815 sacks	0.75 sacks
1976/77	Sesame	300 feddans	00 sacks	00 sacks
	Dura	1200 feddans	1850 sacks	1.5 sacks
1977/78	Sesame	--	--	--
	Dura	550 feddans	1092 sacks	2.0 sacks

Note: The continuous decline in the productivity of sesame. Although the productivity of dura has been on the rise, it is far below that in the above state farms.

5. Scheme No. 240 : It is situated about 20 Km. from Gedaref along Wad Medani Road, and 1 Km. south of the road. It was licensed in 1957/58 and started production in the same year. Its total area was originally 1000 feddans, extended to 1500 feddans in 1981/82.

Scheme No. 240 : Output

Table 36

Season	Crop	Area Cultivated	Output	Yield per fed.
1980/81	Dura	985 feddans	3500 sacks	3.55 sacks
1981/82	Dura	1500 feddans	5663 sacks	3.77 sacks

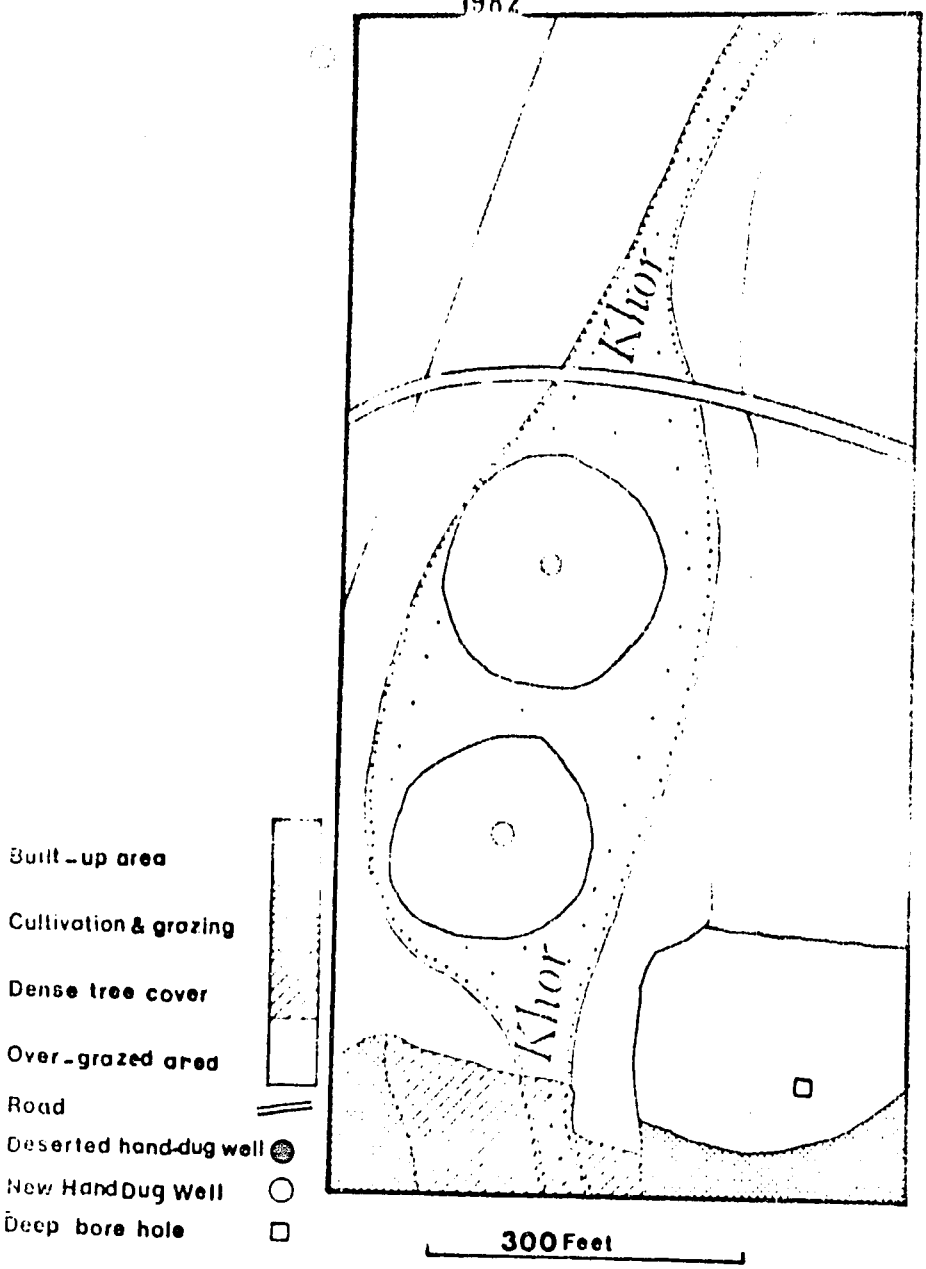
6. Scheme No. 13 : It is the largest scheme in the area. The Canadians use heavy machinery and deep ploughing (4 inches compared to 2 inches in the other schemes). It is noticed that soil humidity is higher than in other schemes. No run-off was noticed during the rainy season perhaps because of the high percolation rate of rain water. It is thought, on the other hand, that deep ploughing may result in more wind erosion of soil.

Scheme No. 13 : Output

Table 37

Season	Crop	Area Cultivated	Output	Yield per fed.
1982/83	Dura	4000 feddans	23,000 sacks	5.75 sacks

FIG.17 GHIREIGANA VILLAGE: LAND USE, 1982



SECTION II

TRADITIONAL VILLAGE

II. TRADITIONAL VILLAGES:

The villages of Ghireigana, Iddal Tein and Kabaros were selected because of easy accessibility for the study of land use over time. A more detailed study was pursued for Kabaros village to identify changes which have taken place since the first study of the village in 1946. Land use patterns around Hafir Sheheit and along a transect S.S.W. of Gedaref Town were sketched. All land use types (and sketch maps) were done during June 1982. The word "forest" is used to denote any association of trees, bushes or a combination of both.

A. CHIREIGANA VILLAGE:

It is located about 10 km. south of Gedaref Town. Types of land use are shown on the sketch map. The northern parts of the khor and of the village perimeter are over-grazed.

The two wells are dug on the bed of the khor. Well No.1 is deserted while No.2 is in use. The density of growth in a one hundred feet radius circle centred at the deserted well is 300 la'ot shrubs of which about 70% are of a height of less than one foot. Growth density in an equal circle centred at the No.2 well is 84 la'ot shrubs of which about 40% are of a height of less than one foot. The difference in density is due to the effect of desertion on the regeneration of shrubs around the well No.1.

B. KABAROS VILLAGE:

1. Land Use:

It lies about 19 Km. S.S.W. of Gedaref Town. The village perimeter (about 100 meters in width) is occupied by small farms of maize. The vegetable garden in the north has an area of about 1.8 feddans. Major types of land use are shown on the sketch map.

The forest at the foot of the hill and about one kilometer west of the village has the following main tree species at the following densities per a 50 x 5. meter area.

Hashab	16
Kitr	12
Habeil	11
La'ot	9
Sider	4
Dingil	3
Kadak	2
Total	57

The density of the small forest between J. Kabaros and the Khor bed is 10[illegible] trees in a 50 x 50 meter area.

The presence of the perimeter of Saraf Village in the north, J Kabaros in the west and J Karo in the east has confined traditional cultivation to the area south of the village.

When we compare the 1948 and the 1982 land use map and sketch map we can identify the following changes

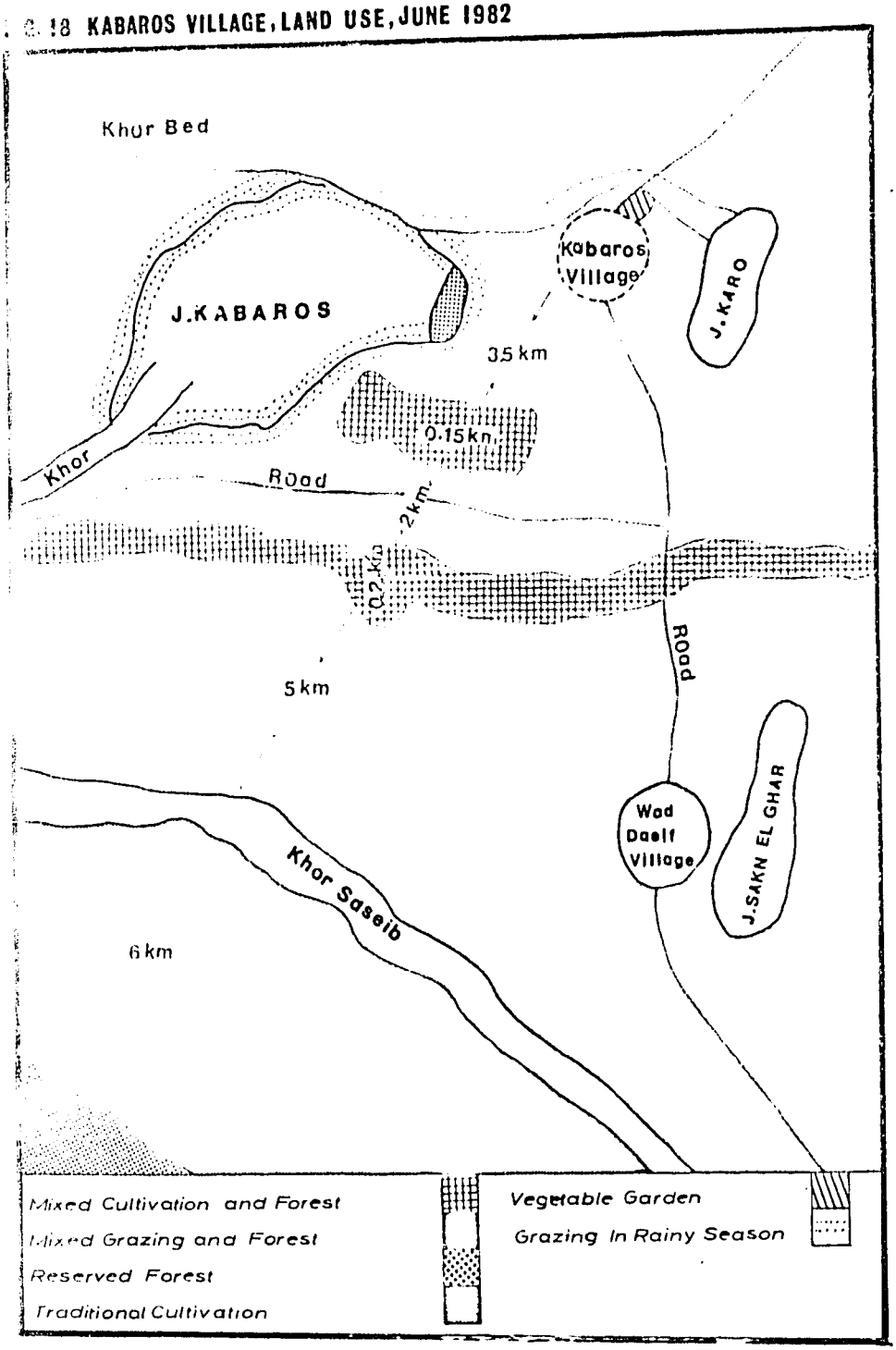
Kabaros Village Changes between 1948 and 1982
Distance from Kabaros Village

Table [illegible]
Kabaros Village Changes Between 1948 and 1982.

Type of Land Use	1948	1982
Mixed grazing and forest	2.4 Km	10.8 km
Mixed cultivation and forest	1.6 km	3.5 km
Reserved forest	6.3 km	17.0 km

Forest authorities estimate the area of unreserved forest which has been cleared in this area between 1948 and 1982 at 420-530 feddans.

C.18 KABAROS VILLAGE, LAND USE, JUNE 1982



2. POPULATION:

The total population is about 800 persons of whom about 430 (54%) are females. The annual rate of increase is about 2.9%. Migration is not significant, i.e., during the last five years only 3 families have migrated to the village, and no one has migrated out of the village.

The tribal composition is as follows: -

Bideiriyya	about	51%
Ma'agla	about	19%
Bargo	about	12%
Dago	about	8%
Others	about	10%

The age structure is shown in the table below: -

Table 39

Kabaros Village Age structure

Age Group	No. of Persons	%
15 years and less	280	35.00
16-49	370	46.25
50 & over	150	18.75

The occupational structure of the working population is as below:

1. Over 95% are traditional cultivators.
2. 24 persons are government employees.
3. Three shop owners who are also cultivators.
4. 40-50 persons provide casual, low-paid labour at Gedaref during dry season.
5. One midwife.

(x) No one works in mechanized farming.

The educational situation is shown in the table below:

Table 40

Kabaros Village : Educational Structure

Level of Education	Male	Female	Total
Primary	62	40	102
Junior High	14	3	17
Senior High	4	-	4
University	7	-	7

The nearest primary school is at El Saraf, about 6 km north of Kabaros; the nearest other schools are at Gedaref. There are 20-30 children at school age but have not found vacancies at school.

Building materials include poles, dura stalks and thatch. There are no brick or mud buildings. Fires are rare. Firewood is collected from as far areas as the reserved forest i.e. 17 kms distance.

3. CULTIVATION:

Cultivation extends for about 20 km. mainly south of the village because the land is rocky in both the eastern and western areas, while to the north lies the cultivation area of the inhabitants of El Saraf.

The main crops are dura, sesame and dukhn, together with maize which is grown on a very small area at the edge of the village.

Size of farms, number of cultivators and main crops are shown on the following table:

Table 41

Kabaros Village: Areas Under Cultivation in Feddans

No. of Cultivators	Dura	Sesame	Dukhn
20	25 and over	10	5
8	20	10	5
22	10	5	2.5
Majority	5	5	2.5

Land rotation does not include fallow: dura-sesame and dukhn-dura.

a) DURA:

Types grown are:

1. "Dabar" (white and of high price), mostly for sale
2. Fetareit
3. Akar
4. Safra'
5. Mugud

- Mechanical ploughing is used in almost all cases. Labour is mostly family labour, but some wage labour is used for weeding and harvesting. The average cultivator hires labour for about 50% of agricultural operations. Women do not take part in agricultural operations. Only two cultivators have used mechanical harvesting.
- Productivity was in 1975 about 10 sacks per feddan, but now it is only 6 sacks of dura. This indicates that land quality has deteriorated and they cultivate sesame to promote the quality of agricultural land for production of dura.
- "Buda" (a weed) reduces output but no damage is done by birds.

About half of the produce is usually sold, including all the produce of the high-quality "dabar" type. The cost of production per sack is Ls.7.35 plus family labour. The sale price ranges from Ls.15 to Ls.25 per sack, depending on the season of sale. Dura stalks are used as building material and animal feed.

b) SESAME.

Agricultural operations and the labour situation are the same as those of "dura". All the produce is marketed at Gedaref Town although there is a nearby oil mill. The per feddan productivity is about 1.5 sacks. The cost of production per sack is about Ls.15 plus family labour, and the sale price ranges between Ls.35 and Ls.42, depending on time of sale.

Despite its high returns and ready market it is not cultivated as widely as "dura" because it needs continuous attention, and all operations, especially harvesting, must be promptly undertaken.

c) DUKHN.

The agricultural season and labour situation are the same as above. The average output is 4 sacks per feddan. The average per sack cost of production is about Ls.6 plus family labour, while its sale price ranges between Ls.20 and Ls.25.

d) VEGETABLES.

A person who lives at Ghireigana owns a 1.7-feddan vegetable garden in the northern edge of the village. It is irrigated from a well "matara" and the water is mechanically pumped. The main vegetables grown include tomatoes, eggplant, chilies and okra. Part of the produce is consumed locally while the greater part is marketed at Gedaref Town.

4. LIVESTOCK:

Figures given by the inhabitants are:-

Cattle	220
Sheep	110
Goats	160
Donkeys	70
Camels	4

These figures seem to be too low for what we have observed.

Livestock is sold only when cash is needed, particularly at the beginning of the cultivation season

Grazing during cultivation season is in the hills and outside the cultivation zone. During the dry period animals graze in the fields. Animals drink at the two bore wells at the village at the following prices:-

Cattle	p.t.	60 per month
Sheep	p.t.	15 per month
Goats	p.t.	15 per month
Camel	p.t.	5 per drink
Donkey	p.t.	1 per drink

5. GUM TAPPING:

Nine persons own gum gardens outside the cultivation zone; garden area ranges from 50 to 150 feddans.

Those who do not own gardens tap on share basis; $\frac{1}{3}$ for tapper and $\frac{2}{3}$ for owner.

Output is one sack per feddan (i.e. 2.5 kantars).
Price is Ls.30 per sack or Ls. 12 per kantar.

C. EL GENNA BARA-GEDAREF TRANSECT:

The land use transect extends along the earth road from Gedaref in a S.S.W. direction for 16 km to El Genna Bara. The transect was done in June 1982, i.e.,

just before or at the very onset of the rainy season. It should be noted here that the road between the two sites does change during and/or after the rainy season; thus transects in subsequent years might be a bit different.

Four major types of land use have been identified. These are:

1. Over-grazed areas: These are mainly the perimeters of the Gedaref Town, Abul Naga village and El Genna Bara village, and along the road.
2. Traditional cultivation: this is practised wherever possible. After harvest time these traditional farms are generally used as grazing areas.
3. Pure "hashab" forest
4. Forest of mixed species also providing some grazing opportunities; the mixed forest is also used as a source of firewood.

D. IDDAL TEIN VILLAGE

The village lies about 3 kms to the N.N.E. of Gedaref Town. The people of the village agree that their well has copious water and that during the dry season no less than 1000 camels are watered here every day. This may be so because during our 4-hour visit we counted 619 camels around the well. Over 80% of these camels are owned by the residents of the village. The well is also used to irrigate (by mechanical means) two vegetable gardens.

The major types of land use around the village are shown on the sketch map. These are

1. Traditional cultivation and grazing
2. Overgrazed area
3. Vegetable gardens
4. Forest and grazing

FIG.19 GEDAREF_EL_GANNA BARRA TRANSECT, [illegible]

