ENVIRONMENTAL TRAINING & MANAGEMENT IN AFRICA (ETMA)

ENVIRONMENTAL MANAGEMENT IN THE SUDAN

THE DINDER NATIONAL PARK STUDY AREA

(CENTRAL REGION)

Final Report

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PART ONE

INTRODUCTION

INTRODUCTION

The Dinder National Park is the closest national park to urbanized centers in Sudan. It is located in the Southeast of the Central Region. Its boundaries follow the River Rahad at latitude 12^{o} 26 N and longitude 35^{o} 2 E, it continues into a southwest direction up to latitude 12^{o} 42 N and longitude 34^{o} 48 E at River Dinder. It further continues up to latitude 12^{o} 32 N and longitude 34^{o} 32 E along Khor Kinana. It then diverts slightly to the Southeast, to latitude 11^{o} 55 N and longitude 34^{o} 44 E, to be enclosed by the Sudan-Ethiopian borders at latitude 11^{o} 24 N and longitude 35^{o} 2 E. The National Park was 6330 km^2, however in March 1982 the area was increased to 8960 km^2 (Fig.1).

Dinder was proclaimed a National Park in 1935 following the London Convention for the Conservation of African Flora and Fauna. During the same decade many African national parks were declared.

The drainage complex of the Rivers Dinder and Rahad is located in the Ethiopian Plateau sloping down from 3133 meters above sea level to 200-400 masl at the southeastern reaches of the Dinder Park in Sudan. The Rivers Dinder and Rahad descend vigorously from the Ethiopian Plateau and traverse the Park in a westwards direction across the Sudan-Ethiopian borders. Their gradient drops gradually and then flows into a north-westerly direction, until they join the Blue Nile near Wad Medani. River Dinder is about 750 km long. Its catchment area is approximately 16 X 10^3 km^2 and it has an average annual discharge of about 3 X 10^9 m^3 per year. The river varies considerably in depth and width, ranging from 50-400 meters in width and 1-9 m in depth. It is a seasonal river, which starts flowing towards the end of June. The peak flow is during September and ceases

running in November. A number of pools are left behind which may hold water up to the next rainy season.

Along the river course levees (Gerf), meadows (maya'as) and Kerrib landforms were developed.

Maya'as exhibit different shapes which are in general crescent like. Their areas vary considerably according to the former meander bends of the river. Areas of maya'as vary between 0.16 km^2 and 4.5 km^2. Generally maya'as are flat with slight and/or no clear banks (Fig.2).

GENERAL CHARACTERISTICS OF THE STUDY AREA:

Geomorphology:

The most distinctive geomorphic feature of the geomorphology of the Sudan is its clay plains. The Dinder National Park belongs to these clay plains. Whiteman (1971) stated that the clays of Rahad and Dinder are probably the most striking feature of the geomorphology of the Sudan. Deposits of alluvial origin were laid down, as Tothill (1948), Berry (1962) and Berry and Whiteman (1968) have suggested, by over-bank floods from the Blue Nile and its tributaries. The clay plains have actively developed probably in the Pleistocene and the current soil cycle was probably developing during the Aolocene wet phase. They reach a thickness greater than 12 m at places, but they get thinner in the northern areas of the plain.

Geology:

Little is known about the basement complex north of latitude 6^{o} N. However, they include ingneous, metamorphic and sedimentary rocks overlain by horizontal and subhorizontal Paleozoic or Mesozoic sedimentary or igneous rocks. They are assumed to be mainly of pre-cambrian origin.

El Atshan formations are dominant in the area. They are characterized by the presence of beds of calcrete at

Fig.1 SKETCH MAP OF DINDER NATIONAL PARK AND ENVIRONS

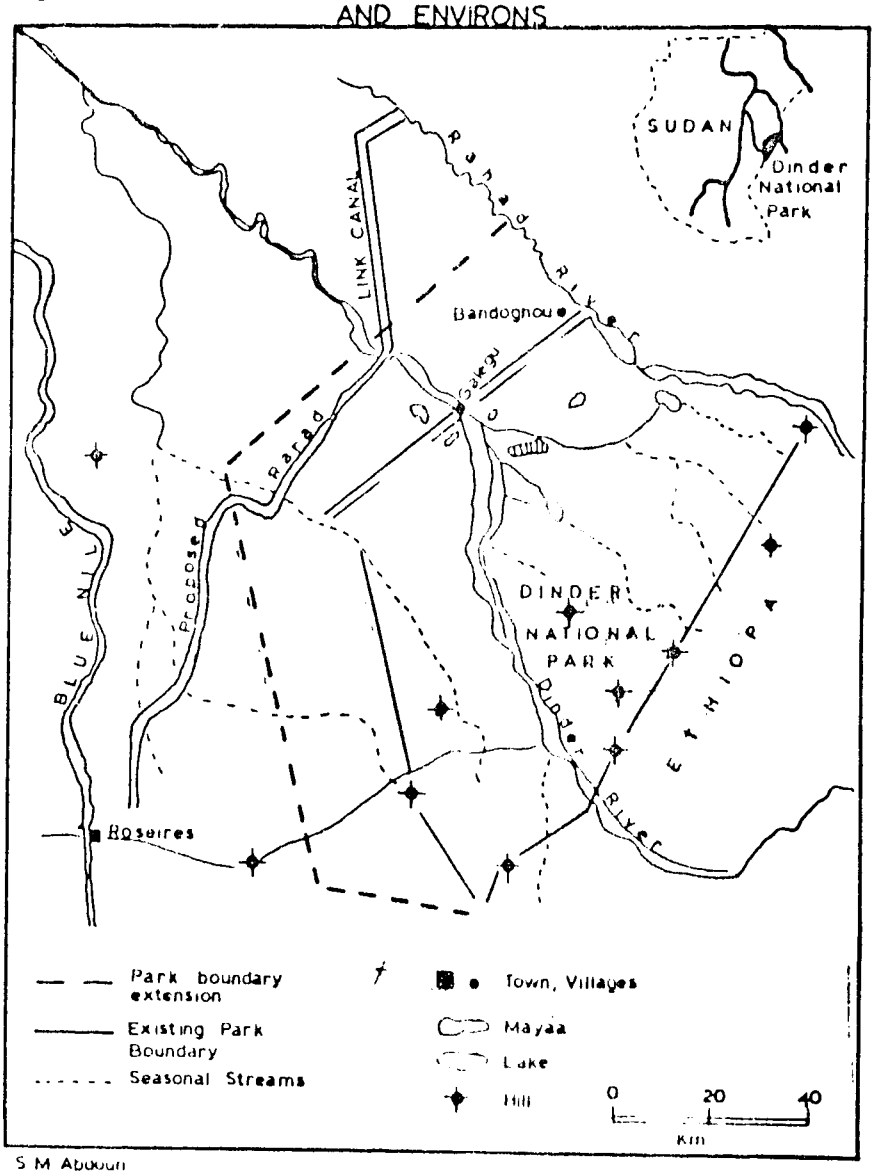

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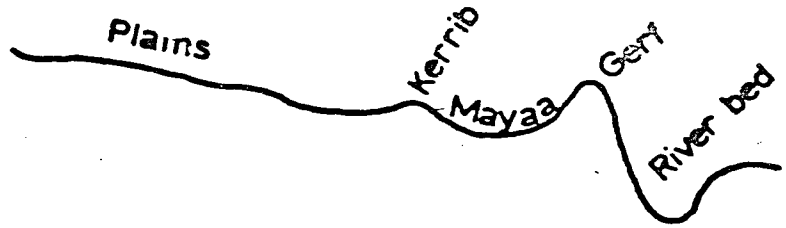
Fig. 2 CROSS-SECTION OF THE VALLEY OF THE RIVER DINDER SHOWING THE VARIOUS FORMATIONS FOUND(AFTER HOLSWORTH,1968)



the top of older alluvium and at the base of the clays. The sediments of these formations consist of unconsolidated sands, sometimes gravelly, clayey sands and clays. The clays are mainly buff to greyish-white or greenish grey. Sediments are unsorted, and the feldspar and biotite present are often undecayed. The age of these formations is uncertain (most probably they are of Tertiary to Pleistocene origin) (El Daie, 1982).

The vertisols of the park are characterized by dark grey or very dark greyish-brown tones. They are sticky and have a high cation exchange capacity. They swell when wet and shrink when dry, forming deep cracks which may exceed a meter in depth. They form hexagonal and pentagonal blocks up to 10 m across, at the faces of contact. The clay content of these soils varies between 50-80%. Coarser material and $CaCo_3$ are found in meager amounts. The display of black colour at the surface is due to weathering. The colour becomes white deeper down. The soils are sometimes alkaline with p^H 8.5-9.5.

Interspersed with vertisols are the entisols. There are sandy clay and sandy loam soils. They are common around the hilly portions of Dinder area and along the banks of the Rivers Dinder and Rahad (Dasman, 1972).

Climate:

There are no meteorological stations at Dinder Park thus no specific records of the climatic parameters exist. However, the area falls within a zone where winter is warm and dry. The rainy season starts in June and lasts to the end of October. Intermittent showers occur in May. The average annual precipitation recorded in stations around the park ranges from 340 to 700 mm.

The average maximum daily temperature between November to February is 30°C, while from March to the start of the rainy season the temperature averages 38°C.

Flora:

The vegetation in Dinder Park has been classified as open grassland, wooded grassland, woodlands and riverine forests. Different species were recorded, but the communities lean towards simplicity (Harrison and Jackson, 1958).

The dominant tree species recorded during the present study in the park are Acacia seyal (schweinf) and Balanities aegyrtica (L). In the clayey plains Combretum glutinosum (Perrott) and the Acacia polyacantha (Wild) are found in the drained silty soils (Azaz). Along the rivers, khors and at the peripheries of the Mayas, Ziziphus spina-christa (L), Acacia nilotica (L), Acacia sieberiana (DC) and Tamarindus indica (L) occur. Hyphaene thebaica (L) is dense along the edges of the River Dinder. Associated with H. thebaica, surrounding the hilly areas, are Combretum hatmannianum (schweint), Anogerssus eiocarrus (Brown & Massey) and Adansonia digitata (L). In the less moist heavier clays Acacia fistula (schweinf) is found with Acacia seyal. They are also found in areas where intermittent floods occur during the rainy season.

The Savannah grasses of the area such as Hyparrhenia spp and Beckeräpsis spp, have been replaced in some places by annuals like Cyperus sp, Echinochloa sp and others. Along the "Gerf" of the Rivers Rahad and Dinder are large areas of tall grasses, e.g., Sorghum sp. This species also covers some of the mayas. Echinochloa and Sorghum sp intermingle with short grasses like Panieum sp. Where water is abundant, Bracharia sp, Cynodon sp and Pennistetum sp thrive in a green-mat form throughout the year.

Fauna:

Knowledge about wildlife distribution, migration, habits, densities, numbers and age groups is limited. Serious research work covered small areas and limited species. A variety of species in the Dinder National Park are represented in good numbers, outstanding of these are the densities of the reedbuck and the guinea fowl and the diversity of birds of prey. The funa of Dinder includes:

Reedbuck	Redunca redunca
Tiang	Damaliscus tiang
Waterbuck	Kobus defassa
Roan antelope	Hippotragus equinus
Kudu	Tragelaphus strepsiceros
Buffalo	Syncerus caffer
Giraffe	Giraffa camelspardalis
Bushbuck	Tragelaphus scriptus
Ostrich	Struthio camelus
Oribi	Ourebia ourebi
Redfronted gazelle	Gazalla rufifrons
Dik dik	Sylvicapra grimmia
Cheeta	Acinonyx jubatus
Lion	Pantnera leo
Leopard	Panthera pardus
Hyena, spotted	Crocuta crocuta
Hyena, striped	Hyaena hyaena
Serval	Felis serval
Civet cat	Viverra civeta
Wild cat	Felis silvestris libyca
African hunting dog	Lycoan pictus
Mongoose	Mimos Lingo
Honey badger	Mellivora capensis
Baboon	Papio anubis
Grivet monkey	Erythrocebus patas ryrrhonotus
Red hussar	Erythrocebus patas
Pangolin	Manis sp.
Aardwolf	Aardvaak orycteropus

There are also over 250 species of birds. The elephant migrates to the Park during the rainy season. Furthermore the Park teems with many species of reptiles and small mammals.

The Ecosystems:

The park has three major ecosystems, each with its own specific plant and animal communities and each contributing to the overall diversity of the park (Harrison and Jackson, 1958). Largest in extent is the Acacia seyal, Balanites aegyptica, and Combretum spp woodland which is characterized by heavy cracking clays and tall coarse grasses (including Sorghum sp).