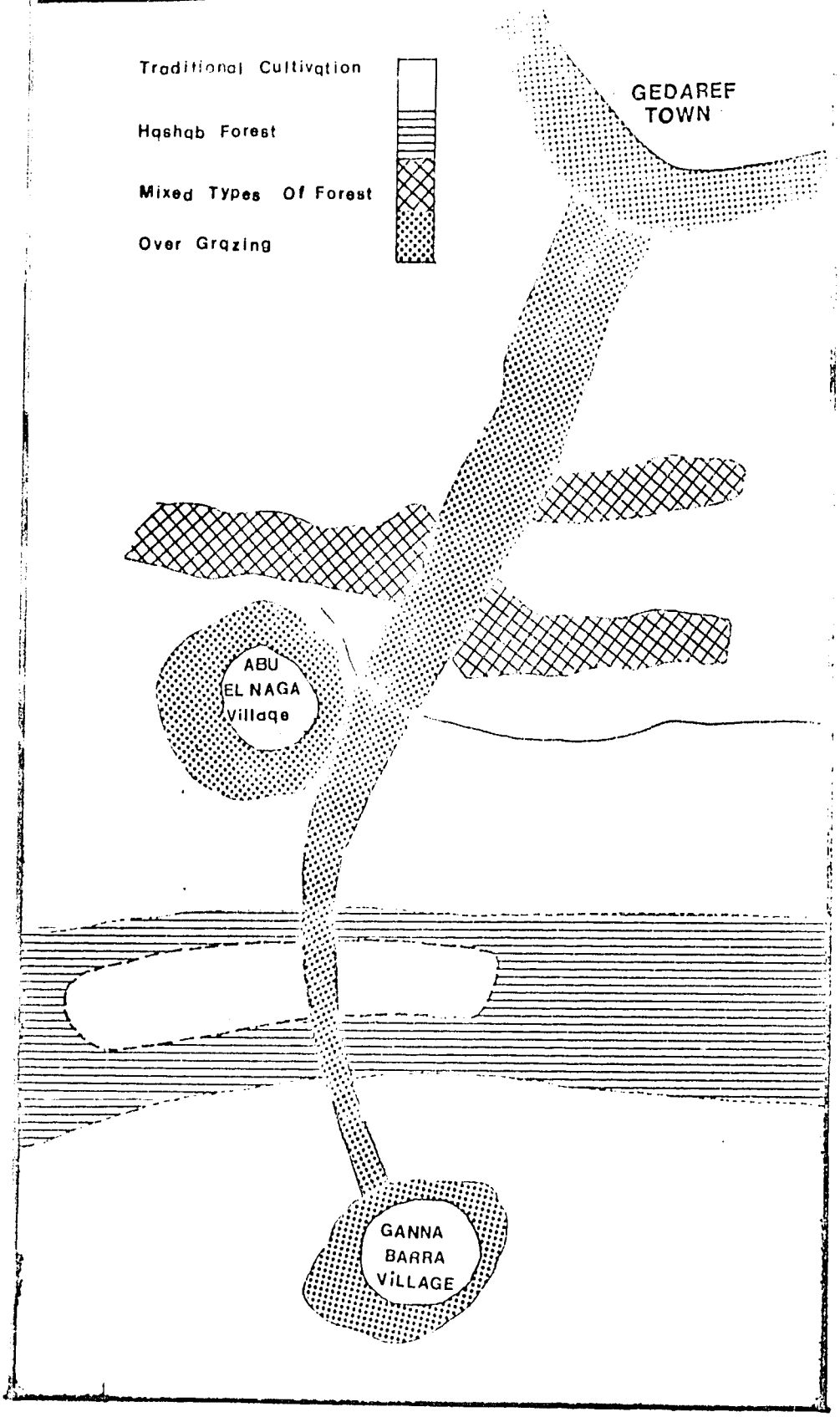
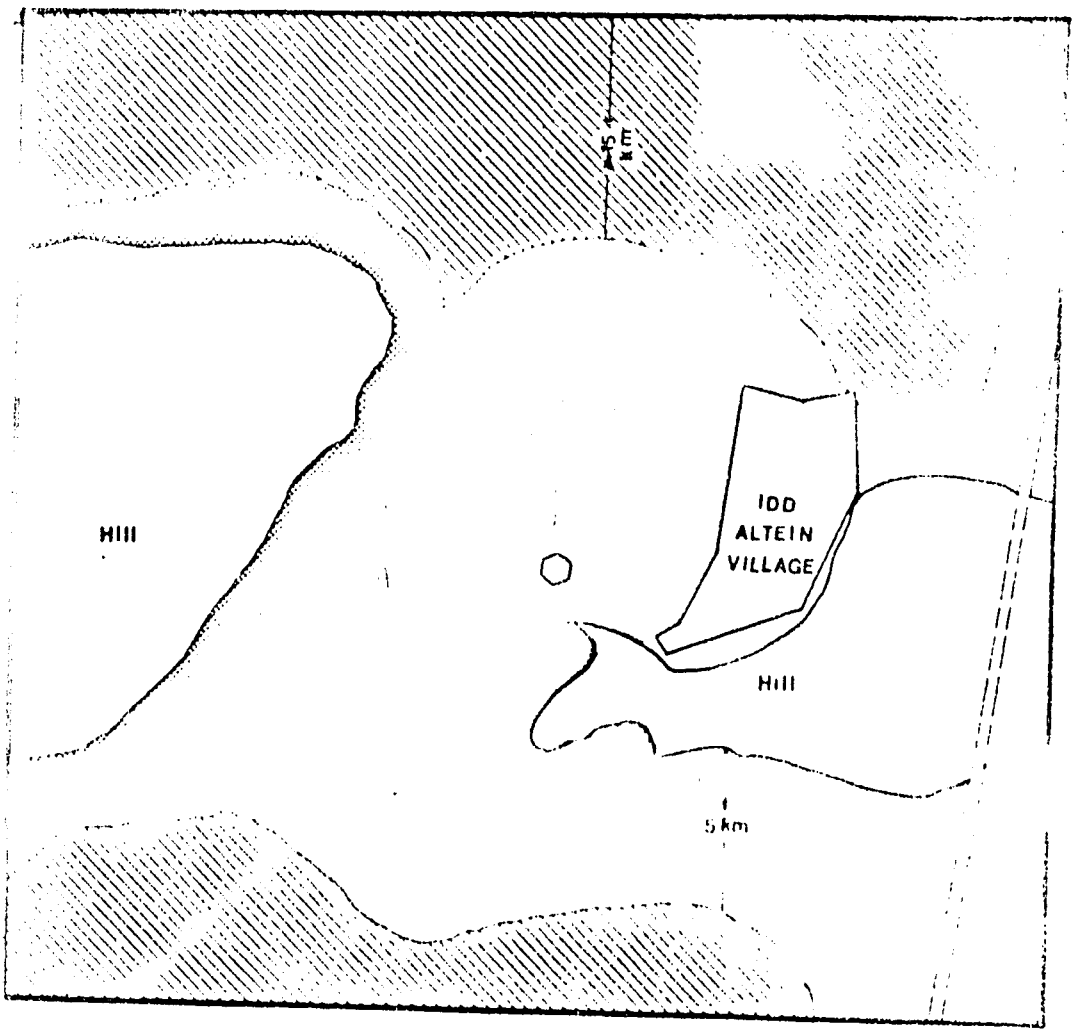


FIG.20 IDD ALTEIN VILLAGE, LAND USE JUNE 1982



Serious overgrazing extends for about 1.1 kms. around the well. The tree growth is sparse and is confined to a narrow strip on the northern hill. The southern hill is bare of trees and bushes can hardly be seen.

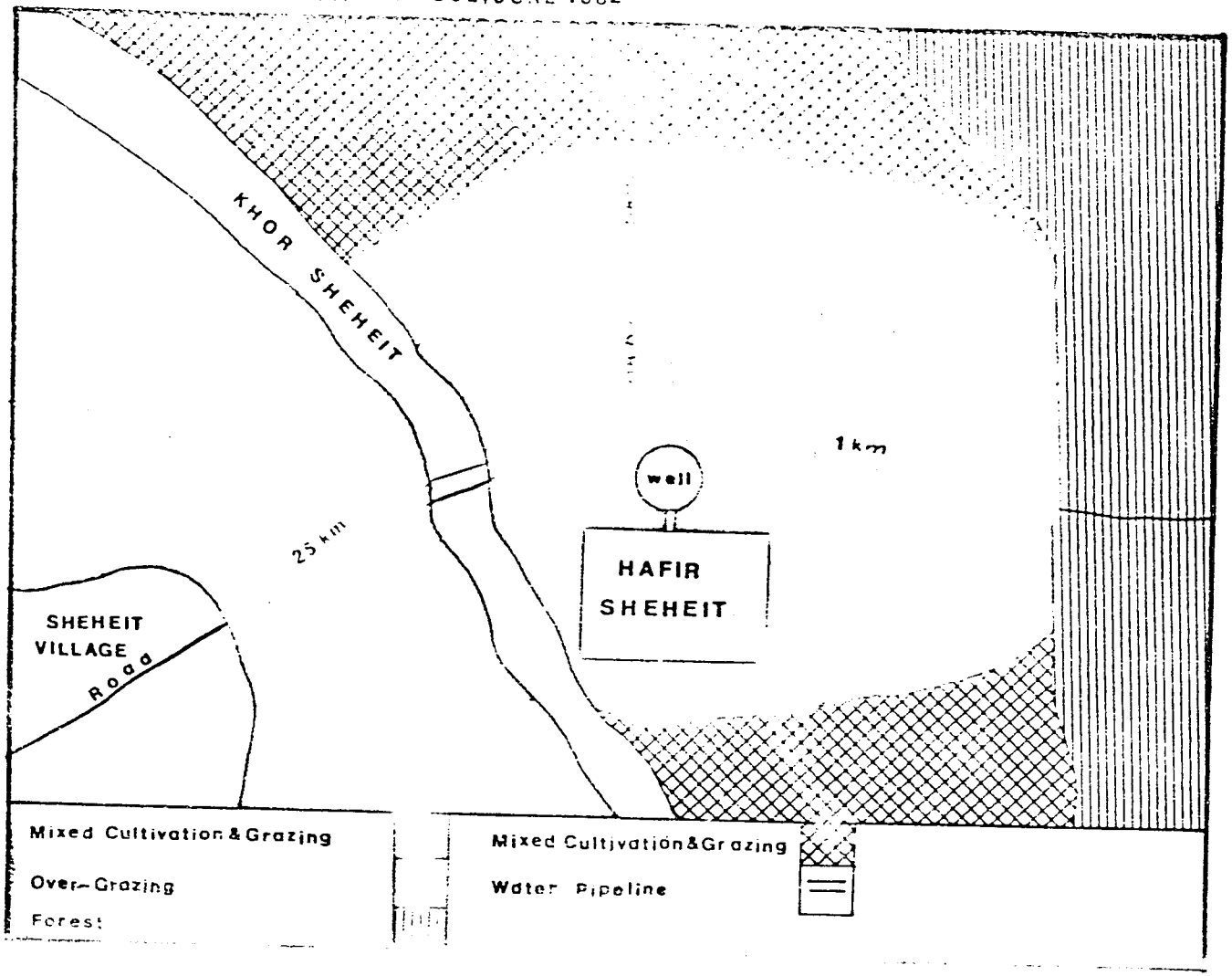
E. HAFIR SHEHEIT:

Land use types around Hafir Sheheit in June 1982 are shown on the sketch map. The four types of land use identified are:

1. Overgrazing
2. Mixed cultivation and grazing
3. Mixed cultivation and forest
4. Forest

It was noticed that land degradation in the area between Sheheit village and the khor is higher than beyond the khor. The sketch map also shows very clearly that the intensity of land deterioration increases towards the hafir.

FIG.21 HAFIR SHEHEIT, LAND USE, JUNE 1982



SECTION III

GEDAREF TOWN

III. GEDAREF TOWN

A. History

The town was first established in about 1800 when Saad El Dhibayani moved into the area and built the first huts. His tribe, El Dhibayaniyya, now lives at Assar village, some 6 km. from Gedaref. It was first called "Gedaref Saad" because it was surrounded by a group of hills taking the shape of " غضـــروف ". In 1840 Al Mak Nimer stayed at the village on his way to Ethiopia and established Hilat al Malik. In 1865 Ahmed Abu Sin migrated to the village and established Deim Hamad; then Al Sufi al Agaig came and established the hai (quarter) which is named after him.

After the battle of Gallabat in 1889 Al Nour Anguara and his soldiers built a part of the town and called it Deim al-Nour. After the Anglo-Egyptian conquest of the Sudan, Bakr Mustafa was encouraged by Sultan Ahmed Fadl to move from Karkuj eventually he came and established Deim Bakkar

B. Land Use

A transect was made to monitor land use changes on the area south of the town. See the 1982 types of land use on the sketch map.

C. Population

1955/56	17,537	persons
1973/74	66,200	persons
1976 (estimate)	122,000	persons
1982 (estimate)	195,000	persons

The annual rate of increase is about 10%, 7.5% resulting from immigration and 2.5% from natural increase.

The three major tribal groups are the Ga'alin, the Beja and the Shukriyya; minor groups come from southern and western Sudan. A good proportion of the population is constituted of Eritreans, other Ethiopians, Chadians and Hawsa. People of similar tribal or geographical origin tend to live together, e.g., Hai Al Malik and Gubarab are mostly occupied by Ga'alin, Hai Al Barno by the Barno, Hai Suakin by eastern Sudan tribes, Dar al-Salam by Eritreans, and Hai October by Hawsa.

D. Expansion and Planning

Gedaref has become the largest town in Kassala Province. Because of the high rate of immigration, Gedaref has expanded significantly. In 1970 the area occupied by the town was estimated at 22 sq.km, but now it occupies an area of about 40 sq.km, i.e., an increase of 82% in 12 years.

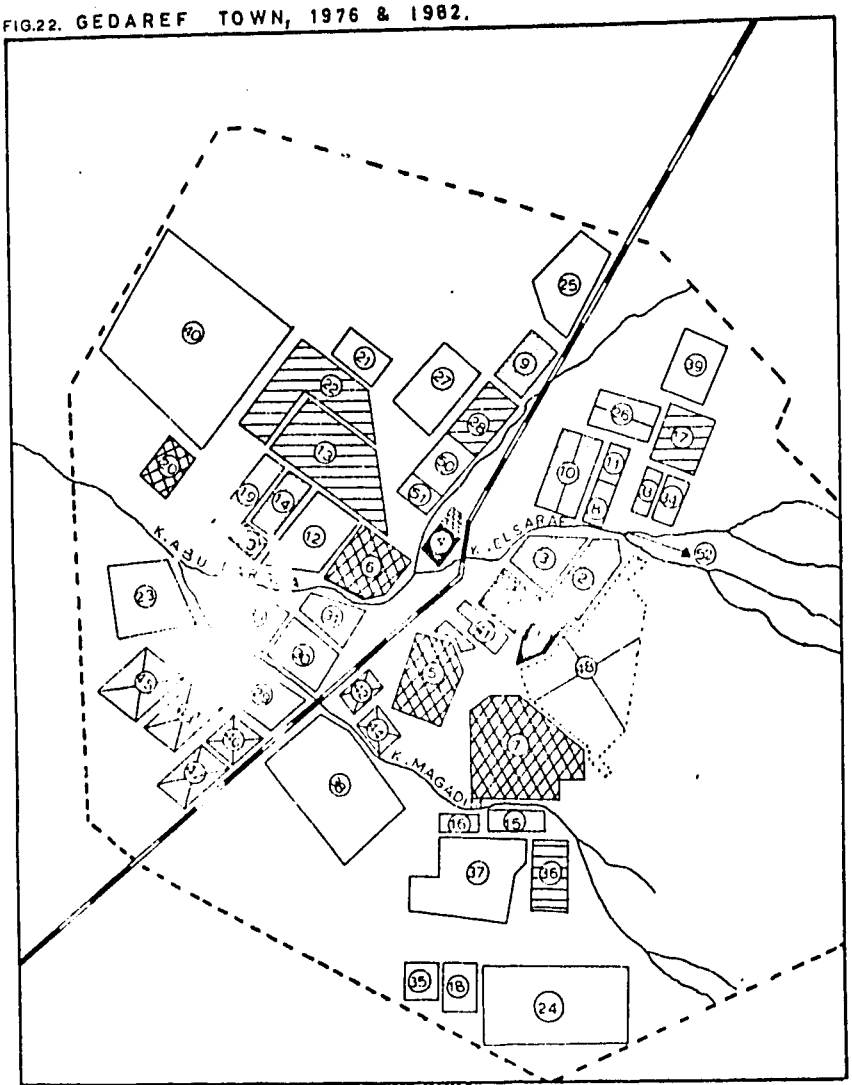
Town planning has recently been introduced. The planned parts of the town are the more extensive and more populated parts.

In 1975 about 85% of the town was unplanned. The various parts of the town were (the numerals correspond with those used on the map):

a. Planned

First class: (4) Diem Hamad (1) El Khama
Second " : (7) Deim El Nur (6) El Asra (4) Deim Hamad
(5) Hai El Muwazafin (1) El Khama
Third " : (7) Deim El Nur (6) El Asra (2) El Meide
(3) El Ganaien (40 El Sadaqa
(8) El Ma'asir North
Fourth " : (36) Deim El Nur South (52) El Masageen
(13) El Matar (22) Imtidad El Matar
(28) Imtidad El Gamhuriyya
(49) Imtidad Karfis

FIG.22. GEDAREF TOWN, 1976 & 1982.



N.B: SEE NEXT TWO PAGES.

KEY FOR GEDAREF TOWN MAP

1. Hair El Khama
2. Hai El Meidan
3. Hai El Ganaien
4. Deim Hamad
5. Hai El Mouazafin
6. Hair El Asra
7. Deim El Nur
8. Hair El Maasir (N)
9. Hai El Mufargaat
10. Hai Rueina E&W
11. Hair El Maasir (S)
12. Hair El Nazir
13. Hai El Matar
14. Hai Barno
15. Hai El Nassara
16. Hair El Zaraieb (I)
17. Karari
18. Khor Magadim
19. Hai Karfis
20. Wad El Kubeir
21. Hai Badouba
22. El Matar ext.
23. Hai El Sufi
24. Abbayo
25. El Malik
26. El Gubarab
27. Taraiona
28. Hai El Gamhuriya (N)
29. Hai Abakur Gibril
30. Hai El Danagla
31. October E.
32. October W.
33. El Thawra
34. El Zaraieb (2)
35. El Matamir
36. Deim El Nur (S)
37. Suakin
38. Salamat El Bey
39. El Tawelat
40. El Sadaga
41. Main Souk
42. Old Cereals Souk
43. New Cereals Souk
44. Old Ind. Area
45. New Ind. Area
46. Stores
47. Silo
48. Military Area
49. Karfis ext.
50. El Gamhuriya (S)

GEDAREF TOWN EXTENSION

1976	1982
A. Planned Residential Units:	A. Planned Residential Units:
1st Class: (1) (4)	1st Class:
2nd Class: (1) (4) (5) (6) (7)	2nd Class: (20)
3rd Class: (2) (3) (6) (7) (8) (4)	3rd Class: (9) (10) (14) (49)
4th Class: (13)(22)(28) (36)(49)	4th Class: (17)
B. Unplanned Residential Units:	B. Unplanned Residential Units:
1st Class: (9) (10) (12) (14) (16)	1st Class:
2nd Class: (18) (19) (20) (23) (24)	2nd Class: (11) (15) (21)
3rd Class: (26) (29) (30) (31) (32)	3rd Class: (27) (34) (37)
4th Class: (33) (35) (38) (50) (25)	4th Class: (39)

2. Non-Residential Areas

The non-residential areas included the main market (41), the old cereal market (42), the new cereal market (43), the industrial area (44), the military area (48), the stores (46) and the silo (47).

3. Unplanned

(31)&(32) Hai October; (30) El Danagla; (33) El Thawra; (10) Ruweina; (9) El Mufarga'at; (26) El Gubarab; (23) El Sufa, El Azraq, (12) Hai El Nazir; (50) El Gamhuriyya North, (51) El Gamhuriyya South; (14) Hai El Barno; (19) Karfis; (29) Deim Bakkur; (20) Wad El Kubier; (22) Hai El Malik; (38) Salamat El Bei; (24) Abbayo North, (24) Abbayo South; (16) El Zaraieb; (18) Khor Magadeim; (35) El Matameer.

Changes between 1976 and 1982 include:

(a) Wad El Kibier was planned as a second class area.
(b) The following were planned as third class areas; El Mufarga'at, Ruweina and Hai El Barno.
(c) Imtidad Karfis was promoted to the third class.
(d) Karari (17), a new extension, was planned as a fourth class area.
(e) New unplanned extensions include; (37) Suakin, (27) Taradouna, (11) El Ma'asir South, (13) El Kassara, (39) El Taweidhat, (34) El Zaraieb, (6) and (25) El Baduba.
(f) A new industrial area (45) has been built.

4. Area and Building Material

(a) The area of the houses in the different classes are 750 m^2 for the first, 600 m^2 for the second, and 400 m^2 for the third and fourth.

(b) All first class houses are built of concrete, stones and burnt bricks (fixed materials). Most houses in the second class are of fixed material while some are of unfixed materials. In the third class most houses are of grass, wood, metallic sheets and crop residues (unfixed materials) while some are of fixed material. All houses in the fourth class are built of unfixed materials.

Of all buildings 3 % are made of grasses and agricultural residues, 3% of burnt bricks, 1% of stone, 0.75% of concrete and 0.25% of wood and metallic sheets.

5. Housing Stock

Year	Population	Housing Stock
1955/56	17,537	933
1973/74	66,200	8,367
1976	122,000	15,443
1982	193,000	24,709

E. Some Economic Data

1. Business

About 90% of businessmen are involved in the agricultural sector and the remaining 10% are concerned with commerce and trade, construction, transport and industry. The main commercial crops are dura, sesame, gum arabic, and cotton.

The main industries are:

1. Candy (tahniyya) - uses a generator for power
2. Soap - two factories
3. Cement tiles
4. Oil mill
5. Agricultural implements
6. A small workshop
7. Ice
8. Soft drinks

Many applications for more industries have been approved, but these industries have not been established because their owners argue that they have not been able to get the required hard currency and that the industrial area has not yet been provided with the basic services of electricity and water. Thus most of these factory buildings are now used for storage.

2. Farmers' Income

Table 41

Farmers' Returns from Various Crops (Ls.)

Season	Dura	Sesame	Gum	Cotton	Total
1975/76	4,628,280	5,121,874	3,156,361	160,428	13,066,633
1976/77	7,099,552	6,706,048	1,320,662	156,228	15,282,488
1977/78	7,650,000	5,186,010	760,266	520,089	14,306,365
1978/79	12,773,283	4,714,575	856,220	7,027	18,351,105
1979/80	34,651,231	11,444,409	773,334	24,915	46,893,979
1980/81	25,021,964	14,574,220	682,599	---	40,278,783

3. Royalties

For the year 1980/81

Ushur	Ls.	7,083,218
Gibana	Ls.	616,029
Others	Ls.	566,842
Total	Ls.	8,266,089

The ushur and gibana go to the Regional Government while the other local taxes go to Gedaref town.

4. Transport

Length of paved roads is 12,780 meters.
Length of unpaved roads is 8,480 meters.

Because of the numerous khors which traverse the town, bridges are very essential. There are 16 bridges, about 7 of them in need of urgent repair. The bridges are old,

weak and narrow they cannot cope with the increasing number of heavy trucks necessary for the increasing commercial role of the town.

The number of cars in the town were:

Private cars	560
Taxis	176
Small vans	630
Buses connecting the town to Kassala, Wad Medani, Khartoum and New Halfa	40

Many trucks and lorries are around.

Weekly consumption of fuel, except for trucks and lorries, was about 12,000 gallons.