Along the banks of River Dinder and the larger of seasonal streams (khors) is a riverine ecosystem. The forest here is multi-layered. The upper region consists of Dome palm (Hyphenia) and Acacia sieberiana, while the lower area contains Ziziphus abyssinica, Ziziphus spina-christa and Mimosa pigra. The dominant grasses are Sorghum sp and Brachiaria sp.

The most important ecosystem for the wildlife of the Park is the "maya'as" ecosystem. The "maya'as" are meander cutoffs that are gradually being filled in by sediments derived from their own small catchment areas. It appears that the water supplied to the mayaas is not derived from the adjacent river but from their own local areas of runoff and groundwater sources. These maya'as are important because they provide the main source of nutritious grasses for the wildlife. In particular the maya'as provide Echinochloa spp for the animal populations during the most severe part of the dry season (March to June).

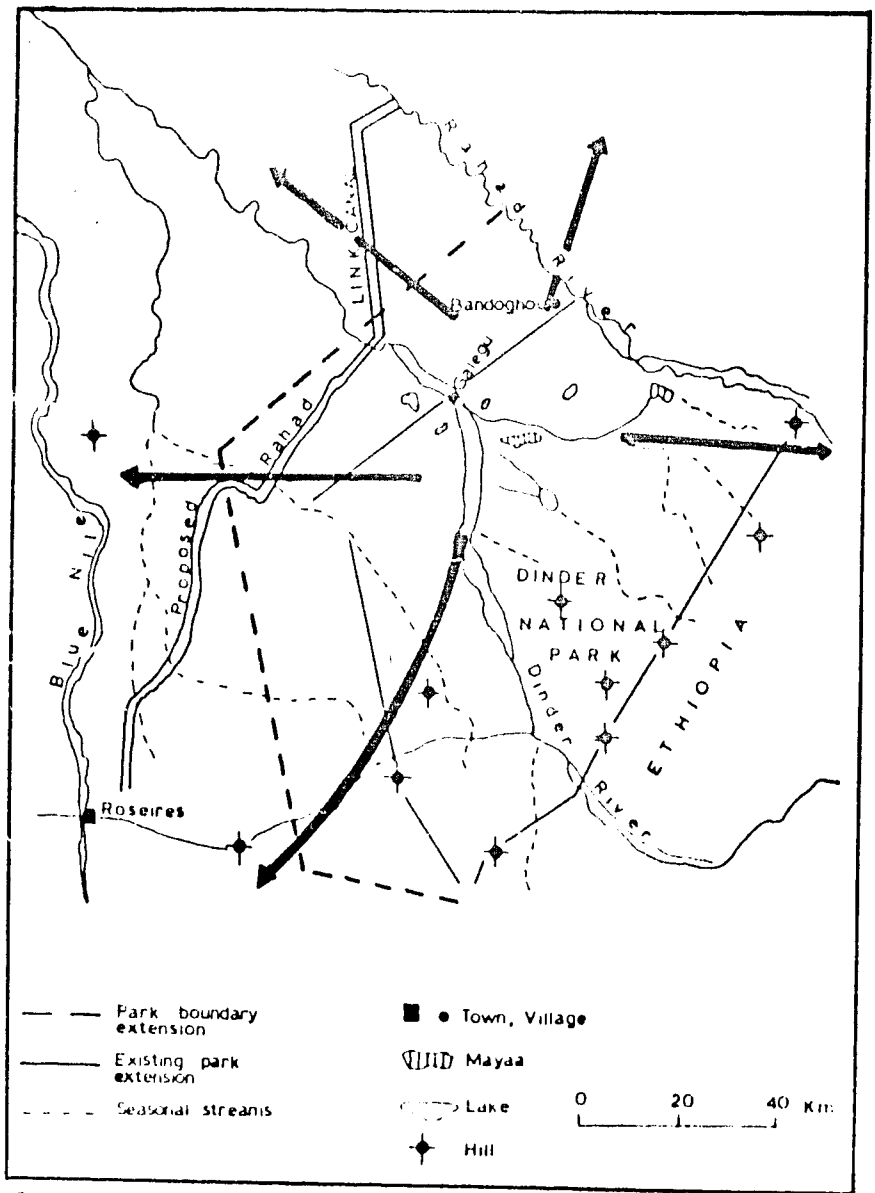
When the Park was originally established its boundaries were demarcated for reasons of administrative convenience rather than any clear understanding of the ecological systems or zones (Dasmann, 1972). Thus the

region occupied by the park has never embraced a self-sufficient ecological area. The wildlife in the park must depend on extensive grazing areas adjoining the park. During the wet season, large numbers of animals migrate outside the park's boundaries to areas where their movements are not impeded by dense stands of Sorghum spp and where there are drier soils with shorter and more nutritious grasses such as Hyparrhenia spp (Fig. 3). In the dry season the animals return to graze along the banks of the Dinder and on the perennials that flourish in the well-watered mayas.

Human Populations:

Towards the end of the last century the Dinder area was deserted due to famine and pestilence. The area was practically uninhabited when it was declared a National Park in 1935. Legislation was passed to prevent trespassing into the park. El Requiba, a village 20 km away from the Northern boundary of the Park, was relocated even farther away from the boundaries in 1974 because of the villagers' poaching activities. Nevertheless since the mid 1970's a multitude of villages mysteriously filtered back along the park's boundary with the River Rahad. In a later section a comprehensive analysis of human populations and settlement is provided.

Fig. 3 THE GENERAL PATTERN OF MOVEMENT OF WILD LIFE DURING THE WET SEASON



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PART TWO

TRENDS

PART TWO

TRENDS

a. Wildlife:

Wildlife has been disappearing from several areas in Northern Sudan during the past 10 to 15 years. Human and livestock populations are increasing, creating more demand on natural resources. Natural pastures are destroyed and very little is being done to keep human activities in harmony with ecological systems.

As mentioned above the Park is not a complete ecological unit because several wildlife species migrate to wet season habitats outside its boundaries. Around 1967, agricultural development had been started in the areas used by the park's wildlife during the wet season. Both authorized (government approved) and unauthorized agricultural schemes are growing rapidly in this area used by the wildlife. In 1983 there were at least 70 unlicenced schemes within the boundaries of the park.

Mechanized farming both legal and illegal has not only cleared vast areas around the park, but has contributed to the degradation of the park in other ways. Almost all groups of people living in the vicinity poach animals, especially during the wet season when there are no Rangers on duty (Whitney & Hogmraby, 1982). The owners of the mechanized farms are said to supplement meat supplies for their workers through this practice. The more professional poachers find a ready market for their kill in neighbouring small urban centres.

The areas surrounding the Park were relatively uninhabited until the beginning of the 1970's when people from western Sudan and neighbouring West African countries affected by drought conditions in their areas moved into

the Dinder region. About 20 villages exist in 1983 along the boundaries of the Park. Inhabitants of these villages grow rainfed crops such as sorghum and raise cattle, sheep and camels along the Park boundaries and often trespass into the Park. They are also active in felling trees for charcoal production, which has become a very profitable products because of its high demand in the cities of central and northern Sudan. Villagers are also responsible for most of the poaching problems in the Park. Although one village was successfully moved in 1974 to a new location away from the Park, there are no similar plans to relocate the rest of the villages (Nimir & Hashim, 1975).

Perhaps more serious than these depredations has been the impact of nomadic livestock herds. Traditionally, great herds of sheep and camels move to the Butana grassland to the north of the Park in the wet season and return to the banks of the Rivers Dinder and Rahad and the Blue Nile during the dry season. Formerly, the nomads grazed their animals as they moved over the extensive areas that are now occupied by mechanized farms or the Rahad Irrigation Scheme bordering the Park to the northwest. But since the nomads can no longer find adequate grazing areas in these farmlands without risk of incurring heavy fines, they are increasingly bringing their animals into the Park itself, where the fines imposed by the courts for trespassing are far lower than the fines for trespassing farmland. Table 1 presents the number of people arrested for illegal activities within the Park and number of herds of livestock found trespassing between 1958 and 1982. The average number of animals in one herd is 800, 200 and 50 for sheep, cattle and camels, respectively. Most of trespassing from 1975 to 1982 has been attributed to sheep (Nimir, 1983).

Table 1

Number of people arrested for illegal activities and number of herds of domestic livestock found trespassing in the Dinder National Park during the period from 1959 to 1982 (1)

Years	Herds of trespassing livestock(2)	Collectors of gum arabic	Poachers	Entering the park without permit	Collectors of dom palm leaves and wild honey	Fishermen	Possession of unlicenced firearms	Total
1958-1959	-	-	15	-	-	-	-	15
1959-1960	9	59	2	-	-	17	-	87
1960-1961	-	144	2	-	6	-	-	152
1961-1962	2	82	3	-	-	-	-	87
1962-1963	-	-	18	-	-	6	-	24
1963-1964	-	-	-	-	-	-	-	-
1964-1965	-	-	-	-	-	-	-	-
1965-1966	-	6	9	30	-	-	-	45
1966-1967	-	15	24	-	-	-	-	39
1967-1968	9	150	-	48	5	-	-	212
1968-1969	-	-	7	-	-	-	-	7
1969-1970	-	-	5	-	85	-	-	90
Total 1957-1970	20	456	85	78	96	23	-	758

Cont../...

Table 1 (Cont.)

Years	Herds of trespassing livestock	Collectors of gum arabic	Poachers	Entering the park without permit	Collectors of dom palm leaves and wild honey	Fishermen	Possession of unlicenced firearms	Total
1970-1971	33	-	-	-	-	-	-	33
1971-1972	2	-	46	-	1	-	-	33
1972-1973	64	-	58	-	11	-	12	145
1973-1974	135	11	65	15	4	33	-	252
1974-1975	155	-	24	26	29	-	11	245
1975-1976	229	-	10	27	36	29	19	350
1976-1977	270	-	10	8	36	29	-	353
1977-1978	181	-	18	6	-	10	-	215
1978-1979	241	-	26	14	-	44	8	333
1979-1980	432	-	22	15	15	10	19	513
1980-1981	422	-	55	96	-	27	25	625
1981-1982	365	8	33	28	18	4	16	472
Total 1970-1982	2529	19	367	235	150	175	110	3585

(1) Table compiled from the Wildlife Administration records.

(2) The average numbers of animals in one herd are 800, 200 and 50 for sheep, cattle and camels, respectively. There is no detailed information on trespassing by different domestic animals, however most of the trespassing in 1975 to 1982 has been attributed to sheep.

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Livestock trespassing has increased about 126-fold during the period of 1970 to 1982, when compared to 1958 to 1970. Besides competing with wild animals for forage and water, domestic livestock are a source of infectious diseases to wild animals. This usually occurs towards the end of the dry season when wildlife concentrate around the few remaining water pools. Rinderpest outbreaks in 1970 and 1982 resulted in losses of hundreds of animals; an outbreak of anthrax was reported in 1974 in wild animals with heavy losses occurring among reedbuck and buffalo. In all the above cases outbreaks were reported among livestock in areas around the park before symptoms started appearing in wild animals.

Several animal species which were reported to occur in the Park had already disappeared. The black rhino and the hippopotamus were last reported at the beginning of the century (Harrison, 1953); crocodiles were abundant until in the 1940's, however an organized government campaign drastically reduced their numbers. The reported purpose of the crocodile cropping was to increase the Game Preservation Department's revenue. No crocodiles were reported in the Park during the 1960's and 1970 (Mahana, Perron. Comm.). However in 1983 one crocodile had been reported in one of the pools of the River Dinder. However, it disappeared afterwards.

The Lelwell hartebeest was last reported in the 1950's (Nimir, 1983). The sommering gazelle, which was abundant until the 1960's, was completely exterminated from the Park by 1970 due to the vast expansion of mechanized agriculture in the wet season habitat of this animal. A serious decrease in the numbers of tiang and waterbuck, amounting to 60% and 30%, respectively, between 1970 and 1976 was also attributed to shrinkage of their wet season habitat and competition with livestock in their dry season habitat (Hashim & Nimir, 1978).

As long as the habitats surrounding the Dinder National Park were undisturbed, the Park was able to support the large and varied big game population described above. However, the loss of the wet season habitats as well as increased livestock trespassing can be related to the lack of any landuse policy in the Dinder region. Decision makers admit now that serious mistakes were made by allowing large areas around the Park to be cultivated. In 1981 the area of the Park was increased by approximately 2500 km^2. The increase in area has been planned to incorporate some of the wet season habitats. However, this decision was not enforced in 1982 and the farmers were allowed to cultivate for one last season within this newly incorporated area; this practice was also allowed in 1983 providing that each farmer payed a 2500 Ls fine. The practise still goes on and has been further intensified in 1985 because of a drought condition in other parts of the country. Adding to the problems of the Park is the lack of enough personnel, vehicles and funds to conduct patrolling management and necessary research. Also natural changes in climate and vegetation succession can not be overlooked.