F. Education

1. Before 1950

Table 43

Level	No. of schools		
	Male	Female	Total
Primary	3	1	4
Intermediate	2	1	3

2. 1976

Table 44

Level	No. of schools			No. of students			Remarks
	M	F	Total	M	F	Total	
Primary	24	22	46	7653	6985	14638	Concentrated in the southern part.
Junior high	6	5	11	1753	1154	2907	All in south except two.
Senior high	3	1	4	694	250	944	All over the town.
Illiteracy	21	-	21	840	-	840	Government employees only.
Kindergartens			17			500	Concentrated in rich area and areas of employees.

M = Male F = Female

3. 1982

Table 45

Level	No. of schools: M	F	Total	No. of students: M	F	Total	No. of teachers
Primary	26	24	50	8647	8036	16683	400
Junior high	7	6	13	2550	1870	4420	171
Senior high	4 (*)	1	5				

(*) Including one technical and one commercial school. In every school, except the technical, there are night classes (Teacher's Union).

There are 20 cultural and sports clubs, a cinema and one theatre (in the military area).

G. Medical Services

1. Clinic facilities, 1982.

There are two hospitals, a civil and a military.

The civil hospital (1982)

The number of medical personnel: 13 specialists
37 general
8 technicians
233 other medical staff

Non-medical staff: 99
Number of beds: 391
6 pharmacies in the town
2 health centres at Police Station and silo
3 dressing stations
1 maternity/child centre
1 mid-wife school
1 nursing school

2. Public Health

a) 1976

The drainage system is limited and uncovered and forms

a favourable environment for the breeding of mosquitoes and flies. Had it not been for the excellent natural east-west drainage system, the town would have been like a pool.

Daily garbage is about 100 cubic metres; number of workers (85) can meet only ¼ of the needs. Furthermore, 3 of the 6 trucks are out of order. There are only 4 tractors and 1 trailers.

There are two small tankers to get rid of the waste water collected in ditches in the residential and industrial areas.

The treatment of human waste is problematic. The hygienic lavatories constitute about 30% of the needs of the town; 8% of the remainder are dug ditches, and the rest are buckets. There are:

4,500 buckets
2 tanks
3 tractors
101 night soil workers

b) 1982

4,000 buckets
2 tanks
3 tractors
61 night soil workers
54 garbage collection workers, ¼ of what is needed.

In 1976 buckets were emptied every day, but in 1982 they are emptied twice a week.

A lot of people, especially in the unplanned areas, have no ditches and they use the khors.

The use of buckets has been delegalized since 1976.

H. Water

Before 1970 the town was supplied by water through pipes from Abu el Naga deep bore wells at a rate of about 1300 cu.m/day. In 1970 a water station was established at Showak and it is supposed to supply the town with 10,000 cu.m/day (2 million gallons). The current daily need is about 15,000 cu.m/day. The water actually piped to the town varied between 8,000 cu.m/day under normal conditions and 6,000 cu.m/day under abnormal conditions, i.e., when electricity is insufficient and/or the Athara water level is low.

In 1979 an attempt was made to reopen Abu el Naga II wells, 8 of which were found in good shape. Financial problems have inhibited this attempt.

Distribution

About 5,600 houses use piped water inside the complex, in addition to government and other offices, factories, silo, etc. For other areas 61 water centres have been constructed for their use.

a) Those which get 100% of their needs from piped water:
   1) El Maidan (2) El Genaiyn (3) Deim Hamad
   4) El Asra (5) El Khama (6) El Muwazafeen.

b) Those which get about 50% of their water requirements from pipes and 50% from water centres:
   1) El Ma'abda (2) Deim El Nur (3) Ruweina
   4) Hai El Malik (5) El Gamhuriyya (6) Deim Bakkur
   7) Hai El Nasir.

c) 15% from pipes and 85% from water centres:
   1) Imtidad El Nasr (2) Karfis (3) Im'idad Karfis
   4) Hai ElNazir (5) Karari (6) El Showra
   7) Salamt El Bei (8) El Gubarab.

d) All other residential areas depend on water centres. Compare this distribution with the classification of residential area in the map.

A water sample was taken, but lack of facilities inhibited the intended bacterial and chemical analysis.

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I. Electricity

The town's demand for electricity before 1972 was met independently by public and private generators. In 1972 the Public Electricity and Water Corporation came into being to cater for this service. The town, which gets its electric power from Khashm El Girba Dam electricity plant, used to get 1000-1200 K.W. which was sufficient. Of this 1000-1200 K.W., about 500 are used by the water supply station at Shawak during the day, but during the night the full capacity is directed to the town.

With the recent expansion of the town, the supply of electric power has become very insufficient. Deficiency is estimated at about 1200 K.W. All new residential areas are provided with electricity. Residential areas supplied with electricity are El Khama, Deim Hamad, El Asra, Deim El Nur, El Ganaien, El Meidan, El Maasir North, Hai El-Nazir, and Deim Bakkur. Abul Naga village is also provided with electricity.

J. Fire Incidence

Number of Fires during 1975/76 and 1980/81

Table 46

Area	1975/76	1980/81
El Matar	36	29
El Meidan	1	3
El Asra	5	5
El Ganaien	4	3
El Khama	2	-
Deim Hamad	-	4
El Masageen	2	1
El Ma'asir	1	3
Deim El Nur South	12	20
Other Planned area	-	46
Deim Bakkur	39	34
Hai El Nazir	10	4
Karfis	12	8
El Sufi El Azraq	9	2
Salamat El Bei	28	20
El Mufaraga'at	8	1
El Gamhuriyya	13	17
El Gubarab	9	6
Ruweina	12	7

Cont..

Table 46(Cont.)

Area	1975/76	1980/81
El Thawra	2	1
Karari	-	7
Suakin	2	4
Other Unplanned areas	35	44
Total	242	269

The fire season starts in December. Fire incidence increases to attain its maximum in April after which it starts to decline to a minimum in August.

In 1980/81 about 76% of all fires occurred in the unplanned parts of the town because;

1) Houses are built mostly of grass, straw and crop residues,
2) streets are so narrow and winding that firemen cannot easily get to the fires.
3) lack of water pipelines, water for extinguishing the fire has to be brought from other parts of the town.

The houses and buildings which caught fire totalled 534; the total loss amounted to Ls.37,930. Had it not been for the efforts of the firemen, total loss would have reached Ls.186,910

Fire incidence is generally high in areas occupied by Ethiopian refugees like Deim El Nur and in areas occupied by a mix of ethnic groups like Salamat El Bei which is occupied by Hausa, Chadians, Ethiopians and Sudanese.

Firemen and related personnel total 102 for all Kassala Province, out of this 66 are for Gedaref Town.

There are only 3 fire cars, and more than one fire may break at the same time.

To overcome the water problem six 100-ton water tanks have been established in those parts of the town with high fire incidence. These are to be used for this purpose only, but water is often insufficient.

F. Urban Crime

Table 47

Type of Crime	Jan.-April 1982
Assault, Grievous Hurt (including rape)	107
Homocide	10
Robberies, Thefts	305
Drugs and Weapons possession	25
Prostitution	143
Alcohol-related crimes	149
Others	406
Total	1,145

Major reasons for increase in urban crime:

1) Unemployment: The unemployed compared to the registered labour force amounted to 9% in 1967 but to 28% in 1971.
2) Migrants' failure to adapt to and be integrated into the new community.
3) The large number of seasonal migrants coming during land clearing and harvesting of mechanized farms.
4) The great diversity of ethnic, tribal and cultural backgrounds of migrants.
5) Most migrants are young males (so sex imbalance) and poverty of women gives rise to prostitution.
6) Because housing conditions are poor, children often spend their time in the streets and public squares, unsupervised by their parents, where they are liable to pick up delinquent behaviour.

L. Floods

1. 1973 Flood: Following the 1973 flood, a committee was formed to look into the reasons and to recommend protective measures. The major recommendations included:

a) Prohibition of placing dirt, garbage and any material onto the Khors' beds.
b) All new buildings should be no less than 50 m. away from the Khors.
c) Construction of bridges across the Khor should be preceded by all appropriate studies.
d) The natural course of the Khor should not be modified without the proper hydrological studies.
e) The maintenance of existing bridges and clearance of the Khor bed.

None of these recommendations were implemented.

2. 1982 Flood: A devastating flood swept the town in August 1982.

a) Losses: Items affected included:

1290 huts - totally lost
1404 huts - 50% damaged
1702 rooms - (Kurmuk)
251 straw/grass enclosures
23 Zinc enclosures
9 fixed utilities
3 temporary utilities
79 personal items
39 gardens and wells
93 other items

Total loss has been estimated at Ls.1,6 million.

b) Areas affected:

The distribution of value of damage is as follows:

	Ls.
Government buildings	334,985
El Jamhuriyya	282,900
El Mufarga'at	230,168
El Matar and Hai El Barno	143,400
Hai El Nazir	141,190
October	91,200
El Gamaien	68,550
Deim Abakkur	49,662
El Asra	77,850
El Meidan	33,300
Deim Hamad	35,704
El Thawra	21,650
Karfis	18,712
Deim El Nur	15,950
Ruweina	27,660
El Zaraieb	2,500
Salamat El Bei	3,350
El Dangla	750
El Ma'asir	700
Suakin	700
El Suf: El Azraq	300
TOTAL	1,581,481

c) Causes:

i) Rainfall:

The town received 663.7 mm of rain in 1975 and 599.3 in 1982, but no flood occurred in 1975. The difference is that most of the 1982 rainfall poured during a short period.

August of 1975 witnessed 193 mm (29% of the annual total), while for August 1982 the figure was 342 (57% of the annual total). More significant was that the first three days of the 1982

flood had 30.70 and 100 mm of rain respectively, i.e., 61% of August's total or 35% of the annual total.

ii) Deforestation of catchment areas:

Expansion of mechanized farming on traditional agricultural land has pushed peasants to clear higher areas of Dalasa which is the catchment area of the two branches of the khor. The removal of trees deprived the area of many protective measures. As a result, most of the rain water finds its way to the khors and runs at a high eroding speed. This has widened the khor bed from about 20 to 50 meters.

iii) The course of one khor has been modified inside the town to meet the other at 90°. The khor which comes first may block the other causing its water to overflow the banks. This has also increased the erosion process, threatening this part of the town.

iv) The local town planners add that the unplanned expansion of the town, which did not follow the contour lines, has encroached on the water courses in the town.

v) The Medani-Kassala Highway has blocked the natural drainage system of the town (the khor).

d) Recommended Solutions:

i) The 1973 recommendations
ii) Widening of the railway bridges
iii) Making a protection drain around the town
iv) Construction of a dam in Dalasa area to reduce water flow into the town and to make water available for people in that area.

SECTION IV

SOILS

IV. SOILS

A. SITES

Sample sites have been selected in such a way as to see whether the different types of land use and different managements have the same or different impacts on the soil.

a) Sampe No. 67: from mechanized scheme No.67; the site is 125° from the north-west corner of the farm and at a distance of one km.

b) Sampe No. 44: from mechanized scheme No.44; the site is at 60° from the south west corner of the farm. and a distance of one km.

c) Sample No.62 A: from mechanized farm No.62; the site is 260° and two km from the north-east corner of the farm.

d) Sample No.62 B: from mechanized scheme No.62, the site is one km and at 240° from the north-east corner of the farm.

e) Sample No. 83: from mechanized scheme No.83; the site is 40 meters from the north-eastern corner of the farm and at 210°.

f) Sample No. 240: from mechanized farm No.240; site is at a distance of 145 meters from the north-eastern corner of the hafir.

g) Sample No. KC: from Kabaros area; the site is at the beginning of the traditionally cultivated area.

h) Sample No. KB: from Kabaros area; the site is 2.5 kms from site of sample KC.

i) Sample No. KA: from Kabaros area; 2.5 kms from sample KC, on a regenerated bush land.

j) Sample No. 13: from the corner of mechanized farm No.13 which was under cultivation last season.

k) Sample No. 31: from the Canadian mechanized scheme No.31 which will be put under production for the first time next season.

B. INTRODUCTION:

Soils in the vicinity of Gedaref have been described by Tothill (1948) as the oldest soil in the Sudan. "Despite the subjectivity of this statement, it is generally believed that these soils have developed on a degradational plain" unlike those of the Central clay plain. Their origin, however, is still controversial.

Whereas Tothill (1948) demonstrated that they are partly residual, Tyler (1932) believed that they were originally from weathered basaltic lavas.

The soils developed on this degradational plain are characterized by being mostly montmorillonitic, dark, alkaline, usually calcareous and cracking clay notable for their low organic carbon (0.5 - 1%). Paxton and Berry (1978) believe that the clay must have formed during a previous wetter climate. The observed changes in several clay properties in relation to current rainfall suggest a balance between the soil and the overhead climate. For instance, clay content tends to increase more in areas of higher rainfall than in drier areas (40-80%). Retention of clay, decrease in salt content and p^H are also observed in areas of higher rainfall.

On the open clay plain near Ghadambaliya (west of Gedaref) there is enough evidence of mixed, though local, provenance for the clay. Olivine and zeolites diminish downslope from their source and sometimes after the contact with basement complex is passed, quartz and hornblende are found near the surface.

C. SOIL SURVEY RESULTS:

A semi-detailed soil survey and land suitability classification was conducted by Buraymah (1976) for

Ghadambaliya area. The dominant soils are typical vertsoils with deep cracking, self mulching, moderately well drained profiles and high clay contents (70-80%). They are of high cation exchange capacities and high base saturation, mild reactions and none to slightly calcareous matrices, non-saline, non-sodic and salt free. The latter phenomenon indicates that these soils, despite their very low permeability, undergo sufficient leaching to keep the salts at a favourable level.

The survey also showed that the natural fertility of these soils, particularly nitrogen (N), phosphorous (P), and organic matters is low (P is 1.7 - 3.4 ppm comparable to 1.4 - 4.5 ppm in the Gezira). Addition of nitrogenous fertilizers is necessary to improve the fertility status of these soils. Potassium (K) status is satisfactory.

Southern Gedaref soils differ from those of Ghadambaliya. The former have a greater swelling capacity and higher available water capacity but still within a favourable range for rainfed agriculture if precipitation is adequate. Hydraulic conductivity is low or very low in all soils, a common feature of all heavy clay soils. Once these soils are saturated and the cracks close, they develop a very low internal drainage. Compared to the soils of Ghadambaliya, the southern Gedaref soils have a better infiltration rate. The observed reduction in the infiltration rate of Ghadambaliya soils is due to the fact that they have been under mechanized farming for over 30 years. Compaction is clearly seen in the field in the soils of Shuheit series. Texture, electrical conductivity (E.C.) and exchangeable sodium percentage (ESP) are similar in both soil types.

D. SUITABILITY FOR CROP PRODUCTION:

The soils of Ghadambaliya (Scheme No.240, K.6) have been classified by Buraymah as moderately suitable for dura production. Yields fluctuate according to the amount and distribution of rainfall. In the past few years

rainfall in the area fluctuated between 300 and 400 mm. The 1976/77 season witnessed the lowest dura yields in Ghadambaliya area (152.9 Kg/fed.). There are minor physical as well as chemical limitations for the use of these soils for cottons, dura or sesame cultivation. The physical limitation, as mentioned earlier, is the poor infiltration rate (1.5 to 2.6 cm/h). Nutrient status, both N & P, is unsatisfactory and requires fertilizer application. According to the FAO (1976) suitability classification currently used in the Sudan, the soils of Ghadambaliya area can be classed as S_2 (high to moderate yields with minor physical limitations).

E. TREND ANALYSIS:

Soil samples have been collected from selected soils at Kabaros (Ghadambaliya area) in 1976 and 1982 with the aim of detecting any trends caused by environmental and cultural changes. The analytical results of soil samples taken in 1976 (see table below) indicate that the soils of Kabaros are slightly alkaline with no salt accumulation. Saturation percentage (S.P.) at the start of cultivation (with the exception of scheme No.240) was over 100% throughout. The soils showed no signs of salt hazard and the exchangeable sodium per cent showed no detrimental effect on crop production, if being very low. Cation exchange capacity was generally around 80 meq/100 g suggesting adequate supply of macro-nutrients in these soils. Clay content was over 90% with sand and silt barely reaching 5%. Scheme No.240 was the only exception with low amounts of clay and S.P. The table below shows that the fertility status in 1976 was generally low with hardly any significant variability with depth. Exchangeable sodium per cent (ESP) and sodium absorption ratio (SAR) are significantly higher, between 30-60 cm, but S.P. is lower.

Significant changes have occurred from May to December 1982. The 1982 tables show that sample KB and Kabaros I (May and December 1982, respectively) have differed greatly in two main physical characteristics that influence crop production: Saturation Percentage (S.P.) and texture

(compare the two tables). The drop in S.P. from 103.8 to 92.2% requires an explanation. More significant is the change in clay content from 96.5% in May to 66% in December and a subsequent increase in coarser particles (fine sand and silt). Results of analysis from FC also showed higher S.P. (111.9) and high clay content (95%). These results are similar to those of FA (control samples) in May.

Samples from Scheme No. 240 showed S.P. of 80%, CEC of 60, and clay content slightly over 70% in May. In December 1982 this scheme showed a sharp drop in S.P. (55.5%) and an increase in fine sand and silt percentages. Soluble salts are mostly sodium whose SAR showed a rise to 10 during this period. Similar changes have been observed at schemes No.44 and 62. It is generally believed that the long period of cultivation coupled with a significant drop in rainfall have resulted in physical as well as chemical deterioration of the soils of Ghadambaliya area. The decrease in clay content is probably caused either by the addition of fine sand by deflation from more northerly arid area, or the degradational effect on this plain has resulted in clay transportation downslope. The former speculation seems to suit the ever increasing aridity in this once humid area.

Table 48

Gedaref District: Soil Analysis (May 1982)

Sample	SP	pH PAST	EC mmhos/cm	SOLUBLE ANIONS me/L CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	SOLUPLE CATIONS me/L Na^+	Ca^{++}	Mg^{++}	K^+
KC	111.9	7.57	[illegible]	.30		1.33	0.77	1.43	1.78	0.12	0.07
240	78.2	7.87	0.28	0.95		1.33	2.25	3.48	1.00	0.60	0.05
KB	103.8	6.50	0.13			1.67	0.43	0.87	0.59	0.31	0.03
KA	101.1	7.75	0.22	0.09		1.67	9.02	1.74	1.11	0.59	0.04
83	103.7	7.60	0.32	1.73		1.17	1.04	2.61	1.11	0.19	0.03
67	100	7.12	0.31	0.74		1.00	2.23	1.74	1.11	1.09	0.03
44	112.6	7.28	0.26			1.00	2.60	0.87	2.00	0.07	0.03
62A	90.2	7.85	0.42	2.17		1.50	1.16	3.48	1.20	0.10	0.05
62B	111.2	6.62	0.20			1.25	1.08	0.87	1.11	0.29	0.06

Cont../..

Table 48(Cont.)

Sample	TOTAL SOLUBLE EXH. Na+ me/L	Na+ m.e./ 100/g	Na+ m.e./ 100/g	G.E.C. m.e/ 100/g.	ESF	PARTICLE-SIZE ANALYSIS Sand %	Silt %	Clay %
KC	0.31	0.16	0.15	79.30	0.19	0.97	2.88	96.15
240	0.85	0.27	0.58	58.58	1.00	15.02	13.54	71.44
KB	0.34	0.09	0.25	79.14	0.32	15.60	1.63	96.51
KA	0.43	0.18	0.25	78.43	0.32	1.49	2.86	95.65
83	0.82	0.27	0.55	78.36	0.70	1.58	2.86	95.56
67	0.50	0.17	0.33	79.75	0.41		2.74	97.26
44	0.28	0.10	0.18	77.94	0.23	2.11	2.84	95.05
62A	0.99	0.31	0.68	78.93	0.86	2.89	2.89	96.25
62B	1.22	0.97	0.25	76.08	0.33	1.49	5.73	92.78

KC = Kabaros Village; Start of cultivation on western side.

KB = Kabaros Village; A traditional farm (2 km to the S.W.) under continuous cultivation.

KA = Kabaros Village; Land under bush and had not been cultivated for the previous two seasons (Control).

62B= Forest near state farm No.62 (Control).

Table 49

Gedaref District: Soil Analytical Data (1976)

Depth Cm	pH PASTE	pH H_2O	pH KCL	EC MMHOS	MEC $CaCO_3$	MECHANICAL ANALYSIS	SAT. %
0-30	7.8	8.7		0.39	0.5		75
30-60	7.9	8.5		0.45	0.5		66

DEPTH Cm	N %	C %	C/N	EXCHANGEABLE CATION MEQ/100g Na	K	Ca	Mg	CEC	BASE SAT.	ESP	SAR
0-30	0.035	0.702	20	3.2	1.0			73		4.4	3.6
30-60	0.028	0.702	25	5.5	0.8			77		7.2	5.4

DEPTH cm	SOLUBLE CATIONS AND ANIONS MEQ/L IN SATURATION EXTRACT Na^+	K^+	Ca^{++}	Mg^{++}	CL^-	SO_4	HCO_3	CO_3
0-30	2.8		1.0	0.2	1.0		2.3	0.0
30-60	4.0		1.0	0.1	1.1		2.5	0.0

Table 50

Gedaref District: Soil Analysis (December 1982)

Lab. No.	Profile No.	Depth in Cm	P.H. 1:2	$CaCO_3$ %	E.C. in mm hos/cm	S.P. %	MECHANICAL ANALYSIS		
							C.S. %	SILT %	CLAY %
1	1	0-50	7.4	2.5	[illegible]	92.2	15	19	66
2	240		7.5	[illegible]	0.22	55.5	27	13	60
3	62		7.9	2.8	0.26	77	7.0	11	82
4	44		7.4	3.6	0.23	81	5	15	80
5	67		6.8	2.8	0.18	82.0	7	13	80
6	13		6.9	2.1	0.23	89	9	15	76
7	31		7.0	2.2	0.21	90	5	11	84
8	83		7.1	2.8	0.2	75	13	9	78

Cont../..