The Dinder National Park does not provide economic benefits for people of the Dinder region. A few temporary jobs are usually created each year following the end of the rainy season. Workers are recruited to open the seasonal roads and build the camp in the Park. Inhabitants of villages near the Park have been allowed to collect gum arabic from acacia trees in the park, but that practice was stopped in 1970.

Although Dinder National Park is the closest African park to Europe and the Middle East, tourists visiting the park averaged 375 per year for the period from 1973 to 1978. The low number of tourists is mainly due to the poor infrastructure development in the country and the lack of national and international publicity about the Park.

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b. Fire:

Park ecologists are still debating the impact of fire on the plant-wildlife system, but the consensus seems to be that the frequency of the fires, burning approximately 60% of the total area each year is degrading the environment (Dasmann, 1972). However a recent study shows that, in the burnt areas, almost 90% of the regenerated growth is of Acacia seyal (Fadil, 1982). The latter seems to be more resistant to fire than the other two dominant species Balanites aegyptical and Combretum spp. The causes of fire in the area are many, ranging from those started by wild-honey gatherers and nomads burning the coarse grasses to allow more succulent younger shoots to grow to the Park personnel themselves who use fire to clear routes through the dense stands of grass.

c. Land Use:

The purpose of this section is to describe land use trends in Eastern and Central Sudan in general and to analyse the various factors that influence the emerging land use trends in and around the Dinder National Park. From the time of its establishment in 1935 and up to the era of the emergence of the resource use conflict in eastern Sudan, the Park seemed to acquire equal chances to struggle for existence with other competitors. The human activities and the different types of land use at that time when compared to the current one are almost the same in their classification but differ in their nature, magnitude and impact, hence threatening the mere existence of the park.

Agriculture in its traditional form is an old practice in the Dinder area, then its mechanized twin followed in the early 1950's, similar to the other areas of the Savanna zone of the country. On the other hand,

pasture for animals, owned both by the nomadic and the sedentary groups, occupied areas convenient for their movement in and out of the area. Other subsistence activities like wood-cutting and charcoal making for domestic use were recognized and sometimes legalized by licences. Settlements were scattered at reasonable distances from the park's boundaries. Poaching and honey collection were registered as the most serious illegal practices that threatened the wildlife population. By narrating these activities we do not mean that there were no land use conflicts in the area before the 1970's, but we want to highlight the fact they were not as disastrous as they are today.

The areas of land use trends and conflicts facing the Dinder National Park accordingly are: agriculture (traditional, licenced and illegal mechanized agriculture), livestock grazing and nomadic movements, wood-cutting and charcoal making and settlements. Poaching and honey collection have been mentioned above.

d. Agricultural Land Use:

This includes mechanized dry farming (in demarcated and undemarcated areas) as well as traditional land use types. Essentially it traces land use in a central and eastern Sudan through a series of maps then focuses in and around Dinder National Park.

Fig.4 illustrates the major and organized land use types in central and eastern Sudan in 1935 when the park was established. There was plenty of virgin land available for development. Because of low population densities there was low demand for food and energy. Traditional cultivation around rural settlements used to produce enough for its own population and little surplus for the slowly growing urban centers.

Fig. 4 LANDUSE IN CENTRAL AND EASTREN SUDAN IN 1935

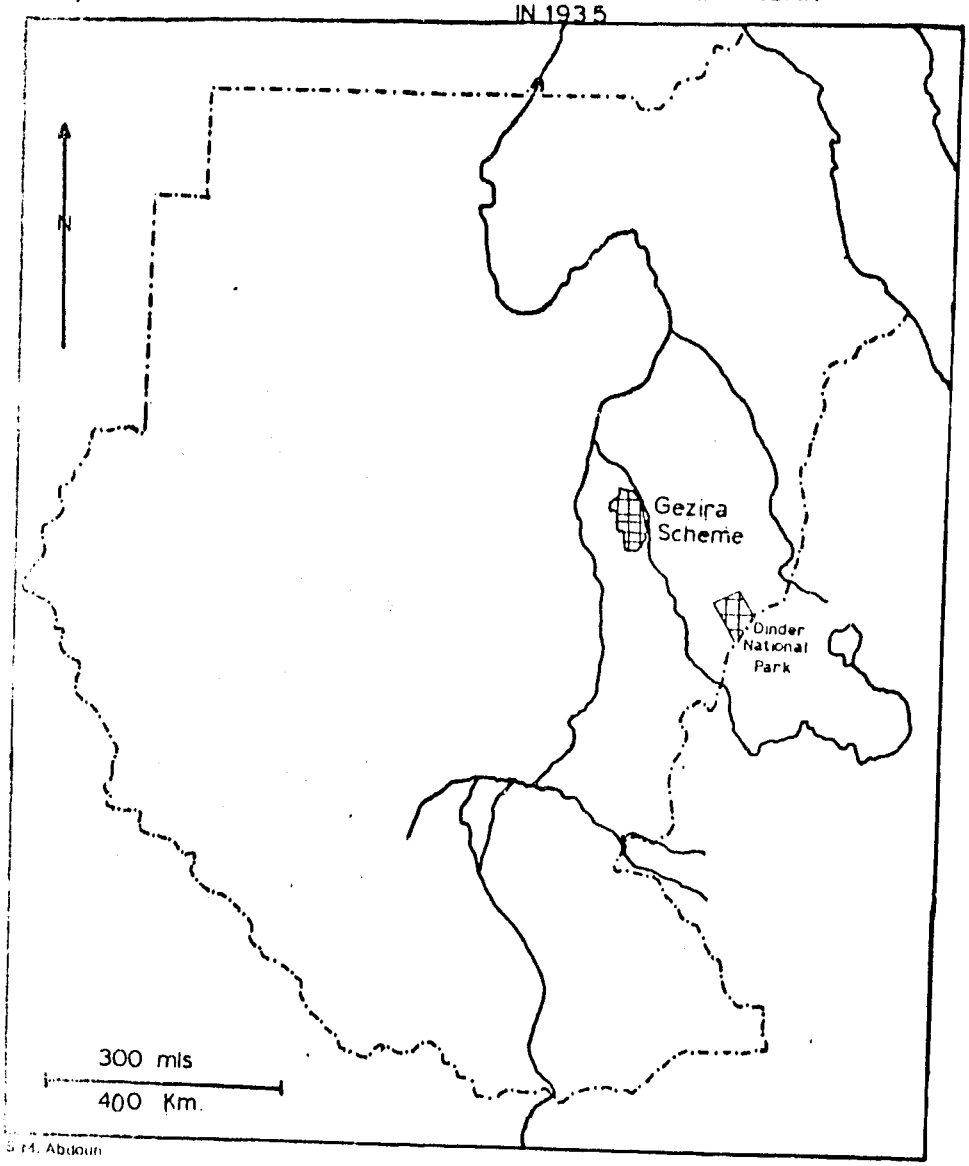

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Fig.5 indicates the accelerated rate of agricultural development in central and eastern Sudan between 1935-1965. Other than the increased acreage in the irrigated sector, the major and the most spectacular expansion took place in the rainlands. Mechanized dry farming introduced into the Gedaref area by early 1950's expanded quickly to other parts in Kassala and Blue Nile Provinces. As demand for sorghum and other products increased, it encouraged large scale clearance of additional areas (using hired and privately owned machinery).

These developments have deleteriously affected areas of land available for other subsistence activities including nomadic movements in and out of the area. At the same time the area started to experience large scale influx of population from other parts of the country.

Land use patterns in central and eastern Sudan between 1965 and 1985 are displayed in Fig. 6. The area has experienced further development and expansion in both irrigated (e.g. Rahad Scheme) and dry farming (e.g. Dinder Mechanized Schemes). Other than the Government financed demarcated schemes, development of dry farming took place through joint ventures and large scale privately owned companies. These new developments required acquisition of large areas as well as infusion of capital. These developments have further squeezed out subsistence farmers and nomadic groups as well as other peripheral activities. This legal official development has been always accompanied by further expansion of cultivation in undemarcated areas. The major environmental impacts are probably caused by both. All maps thus fail to show the concealed transformation of subsistence agriculture into the large illegal occupation of rainlands. The Dinder National Park is shown throughout the maps to provide a comparison through phases of land use patterns in central and eastern Sudan.

e. Land Use Patterns in and around the Dinder National Park:

Mechanized farming was introduced to the Dinder area as early as the 1950's by the wealthy businessmen. A total area of 252,000 feddans was planned and demarcated by the Mechanized Crop Production Administration in 1968/69 and licences were given to 144 farmers in 1969/70 to cultivate holdings between 1000-1500 feddans. The planned area is at a distance of 12-13 km from the new boundaries of the Park.

The accumulation of capital in the hands of the mechanized farmers, traders, government officials in addition to the profitability of such agriculture attracted investments to this field. At the same time the planned areas do not match with the new situation and consequently the rush to the unplanned areas continues. Of particular interest to our current report is the invasion of the land extending between the planned area and the park boundaries. Within this area there exists the 20 km extension of the old Park boundary. This area has experienced the most intensive encroachment by mechanized farmers outside the demarcated areas. This new boundary has been established to create a buffer zone around the park especially to protect wildlife during the wet season which coincides with the peak of farming activities.

Recently, and because of the pressure of the mechanized farmers, local businessmen and community leaders, the former National People's Assembly(Khartoum) issued an order, based on the recommendations of the Regional People's Assembly (Wad Medani), in which the 20 km wide zone is to be divided between the park 9.6 km, the farmers and nomadic groups 9.6 km, and 0.8 km as a neutral zone (Fig.8). The land allocated to the farmers and nomadic groups is expected to be planned and divided

Fig. 5 THE GENERAL LANDUSE IN CENTRAL AND EASTERN SUDAN BETWEEN 35-1965

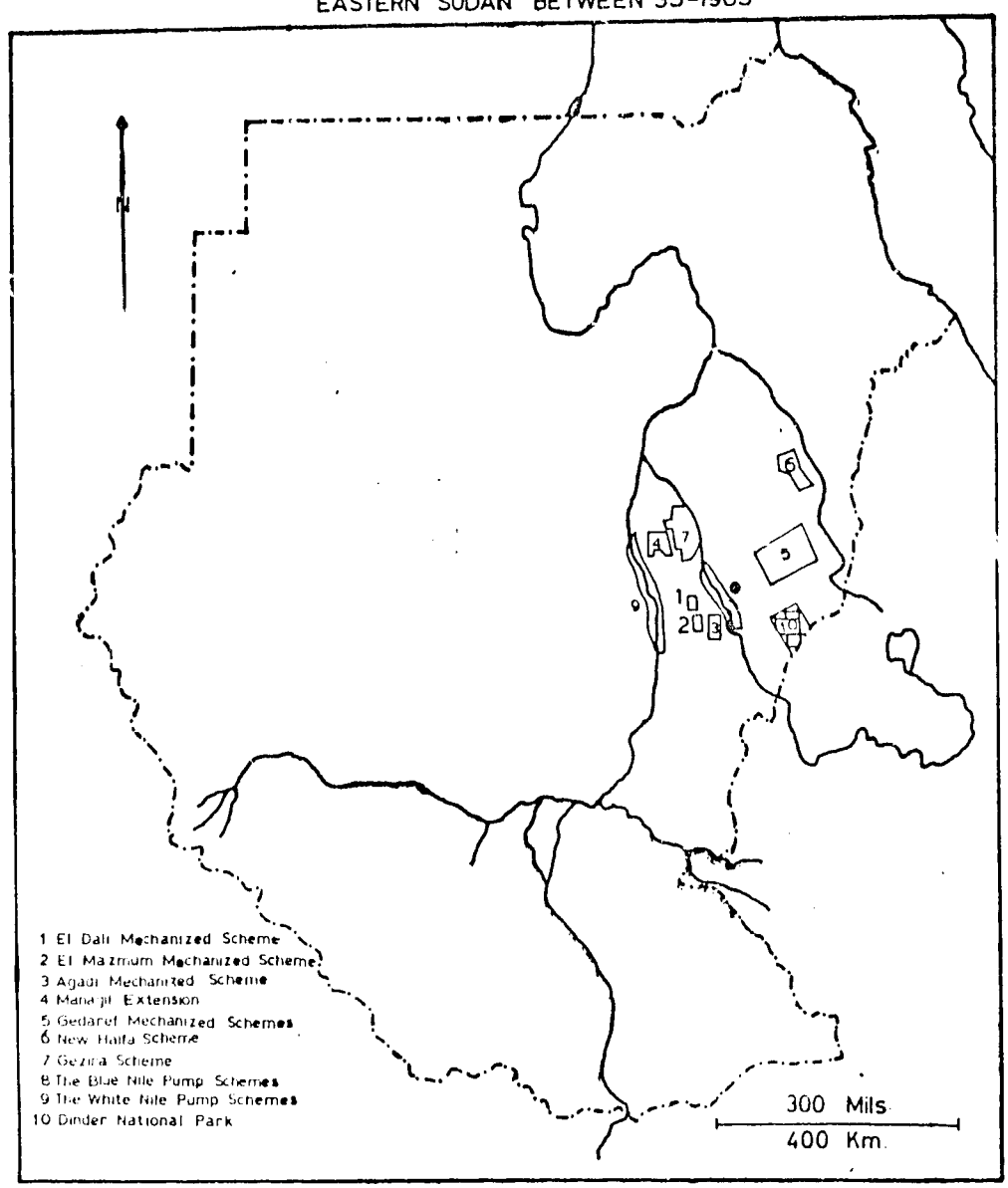

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Fig. 6

GENERAL LANDUSE IN CENTRAL AND EASTREN SUDAN BETWEEN 65-1985

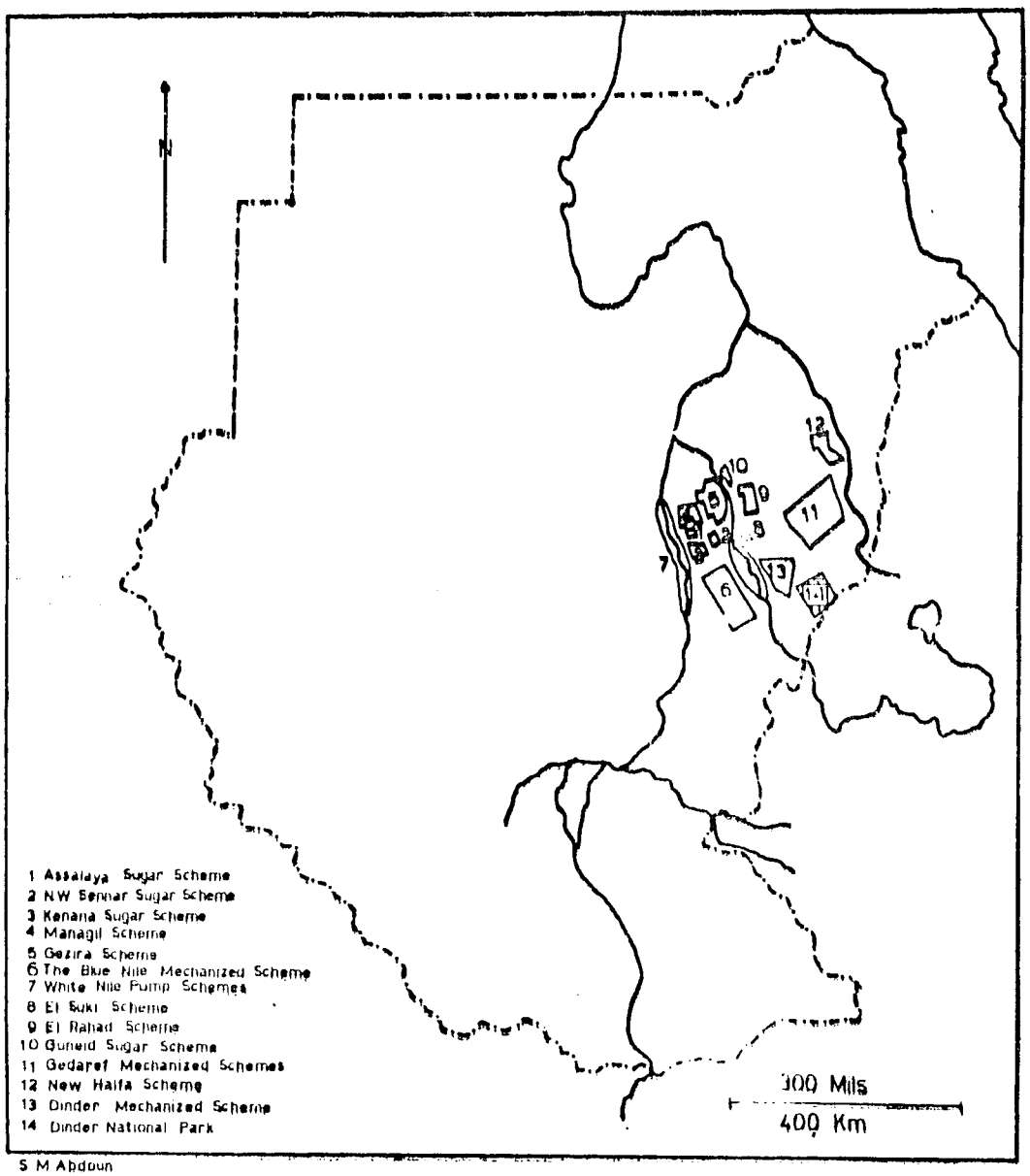

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Fig. 7 ENCRDACHMENT OF UNPLANNED MECHANIZED CROP PRODUCTION ONTO DINDER NATIONAL PARK

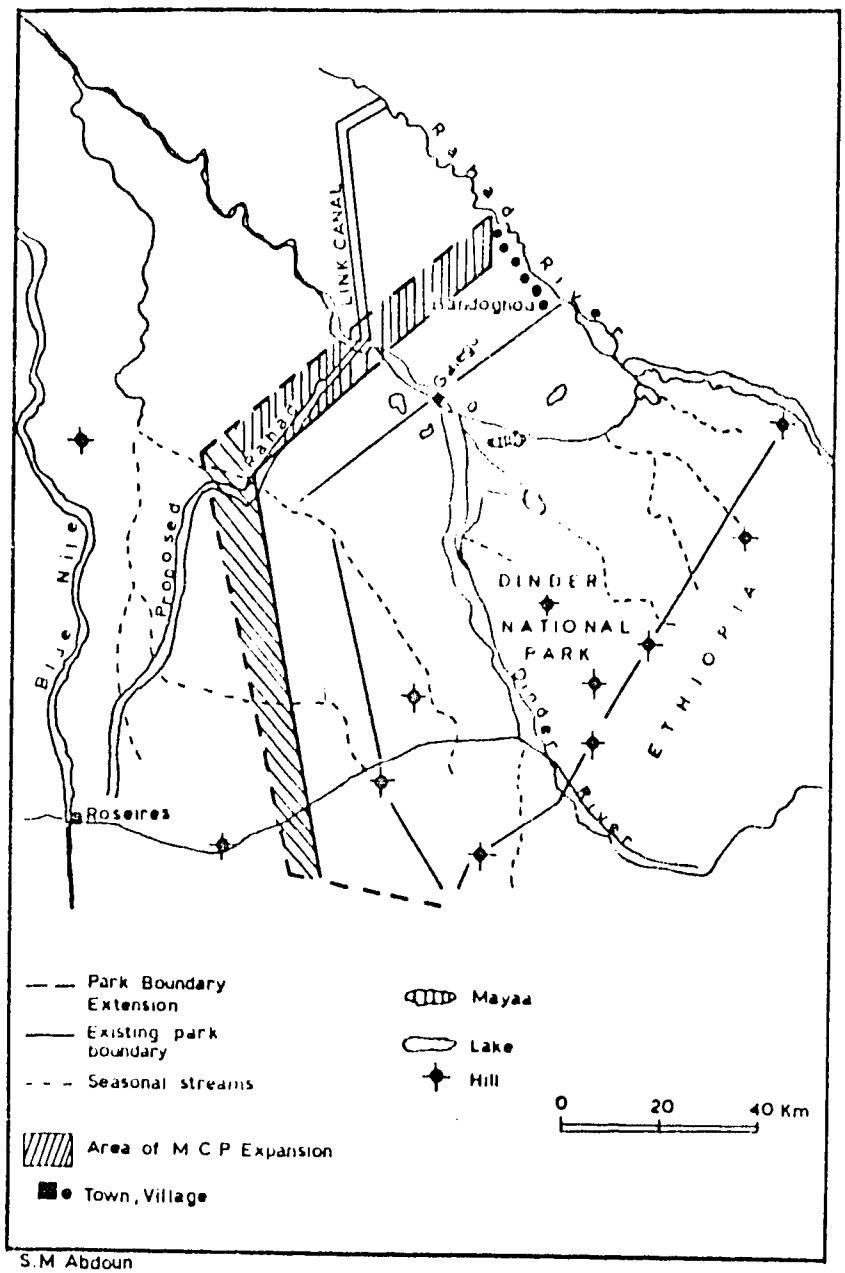

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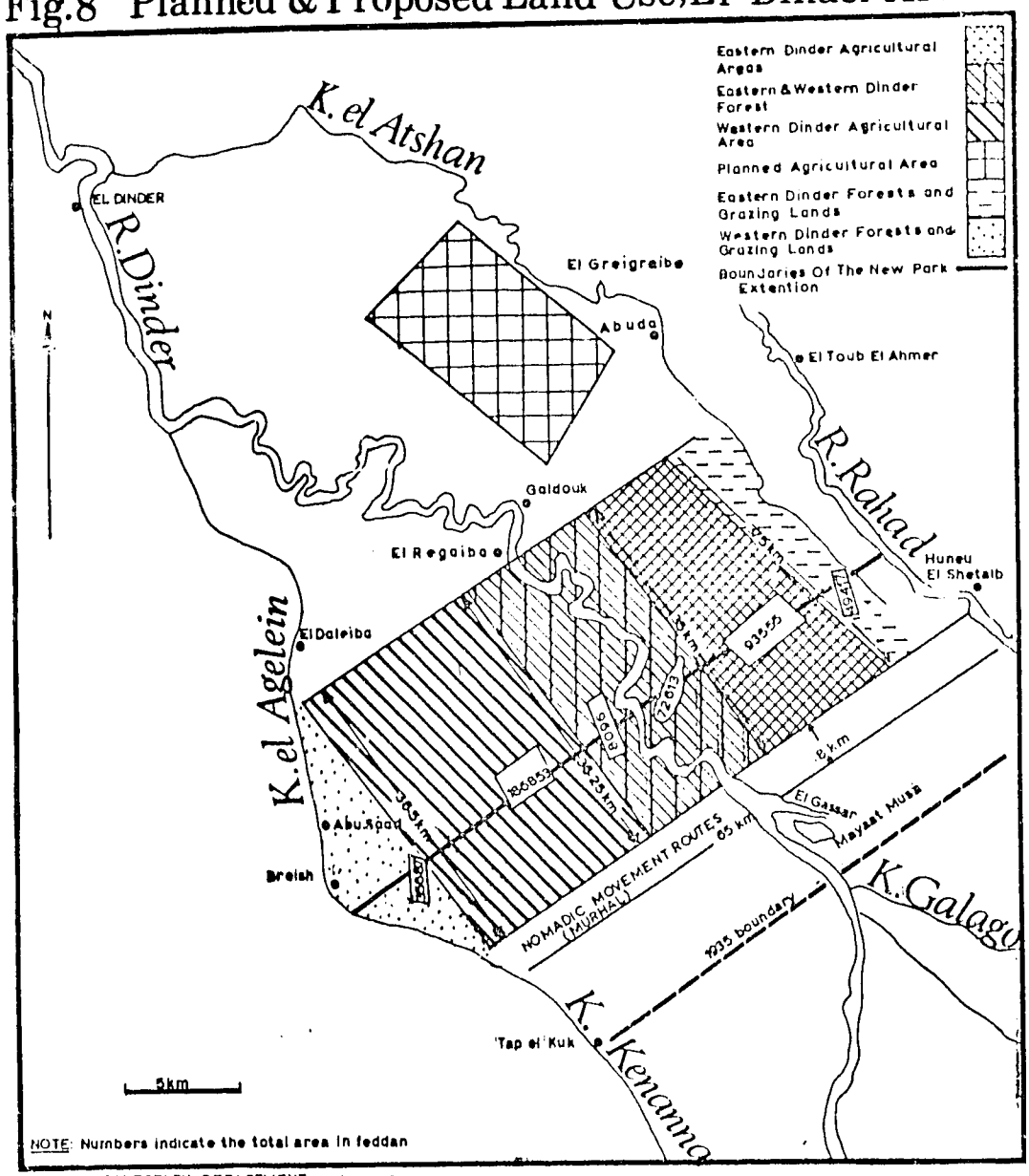
Fig.8 Planned & Proposed Land Use, El Dinder Area



SOURCE: FORESTARY DEPARTMENT, EL DINDER

between the involved groups. Till that time the present Military Governor and the Regional Director of Agriculture of the Central Region (Wad Medani) has given the farmers the green light to cultivate their former plots for the current year 1985/86 despite the dispute between them and the wildlife authorities.