Table 50 (Cont.)

Lab. No.	Profile No.	SOLUBLE CATIONS IN meg/L				SOLUBLE ANNIONUS meg/L			S.A.R.
		Na	K	Ca	Mg	CO_3	HCO_3	Cl_2	
1	1	1.1	0.04	1.5	0.5	Nil	2.8	0.5	1.1
2	240	2.8	0.04	1.0	0.5	Nil	2.8	0.5	10.1
3	62	1.7	0.04	1.5	Nil	Nil	2.4	0.45	1.9
4	44	1.3	0.03	1.0	0.5	Nil	2.2	0.4	1.5
5	67	0.87	0.03	1.0	Nil	Nil	1.4	0.5	1.7
6	13	0.4	0.05	1.0	1.5	Nil	2.0	0.5	0.4
7	31	0.7	0.06	1.5	0.5	Nil	1.6	0.5	0.7
8	83	0.87	0.05	1.0	1.0	Nil	2.0	0.4	0.87

N.B. : E.C. : Electrical conductivity m.mlis/cm.
S.P. : Saturation percentage
O.C. : Organic Carbon
N. Nitrogen
C.E.C. : Cations Exchange Capacity
S.A.R. : Sodium Adsorption Ratio
E.S.P. : Exchangeable Na. per 100 gm.
T.S.C. : Total Soluble Cations
T.S.A. : Total Soluble Na per 100 gm. over-dry soil

SECTION V

WATER RESOURCES

V. WATER RESOURCES

In our field study we examined three aspects of water supply in Gedaref District:

a) Water requirements for labourers in mechanized schemes;

b) Overgrazing associated with water points; and

c) The water quality of village wells and a hafir in the Ghadambaliya Scheme.

These aspects are discussed in the following section.

A. Water Requirements for Labourers in Mechanized Schemes

Water requirements for farm labourers and other categories of field workers vary appreciably. On most schemes or projects, artificial ponds or hafirs are excavated and when they fill during the rainy season they provide the only source of water for those working in the fields.

We wanted to see if, in the Gedaref District, there is enough water provided for labours, so we prepared the following calculations.

Table 52

** Estimate of the Number of Workers in a Farm Unit of 1000-1500 Feddans

JOB	NUMBER OF LABOURERS	AMOUNT OF TIME	PERSONDAYS
Tree Clearance	100	5 months	15,000
Weeding	80	1 month	2,400
Harvest	125	1 month	3,750
Sack Handling	30	2 months	1,800
Total			22,950

Table 53

* Water Resources in Mechanized Rainfed Areas

AREA OF	HAFIRS	TOTAL CAPACITY(m^3)
DAMAZIN	96	1,898,000
GEDAREF	120	3,815,000
Renk	5	200,000
Dilling	11	350,000
Megennis	5	80,000
Total	237	6,343,000

** Figures come from the National Council for Research

* Water Resources in the Sudan, 1982.

If the average scheme (1250 feddans) requires 22,950 persondays of labour per growing season, then:

1. the feddan labour requirement = 14.4 persondays;
2. on the average a worker needs 1 gallon of water per day;
3. therefore, the feddan water requirements for human use = 14.4 gallons.

Under the conservative assumption that mechanized farming covers 1 million feddans, then the water needed by workers in the mechanized schemes is 14,400,000 gallons or 53,900.28 cubic meters. If the actual need is compared to the capacity of the hafirs, it would appear that there is more than an adequate supply of water for labourers. However, in actuality this is not the case. During the June 1982 field trip we observed lorries taking water in barrels to scheme workers.

The month of June falls toward the end of the dry period and hafirs may have dried up. Secondly, we have no data showing the actual amount of water in hafirs; we only have their total capacity. The actual amount of water depends on the amount and frequency of rain. Therefore, from our observations, it appears that there is not enough water for labourers.

Overgrazing around Water Points

Due to recent expansion of water supply in the Gedaref Region, high rates of localized overgrazing are taking place.

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* Based on calculations and discussions with Dr. M.O. Sammani, who has just completed a detailed water use survey in several parts of Sudan.

Considerable expansion of wells and hafirs took place in the period between 1955 and 1982. As can be seen from the following tables, there were only 13 hafirs in 1954-55 while by 1982 these were 256.

Table 5.3

Hafirs and Wells in Gedaref District in 1954-55 and 1982

a. 1954-1955

HAFIRS	COORDINATES LAT.	LONG.	CAPACITY IN CUBIC METERS(m^3)
Wad Gigi No. 2	15-17	35-04	15,000
El Husheib No. 2	15-07	35-22	20,000
Surug Mohmoud	14-15	34-58	20,000
Abu Grad No. 2	15-04	34-32	10,000
Wadi Atshan	15-34	34-36	25,000
Abu Ganafid	14-51	35-19	20,000
Wadi Musran	15-15	35-19	15,000
J. Nawasil	14-54	35-28	10,000
J. Kasamon	14-36	35-28	30,000
J. Meganis	14-34	35-13	20,000
J. Mundra	15-00	34-23	10,000
J. Ghur	14-49	34-20	10,000
J. Deraia	14-40	34-16	10,000

Source: Harrison and Jackson, 1958

b. 1982

GENERAL LOCATION	NUMBER OF HAFIRS	NUMBER OF WELLS
Northern Gedaref	56	52
Southern Gedaref	29	119
Total	85	171

Source: Rural Water Development, 1982, Khartoum.

The table below shows the magnitude of overgrazing around these permanent water points.

Table 54

Distance walked from water points and area grazed by camels, cattle, and sheep in Gedaref District

Animals	Moderate year		Bad year	
	Normal distance walked from water (miles)	Area grazed (sq. mi)	Maximum distance walked from water (mi)	Area grazed (sq. mi)
Camels	30	2,800	45	6,400
Sheep	15	700	25	2,000
Cattle	12	450	20	1,300

Source: Harrison and Jackson, 1958.

Already in 1958 overgrazing was extensive, although by 1982 there were many more water points and the herd size and the number of herds also increased.

C. Well Depths and Water Samples

During the 1982 field trip data on well depths of the traditional village (Ghireigana, Genna Barra and Iddal Tein) were collected. All depths were measured on the 5th of June 1982.

1. Ghereigana

The well is located at Wadi Modraseib and has a depth of 11.3 meters. The depth of water found in the well was 0.70 meters.

The village of Ghereigana also has a "donki" (wateryard) established over ten years ago.

This "donki" is used mainly for watering animals owned by the villagers. Water from the "donki" is bought at 3 piastres for 4 tins (16 gallons) or 10 piastres for 1 barrel.

Table 55

Chemical Analysis of Hafirs and Well Water of Gedaref Area (September, 1983)

	Locality				
	Gh. Tolgana	Genna Barra	Idda Tem	Gedaref(i)	Ghadambaliya Hafir 240
Date	11.9.83	11.9.83	11.9.83	12.9.83	13.9.83
Time	8.45 am	12.20 pm	3.30 pm	7.30 am	8.45 am
Temp. °C	25.7	25.9	26.8	25.6	27.5
pH	7.7	7.3	7.2	7.5	7.8(ii)
NH_3-N mg/l	0.12	0.1	0.2	0.08	0.52(iii)
NO_2-N mg/l	0.4	0.1	0.4	0.06	0.02
SIO_2 mg/l	10.0	10.0	12.0	4.0	4.0
PO_4P mg/l	1.8	1.2	0.8	0.8	2.0

Notes: (i) Water sample from tap.
(ii) pH recorded in the laboratory.
(iii) This indicated pollution.

2. Genna Barra

The well at Ganna Barra is 2 metres deep, and the water depth in the well is 12.7 centimeters.

3. Iddal Tein

The depth of this well is 19.2 meters, and the depth of water in the well is 17.78 centimeters.

On the September 1983 field trip we were able to collect water samples and bring them to Khartoum for analysis. The analysis is shown in the following table.

When these figures are compared to the 1982 World Health Organization's Guidelines for Drinking Water Quality (see attached table), the water of the three wells and Gedaref Town is well within safe drinking standards.

Only the hafir water shows signs of pollution. The ammonia level is just over the accepted limit. We were unable to perform a total coliform or fecal test, but we suspect that the hafir may be contaminated by urine or other ammonia sources draining into the hafir.

Water Resources Evaluation

WORLD HEALTH ORGANIZATION GUIDELINES FOR DRINKING WATER QUALITY*

AESTHETIC QUALITY	mg/l
Aluminum	0.2
Chloride	250
Copper	1.0
Hardness (as $CaCO_3$)	500
Iron	0.3
Manganese	200
Sulphate	400
Total Dissolved Solids	1,000
Zinc	5.0
Color	15 True Color Units (TCU)
Taste and Odor	Not offensive
Turbidity	5 Nephelometric Turbidity Units (NTU)
pH	6.5-8.5

INORGANIC CONSTITUENTS OF HEALTH SIGNIFICANCE	mg/l
Arsenic	0.05
Cadmium	0.005
Chromium	0.05
Cyanide	0.1
Fluoride	1.5
Lead	0.05
Mercury	0.001
Nitrate (as N)	10
Selenium	0.01

ORGANIC CONSTITUENTS OF HEALTH SIGNIFICANCE	mg/l
Benzene	10
Chlorinated Alkanes and Alkenes	
Carbon Tetrachloride	3 (T)
1,2 - Dichloroethane	10
1,1 - Dichloroethylene	0.3
Tetrachloroethylene	10 (T)
Trichloroethylene	30 (T)
Chlorophenols	
Pentachlorophenol	10
2, 4, 6 Trichlorophenol (Odor threshold 0.0 mg/l)	10
Polynuclear Aromatic Hydrocarbons	
Benzo (a) Pyrene	0.01
Trihalomethanes	
Chloroform	30
Pesticides	
Aldrin/Dieldrin	0.03
Chloridan	0.3
2,4D	100
DDT	1

ORGANIC CONSTITUENTS OF HEALTH SIGNIFICANCE
(Continued)

	mg/l
Heptachlor and Heptachlor Epoxide	0.1
Hexachlorobenzene	0.01
Lundane	3.0
Methoxcylore	30
Radioactive Materials	
Gross Alpha Activity (Bq/l)	0.1
Gross Beta Activity (Bq/l)	1

BACTERIOLOGICAL QUALITY	No. per 100 ml
Treated Water Entering Distribution System	0 Fecal Coliform 0 Coliform Organisms
Untreated Water Entering Distribution System	0 Fecal Coliform 1 Coliform Organisms per one sample 0 Coliform Organisms per two consecutive samples
Water in Distribution System	0 Fecal Coliform 1 Coliform Organisms per sample 0 Coliform Organisms per two consecutive samples

* All values presented are guidelines established by the United Nations World Health Organization (1982).

(T) Tentative guideline value.

SECTION VI

LIVESTOCK, GRAZING AND NOMADS

VI. LIVESTOCK, GRAZING AND NOMADS

The aim is to compare the forage requirement of the herd in the District with the available pastoral resources which include both rangeland forage production and rainfed crop residues.

The method used here is fully in line with the methods and criteria adopted and adapted by the Range and Pasture Administration, Ministry of Agriculture and Natural Resources, Sudan.

A. GENERAL

Being located in the southern part of Kassala Province, Eastern Region, between latitudes 13°N and 17°N and longitudes 34°E and 37°E, the entire Gedaref District (with a total area of 78,228 sq. kms.) is included in the eastern part of the Savannah Belt, where soils are predominantly clay (vertisols). These soils were formed mainly by alluvial action of running water. The clay content increases southeastwards with the gradual increase in rainfall. Except for limited areas of hills, rocky outcrops and red soils, the entire District is characterized by minimum edaphic diversity.

The District can be roughly divided into two areas, the predominantly pastoral Butana area in the north and the predominantly rainfed agricultural southern Gedaref area. From the standpoint of range management, these two subdivisions can be treated as separate range areas with different, current and potential range productivity.

Mean annual rainfall ranges from 175 mm at Qoz Ragab in the north to 570 mm in Gedaref Town in the centre to 650 mm at Doka in the south.

B. VEGETATION

The vegetation of the Gedaref District is less diversified than in other parts of the Savannah Belt. This is mainly due to the limited diversity in soil types and to the small and gradual variation in rainfall amount and pattern in the District.

The climax vegetation of the District is typical semi-desert vegetation in the northern part and low-rainfall savannah on clay in the southern part of the District. In a north-to-south sequence, the vegetation can be classified into four major zones viz; semi-desert grassland on clay, Acacia mellifera belt, Acacia seyal belt and Anogeissus combretum belt (see the vegetation map).

The semi-desert grassland on clay belt is confined to the most northerly part of the Gedaref District (Butana). In this belt Acacia mellifera and Acacia nubica grow along the valleys and near water courses, respectively. The most important herbaceous plant species in this belt are:

Cymbopogon	nervatus	(grass)
Sorghum	spp.	(grass)
Blepharis	spp.	(grass)

These herbaceous plant species constitute the most important grazing resource of the Butana area in its climax status. However, because of its extremely high palatability and excellence for camels and sheep, Blepharis sp. (silba) is considered as the key species to the understanding of grazing in the Butana area. It has particular grazing significance during the dry season.

In the southern and southeastern part of the semi-desert the Acacia mellifera belt extends as far south as Gedaref Town. Throughout this belt Acacia mellifera is the dominant species ; it alternates with

grass areas on intervalley plains. In the order of their abundance, important plant species in this belt are:

Acacia mellifera	(shrub)
Boscia senegalensis	(shrub)
Cadaba glandulosa	(shrub)
Cymbopogon nervatus	(grass)
Sorghum spp.	(grass)
Setaria spp.	(grass)

The Acacia seyal belt starts from the southern boundary of the previous belt and advances southward up to the area south of Doka Town. This belt has been almost entirely put under mechanized rainfed agriculture; the more recent Rahad Scheme has also taken a considerable portion of this belt. The most important plant species here are:

Acacia seyal	(tree, often in pure stand and suppressive of other tree species)
Hyparrhenia sp.	(grass)
Ctenium elegans	(grass)
Aristida spp.	(grass)
Sporobolus spp.	(grass)
Setaria incrassata	(grass)

The Anogeis us-Combretum belt is located in the most south eastern part of the District, i.e., roughly around Gallabat. The vegetation of this belt is a typical representative of the High Rainfall Woodland Savannah. Thorny or Acacia trees are relatively infrequent while broad leaved species predominate. The dominant plant species in this belt are:

Anogeissus	leiocarpus	(tree)
Combretum	spp.	(tree)
Khaya	senegalensis	(tree)
Ctenium	elegans	(tree)
Hyparrahenia	elegans	(tree)

C. RANGELAND

The northern part of the Gedaref District (the semi-desert grassland on clay, or Butana) is predominantly pastoral. This area of the Butana (the Northern Gedaref District) has always been considered to be the best rangeland for camels and sheep in the whole country.

The importance of the Butana as a rangeland stems mainly from the occurrence of Blepharis sp. (siha) as a good fodder for camels and sheep. Blepharis is by far the best Butana dry season grazing plant. Other forage plants are of limited value. When Blepharis is grazed out, the grasses that replace it are almost useless from the standpoint of animals' nutritional requirements Cattle also graze Blepharis but only during the rainy season when the spiky leaf heads are still tender.

In recent years Blepharis has been reported as a disappearing plant and almost extinct from vast areas of the Butana. As early as the 1950's Jackson and Harrison reported that this plant was highly susceptible to over-grazing. They attributed this mainly to the fact that the plant does not shed its seeds in the dry season. Instead it holds its seeds firmly in the dried and spiky flowering heads. Being highly nutritious, the seeds are particularly more attractive to grazing animals. In the process of grazing and digestion, the seeds are eventually destroyed. So, if the plant holds all its seeds in the dry season and if it is grazed out completely every dry season, the plant will eventually disappear.

A strong correlation exists between the occurrence of Blepharis sp. and the provision of water for livestock. The extent to which Blepharis is grazed out depends on the size and distance of the nearest permanent water supply, since this in turn determines the stocking rate

and intensity of grazing. For example, Harrison and Jackson reported that Blepharis was found only ten miles away from small wells, such as the Jebel Lebaitor wells (Wad Araki), while it was more than twenty miles from abundant water supplies, such as the River Atbara and the Subagh wells.

Browse resources come second to Blepharis in the Gedaref District. Browse (shrubby vegetation) species, such as Acacia mellifera, are important shrubs that constitute a considerable portion of the dietary composition of both camels and sheep.

Grass species such as Sorghum sp. and Cymbopogon nervatus are palatable to cattle only during their early phenological stages, and are less attractive to other kinds of livestock throughout the year.

Southern Gedaref District is predominantly agricultural. The largest extensions in rainfed mechanized farming have taken place in this particular area. As a result the traditional transhumance pattern of the pastoral tribes in the whole District has been severely disrupted.

Table 56

Rangeland Area in the Gedaref District

	AREA km^2
Northern Gedaref:	
1. Semi-desert grass and on clay	25,288
2. Acacia mellifera Belt	24,039
Sub-total	49,327
New Halfa Rural Council (minus	5,192
Net Area	44,135
Southern Gedaref:	
1. Acacia seyal Belt	18,806
2. Anogeissus-Combretum Belt	4,903
Sub-Total	23,709
Rainfed Mechanized Farming (minus) 13,868	
Rahad Scheme (minus) 1,260	15,128
Sub-Total	8,581
Total Area = 44,135 + 8,581 =	52,716

D. HERBAGE YIELD AND FORAGE PRODUCTION

Most estimates pertaining to pastoral resources and on carrying capacity in the Sudan have not distinguished between herbage yield and forage production. The former usually refers to the total above-ground phytomass irrespective of its forage value, while the latter refers to the actual amount of plant material that is palatable and available to grazing animals.

As mentioned earlier, the whole District can be divided into two range sites, namely the Butana range site and Southern Gedaref range site. However, each range site is subdivided into two as shown on the table above.

Forage production from crop residues is by no means a traditional ingredient in the process of livestock grazing in the Sudan. However, because of the recent deterioration of rangelands and increasing loss of rangelands to irrigated and rainfed mechanized agriculture, forage from crop residues has become an important source of fodder for both resident and nomadic livestock owners.

Dura (sorghum) is considered one of the important cash crops produced in the Sudan and the most important in the Gedaref District. Straw and standing hay from dura represent about 70-75% and the grain 25-30% of the plant.[1/] This indicates that straw from dura cultivation is always high; bearing in mind the extensive area put under dura production, one will imagine the huge amount of straw that can be produced and used for livestock grazing.

George found only 1.2% protein in dura straw. However, the straw is rich in energy and fiber. He also found that dura straw can constitute up to 30% of ration

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1/ Mohamed Mahmoud, Research and Sorghum Specialist, M.F.C., Khartoum, Oral Talk, 1982.

weight for calves under fattening with a performance of 1 kg. per day growth weight.[1/]

There are about 5 million feddans under dura in the Gedaref District, together with over 200,000 and about 10,000 feddans under sesame and cotton, respectively. The table below shows forage (standing hay) production from dura crop in the Gedaref District. It is, perhaps, worth noting that the per feddan production is 2 tons in commercial farms and about 3.5 tons in research farms.

However, all this amount of forage is not always available to grazing animals. Sometimes remoteness, lack of water for animals and lack of transhumance routes make some dura fields less accessible to animals. Thus one can safely assume that only 50% of this amount of forage is available and accessible to grazing animals.

Table ...

Herbage Yield and Forage Production in Gedaref District

Range site	Area Sq.Km	Carrying Capacity Animal Unit per sq.km	Average Yield Ton/sq.km	Forage Value	Forage Production Ton/sq.km	Total Forage Production (Ton)
1. Butana						
a) Semi-desert grassland on clay	15288	25	35.7	95	22.9	681,254
b) Acacia mellifera belt	x 847	30	47.6	85	40.5	763,303
2. Southern Gedaref						
a) Acacia seyal belt	xx 4938	35	71.4	65	46.4	229,123
b) Anogeissus-Combretum belt	4903	60	95.2	75	71.4	350,074
Total						2023,754

x 24,039 - 519 (New Halfa Scheme)
xx 18,805 - 1,380 (Mechanized Rainfed Farms)

Table 58

Forage (Standing Hay) Production from Dura Straw in Gedaref District

Scheme	Area (Feddans)	Production Ton/Fed. Dry Wt.	Total Production (Tons)
Planned M.F. Schemes	1,211,350	2	2,422,700
Unplanned M.F. "	1,669,270	2	3,338,540
African Co. Scheme	13,000	2	26,000
Abu Sabeta Scheme	6,000	2	12,000
State Farm	12,667	2	25,334
Canadian Scheme	3,800	2	7,600
Total	2,916,087		5,832,174

Source: M.F.C., Khartoum, 1982.