As further evidence of continued encroachment by farmers even into the 1935 boundaries, we located several farmers in the area of Tabb el Kouk well within the western boundaries of the Park (June, 1985).

In fact the expansion of mechanized farming, if not controlled, will not stop at its demarcated boundaries - whether planned or unplanned - but it could even penetrate deeper and deeper into the park as far as Galagu (the centre of the wildlife guards and the tourism camp in the park). The acquisition of land and opening up of new land (and in the process elimination of vegetation cover as well as wildlife) is the ultimate goal of the mechanized farmers. "Why have we to reserve (or leave) all that fertile land for a handful of baboons? We do not want the park", is a well known phrase that one repeatedly hears from farmers.

Furthermore, a planning and licencing system will not solve the problem of the agricultural expansion. Evidently the farmers who have holdings in the planned areas (including Dinder, Singa and Er Roseires) are expanding into the unplanned areas inside the new boundaries of the park.

To a large number of farmers this area is particularly attractive (and they are ready to take the risk of persecution) for the following reasons:

a) Since the area has been under reserve for a long time soils are virgin, promising high yield rates.

b) By virtue of its location near the slopes of the Ethiopian highlands the area receives higher amounts of rainfall. In 1984/85 crop year farmers were able to produce large amounts of sorghum and other crops from relatively small areas, where in other areas there were high rates of crop failure. According to them the rains never fail (in total amounts and frequency).

c) Since these areas are relatively higher (Azazat) than the surrounding lands they are well drained. Geomorphologically they seem to form the water divide between the various drainage systems in the area. Because of these factors these areas attract both the mechanized farmer and the park's animal population.

d) Because of the above characteristics areas cleared for cultivation can sustain high yields for 6-8 years against 4-5 years in other mechanized crop production areas.

e) In spite of protection provided by the wildlife authorities and acknowledgement by most of the farmers that it is illegal to clear land within this area for cultivation they (farmers) hope that one day these Government lands (common property) will be eventually planned and divided for mechanized agriculture.

According to Moghraby et al. (1983), there were 70 unlicenced schemes within the boundaries of the park. Today statistics collected from the Agricultural Office, in Ed Dinder, indicate that there are 460 farmers outside the demarcated area controlling a total area of 266,000 feddans. Size of farms range from 500-1000 feddans. These licences are usually issued provisionally till new areas are planned, demarcated and divided. One of the basic flows in the system of licencing is that the Agricultural Office does not specify location although they generally indicate the size of the holding (100 feddans). What happens after the farmer gets the permission

is a different story. The above size figures show the farmers clear land that is 5-10 times the allowed area. The areas actually cleared show an increasing tendency towards large scale commercial production rather than subsistence purposes.

Within the newly established boundaries of the park, data collected indicate that there are 142 farmers (74 farmers in the Eastern Sector-area between Dinder and the Rahad Rivers and 68 farmers in the Western Sector-area west of Dinder River). Farm size ranges on average between 300-6000 feddans in the Eastern Sector, while it ranges from 300-3500 feddans in the Western Sector. The propensity of the farmers to expand within the new boundaries seems to have no limits. None of the farmers in accountable to the local Agricultural Office. They pay only a nomainal land tax of 50 p.t. per feddan.

Table 2 is derived from our field observation, wildlife records and the Dinder Agricultural Office. It shows areas cultivated in 1984/85, areas newly cleared (illegally) for 1985/86 season and percentage increase in one year.

The table provides further evidence to the growing land use conflict within the new boundaries of the Park. Among the total number of farmers (74 farmers) the annual percentage increase (encroachment) is 80 per cent. The average farm size is 14 times the area allowed by the Agricultural Office. Among the sampled farmers the farm size is 34,5 times the officially allowed subsistence size. Most of the farmers own and use more than one tractor. This allows the farmers to expand cleared areas indefinitely. This has also encouraged many farmers from other planned mechanized crop production areas (e.g. Dali and Maamun, Ed Dinder, El Gedaref) to open up new areas in and around the park. This influx has been intensified during the 1984/85 drought. At the rates indicated by the figures

in Table 2 the farmers will not only occupy the area within the new boundaries, but the park itself will probably disappear in less than a decade.

Table 2

Number of farmers, farm size in 1984/85, areas cleared for 1985/86 season and percentage increase the eastern sector Dinder National Park.

No.	Farm size in 1984/85	Areas cleared for 1985/86	Percentage increase
1	1,000	1,000	100
2	2,500	1,000	40
3	3,000	1,000	34
4	500	250	50
5	1,500	500	34
6	2,000	2,000	100
7	1,000	500	50
8	1,500	3,000	200
9	1,500	2,500	134
10	4,000	2,000	50
11	3,000	1,000	34
12	1,000	3,000	300
13	5,500	1,000	18
14	2,000	1,000	50
15	2,500	1,500	60
16	2,500	1,000	40

Notes:

- On average the annual percentage increase = 80%
- Total area occupied by 74 farmers in 1985 = 106,000 fedeans
- Average area per farm = 1,430 "
- Total area occupied by farmers in the sample (16 farmers) in 1985 = 35,000 "
- Areas illegally cleared in 1985 = 20,250 "
- Total area to be cultivated in 1985/86 = 55,250 "
- Average area per farm among the sampled farmers = 3,450 "

Traditional Agriculture:

From the field observations and the interviews with the local people, the traditional agriculture is restricted to a handful of plots at the northeastern and the northern margins of the Park where the local people in some villages like Ein El-Gamal, Umm Kuraa, El Jumam, El Gogani, and Hona El Azrag cultivate small holdings depending, to a great extent, on their manual capacity similarly to other areas at the northwestern side of the park near Eraif-El Deek. Most of those practices are out of the 1981 boundaries with the exception of that of Ein El Gamal which is located within the park according to the new boundaries of 1981 due to the fact that the village itself was founded in 1960 and its legal problem of existence is not solved yet.

The expansion of traditional agriculture is expected as the result of the recent exodus prevailing with the drought that inforced the phenomenon. On the other hand the new migrants have other alternatives uch as to work as agricultural labourers in the expanding mechanized farms together with the seasonal migrants. The latter come mainly from Western Sudan in addition to small groups from Southern Sudan. Traditional agriculture in the way discussed above plays a minor role in the conflicts upon the park relative to the mechanized one.

As a summary we can say that the main reasons behind the agricultural expansion out of the planned area to the margins of the National Park are the following:

i- The planned area of 1968/69 is lagging behind the accumulated capital and the outlook of the farmers.

ii- The pioneers have acquired as much land as they could for themselves and their families so that the only alternative left to the late-comers is to invade the Park.

iii- The soils of the Park and its surroundings are virgin and fertile enough to attract mechanized farming.

iv- Absence of land control by the concerned authorized government departments and lack of co-ordination between them, i.e. Wildlife Dept., Forestry Dept., Range Management, Regional Councils, etc.

v- Light sentences against law breakers.

vi- Decision making is directly or indirectly biased by the farmers' pressure groups.

vii- Lack of field inspection facilities for the wildlife rangers.

viii- The discrimination of the grazing rights.

ix- Lack of scientific techniques of agricultural production vis-a-vis land and crop rotation, use of fertilizers and praticides.

Grazing Lands:

Animals rearers acquired grazing rights for their long history in the area where they can use the marginal pastures between the cultivations known as "marahil" or "masarat" (grazing strips). The "marahil" used to lessen the frictions between the animal rearers and the farmers as long as they are wide enough. The competition becomes harder if their carrying capacity is lower than the number of the livestock.

The clans and the tribes found in the area are Umm Aroza (Ruffa El Sharig), Awlad Badawi (Ruffaa), Shibilat (Ruffa El Hog), Wadean (Ruffaa), Wad Abu Khiraiz (Ruffa), El Shibba (Ruffaa), Galatin (Ruffaa), Nasrab (Ruffa El Hog), El Singrab (Halawin) and El Gilifab(Kenna). These tribes rotate between River Dinder and the

Blue Nile in the dry season. They are now suffering from the expansion of the mechanized agricultural schemes that are closing the "marahil". Some of them confine themselves close to the banks of the two rivers most of the year to avoid the contact with the farmers.

The drought conditions have expelled other nomadic groups to the already overstocked Dinder area in the last few years. The area witnessed for the first time the invasion of nomadic groups from as far northeast as Atbara and Kassala and as far southwest as Singa and the White Nile with their sheep, cattle and camels. The newcomers are Kawahla, Ghazaya, Shukria, Arakien, Agalien, Lahawin, Bani Amir, Zubidia, Fallata and Umm Barraro. Most of the interviewers (during June 1985) explained that they have come to the Dinder for the first time looking for better pastures. Consequently they have changed their former lines of movement.

Lack of grazing lands and the overstocking of the area introduced a new disastrous habit of chopping-off the tree branches of evergreen spp to provide more food for the animals. Not only that but the rearers drive their herds into the park stimulated by the poor facilities of the park wildlife rangers. Some cases were caught and taken to the court.

The animal rearers are complaining about the scarcity of the land left for the pastures and the discrimination of the grazing rights by the farmers. This is explicit when we refer to the distribution of the mechanized agricultural schemes in the whole area. Even the decree of the ex-National People's Assembly mentioned before has neglected the acquired rights of the nomadic groups by allocating only 0.8 km wide strip for grazing and a route (marahil) out of the disputed 20 km new park extension. On the other hand the mechanized agriculture was given a free-hand to expand formally into 9.6 km wide strip in addition to the areas it is already occupying.

PART THREE

HUMAN SETTLEMENTS AND SOCIO-ECONOMIC DYNAMICS IN ED DINDER AREA

PART THREE

HUMAN SETTLEMENTS AND SOCIO-ECONOMIC DYNAMICS IN ED DINDER AREA

There are three growth poles surrounding the Dinder National Park and covering areas which can be considered as ecological and economical extensions of the Park. Ed Dinder (El Guasi), Ed Damazine and El Gedaref are three urban centres with rapidly growing human settlements, increasing commercialization of production, mechanization of cultivation and utilization of forests. The further growth of population, animal stock and economic activities in these regions will have great impact on the future of the Park. First, because the Park itself is not considered as one complete ecological zone (Hakim, 1984). Second, because the urge for expansion and competition over land is leading to further infringements into the boundaries of the Park.

The purpose of this section is to analyze in a preliminary way the socio-economic dynamics of one of these growth poles with the purpose of projecting any possible conflicts, resolution of conflicts and outcomes. The study concentrates on Ed Dinder town and area. However, a comprehensive study of the area is necessary in order to give an overall view of the spatial linkages and socio-economic interactions in the area. In fact a further extension of the study is needed in order to incorporate the national level demonstrating the interdependence and interactions in the political dimension and the utilization of resources.

The urban centres of Ed Dinder, Ed Damazine and El Gedaref constitute a triangular containing Dinder National Park and a large area with a drainage system including parts of the Blue Nile River, Ed Dinder and Rahad rivers.

El Gedaref lies in the southern part of Kassala Province, east of the Rahad River (Tayeb, 1984). Due to the richness of the soil and reliability of rain, the area invited a rapid growth of mechanized rainfed cultivation. The first mechanized farming began in 1944 in the Ghadambalayia. Thereafter, it became the most dynamic area in Sudan experiencing rapid growth of population and production of sorghum, sesame and rainfed cotton.

Ed Damazine is the provincial capital of the Blue Nile Province and is situated on the west bank of the Blue Nile (Simpson and Simpson, 1978). Though the old town of Roseires was the major centre in the Southern Fung Region, Ed Damazine became the major commercial and administrative centre after the establishment of the Roseires Dam in 1966.

Our own observation in addition to studies by Hakim (1984), Nimir (1983), Tayeb (1984) and Simpson (1978) showed the following common trends in the area:

a. Increasing Human Settlements

Human settlements have increased significantly in the last few decades. Around the Park several new settlements have been noticed. Nimir reported that 20 new villages have been built during the last decades. This is to be contrasted with a history of little or no population around the Park in the beginning of the century as noticed by Harrison (1953). By the early 1980's the population has increased significatnly. According to 1983 Population Census the population of Ed Dinder area was 93,023 persons (Table 3). This can be compared with 730,000 persons estimated to be the population of the Gedaref region with a population density of 9.4 persons per km^2 (Tayeb, 1984). Similarly in the Damazine area there is an increasing number of settlements. According to Duffield a substantial number of West Africans settled over 210 villages along the banks of the Blue Nile south of Sennar.

Table 3

The population of Ed Dinder as percentage of the province, region and total porulation

	Households		Males		Females		Total	
	No.	%	No.	%	No.	%	No.	%
Dinder area	16,162	00	48,369	00	44,658	00	93,023	00
Blue Nile Province	184,088	8.78	571,539	8.46	537,590	8.30	1,109,129	8.38
Central Region	698,010	2.32	2,127,828	2.27	2,085,342	2.14	4,213,170	2.2
Sudan	2,838,305	0.57	10,963,605	0.44	10,628,976	0.42	21,592,282	0.43

Source: Department of Statistics, 1983 Census.

b. A Process of Sedantarization

The settlements are not new phenomena to the Dinder area where towns like El Suki, Ed Dinder (El Guaisi) represent the centres in their upper hierarchy. Close to the National Park some villages, like Eraif El Deek, were founded before the park itself. For the sake of protecting the Park from poaching, honey collection and other activities those villages were moved from their original sites to keep them at a reasonable distance from the Park. Although other villages, like Bain El Gamal (founded 1960), are located outside the 1935 boundaries of the park, the new boundaries of 1981 have added them to the Park.

The early migrants who arrived to the area around and before 1940 have established themselves and are claiming rights for riverine lands (groof) for growing fruits, vegetables and other horticultural products as well as rainfed holdings and pastures. In 1948, Tothill described the area as largely inhabited by Rufaa esh Shareg, tribes who were mainly camel-owning with large holdings of camel and sheep (Tothill, 1948).

Recently settlements have been growing at faster rates, - two to three - fold due to the exodus from the desertified areas particularly from Western Sudan.

It is interesting to observe that the kinship affiliation characterises the pattern of migration to the Dinder area. The new members of clans and tribes join their kin who settled before them in well established villages. In this way groups from Messeria, Baggara (Rezigat, Bani Halba, Taisha etc.), Zaghawa, Salamat, Dago, Massalit and some West Africans like Hausa, Barnu and Umm Barraro have found refuge in villages of kin; Tables 4, 5 and 6 show population trends in Ed Dinder area.

The ratio of nomadic to total population might have been as high as 80% during the 1950's. During the last 30 years, sedentary population has increased, first as a result of migration and new settlements and second and more important, as a result of a slow process of sedentarization where many of the nomads settled down. The ratio of sedentary population was 53% in 1983 (Table 4). The number of villages doubled.

Table 4

Nomadic population in Dinder Area - 1983

	Families	Males	Females	Total
Dinder East-Rural	1,768	5,372	4,956	10,328
Dinder West-Rural	1,434	3,831	3,422	7,253
Total	3,202	9,203	8,378	17,581

Source: Department of Statistics, 1983.

Table 5

Geographical distribution of population in Dinder Area

	Families	Males	Females	Total
Dinder Town	1,421	4,881	4,515	9,496
Dinder East-Rural	5,536	16,083	14,523	30,606
Dinder West-Rural	6,003	18,098	17,242	35,340
Total	12,960	39,162	36,280	75,442

Source: Department of Statistics, 1983.

Table 6

Total population in Dinder Area

	Families	Males	Females	Total
Rural Nomadic	3,202	9,203	8,378	17,581
Rural Sedentary	11,539	34,281	31,765	65,946
Urban	1,421	4,881	4,515	9,496
Total	16,162	48,365	44,658	93,023

Source: Department of Statistics, 1983.

There is certainly overgrazing and overstocking in the area. It is estimated that there are 60,000 cattle, 30,000 sheep and 10,000 camels. The carrying capacity of the available grazing area is less than the demand. This led the nomads to move to the Park area. We have come across tens of herds owned by Rufaa esh - Sharag as well as other tribes grazing inside the Park. In fact the data compiled by the Wildlife Administration recorded 2,529 incidences of herds trespassing during the period 1970-82 (Nimir, 1983). The extent of trespassing is increasing with the shrinkage of the area available for grazing. Recently the Wildlife Administration started enforcing very harsh regulations of shooting and confiscating trespassing animals. Despite that the nomads continued to take the risk and penetrate the Park. This may reflect mere desperate behaviour due to the lack of grazing land. To the Wildlife Administration, the nomads' animals pose a threat to wildlife not only because of competition over the grazing land but more so because nomads' animals are held to be behind the outbreak of some epidemic diseases that killed some wildlife. Hence, there is increasing tension between the nomads and the Wildlife Administration, much more than that with mechanized farming.

c. A Process of Urbanization

Ed Dinder and Abu Hashim are rapidly growing administrative and commercial centres. The latter is even older - referred to by Tothill in 1948 - and might have been the capital of the tribe. The Abu Sin family which was mentioned during the Turco-Egyptian era resided in Abu Hashim.

Ed Dinder grew as an important centre due to its location near the railway line (a railway station) and the fact that it became a crossroad of transportation to Gedaref linking it with Es Suki. Afterwards it became an administrative centre when a municipal council was

established there in the 1950's. Thereafter it grew as an important centre for administration and a commercial centre, Tables 5 and 6.

Several wholesale grain, crop merchants and retail traders moved to Ed Dinder. There are probably over 200 merchants and traders in the town. The major big merchants trade in grain (sorghum), sesame and charcoal. In 1981 there were 69 registered charcoal merchants. The surpluses generated in trade are often siphoned into mechanized farming and/or charcoal production.

d. Charcoal Production and Forest Utilization

To the local villagers and nomads the forests constitute the major source of energy. The rate of use of wood and forest products by the traditional villagers is very limited and mainly intended for own consumption. However, commercial production of charcoal in Ed Dinder area began before the 1950's. The merchants expanded their activities to charcoal production. One who is interested in producing charcoal gets a permit from the Department of Forestry. He dispatches workers with food, water and tools in order to produce charcoal from Acacia seyal. The workers are paid at piece-rate (per sack). The merchants send lorries to collect the charcoal. They may store it in Ed Dinder itself where hills of charcoal can be seen from far in the northestern side of the town. Sometimes the merchants store the charcoal in neighbouring towns or consuming centres - such as Khartoum, Medani, Sennar, etc. In addition to the big producers each of whom may produce as much as 20,000 sacks annually there are also small producers who usually produce very small amounts either by working themselves or employing few workers.

Cutting and replacement of trees are catered for according to the map (Fig.8). In the past the licence approval of charcoal makers was the authority of the

Forestry Department, but currently it is the job of the Regional Councils which creates weak control over the activity.

The government collects duties from the licences. In the last three years the production of charcoal and the revenues for Ed Dinder People's Council are presented in the following table.

Table 7

Charcoal revenues collected by Ed Dinder Council (1981-1984)

Year	Production (in sacks)	Revenue (in Ls)
1981/82	646,064	161,517
1982/83	817,948	204,488
1983/84	1,242,763	310,692

Source: Forestry Department Office, Dinder, 1984.

Data about the production and the revenue of fuel and timber are not at hand. Nevertheless, the table indicates a rapid increase in the activity. It recorded 26.6% production increase in 1982/83 from the base year 1981/82 and 51.9% between 1982/83-1983/84. The production almost doubled in the last year 1983/84 from the base year 1981/82 by recording 92.4% increase. This increase in the charcoal production is not only due to the demand by the market but it is also ascribed to the increase in the area under mechanised farming. The authorities have no way out in giving the farmers, and traders as well, licences to produce charcoal because the farmers have the right of clearing their agricultural lands (tree cutting and up-rooting, burning of straw and weeds etc.) and they would burn the trees even if they failed to get the charcoal making licences.

The increasing activity of wood cutting and up-rooting, no doubt, leads to soil erosion and degradation (environmental deterioration). It consequently reduces

the production capacity of the land (crops) and the shift to other land is the handy alternative. Wood cutting and up-rooting will give more chances of pressure on the land and becomes more dangerous when extended to the National Park.

e. Wild Animal Poaching

Poaching of wild animals is prohibited by laws all over the country even outside the animal reserves. The sun dried meat is required by many people. Cheap prices attract the farmers to supply meat for the agricultural labourers together with dried fish. Poaching is one of the problems the park has experienced throughout its history. The concentration of wild animals in the park stimulates poachers to break in. Some animals are unpalatable but poached for their skins or other usable part of their bodies. It is an easy profitable job in which traps, traditional hand tools and guns are used. The poachers usually move in groups and establish temporal camps where they could spray the meat and stretch the skins for drying.

Many cases of poaching are caught by the wildlife guards and taken to the court. In this respect it is a dangerous task to pursue poachers, bearing in mind that they are usually armed and strongly resist arrest. Contemporary to the field visit of the authors to the park a guard was shot by a poacher in one of the campaigns. The solutions for the poaching problem, no doubt, require provision of inspection facilities for the guards and hard sentences against those who are engaged in the activity.

f. Honey Collection

The National Park provides a good habitation for the bees, hence honey is available for the collectors who find flourishing markets. Formerly honey collectors were allowed to enter the park but now honey collection is prohibited and considered unlegal. The prohibition is

justified by the fact that the collectors used to smoke out the bees by setting fire to the herbs and weeds so haphazardly and carelessly that the fires usually extended to unlimited areas and destroyed the surrounding habitats beside burning the bees themselves.

The collectors have failed to adapt more advanced techniques that could enable them to collect honey and at the same time preserve the environment from destruction. There is also no guarantee that they will confine themselves to honey collection alone; under the umbrealla of this activity they have the chance to practice other jobs, i.e., poaching.

INDICATORS

A combination of physical and social indicators are needed. However, the present Dinder group felt more comfortable in focusing on the physical system indicators, a situation that probably reflects the need to involve more input from the social sciences. Critical indicators to monitor change in the area of Dinder National Park would be found in the areas of soil, vegetation, animals, nomads, forest products and mechanized agriculture.

In attempting to think through some of these issues further and to define potential indicators, we constructed the very simple causal loop diagram (Fig.9) that supplements the more elaborate systems model of the Dinder ecosystems (Fig.10). As elaborated in ETMA-Sudan working paper No.1, the meaning of an indicator is often ambiguous. In interpreting an indicator, much depends on the underlying philosophical parspective that is thought to bear on the indicator. Thus if one favours wildlife conservation as a primary value, then any environmental change that reduces animal habitat will be viewed as a negative development. If, on the other hand, one is concerned