E. LIVESTOCK IN GEDAREF DISTRICT

As mentioned earlier, the northern Gedaref District is predominantly pastoral and the local tribes are traditionally livestock owners. In the order of their importance, animals raised in the District are camels, cattle, sheep and goats.

Livestock in the District represents over 90% of the total animal population in Kassala Province. According to 1975-76 animal census, the District possesses more than 3.7 million of all kinds of livestock.

Livestock raising in the District is predominantly nomadic. Pastoral tribes follow specified transhumance routes in their seasonal movements which are dictated mainly by the need for forage and water. During the dry period they stay in their grazing areas in the southern part of the District and near water resources, with the onset of the rainy season they start to move northwards to avoid the biting insects and the general inconvenience of the sticky muddy soil.

They spend these wetter parts of the year on certain higher grounds where the soil is mainly rocky outcrops. These sites, mainly in northern Gedaref District, include El Subagh, Goz Ragab, Jebel Geili, Es-Sefia and some stretches of the Atbara River. Animal concentration thus occurs twice during the dry period around water resources like hafirs and along small stretches of the Atbara and Rahad Rivers and during the wet season around the relatively high, hard-surfaced areas.

This traditional pattern of movement or transhumance has recently been greatly and increasingly disturbed and in some cases blocked by the significant expansion of mechanized rainfed agriculture as well as irrigated schemes, as Khashm El Girba and Rahad Schemes.

Table 24

Livestock Population

ANIMAL	NUMBER	ANIMAL UNITS
Sheep	1,907,435	317,906
Goats	1,050,000	185,001
Cattle	642,883	642,883
Camels	265,100	397,654
Total	3,865,418	1,543,444

F. GRAZING CONDITIONS

The total amount of forage available for livestock in the District is constituted by total forage from rangelands and standing hay from dura grown in mechanized schemes. It is reasonable to assume that only 50% of the total forage is actually available for grazing since some schemes and areas are not accessible to animals while other scheme-owners prevent livestock from using their scheme areas on the argument that

animals carry seeds of harmful weeds which adversely affect next year's output; a further reason is the recent development of a widening market for dura stalks in Port Sudan.

On the other hand, the 1,543,354 animal units require a total of 5,556,074 tons of forage per year since the average daily requirement of an animal unit is 10 kg of forage per day. The table below shows that there is a deficit of 464,421 tons of forage, which is equivalent to 8.36% of the total feed requirements of the livestock in the District. In other words, the overstocking rate is 8.36%. This deficit has more bearing on the environmental degradation of the District than the figure would suggest because utilization of rangelands and pastoral resources, distribution of livestock and movement of animals are far from being uniform. Some areas, therefore, are much more overgrazed, such areas receiving high concentrations of animals and having high grazing pressure are:

1. Khashm El-Girba and Rahad Schemes where water resources are permanent,
2. the perimeters of most hafirs and wells,
3. Atbara and Rahad Rivers, and
4. areas not yet very disturbed by mechanized farming between Gedaref and Gallabat.

Table 60

Available Forage and Livestock Needs

Forage Production		Livestock needs	
Forage resource	Tons	Herd/period	Total need (Tons)
Rangeland	2,175,566	$\frac{1,543,354 \times 10 \times 360}{1,000}$	
Dura	2,916,087		
Total	5,091,653		
Deficit	= 5,556,074 - 5,091,653	=	464,421 Tons

G. NOMADS

1. GENERAL

In addition to what has been mentioned about nomads, livestock and grazing in the preceding parts and sections, the following points may add to our knowledge of the general situation of nomads in the Gedaref District.

(1) The greater part of the District was used for grazing, but now the herding zone is confined to an area extending from Jebel Kolobeib, north-east of Kassala Town, to Jebel Yasit, north of Showak to Wad Ghei, to El Maharagat and north of Gedaref. This is the drier part of the District, and hence nomads are forced to move into other areas and for longer distances. During the sixties Basalam was the farthest area to be grazed, but now nomads move as far as the Rahad area and into Ethiopia. The high concentration of veterinary services in the southern part of the District indicates that most of the nomadic herders stay most of the time in that area.

(2) Mechanized schemes are supposed to be open for herds after harvesting. Now increasing numbers of scheme owners are not abiding by that rule for reasons mentioned earlier.

(3) More and more scheme owners now burn the grasses around their schemes so that nomads do not come to their areas.

(4) Many scheme owners are resisting the establishment of hafirs for nomads' use in the vicinity of their schemes because of fear that herds may move into their schemes.

(5) Camels need shade, but most of the area has been cleared of shady trees. The extent of tree clearance can be indicated by the fact that the amount of charcoal produced in the District was 1.5 million sacks which needed the clearance of about 300,000 feddans. Some nomads are, therefore, entertaining the idea of reducing the numbers of camels they have.

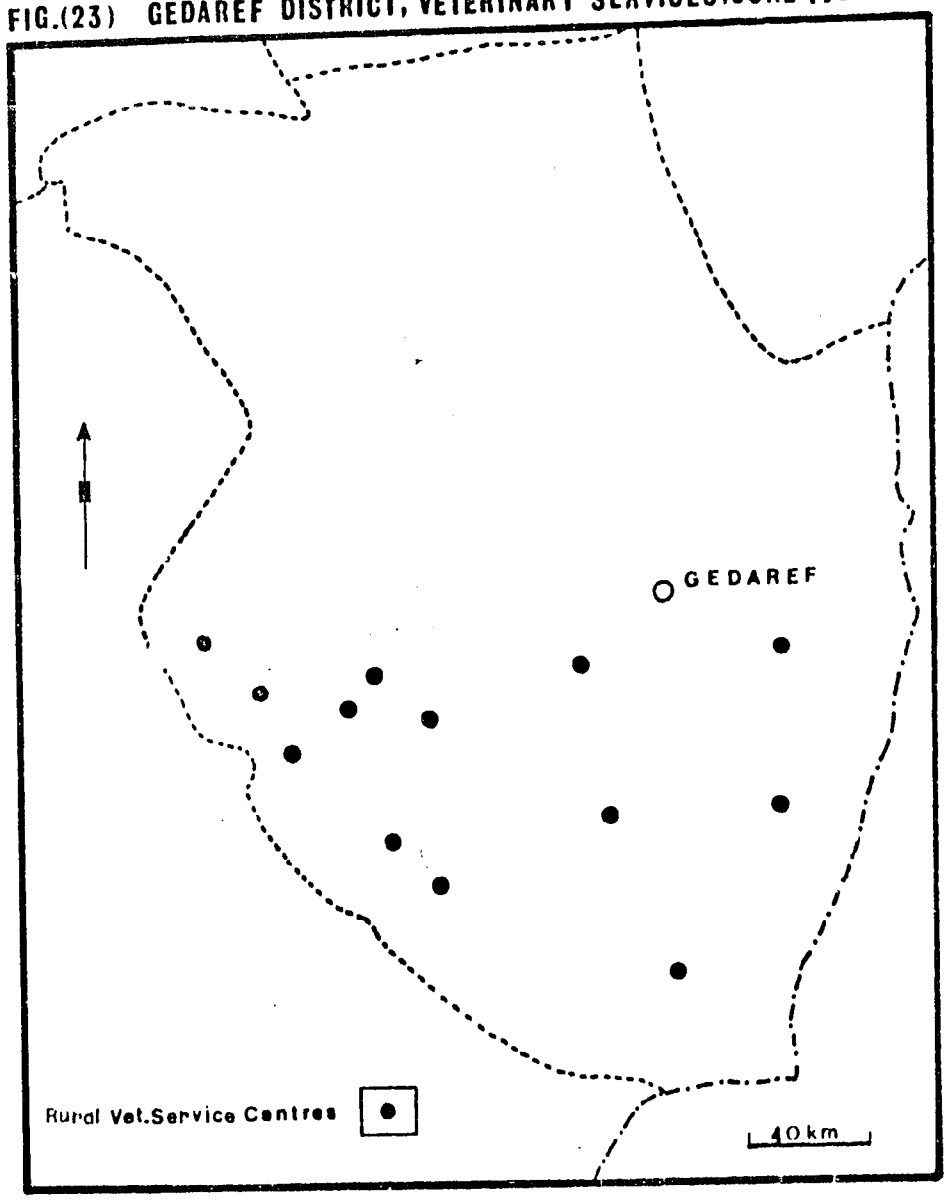
(6) Some valuable species, like "Abu Sabib" and "Ed-Dam Ballab" have disappeared.

(7) To improve the deteriorating natural pasture the Gedaref Range Management staff have completed reseeding an area of 1500 feddans between El Hania and El Miteir, and another area of 2000 feddans in the full generation of palatable grasses before it is opened for the use by nomadic herds. The appreciation and cooperation of the nomads are vital for the success of this reseeding programme not only by keeping away from these areas but also by not overstocking these areas by herds when the pastures are open for use after the prescribed period. The carrying capacity of these pastures will be 12 animal units per feddan.

(8) To protect the natural pastures against fires the Gedaref Range Management staff have completed a total length of 720 miles of fire-lines this year. The width of the major fire-lines ranges between 18 and 30 meters, the width of minor fire-lines is less.

(9) The use of manufactured animal feed for nomadic herds is still very negligible partly because of their culture but mainly because this feed is too expensive to afford, particularly for a large herd.

FIG.(23) GEDAREF DISTRICT, VETERINARY SERVICES, JUNE 1982



2. NOMADS IN GEDAREF TOWN

A visit was made to the Beni Amir nomads who have come to "settle" on the southwestern fringes of the Gedaref Town. This camp was first started by two families who came in 1959 from Tokar and Gash areas looking for grazing. Their number now is about 310 persons, and the number of their cattle ranges between 1400 and 2000. Some members of some of the families are still in the main Bani Amir area looking after animals.

During the sixties livestock depended entirely on natural pasture because the number of animals was small and the rangeland was very extensive. Now cattle wander around the margins of the farms for a distance of 15-20 km. around the Gedaref Town. They are not allowed to graze the schemes after harvesting. They, together with other livestock owners in the town, are asking that cultivation should be prohibited in the perimeter of the town so that it can be used exclusively by their herds.

The use of manufactured animal feed has been increasing steadily since the late sixties. To augment the meagre natural pasture, these nomads use one or a combination of the following feeds: clover, oil seed cakes, agricultural residues (mostly dura stalks), dura, flour milling by-product (radda) and mushuk (residue of native beer). The average cow consumes L.S. 1.8 worth of feed per day during the dry period and L.S. 0.8 during the rainy season. To get cash for the purchase of animal feed and household requirements, the nomads sell some of their animals as well as their animal products. The average family sells about three calves per year at a price of L.S. 330 per calf during the dry period and L.S. 240 during the rainy season. They also sell milk, robe (sour milk) and semn (edible oil). The

average cow produces 10 lbs of milk per day during the rainy season, and 5 lbs during the dry season. The market price of milk is 25 P. T. per lb. These products constitute the basic items of the nomads' diet which is now changing gradually. Thus the deterioration of rangelands and being on the fringe of an urban centre have forcibly destroyed the relative self sufficiency of this nomadic community, have drawn them into the market economy, and have commercialized their products.

The nomads have no source of water in their neighbourhood, however, they get their drinking water from the nearby neighbourhoods of Karfis, Hai October, and hai El Nazir. The shortage of water for livestock is very severe during the dry season, last year three cattle died of thirst. They have no school and only about 7% of children at school age are enrolled. No one has ever enrolled in a higher secondary school.

SECTION VII

REFUGEES

VII REFUGEES

The vast majority of refugees coming to Sudan from Ethiopia settle (temporarily or permanently) in Eastern Sudan. It is estimated that of the approximately 350,000 refugees in eastern Sudan, about 110,000 are living in the towns of Port Sudan, Kassala and Gedaref. Gedaref District has somewhere between 50000 and 60,000 refugees.

The refugees in Gedaref District are from the Eritrean and Ethiopian ethnic groups. There are several refugee camps or centres in Gedaref District of which Tawawa, Umm Gulga, Umm Rakuba, El Showak, Wad Shareifie and El Hawata are for Ethiopian refugees while Umm Sagata Abu Rakham, Umm Gargur and Narkara are for Eritreans.

Urban Refugees

The Town of Gedaref has a refugee population of about 30 000 most of whom came between 1976 and 1982. The majority of the refugees are Amharic speaking Ethiopians. Just outside of the town limits is the Tawawa Camp where it is estimated that there are an additional 14 000 Ethiopian refugees.

Most of the refugees in Gedaref District left Ethiopia because of drought conditions, economic difficulties or refusal by men to enter national military service. Gedaref is also the Eastern Region headquarters of the United Nations High Commission for Refugees UNHCR and the headquarters of the Sudan Government Commission for Refugees.

In the Gedaref area the two main sources of employment for refugees are the mechanized agricultural sector and the service sector (petty trading, restaurants, tea shops, hotels, domestic service, driving, etc.). Both of these sectors employ large numbers of unskilled people.

The refugees coming to Gedaref are better educated single young men, head of household women with children and older families with little education.

Unemployment in Gedaref is high, however, this varies by the month. Large numbers of male refugees are employed on the mechanized schemes, for weeding and harvesting, during the growing season. Others find part-time employment in the service sector. Inevitably some turn to crime. They are many restaurants, tea shops and hostels established by refugees that to both Ethiopians and Sudanese. Job prospects for women are bad and prostitution is widespread among refugee women.

Prostitution, beer making and the reported crime wave among refugees make them unpopular with local Sudanese officials and residents. With worsening economic conditions blame is placed on the refugee population for such things as higher prices and occasional food shortages.

The cost of providing basic services to the refugees is a controversial issue for Sudanese government officials and assistance agencies. Water, education, housing and health facilities are all under-financed and overburdened by the Sudanese themselves. Refugees create additional pressures on these services. It should be noted, however, that some services are receiving assistance as a direct result of the presence of refugees. The Gedaref water system, which failed for several weeks this spring, will be rehabilitated and expanded and a water system for Tawawa Camp will be constructed in the coming year.

Rural Refugees

The majority of the refugee camps in Gedaref District are located in rural areas. These rural

refugees are farmers or herders. Some commute daily to Gedaref Town for work in the service sector.

Refugees operate several agricultural schemes (see table below). Five feddans of land is allocated to each family and the government finances the agriculture. The production belongs to the refugees. Facilities and equipment are given without fee. The refugees run their farms for four years, after which they are subject to the farming regulations of the Executive Council of the area.

The UNHCR is beginning a project to create a self-sufficient rural village for Ethiopian refugees who settled in the Umm Rakuba area. Activities to be undertaken by the project include support strengthening of the settlement headquarters water supplies, health services, sanitation facilities, education, agricultural schemes and development of community centres for handicraft activities. Estimated cost of the project is 280,000 L.S.

Deforestation

Refugees are contributing to the already severe problem of desertification by cutting trees and bushes to clear land for agriculture, build their homes and for charcoal production. By and large, they have a rather short term perspective when it comes to the environment. Most feel they are only in the area temporarily until they are resettled or return to Ethiopia.

Table 61

Refugee Scheme Areas in Gedaref District

LOCATION	AREA
Umm Rakuba	4,000 feddans
Abuda	10,000 feddans
El Hawata	12,000 feddans
Others	5,000 16,000 feddans

THE 1983/84 MONITORING REPORT

THE 1983/84 MONITORING REPORT

This is a follow-up of monitoring environmental change in the Gedaref District of the Eastern Region, Sudan. Sites monitored are the same sites identified and monitored in the previous 1982 monitoring report. Data and information included in this report are to be compared with similar data and information included in the previous report to identify changes which have taken place since the previous field visit.

For the purpose of this monitoring activity two field trips were made to the sites: one in September 1983 and the other in February 1984.

A. Mechanized Farms

Monitoring of land productivity has been continued for the same selected mechanized farms:

1. Scheme No. 67

It was under the production of the high-grade (dabar) variety of dura. The average yield was 2.95 sacks per feddan for the season 1983/84, compared with an average of 4.62 sacks per feddan during the season 1981/82.

2. Scheme No. 4

This scheme was also under dura production. During our 1984 visit, the scheme was about one-third harvested. The estimated average yield was about 3 sacks per feddan. The average yield for the season 1981/1982 was 4.11 sacks per feddan.

3. Scheme No. 62

During the 1983 visit, this scheme was inaccessible since it was cut off by rains; 2/3 was not cultivated. On our 1984 visit to the area we found that this state farm had been handed over to the private sector and had

become a private farm. The reason given for this change in management pertains to a basic change in the policy of the state which has decided to dismantle and privatize all mechanized state farms and to restrict the role of the M.F.C. to the provision of various facilities and services to the private capital involved in rainfed, mechanized farming.

It will be interesting to observe the performance of this scheme under the new management. It is perhaps worth reckoning that this scheme has continuously had the highest productivity in the area, scoring an average yield of 6.8 sacks of dura per feddan in 1979/1980, 3.1 kantars of sesame in 1980/81, and 4.9 sacks of dura in 1981/82.

4. Scheme No. 83:

This scheme has now completely quit the production of sesame because of the continuous decline in the productivity of this crop. It has shifted to a monocrop (dura) system of production because the productivity of dura has been on the rise. The 1983/84 average per feddan yield was 4.1 sacks of dura, compared to 2 sacks in 1977/1978, 1.5 sacks in 1976/77 and only 0.75 sacks in 1975/76 season.

5. Scheme No. 240:

The 1983/84 agricultural season has been an exceptionally bad one for this scheme since the average yield was only 0.9 sacks of dura per feddan, compared with an average of 1.96 sacks in 1982/83, 3.77 sacks in 1981/82 and 3.55 sacks in 1980/81. The owner of the scheme attributes this sharp decline in productivity to the small amount and late incidence of rainfall in 1983/84. This is the most northern of the monitored schemes.

6. Scheme No. 13:

It seems that the Canadians are still experimenting on the schemes No. 13 and 31. Last season (1982/83) the rate of seeding was 6 pounds per feddan, and the average yield was 5.75 sacks of dura per feddan. During 1983/84 season, they increased the rate of seeding to 8 pounds per feddan, the result was a sharp decline in productivity to only 2.5 sacks per feddan, a decline of over 56%. We saw how stunted the dura plant was in scheme No. 13.

B. Traditional Villages

1. Ghireigana Village:

There has been no significant change in land use. Even during the rainy season (September), the area west of the wells was bare except for very sparse grasses, of a height of no more than 10 cm. By February, these grasses had completely disappeared.

Monitoring the density of growth was carried out in September and February to see the effect of the rainy season. This was pursued around the deserted well and the well in use to see the effect of desertion on the natural regeneration of bushes.

In September 1983 and within a 100-radius circle centred on the well in use, there were 30 bushes of a hight of more than one foot and 37 bushes of a height of one foot or less. In an equal area centred on the deserted well, the density was 51 bushes of a height of more than one foot and 156 bushes of a height of one foot or less. In both cases bushes were concentrated on areas further away from the built-up area. These figures clearly reflect the favourable impact of desertion on the natural regeneration of bushes.

In February 1984, the bush density in the same area around the used well was 53 bushes of a height of more than one foot and only 9 bushes of a height of one

foot or less. On the other hand, the bush density in the same area around the deserted well was 142 bushes of a height of more than one foot and 144 of a height of one foot or less.

2. Kabaros Village

Traditional cultivation and livestock rearing are still the main occupations and economic activities. No significant changes have taken place in the socio-economic or physical areas during the last two years; but some practices recorded during the 1983/84 season signal some forthcoming changes which may bear on the environment

In the area of cultivation, the following remarks may be indicative of future changes:

a. Still all households cultivate dura and sesame, but the average farm area in 1983/84 was 7.5 feddans for dura and 6 feddans for sesame.

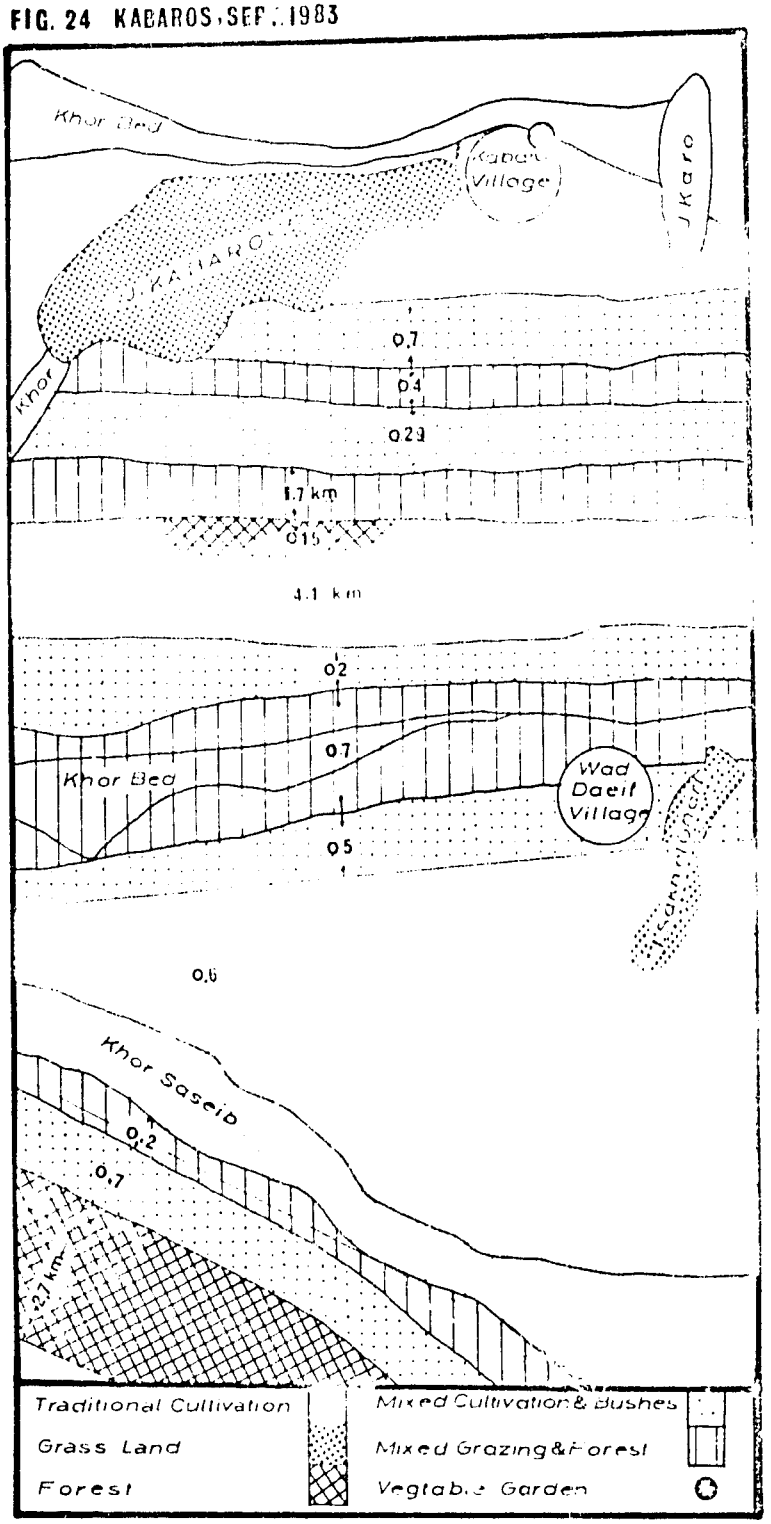
b. The average per feddan yield was in the same season 0.6 sacks of dura and 0.2 sacks of sesame while in the previous season it was 2.6 and 1.5, respectively.

c. The total area under dukhun and under the feterita variety of dura has significantly declined. In 1983/84 only about 20% of all households at Kabaros grew dukhun and less than that grew feterita. In both cases the reason has been stated by the farmers to be low productivity and high cost of production.

d. The harmful buda weed was reported to have spread over wider areas than during the previous season.

e. Some people have been compelled to revert to land rotation. One farmer cultivated two of his three farms, another farmer left his only farm as fallow and hired another farm from a multi-farm farmer

FIG. 24 KABAROS, SEP. 1983



for two years after which he would go back to his original farm.

f. More people are leaving the village to search for other occupations. Family labour has become less and the need for hired labour has increased; 70 farmers reported that they hired more wage labour than two years ago. Some families who have small farms did provide wage labour for other farmers to get some cash for consumption purposes.

g. Sesame was still all for sale, but the amount of dura sold was significantly less than before. Dura is becoming more of a subsistence crop than before.

h. The sale of dura stalks has declined. None of the twenty interviewed farmers sold dura stalks which were kept as a fodder to augment the deteriorating natural pasture.

j. Only 30% of the total area of the vegetable garden was under production in February 1984. The owner was using his well not to irrigate the garden but to sell water for animals. The average watering price was reported to be Ls.2.5 per sheep per month. It was thus more rewarding for the owner to sell water than to grow vegetables.

In the area of livestock, we recorded the following points:

a. The composition of herds has not significantly changed, but some villagers started to keep more goats and sheep than cattle to cope with the problem of pasture.

b. Animals graze on the fields after harvesting, but the grazing problem arises during the cultivation season when the jebels are the only grazing areas.

c. Water has never been a serious problem since the village has two bore wells; but water appeared to be a problem during Sept. 1984 for two reasons: lack of gasoline for the engines, and the big quantities of water transported daily to the Gedaref town.

d. The animal death rate has increased; it was estimated at 9% for cattle and 3% for sheep and goats. The main reasons were reported to be inadequacy of water and pasture, diseases and the skyrocketing prices of manufactured fodders which increased by 62% from last year's (1983) price. More people (about 35%) used manufactured fodders for their animals.

The deforestation process was carried on by the villagers. More people got licences to cut wood in the reserved forest to produce charcoal. Firewood was produced from reserved and unreserved forests without

permission. The average family was reported to consume 0.3 kantars of charcoal and one kantar of firewood per week. Although firewood is used more than charcoal, no one buys firewood but most of the people buy charcoal. Firewood is also used to drive away insects and mosquitoes at night. Wood is also collected for construction purposes.

3. El Ganna Barra - Gedaref Transect

The 1983 transect is more detailed than the 1982 one. It shows that traditional cultivation extends to the very fringes of the Gedaref Town, leaving no natural pastoral land for livestock kept inside the town. It also shows that the immediate perimeter of El Ganna Barra village is bare of vegetation during the last period of the rainy season.

Overgrazing around settlements was quite extensive during February 1984. The overgrazed area around the Gedaref Town extended over 3.7 km compared to 1.2 km in June 1982. A similar expansion of overgrazed area took place around El Ganna Barra village from 0.[illegible] km in June 1982 to 2.2 km in February 1984, and from 0.7 km to 1.0 km around Abul Naga village in the same months.

4. Iddal Tein Village

The September 1983 land use pattern of Iddal Tein village was similar to that of June 1982 except that.

a. The overgrazed area was confined to about 50 meters around the well; and

b. The rest of the area around the well was under a sparse grass cover.

More serious land use changes appear on the 1984 land use map of the village. When we compare the 1984 and the 1982 land use maps, we see the following main changes:

a. Dura had replaced vegetables in all the vegetable garden west of the well, marked(a) on the 1984 sketch map.

b. Vegetables occupied only 20% of the total area of the other vegetable garden (marked(b) on the 1984 sketch map), and the remaining area was put under dura.

c. Overgrazing extended well up onto the hill.

d. Bushes and grazing decreased on the jebel.

e. Cultivation was no longer practised west of the village, which was then all overgrazed.

5. Hafir Sheheit

Compare the 1984 land use sketch map with that of 1982. No land use map was prepared for 1983 because of the highly muddy conditions resulting from the heavy rains when we were on the site.

FIG.25 ELGENNA BARRA-GEDAREF TRANSECT
SEPT.1983

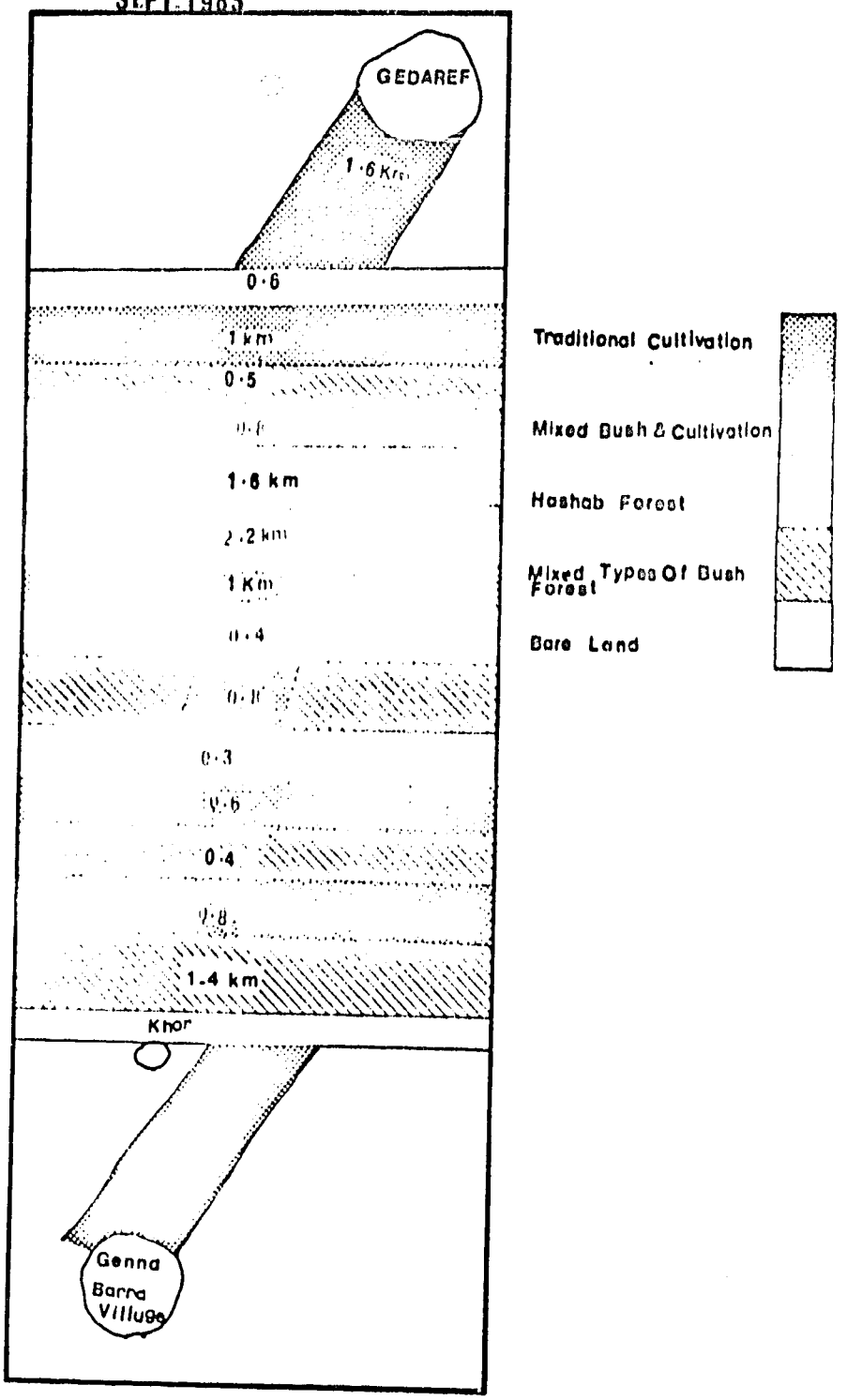
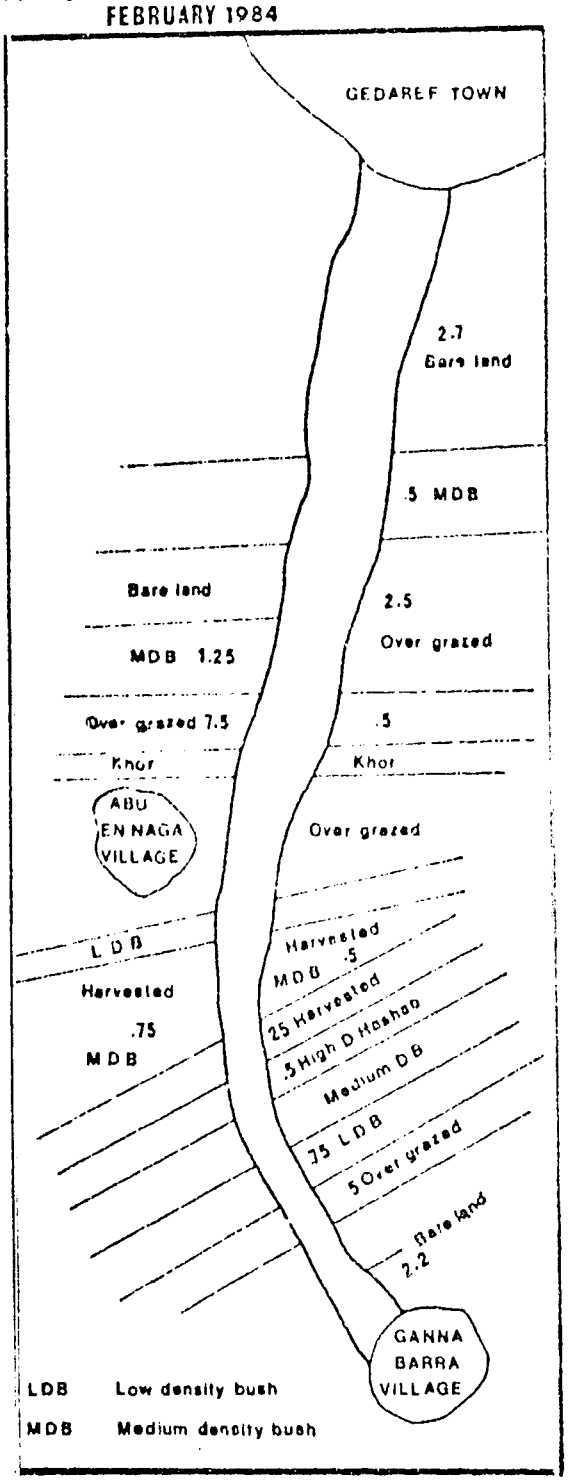


FIG. 26 EL GANNA BARRA, GEDAREF TRANSECT, FEBRUARY 1984



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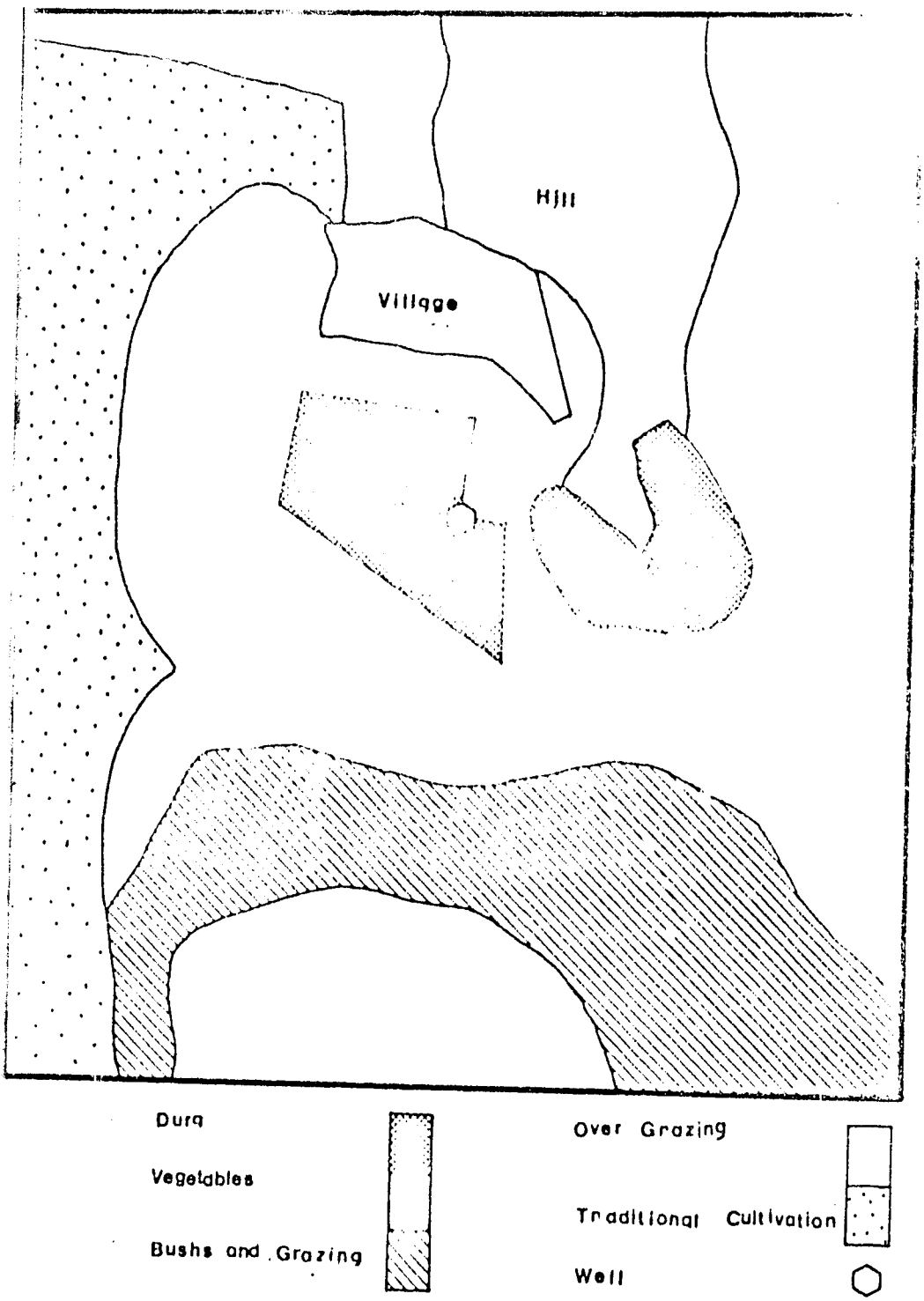
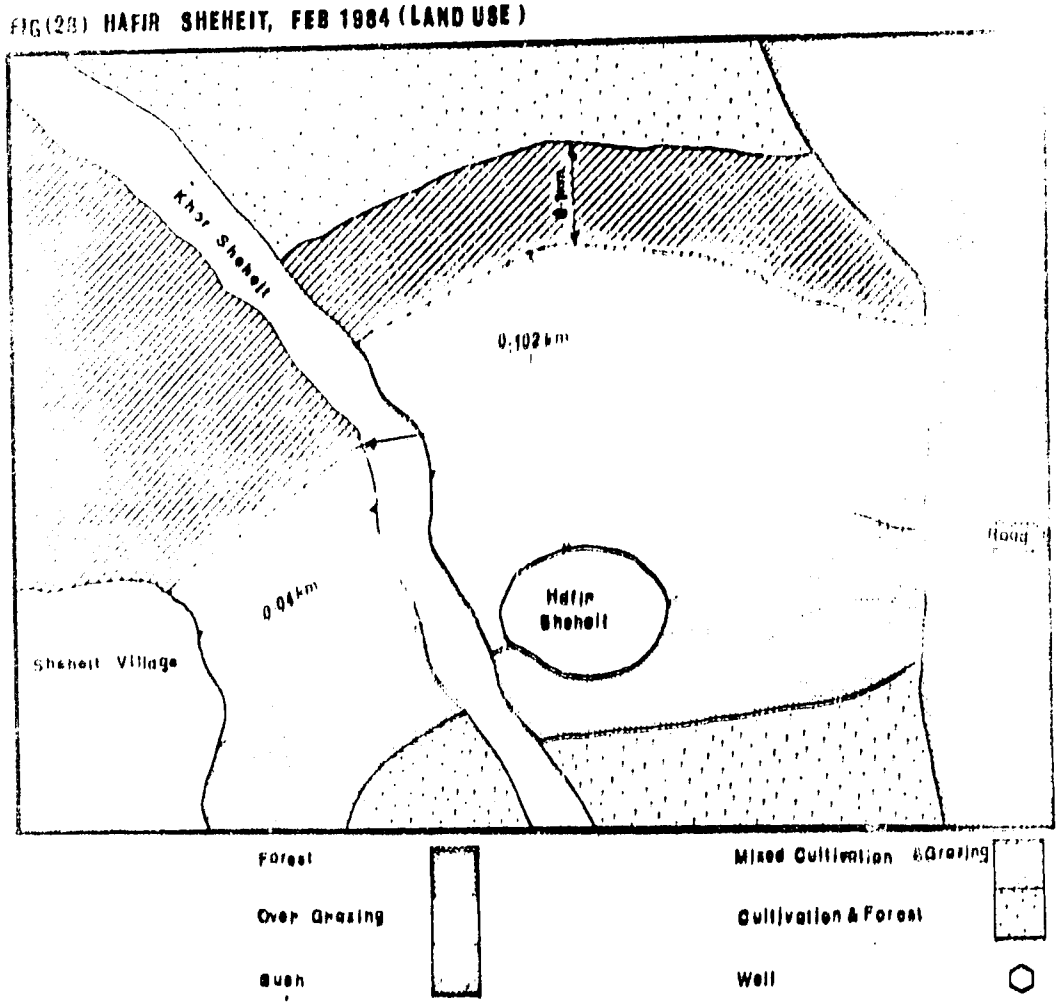
IG27. IDD ALTEIN VILLAGE (LAND USE) FEB.1982



FIG(28) HAFIR SHEHEIT, FEB 1984 (LAND USE)



C Gedaref Town:

Some of the basic statistics have been collected about the town. The time lapse may be too short to reveal any change of magnitude or significance.