Fig 9 INTERACTION OF ENVIRONMENTAL INDICATORS OF DINDER PARK

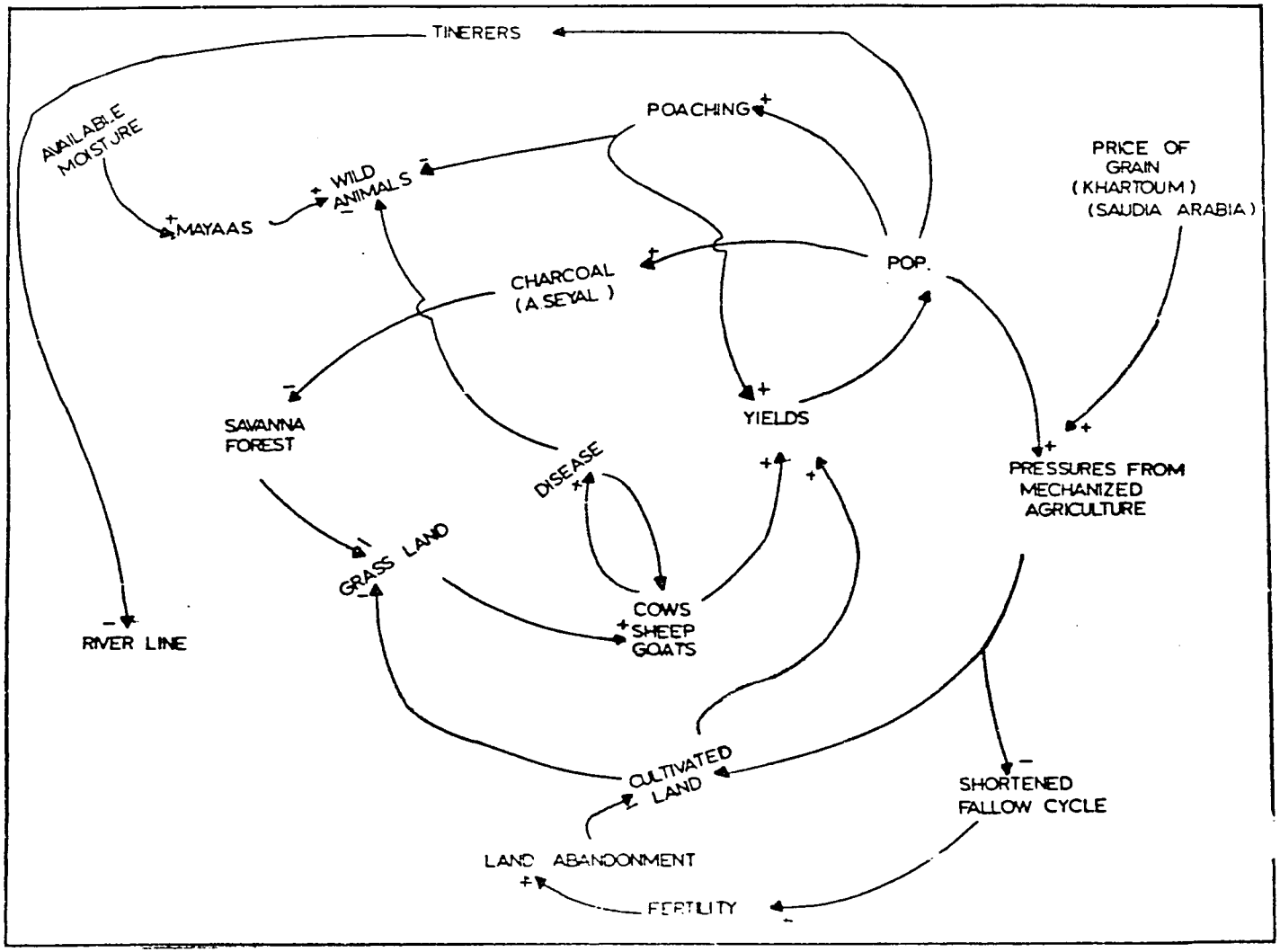
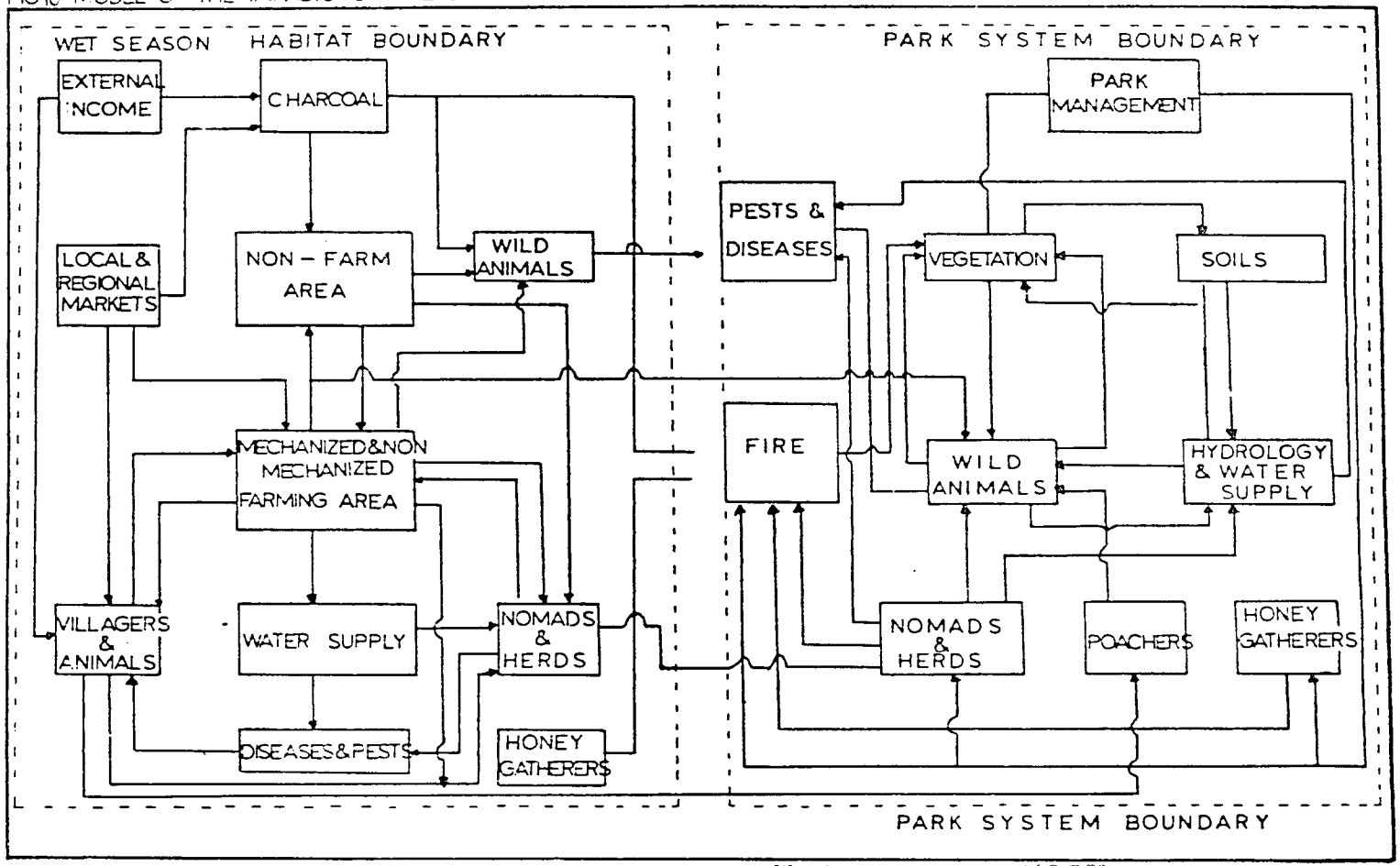


FIG10 MODEL OF THE IMPACTS ON THE DINDER PARK ECOLOGICAL SYSTEM (AFTER WHITNEY 1981)



S. M Abdoun

about providing food and other resources for people, then the conversion of grassland to mechanized agriculture is a positive blessing.

Indicators to monitor environmental change in the area of Dinder National Park include:

The amount of grassland as compared to the extent of open Savannah forest. This indicator can readily be monitored over a broad area through remote sensing images. Several possible pressure mechanisms can be envisaged as producing changes in the grassland/forest ratio, including charcoal cutting and burning and/or expansion of mechanized farming.

Both of the above processes might be due to changes in local population dynamics and distribution of local villages. In addition other important factors could be operating at a regional scale to promote change. Not least of these is likely to be the price of grain in the national market place.

Equally important are the feedback loops in the system that regulate the pace of change. Thus, changes that reduce soil fertility and encourage land abandonment act as a constraint on the expansion of cultivated land and promote the reestablishment of grassland and, presumably, the original savannah forest community.

The amount of (or percentage increase in) abandoned land would under these conditions be a useful indicator of the direction of environment change.

The increase in quella-quella with agricultural expansion might also be a valuable indicator, as would some measure of the amount of charcoal production from the area.

The extent of burning, both in the Park and outside it, from one perspective would indicate the potential for

substantial ecological change. It is also possible that fire (at least if maintained at or below certain levels) might be important in the maintenance of the more open savannah forest ecosystem that is valuable to both domesticated and wild animals.

Other ecological change indicators are best represented by examples of tree regeneration, rather than the mature, canopy level specimens. A focus on species regeneration is seen as one of the most suitable measures of shift from one system state to the other. Tree regeneration is affected by fire, grazing and other human activities as well as changes in environmental conditions, such as rainfall.

The areas selected to test ecological indicators should be areas vulnerable to ecological transformation. The ecotones are of more interest than the core of ecologically stable environments, if the objective is to understand the stability and resilience characteristics of the system under consideration. Thus particular attention is drawn to the 20 km transitional zone recently added to the park, an area that has long been under human exploitation.

Another example is readily available in the old "clearance" alignment of the Rahad canal. The area had been cleared in the late 1960's. To date the only woody species regeneration is found in the mechanized agricultural plots within the area. This could compare nicely with the clearing of the protedted airport strip near Gelag (abandoned for at least six years). Acacia seyal regeneration is quite dense in the latter. This probably reflects the intensity of grazing, thickness of grass cover and fire.

The wildlife population in the Park and adjacent areas may be an indicator of ecological change. Deterioration of the grazing and water resources upon which the

wildlife depend should be reflected in fluctuation in animal numbers and herd structure. This, in turn, is linked not only to climatic fluctuations, but also to other negative feedback loops such as poaching pressure or diseases transmitted from livestock.

Another critical indicator is the change in the physical and biological state of the mayas through siltation, water residence time and use by wildlife as well as changes in the distribution of vegetation rings and clogged feeding inlets. All these are parameters which may seriously reduce food and water supplies for wild animals, especially in the dry season.

Other subtle indicators include:

1. Appearance and extent of occurrence of new plant species and replacement of perennial grasses with annuals - indication of loss of soil fertility and/or decreased rainfall, e.g., the appearance in several areas within the Park of Calotropis procera.
2. Range and occurrence of species of wildlife, e.g., a lion was reported to have been seen near Abu Hassheim in August 1983. The extension of the lion's range could indicate the extent of wet season habitat of wildlife. Elephant was hunted near Abu Hassheim in the 1930's (Mahana, person. commun.). On the other hand it could indicate a shift in the feeding preference of some lions to domestic livestock.
3. Wildlife herd structure and rate of recruitment.
4. Number of herds and geographical extent of illegal livestock grazing.
5. Extent and frequency of wildlife diseases.
6. Number of poachers caught and the weight of dried meat bagged.
7. Number of visitors to the Park.

8. Expansion of the area of mechanized cultivation and size, location and number of villages around the Park.

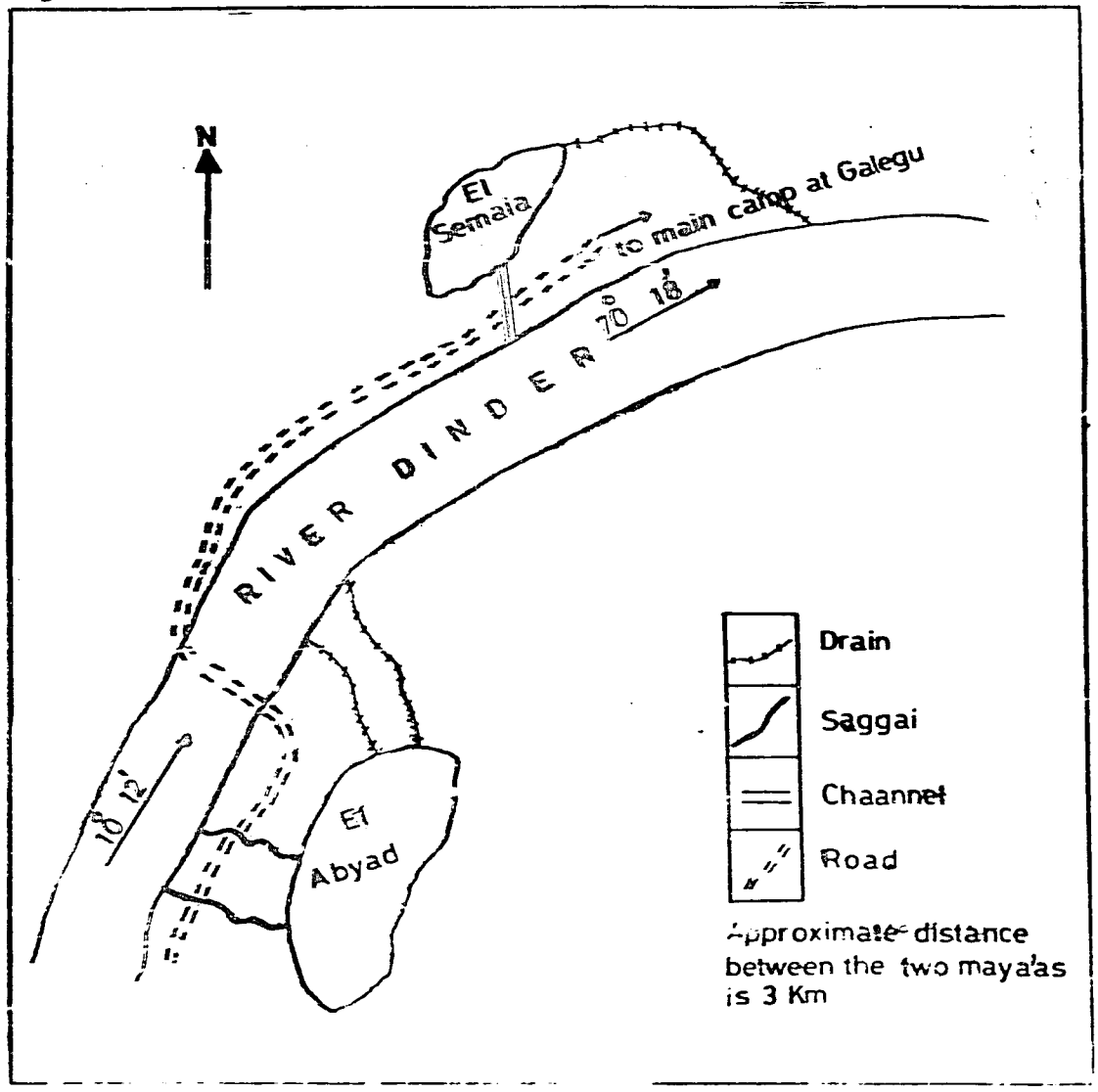
INTERVENTION

It has been observed during the past 5-7 years that most of the maya'as in Dinder National Park have dried up. The feeding channels connecting maya'as to River Dinder (Saggayat) are no longer transporting water to the maya'as, the reason being that the discharge of the river has decreased from the normal of 3 X 109 m^3/year to 2 X 109 m^3/year. This had trigerred a chain of events starting with the blockage of the saggayat. Repeated fires, decrease in the amount of rainfall and deterioration of plant cover in the catchment areas of maya'as had caused the substitution of perennial grasses by annuals and the eventual silting up of maya'as.