1. Education.

Primary

Table 62

Year	BOYS					GIRLS				
	Number of Schools	First Graders	Final Graders	Total Students	Teachers	Number of Schools	First Graders	Final Graders	Total Students	Teachers
82/83	26	1172	1250	-	207	25	1045	1269	-	194
83/84	26	1187	1073	8926	205	25	1150	1103	7479	194
	Junior									
82/83	7	778	705	2514	104	6	713	760	2227	90
83/84	7	843	543	-	104	6	757	670	-	90
	High school									
82/83	5	447	305	-	66	2	237	261	-	35
83/84	6	521	363	-	93	2	507	582	-	38

Adult Education

	CLASSES	STUDENTS
Male	9	309
Female	19	425

Kindergartens

20 kindergartens taking care of 1800 children.

2. Health:

a) Medical

Hospitals	2
Specialized doctors	9
Gen. Practitioners	40
Medical assistants	35
Sister	1
Nurses	224
Technicians	6
Classified staff	67
Unclassified staff	35
Beds	411
Cars	5
Ambulance	-
Death rate of patients admitted	3.2%

Outpatients(1983)

Jan.	Feb.	March	April	May	June
6924	6797	6047	8353	6537	4940

Nursing school	1
Dispensaries	10
Dressing stations	4

Rural hospitals: One at each of Fau, Showak, Hawata and Umm Doka.

b) Public Health

Item	Available	Deficit
Health inspector	1	1
Health officer	1	2
Mulahiz	4	2
Assistant Mulahiz	23	17
Mosquitoe workers	3	7
Sweeping & garbage workers	50	200
Night soil workers	65	100
Buckets	---	200
Tanks	1	2
Tractor and/or Trailer	7	10
Cars	2	2
Motor cycles	0	7
Bicycles	0	40

3. Crime

Below is the number of crimes by type for the period 1981-1983.

Table 63

Type of Crime	1981	1982	1983
Grievous hurt	181	241	203
Rape and adultery	41	48	48
Homocide	34	45	45
Robbery and theft	1,076	2,372	1,782
Homosexual	8	8	8
Slight hurt	1,811	2,066	1,826
Alcohol related crimes	327	240	331
Assault	763	1,320	1,133
Damage of gardens and water resources	255	486	549
Crime against animals	26	25	27
Attempted suicide	9	9	10
Threat and insult	896	1,097	977
Starting fire	30	45	36
Others	2,773	3,506	3,001
Total	8,230	11,508	9,976

Crime has developed with the influx of refugees, the development of the town, the tremendous increase in circulating money, and the increasing number of seasonal agricultural workers. Most crimes occur during and immediately after the harvest season, particularly crimes related to money, sex and alcohol.

We were told by two police officers that crime had not decreased by the Shariaa Law, but the number of reported crimes had declined because people had become afraid to report all crimes since under the Shariaa Law the report of a crime (accuser) has to provide solid evidence or else he himself will be tried.

4. Fires

Table 64

Fire Incidence, Gedaref Town

QUARTER	1.7.82-30.6.83: No. OF FIRE:	DAMAGE Ls	1.7.83-18.2.84: No. OF FIRE:	DAMAGE Ls
El Matar	25	13,735	5	10,900
El Meidan	6	1,650	1	1,000
El Asara	-	-	-	-
El Ganaien	3	900	2	165
El Khama	-	-	-	-
Deim Hamad	10	8,850	4	650
El Masageen	2	10,250	1	700
El Ma'asir	-	-	-	-
Deim El Nur South	15	26,400	4	4,550
Other Planned areas	23	40,000	11	9,450
Deim Bakur	11	3,850	1	200
Hai El Nazir	1	100	3	50,800
Karfis	18	13,750	2	1,800
El Sufi El Azraq	5	2,300	3	1,600
Salamat El Bei	38	58,850	7	6,350
El Mafarga'at	6	1,600	3	800
Hai October E. & W.	14	9,750	-	-
El Gamhuriya	7	2,250	2	800
Hai El Barno	7	2,150	1	350
El Gubarab	5	7,450	1	400
Hai El Sadaqa	6	2,650	4	2,100*
Ruweina	8	1,715	2	550
Hai Abakkar Gibreil	26	30,580	4	4,550
El Thawra	3	7,850	2	1,300
Karari	3	1,300	2	1,010
Suakin	-	-	-	-
Other unplanned areas	33	16,300	10	7,200

* Two persons were burnt to death.

Equipment and manpower were reported to be too meagre to cope with the high fire incidence in the town and district. There were only two operating extinguisher cars. All manpower consisted of 70 firemen in Gedaref Town, 18 at Hawata and 16 at Showak.

D. Soils

The analytical results of samples taken in Sept. 1983 and Feb. 1984 (Sept. 1983 data and Feb. 1984 data respectively) showed certain changes of interest. The samples taken in Sept. 1983 (rainy season) showed tendencies towards slight acidity and neutrality with pH values ranging between 6.7 and 7.4 (paste). This can be explained by the fact that the continuous rather heavy rainfall at this period tends to enrich these soils in H^+ and consequently acidity increases. In February (dry period) the situation changes with alkalinity increasing due to the concentration of alkaline earth cations. Values of pH range between 6.8 and 7.7 in the dry period.

It is also observed that $CaCO_3$ percentages which are low in the rainy season (Sept. 1983) ranged between 0.5 and 3.9% becoming significantly higher in the dry season (average 4% and range 3.0 - 5.7). Kalavros village showed the highest concentration in $CaCO_3$ (5.7%) during the dry season whereas in the rainy season it averaged 3.9%. On the other hand the E.C. readings showed lower values in the dry season than in the rainy season.

It has also been observed that saturation percentage (S.P.) of most of the soil samples in the area dropped in Feb. 1984 compared to that of Sept. 1983 (rainy season). Such a pronounced change suggests some kind of relationship between saturation percentage and moisture content (there is an increase in S.P. with increase in moisture content). This relationship, however, has not been calculated because data on moisture content are not available at present.

Changes in particle size percentages are not of significance being more or less stable within such a short time (Sept. 1983 to Feb. 1984). Cation exchange

capacity (C.E.C.) values, however, follow the same pattern as those of the S.P. Whereas there is a drop in the dry season, we observe a significant rise in CEC in the rainy season (range 58-85 in dry season and 63-93 in the rainy season)

Total soluble cations (T.S.C.) decreased in the dry season soluble anions, e.g., HCO_3^- increased thirty times in some cases. Sodium Absorption Ratio (SAR) also increased remarkably in all sites during the dry season. For instance, in Ghadambaliya (Profile No. 240) S.A.R. was 0.9 in Sept. 1983 (rainy season) whereas in Feb. 1984 (dry season) it jumped to 5.2. These values, however, are still far below the critical point for crop growth in the Sudan.

In conclusion, the development potential in these soils as shown by the analytical results is generally limited by the amount of rainfall penetrating the heavy cracking clay soils. The age of the land has a pronounced influence on the potential for future developments. Virgin lands have far better potentials for use than those already in use.

Physical and chemical attributes conducive to higher potentials for cotton and dura per se indicate that seasonal variations have certain influences which could affect future yields. To improve productivity these attributes need to be maintained at their best level through amelioration.

Table 65

Soil Analysis. September, 1983

Profile No.	pH Paste	pH 1:5	$CaCO_3$ %	E.C. in mm HOS CM	S.P. %	MECHANICAL ANALYSIS CS %	SILT %	CLAY %	C.E.C. MEQ/100 gms	SOLUBLE CATIONS Na	K	Ca	Mg	TSC	SOLUBLE ANIONS CO_3	HCO_3	Cl	SO_4	TSS	SAR
23	6.9	7.2	3.9	0.38	66	8	17	[illegible]	91	1.	0.05	2.0	0.5	4.2	Nil	0.1	1.4	2.7	4.2	2.7
31	6.8	6.8	7.0	0.42	88	[illegible]	[illegible]	[illegible]	96	1.7	0.03	2.0	1.5	5.3	Nil	1.5	1.4	2.4	5.3	3.3
44	7.1	7.2	[illegible]	0.35	[illegible]	[illegible]	[illegible]	[illegible]	87	2.3	0.0[illegible]	[illegible].0	0.5	4.9	Nil	0.5	[illegible]	1.9	4.9	2.1
[illegible]	6.6	6.4	1.0	[illegible]	90	[illegible]	1[illegible]	83	92	3.5	0.09	1.[illegible]	1.0	6.1	Nil	0.5	2.5	3.1	6.1	3.2
57	6.8	7.0	1.[illegible]	0.4	84	6	13	81	93	2.2	0.09	1.5	0.5	4.3	Nil	1.9	2.5	0.[illegible]	4.3	2.2
83	6.[illegible]	6.3	0.5	0.44	80	4	15	81	80	1.7	0.1	1.9	1.0	4.3	Nil	0.5	1.4	2.4	4.3	1.[illegible]
240	7.4	7.5	3.2	0.42	90	4	35	61	63	1.[illegible]	0.08	1.5	3.0	5.9	Nil	0.1	2.5	3.3	5.9	0.9
Kab.	7.2	7.3	3.9	0.3	83	8	21	71	87	3.5	0.07	1.0	Nil	4.6	Nil	0.15	2.5	1.4	4.6	5.0

N.B.: E.C.: Electrical conductivity mimlis/cm.

S.P.: Saturation percentage.

O.C.: Organic Carbon.

N.: Nitrogen.

C.E.C: Cations exchange capacity.

S.A.R: Sodium adsorption ratio.

E.S.P.: Exchangeable Na per 100 gm.

T.S.C.: Total soluble cations.

T.S.A.: Total soluble Na per 100 gm. over-dry soil.

Table 66

Soil Analysis. February 1984

Profile No.	pH Paste	pH 1:5	$CaCO_3$ %	E.C. in mm HOS CM	E.S.P. %	MECHANICAL ANALYSIS CS %	SILT %	CLAY %	C.E.C. ME/100 gms	SOLUBLE CATIONS Na	K	Ca	Mg	TSC	SOLUBLE ANIONS CO_3	HCO_3	Cl	SAR
240	[illegible]	8.2	4.2	0.48	[illegible]	[illegible]	18	80	[illegible]	[illegible]	0.1	[illegible]	0.75	4.80	Nil	3	2.0	5.3
14	8.8	[illegible]	3.0	0.28	[illegible]	[illegible]	12	[illegible]	[illegible]	[illegible]	0.0	0.9	0.3	4.0	Nil	3	1.0	2.2
52	[illegible]	[illegible]	4.2	0.38	[illegible]	4	20	76	82.8	[illegible]	0.3	[illegible]	0.25	335	Nil	1.5	1.5	3.0
61	8.8	7.0	4.8	0.[illegible]	[illegible]	7	11	82	84.5	[illegible]	0.1	1.0	0.25	250	Nil	[illegible]	1.0	1.4
Kab.	[illegible]	[illegible]	5.[illegible]	0.42	[illegible]	4	24	72	80.1	1.9	0.1	[illegible]	0.5	420	Nil	3	1.5	1.8
13	[illegible]	[illegible]	5.4	0.42	[illegible]	4	22	74	84.8	1.7	0.3	2.0	0.25	405	Nil	2	1.5	1.6
31	8.9	[illegible]	3.8	0.55	[illegible]	2	18	80	[illegible]	0.9	0.1	[illegible]	1.0	[illegible]	Nil	3	2.5	0.7
83	[illegible]	[illegible]	3.[illegible]	0.[illegible]	[illegible]	4	22	74	[illegible]	0.3	0.1	[illegible]	[illegible]	[illegible]	Nil	2.5	1.5	0.8

N.B.: E.C.: Electrical conductivity mimlis/cm.
S.P.: Saturation percentage.
O.C.: Organic carbon.
N.: Nitrogen.
C.E.C.: Cations exchange capacity.
S.A.R.: Sodium adsorption ratio.
E.S.P.: Exchange Na per 100 gm.
T.S.C.: Total soluble cations.
T.S.A.: Total soluble Na per 100 gm. over-dry soil.
T.S.: Total sand (%).

E. Water

The well measurements in the three sites were as follows:

Water depth at	Sept. 1983	Feb. 1984
Ghireigana	6"	2"
El Ganna Barra	22"	20"
Iddal Tein	48"	13"

F. Refugees

According to the Refugees Relief Coordinator at Gedaref, there are over 100,000 Ethiopian and Eritrean refugees resettled in 17 villages. Over 50% of these refugees are young males. The main relief under the coordination of the Sudan Council of Churches covers areas of medical aid, social programmes, and equipping refugees with skills to build up self-sufficiency or self-dependence. It also includes the provision of first aid, food and clothes for the fresh comers.

To build up self dependence a 600 feddan agricultural scheme has been established at each of Umm Rakoba and Umm Saada for the production of dura, together with the pilot agricultural schemes at Abu Rakham and El Suki.

Other organizations providing relief and assistance to refugees include the American Food Organization, the Swiss Red Cross, the American LALAMPA, the British Motherhood and Child Care Organization and the Islamic African Rescue Agency.

Food aid provided last year included 3580 tons of dura, 130 tons of peas, 185 tons of Semn (butter oil), 235 tons of milk powder and 1500 tons of wheat. The number of refugees receiving that aid totalled 29,244.

To promote self dependence, a number of schemes have been established for the refugees. For the production of dura the following schemes and tractors have been allotted in the corresponding sites:

Table 5

LOCATION	AREA IN fed	TRACTORS
Umm Gargour	11 300	8
Karkura	2 500	2
Abbuda	5 000	6
Umm Ali	6 000	2
Abu Rakham	3 000	2
Wad Awwad	3 000	4
El Tineidba	10 000	7
El Hawata	5 000	3
Umm Rakuba	3 000	3
El Mafaza	5 000	2
Umm Galaga	600	1
Total	54 400	40

Below are the areas designated for the production of fruits and vegetables and put under production last year.

Table 66

SITE	TOTAL AREA fed	AREA UNDER FRUIT	VEGETABLES AREA SUMMER	VEGETABLES AREA WINTER
Kilo 26	20	9	7	9
Khashm El Girba	20	-	7	9
Abu Rakham	24	7	8	8
Wad Awwad	24	5	10	5
El Tineidba	40	16	10	15
El Hawata	24	4	4	4

Many of these registered refugees and almost all the unregistered provide valuable wage labour for mechanized rainfed agriculture in the Sudan.

But it is noted that up to now (Feb. 1984) the refugee settlements are left to get their requirements of charcoal and firewood from the surroundings of the villages, exerting a new pressure on the already degraded natural vegetation, especially the woody cover. But, unlike indigenous settlements, plans are underway for afforestation activities to provide these refugee settlements with their needs of wood for the various purposes.

Refugee settlements around Gedaref (Tawawa: 17,000 persons, Umm Galaga: 7,000 and Ab. Jokhams 8,700) are provided with the basic services: elementary schools, 15 small butcheries, 12 vegetable selling tables, and 8 offices and stores to keep insecticides. In the medical field there are:

One hospital

Two health centres

Eight dispensaries

Thirteen dressing stations

The most widespread diseases are malaria, dysentery, eye diseases and tuberculosis.

PART THREE

RECOMMENDATIONS AND STRATEGY

A. ENVIRONMENTAL DEGRADATION IN GEDAREF DISTRICT

A WORKSHOP ORGANIZED BY IES, U. of K.

WITHIN ETMA PROJECT

FARMERS' UNION HALL, GEDAREF TOWN

14-16 APRIL, 1984

ENVIRONMENTAL DEGRADATION IN GEDAREF DISTRICT
A WORKSHOP ORGANIZED BY IES, U. OF K.
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1. Introduction

The workshop was intended to be a culmination of the research and monitoring activities of the Gedaref group, ETMA, SUDAN. The contentions of the organizers are: that academic research is useless if it has no practical value, that people are the prime means and ultimate goal of change, that grass-root involvement and local participation are prerequisites for the success of the workshop, that local people are more aware of their problems than other people, and that the workshop should come out with what the local community wants.

The local people were, therefore, involved from the very on-set. The idea of the workshop was first discussed with them and they were very receptive. They alone decided the time and place of the workshop, the Farmers' Union offered its hall for the workshop free of charge. The contents and number of the discussion papers were decided by the local people; 75% of these discussion papers were written by local authors and 92% of all participants came from the local area. The number of participants in individual working sessions ranged between 36 and 49, a number which outnumbers participants in similar workshops organized even at Khartoum. The preparatory work was carried out simultaneously by two secretariats: the major one at Gedaref Town and the other in Khartoum. So, one can say that the local people were quite enthusiastic and supportive and their response was positive and encouraging.

The offical response was also positive:

a) Greetings and apologies for not being able to attend the opening session were received from their excellencies the Governor of the Eastern Region, the Regional Minister of Agriculture and Natural Resources, the Regional Minister of Services and Public Utilities, and the Commissioner of Kassala Province.

b) The attendance and addressing of the opening and closing sessions of the workshop by Dr. Mustafa Basher, the Minister for the Affairs of the Regional People's Assembly and the representative of the Regional Government to the Workshop. Being himself a scientist, he participated effectively in the working sessions. His address, summarized later in this report, reflects the response of the Regional Government to the Workshop.

c) The presence of the Regional Information Unit during some of the sessions.

The remaining part of this section is composed of summaries of the three components of the Workshop: the two addresses delivered during the opening session, the working papers presented and discussed during the working sessions, and recommendations passed during the closing session.

2. The Opening Addresses

A. I.E.S. - EIMA Address

The first address was presented, on behalf of I.E.S. and E.T.M.A. by Dr. Galal El Din El Tayeb, the Leader of the Gedaref monitoring group and the organizer of the Workshop. Among other things the address:

1. explained that the Gedaref District was chosen for the multiplicity of its land use types and for its human and economic significance for the local, regional and national economies;

2. revealed that the studies had shown that environmental deterioration was advancing and getting more intensive and that threat of desertification is real in parts of the District, and thus called for prompt remedial actions before it was too late;

3. cautioned against the piece meal and sectoral approaches and stressed the importance of a wholistic, integrated and interdisciplinary approach in addressing environmental problems;

4. stated the objectives of the Workshop as follows:

   a. to present and disseminate the findings of the Gedaref monitoring group,

   b. the presentation and discussion of specialized working papers addressing themselves to the various aspects and problems of the local environment;

   c. to bring under one roof policy-makers, planners, executives and different users of the local natural resources to discuss their perceptions of the environment, to reconcile their competing and/or conflicting interests, and to work together for the conservation and promotion of their environment; and

   d. to initiate and then promote public awareness of the local environment, and to get people to care for and be involved in its preservation and betterment.

B. The Government Address

This address was delivered by Dr. Mustafa Basher, reflecting the attitude of the Government of the Eastern Region towards the Workshop. After expressing the greetings and gratitude of the Regional Government and the apology of the Governor for not being able to attend, and after extending appreciation and thanks to IES, ETMA and the organizers of the Workshop, Dr. Basher:

1. praised the choice of the study area, stressing that the Gedaref District represented the population and economic gravity of the Eastern Region, as well as the concentration of natural and renewable resources;

2. confirmed that the Regional Government was very concerned about environmental degradation and very serious about combating it, and had already declared 'land problems' to be of high priority in all programmes of action. He related this regional policy to the national policy declared in:

   a) Khartoum Declaration in which the President requested the international community to help the underdeveloped countries in their efforts to combat desertification, and

   b) the Comprehensive Political Programme where stress had been made on the preservation of the environment and the protection of natural resources.

3. made it quite clear that governmental or official efforts alone were inadequate to resolve the problem, and hence he called for the mobilization of the people-pastoral nomads, cultivators and fishermen and for the close cooperation, coordination and integration of all efforts pertaining to the protection and promotion of the environment, and

4. urged the participants to come out with workable alternatives, and promised that the recommendations of the Workshop would be given full consideration by the Regional Government. He repeated this promise in his short speech during the closing session.

3. Working Papers

Twelve working papers were presented at the workshop. It was regretted that farmers and nomads presented no papers. However, farmers and pastoral nomads were present during the working sessions and participated in the discussions

It is beyond the scope of this short briefing to give a summary of each paper presented. A list of the titles of these papers might give a fair idea about the range of topics covered:

1. Environmental Planning and its Role in Combating Environmental Degradation in the Sudan

   By: Dr. Yagoub Abdalla Mohamed

2. Some Aspects of Agro-Climate in Gedaref: Is there Change or Fluctuation ?

   By: Dr. Siddig Ahmed Awadalla

3. Deterioration of the Environment in the Gedaref District

   By: Mohamed Gumaa Mohamed

4. Wildlife in the Gedaref District

   By: Dr. Salah Hakim

5. Indicators of Environmental Change in the Gedaref District

   By: Ahmed Mohamed El Hassan

6. Rainfed Mechanized Farming in the Gedaref District

   By: Mohamed Osman S. Theirab

7. The Phenomenon of Environmental Degradation and its Impact on Forests in the Gedaref District

   By: El Tayeb Ahmed Abdalla

8. Degradation of the Natural and Renewable Resources in General and Pastoral Resources in Particular in the Gedaref District

   By: Dr. Mustafa Basher

9. Environmental Factors Related to Soil Deterioration and Actions Recommended to Improve It in the Gedaref District

   By: Ibrahim Mahmoud Bireima

10. Environmental Degradation in the Gedaref District and Its Impacts on Animals and the Reflections of These Impacts on the Social Life and Health of the People in the District

By: Dr. Babiker Ahmed Babiker

11. Reforestation and [illegible] Significance

By: S. Tahir Qadri (Refugees Office)

12. Environmental Degradation and its Impacts on the Gedaref Town

By: Mohamed Osman Ali El Hag

4. The Recommendations

Acknowledging the fact that the Gedaref District faces serious environmental problems manifested in active desertification process, decline in the productivity of agricultural land, and deterioration of natural pasture and of animal and forestry resources, and being aware of the concomitant negative impacts on all aspects of life in the area the participants in the Workshop have unanimously passed the following recommendations:

1. The [illegible]tion and encouragement of popular and offic[illegible] Workshops and conferences to make people aware of and to combat environmental deterioration in the District.

2. The formation in villages and towns of environment protection [illegible]ettes to make the local populace aware of and concerned about their environment. This should be coupled with the intensification of the role of the guidance and information agents together with all means of communication to create and raise public awareness about environmental issues, [illegible] about the economization in the use of firewood and charcoal, and about the use of alternative sources of energy. The Workshop has also recommended the declaration of a "Tree Day" or "Tree Festival" in all parts of the District.

3. The inclusion of environmental studies as a basic subject in the curricula of school at all levels to make sure that youngsters are, at an early age, aware of the environment, its constituents, the necessity to preserve it, and the rational utilization of its resources

4. Use should be made of the environmental training opportunities offered by the Institute of Environment Environmental Studies, U. of K. by sending some local school teachers to participate in these training classes and come back as environmental educators.

5. The continual preparation and pursuance of adequate studies about the numbers and distributions of the human and animal populations as well as about land use and land capabilities.

6. The cultivation of forests and the protection of the natural vegetation, especially in the northern area, and the organization of felling of trees for firewood, charcoal and construction purposes in the southern area of the District. Cultivation of trees on the perimeters of villages and towns and around water points should be taken seriously for the production of firewood as well as for protection purposes since these sites are most susceptible to environmental degradation. This should be carried out in accordance with a carefully-drawn plan integrating all relevant aspects and covering all areas of the District.

7. The promulgation of laws and regulations to compel farmers to plant tree shelters around all authorized and unauthorized rainfed mechanized farms. To effect such a legislation, local and international organizations should be requested to provide technical and financial assistance.

8. The formation of an effective body constituted by the Central and Regional Governments to study the on-going expansion in the unauthorized mechanized farms with the intention of organizing and rationalizing this sector in conformity with a general investment plan.

9. The genuine search to make available from within the country or from international organizations, like the I.B.R.D., the required finance to formulate and implement plans and programmes to improve the general environment within the existing and planned mechanized farms. Promotion of such an environment may be attained by making maximum use of the results of contemporary agricultural research in aspects like mechanization of agriculture and agricultural inputs and operations.

10. The introduction and enforcement of agricultural rotations in all rainfed mechanized schemes to help in combating harmful herbs and insects and the introduction of the animal as an integral part of this rotation.

11. The introduction of some specialized units, like forestry and soil conservation, within the existing framework of the Mechanized Farming Corporation to ensure coordination and a more rational utilization of the natural resources of the District.

12. The declaration of a well defined policy and the promulgation of laws and regulations to specify areas of jurisdiction and give adequate powers to the Range and Management Department and the Mechanized Farming Corporation to fill in the legal and administrative vacuum resulting from the abolition of Native Administration.

13. Every possible support and assistance to be extended to the agricultural guidance unit to play its educative role inside and outside the planned schemes.

14. The pursuance by the Eastern Region's authorities of a comprehensive, integrated study starting with a general survey of the regional natural resources with the intention of compiling a map of the natural resources as well as a basic scientific document similar to that of the land resources. This map and document should be used, after consultation with the Government of the Eastern Region, to prioritize the location of developmental schemes compatible with the local economic and social conditions. Then detailed studies of the natural resources in areas of high priority should be conducted by all appropriate specialists, working as a single, well integrated team, to come out with the technical feasibility studies for these schemes. Further consultation about these technical feasibility studies should be made with the Regional Government so as to choose from the possible land use alternatives that type of land use which attains the desired ecological balance and environmental equilibrium. A follow-up study should be made in due course to assess the concrete impact of that type of land use on the environment.

15. Reconsideration of the nature and timing of agricultural operations in the mechanized farming venture to render them more suitable to the climatic conditions and the characteristics of the soils of the semi-arid climatic regions.

16. The initiation, in collaboration with the Social Analysis Department, of a study programme to

follow up the changes which occur in the physical and chemical characteristics of the soil as a result of the continuous and intensive utilization by mechanized farming.

17. The formation of a high-level committee constituted of representatives of the Central Government, Regional Government, the Institute of Environmental Studies of the University of Khartoum, Mechanized Farming Corporation, Survey Department, Soil Analysis, Range and Pasture, Wild Life, Local Authorities, and the Regional Farmers Union. The function of this committee is to survey and study all areas of unplanned cultivation, and to make recommendations about the optimum utilization of the available natural resources to the appropriate authorities to take the suitable decisions by which everyone should abide.

18. The Mechanized Farming Corporation should continue its applied research to establish ways and means capable of raising the deteriorating productivity in mechanized farms.

19. The Mechanized Farming Corporation should be asked to exert more effort to construct the basic infrastructures such as roads, hafirs and means of communication in the areas of mechanized farming in the District.

20. The provision of adequate financing for the local small (poor) farmers through the formation of appropriate societies or the establishment of a farmers' bank to enable them meet the costs of the agricultural operations and the planting of trees.

21. The re-establishment of the hashab (Acacia senegal) areas which have been transformed to agricultural

schemes, through the introduction of the hashab tree in the crop rotation or through inter-cropping.

22. The reservation of all areas which were recommended to be declared reserved forests, and the reservation and rehabilitation of more areas to function as protective forests.

23. The encouragement of individuals to plant forests as an alternative economic activity.

24. The replanning and re demarcation of mechanized agricultural schemes, especially those in the south Gedaref [illegible] according to contour lines instead of the existing longitudinal pattern so that all agricultural operations can be performed in accordance with this planning and new patterns.

25. The replacement of the existing shallow plough the use of which has led to the formation of a compact layer in the soil by other ploughs capable of ploughing to a depth of more than 10 cm.

26. Since agricultural expansion in the rainfed mechanized [illegible] of Gedaref District has had a direct harmful impact on wildlife which has lost a good many [illegible] and natural habitat, the workshop recommended the prohibition or at least control of hunting in the southern area of Gedaref District as well as in the other parts of the Region to protect and preserve the rare wild life species. The workshop has also recommended the establishment of a Wild life Administration in the Region.

27. Every possible care should be given for the pastoral resource, grazing should be organized, pastures should be protected, and grazing areas should be

extended and their quality promoted in the Butana area to help release local pressures and sufferings and reduce friction between local cultivators and pastoral nomads.

28. The introduction of fodder crops in the rotation of mechanized farms.

29. The expansion and intensification of hashab cultivation (for both protection and production purposes) either through taunga (which is a kind of inter-cropping) or alternating belts or in separate and exclusive schemes, or through all or a combination of these methods.

30. The workshop has acknowledged and blessed the decision of the Regional Government to promulgate laws to organize grazing and its decision to demarcate a grazing line (north of which all types of cultivation are strictly prohibited) and has called for more regulatory by-laws and measures.

31. Since planning constitutes the corner-stone in the integration of resources and their preservation, the workshop has recommended the prompt formation of an environmental planning agency and the compilation of a guiding map of the natural resources for the Gedaref District (see recommendation No. 14).

32. The protection of existing tree belt between Simsim and Umm Seinat.

33. And, the central Ministry of Energy should finance the establishment of forests in the Eastern Region (particularly the Gedaref District) to compensate the Region for supplying the other parts of the country with firewood and charcoal.

B. TWO RECOMMENDED PILOT INTERVENTIONS

B. TWO RECOMMENDED PILOT INTERVENTIONS

1. Establishment of Shelter Belts

General Introduction.

Rainfall and water from other sources have an important role in ecosystem regulation in semi-arid and savanna areas. Water is generally a more limiting factor for plant growth and development than soil, topography, elevation and other climatic factors. However, these factors interact with each other and lead to further complications when they are tied with the type and intensity of land use by both man and his animals. Unplanned exploitation of the renewable natural resources has led to disappearance of plant cover, soil erosion and desertification. Overgrazing, unplanned expansion in traditional and mechanized agriculture, tree removal and fire are the major factors leading to site deterioration.

The Gedaref area has soils of moderate fertility and sufficient rainfall for crop production. However, the development of mechanized and traditional agricultural schemes was accompanied by extensive destruction of the tree and grass cover. This in turn has influenced plant - soil - water relationship and caused not only a drop in productivity level but also created many desertified spots in the area. The lack of soil improvement measures together with the absence of tending operations for crop production have enhanced this degradation process.

It is imperative that immediate intervention should take place to remedy this situation. The introduction of a rotation policy, laws and regulations together with the establishment of a series of properly designed shelter belts are among the major factors to be considered. The present study includes the introduction of a series of shelter belts on a small area of 1000 feddans together with the establishment of an enclosure for monitoring plant

growth and development and recording improvement measures afforded by protection.

(a) Shelter Belt Experimental Plot

The introduction of shelter belts in rainfed agricultural projects is a form of multiple land use approach. This form of agro-forestry practice is anticipated to raise productivity levels, maintain soil fertility and improve water balance. Shelter belts ameliorate the climate by reducing wind speed and lowering temperature. The reduction of water runoff and surface soil movement curb the desertification phenomena. The wood and other tree products derived from the tree belts constitute an asset over and above crop production.

However, the establishment of shelter belts under rainfed conditions might be met with difficulties related to water availability, especially at the initial phase of tree growing. Although an average of 600 mm of rainfall is adequate to support many indigenous and some exotic trees, some precautionary measures should be taken into consideration for availing water. This can be achieved by considering the following alternatives:

a) pumping water from River Atbara (expensive),
b) water harvesting through proper drainage systems followed by water storage facilities,
c) adopting runoff agricultural systems through harvesting rain water runoff and using it directly for crop and tree production,
d) spreading water through diverting it from its natural courses and spreading it over adjoining fields,
e) utilizing the manpower resources of the people living nearby the project to water the newly established tree seedlings by animal drawn carts carrying rain water (if feasible).

(b) Choice of species:

The choice of species is governed by many factors including

a) soil condition, adaptation and climate,
b) usefulness as a shelter belt component,
c) contribution to income generated from the area,
d) freedom from diseases affecting agricultural crops,
e) improvement afforded to micro habitat through nitrogen fixation, humus formation and/or other ameliorating effects.

On the basis of the above mentioned two indigenous and two exotic species have been selected for the formation of a series of shelter belts. The species selected include;

A. senegal	2 trees/row
A. seyal	1 tree/row
E. Hybrid (Missouri)	1 tree/row
E. microtheca	1 tree/row

a) A. senegal is capable of nitrogen fixation, good for camel browse, a source of wood and charcoal production and an income generator through its gum production. For these reasons it is suggested to contribute 50% of each row.
b) A. seyal is a fast growing indigenous species and a good source for firewood and charcoal production.
c) the two exotic species are selected for their growing characteristics as well as for their economic contribution through pole production. The species coppice well and can be harvested while the other indigenous species are standing. E. Missouri (hybrid) has been grown successfully under rain condition in the Damazin area at both Khor Donya and Jebel Garri. E. microtheca is

anticipated to thrive under 600 mm rainfall in the initial phase of establishment is well looked after. However, both species are susceptible to termite attack. This can be overcome by dipping the seedling roots in a solution of aldrin prior to planting.

(c) Computation of the growing stock

a) planting space within and between rows is 3 x 3 m.

b) number of trees/row is five

c) height of the tall species (H) is assumed as 12.5 m.

d) distance between the shelter belts is 20 x H (20 x 12.5 = 250 m.). This is to be utilized for crop production.

The area of 1000 feddans can have the shape of a rectangle of the dimensions 3500 x 1200m taking the above into consideration we can plant 14 sets of shelter belts along the length of this area. The suggested spacing gives a total of 400 trees along the width of the block.

∴ 400 x 5 trees/row x 14 sets of rows
= 28,000 trees

Assuming that there are four good rainy days per season and if safe transplanting for four days is afforded by each one of the rainy days; then the manpower for planting can be computed as follows:

4 x 4 = 16 planting days

If each man can plant 50 trees per day then the number needed is:

x (4 x 4 x 50) = 800

x $\frac{28,000}{800}$ = 35

The number of seedlings required to be grown in the nursery is estimated as 40,000. This takes into consideration a 30% loss as germination failure together with other sources of mortality.

Cost of raising seedlings in the nursery:

Operations	Cost/1000 seedlings (Ls.)
Purchase of seed	0.65
Cost of silt	18.00
Filling polythene bags	6.00
Bed preparation	4.00
Cost of irrigation	1.00
Cost of hand sowing and singling	6.00
General maintenance	40.00
Total cost/1000 seedlings	75.65
Total cost for 40,000	3,015
Cost of transplanting Ls.20 x 40 (thousand)	800
	3,815

(d) Yields and Income

Of the trees grown in the belt 40% belong to A. senegal giving 11,200 trees, each of the other 3 species is represented by 5,600 trees. Gum production starts at year five and gives maximum production at year eight. Assuming that each tree gives an average of 0.4 kg/season we get 11,200 x 0.4 = 4,480 kg of gum arabic. The two eucalyptus give saleable poles at age ten years. The utilization of A. seyal for firewood and charcoal should be delayed to age 10 years when the eucalyptus species have coppiced well. The income generated can be computed as follows:

A. senegal

4480 ÷ 40 = 112 kontars

Production for 5 years = 112 x 5 = 560 kontars

Income generated = 560 x 20 = 11,200 Ls.

A. seyal

The stocking of this species amounts to an area of ten feddans. Each feddan yields 15 cubic metres of fire wood, giving 10 x 15 = 150 cu.m. Income generated = 150 x 12 = 1,800 Ls.

Eucalyptus species		Ls.
11,200 x 15 Ls.	=	168,000

Total income generated	Ls.
A. senegal	11,200
A. seyal	1,800
2 Eucalyptus species	168,000
Total	181,000

2. Enclosure

Monitoring change in vegetation cover and habitat type can be achieved through excluding activities of man and his animals from a certain reserve area. This can be achieved by fencing an area of 2 X 2 Km. As fencing is very expensive other protection strategies can be considered. Such protection measures are anticipated to:

i) improve plant cover,
ii) increase species diversity,
iii) reduce runoff and improve infiltration rate of the soil,
iv) give protection to adjoining agricultural areas,
v) prevent soil movement and desert creep from neighbouring lands,
vi) promote environmental quality.

(a) Methodology

General background

Protection measures should be preceded by a complete inventory of existing vegetation cover through assessing density, frequency, per cent cover and general habitat condition. Soil analysis including chemical and physical conditions should be considered. Wind speed, relative humidity and evapotranspiration are to be assessed. Species which are adapted to the locality should be selected or seeding and/or planting. The introduction of grass and

tree species should be based on previous knowledge about success and adaptability to areas of similar potentials.

(b) Improvement Measures

If seeding is to be considered, some soil working might be necessary to ensure successful establishment; this includes shallow ploughing and ridging. Seed source must be from the locality or from areas with similar soil and environmental characteristics. Tests for viability, germination per cent and purity per cent should be conducted before seeding. Pre sowing treatment may be necessary for some species and these may include scarification, soaking in hot or cold water and or treatment with concentrated sulphuric acid. The appropriate time for seeding is very important for germination, especially as regards timing with the rainy season. Supervision and recording of germination success is necessary for assessing the necessity for reseeding and/or beating up with seedlings from nursery stock. Suggested species for the project include A. senegal, A. seyal, prosopis species, A. albida together with local fodder species. The mixture of species should be arranged in accordance with the existing pattern of species association in the area. Maximum benefit should be drawn from knowledge of the terrain, this includes contour, elevation, soil types and movement of rain water. This is important for water harvesting and diversion to maximise the benefit of existing water on the area. Rain water storage should be taken into consideration whenever feasible.

(c) Helping factors for project success

It is important to invite the local people to participate in this project. This helps in defraying expenses as well as protecting the area. The farmers and herdsmen are an important component of this project. Joint meetings for delineating the project area and catering to access routes for human and livestock are necessary. The participatory spirit can be raised by specifying shares for

the local people from the outcome of the project. This can be in the form of organized grazing rights based on specific grazing management systems. This has to take into consideration the carrying capacity of the site. Such a self-generated reform can encourage the local people to create other protected areas in many parts of the area. A proper system of rotation and deferment can be established and serve as a range development and improvement programme. Moreover, the timber produced from these enclosures can be harvested and distributed among the local people after subtracting the cost of production.

(d) Method of Protection

The protection strategy can be outlined as follows:

1) Properly fence 200m at each corner of the 2000x2000m. This helps as demarcation of the area as well as affords partial protection.

2) Establish four patrolling points where four guards give protection and supervision against man and animal damage.

3) Introduce live fencing by planting trees or shrubs adapted to the area.

(e) Cost of the project

	Ls.
Cost of seeds and seedlings	2,400
Cost of seeding and transplanting	1,600
Fencing 800m x Ls.10	8,000
4 guards X Ls.80 x 12 months X 5 years	19,200
Total cost	31,200

(f) Income and output

1. After the second year of protection this area can support 400 sheep year-round. This amounts to 400 ton of forage per year. The value of this forage amounts to about 9,000 Ls.

2. Returns from firewood, charcoal and building materials can be estimated as follows:

	Ls.
10,000 poles x Ls.15	= 150.000
1,500 cu.m. x Ls.10	= 115,000
10,000 sacks of charcoal x Ls.5	= 50,000
Total	215,000

This justifies the incurred expenses invested in this pilot intervention.

APPENDIX A

INDICATORS OF ENVIRONMENTAL CHANGE IN GEDAREF DISTRICT

APPENDIX A : INDICATORS OF ENVIRONMENTAL CHANGE IN GEDAREF DISTRICT

LAND-USE

A. Pastoral to Agricultural

1. Herd size
2. Grazing areas
3. Population of nomads
4. Change in location of pasture
5. Legal and social conflicts between nomads and cultivators
6. Rural nomads and nomads in town

B. Traditional vs. mechanized agriculture

1. Number of feddans in traditional agriculture
2. Number of feddans under mechanized crop production

C. Forestry

1. Number and size of forests
2. Species variety

DESERTIFICATION

A. Physical Indicators

1. Soil Indicators
   a. Effective soil depth
   b. Soil organic matter
   c. Crusts
   d. Salinization and alkalinization
2. Relative Reflectance

B. Biological Indicators

1. Ground cover
2. Above ground biomass
3. Key species-vegetation
4. Key species-animals

5. Domestic animal population
   a. herd composition
   b. production
6. Yield

URBANIZATION

A. Infrastructure and services
   1. Housing
   2. Health and sanitation
   3. Education
   4. Roads and public work

B. Employment Opportunity
   1. Primary sector
   2. Secondary and tertiary sector

C. Development of Town and District Government
   1. Administration
   2. Police and Fire Protection
   3. Court System
   4. Social Services
   5. Crime
   6. Urban land-use
   7. Industrialization

D. Migration Patterns
   1. Growth rates
   2. Demographic

SOCIAL INDICATORS

A. Change in social structure
   1. Effects of migration
      a. settlement patterns
   2. Change in family structure
   3. Change in the role of women

ECONOMIC INDICATORS

A. Standard of living
   1. Housing
   2. Nutrition
   3. Education
   4. Social services

B. Availability of Goods

C. Subsistence vs. Market Economy

D. Income and Sources

WATER RELATED INDICATORS

A. Physio chemical
   1. Suspended matter
   2. Turbidity
   3. Transparency
   4. Colour
   5. Conductivity
   6. Temperature
   7. pH
   8. Dissolved oxygen
   9. Biological oxygen demand (B.O.D)
   10. Chemical oxygen demand (C.O.D)
   11. Phosphate
   12. Nitrate
   13. Nitrite
   14. Ammonia
   15. Current or discharge
   16. Potassium
   17. Sodium
   18. Calcium
   19. Magnesium
   20. Pesticides
   21. Herbicides

B. Standing and open water

C. Groundwater
   1. Depth
   2. Quantity
   3. Quality

D. Rainfall
   1. Frequency
   2. Duration
   3. Quantity

E. Biological
   1. Phytoplankton
   2. Zooplankton
   3. Bacteria
   4. Protozoa
   5. Benthos
   6. Fish

F. Health
   1. Malaria
   2. Dysentery
   3. Bilharzia

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1. In rural camps
2. In urban areas

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