The hypothesis of the present intervention (carried out in May 1984) is that by improving the slope of the saggayat water will flow into the maya'as during the annual flood of the river. To achieve this purpose lines of levels were run through the beds of selected saggayat to the far edge of the maya'as. This was to determine the relative height between the bank of the river and the bed of the maya'as. Tacheometry was also employed to find the height of the river bed relative to level of the saggayat at the bank of the river. It should be mentioned that the levels of various points related to the mean Sea level, due to the lack of vertical control points on that area. Instead an arbitrary datum was used.

Two maya'as were tackled, El Abyad (in which the above procedure was followed) and El Semaia (in which an artifical channel was excavated from the nearest point on the river bank to the maya'a (Fig.11). The scale used was feet and not meters.

Fig. 11 SKETCH OF THE AREA OF SURVEY



El Abyad:

Once one of the most productive maya'a in the park. El Abyad is located about 30 km south of the junction of Khor Gelagu with River Dinder (on the eastern bank). Here two saggayat 500 ft (a) apart were surveyed. An arbitrary datum of 100 ft was chosen for the first point on the northern saggai (we named this saggai "Khor Mirghani"). The same datum was used for the southern (Khor Beshir). The difference in height between the starting points of these saggayat was found to be 3.29 ft.

Longitudinal profiles were drawn (Figs.12, 13 and 14). The following table compares Khor Beshir to Khor Mirghani.

Table 8

Name of Saggai	Length of level line	Datum (ft) 1st point	River bed	Far edge of maya'a	Slope	Approx. bearing
Khor Mirghani	5600 ft	100.000	94.01	101.426	1in 1100	95° 00
Khor Beshir	3600 ft	103.290	96.763	102.255	1in 550	75° 00

Furthermore, the two khors draining the maya'a were blocked using dom palm and earth barriers. The barriers were constructed to raise the level of water in the maya'a so that water would cover the whole undulating bed and to increase the residence time in the shallow edges of the maya'a.

El Semala:

A dry maya'a which was once renowned for the large number of packs of the African Hunting Dog lies about

(a) The metric system was not employed here because all equipment used was calibrated in feet.

3 km south of El Abyad (on the western bank of River Dinder). Due to the length of the saggai and the limited time available to the survey team, a new saggai was excavated along the shortest span between the maya'a and the river. The length of this channel (Khor Goni) is 600 ft with a slope of 1 in 400.

An arbitrary datum of 110 ft was chosen for the first point at the bank of the river.

The datum for the river bed	=	100.910 ft.
The datum for the last point	=	00.12 ft.
Approximate length	=	102.495 ft.

A longitudinal profile is shown in Fig.13. It should be mentioned that the line of level was not run up to the far edge of the maya'a.

Excavation was carried out by a motor grader and a tractor, controlled by values read on the staff at the locations of the pegs, at intervals of 100 ft along the slope. The last 20 ft. (near the bank) were dug manually.

Future plans include monitoring of water level in the two maya'as, calculation of the hydrological balance, identification of pioneer plant species and the recedes towards the centre of the maya'as (the last two parameters will be studied by a graduate student from the Botany Department, University of Khartoum, who has already started his field work in the park).

In conclusion we must stress that we have carried out the above intervention in spite of our appreciation of basic principles of management related to National Parks. Our justification in attempting to preserve the natural cycle (and it may be man induced) of drying up of maya'a is that without revitalizing the maya'a we will lose the park.

Fig. 12 LONGITUDINL PROFILE OF MAYA.AT EL ABYAD AND KHOR BESHIR

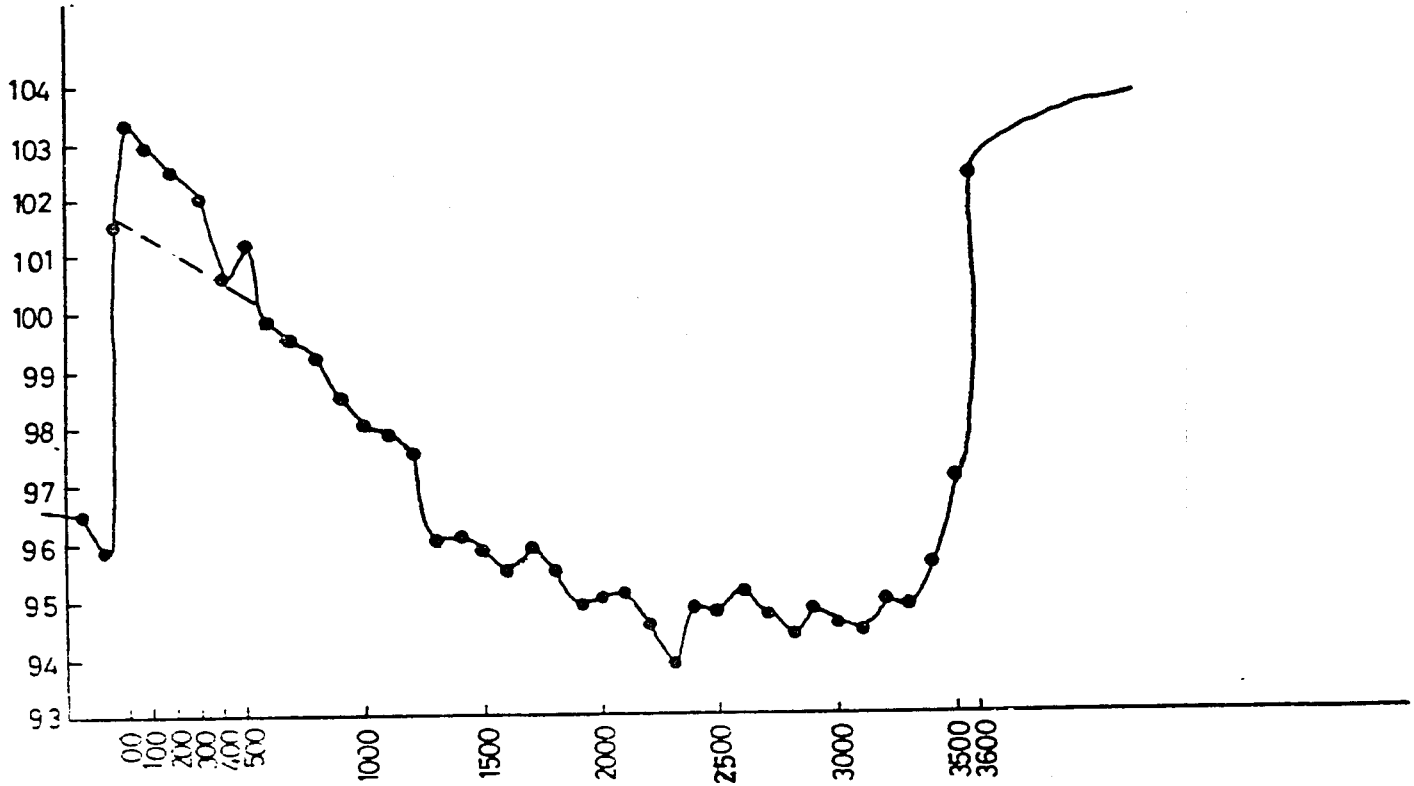


Fig.13 LONGITUDINAL PROFILE AND KHOR GONI AT EL SEMAIA

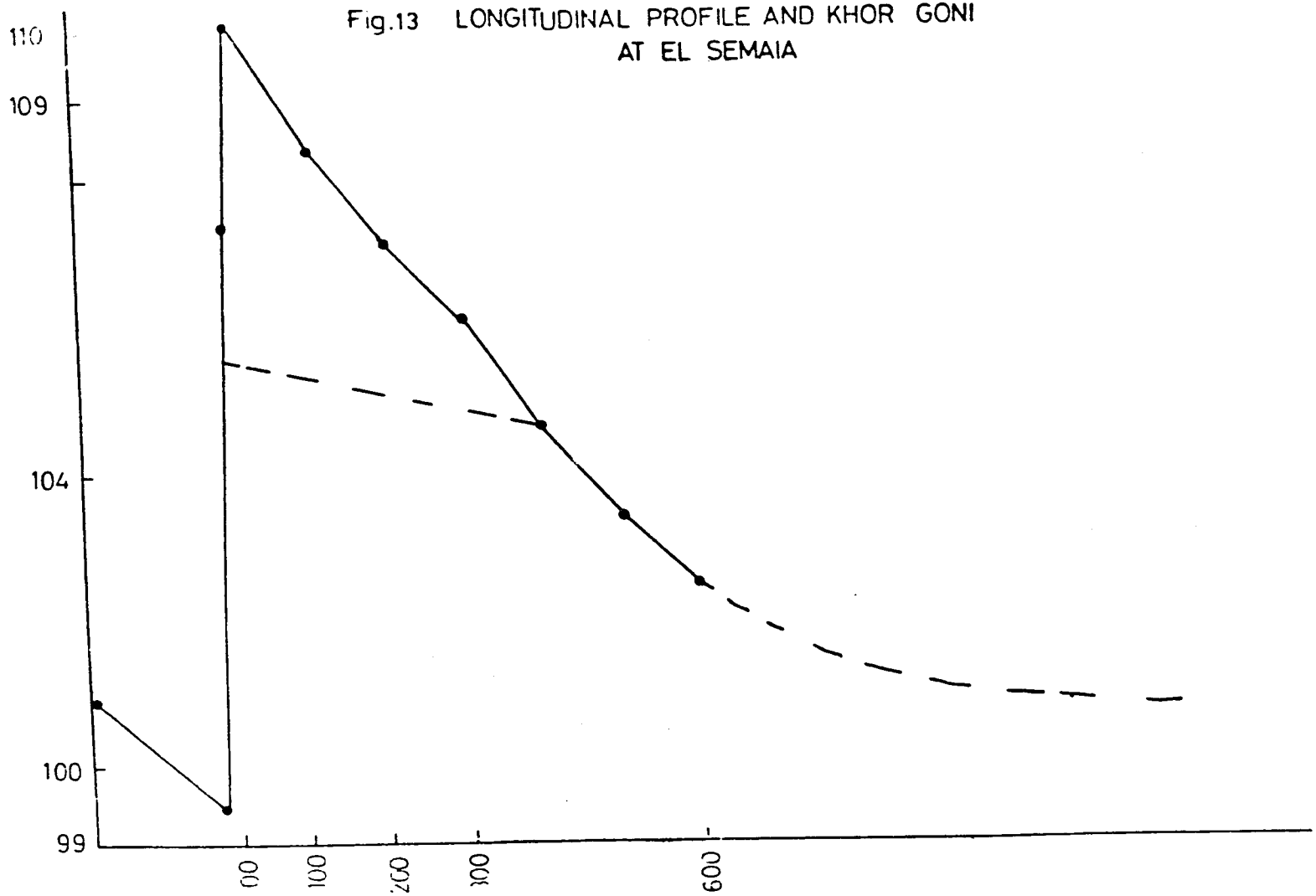


Fig.14 LONGITUDINAL PROFILE OF MAYAAT EL ABYAD AND KHOR MIRGHANI

We intend, if the intervention is successful, to write up a detailed proposal to study the hydrological setup of the 70 or so important maya'as inside and outside the park and attempt to raise enough resources to make them a viable habitat once more. The reason of including maya'as outside the bounduries of the park is that we are convinced that it would be impossible to stop trespassing and illegal grazing inside the park if the carrying capacity of rangelands around the park is not improved.

Results:

As for the reaction of the system to the intervention at El Abyad and Semaia there seems to be none. It must be emphasized however that 1984 was an exceptional unprecedented year for drought as well as being a record year for low discharge values of the tributaries of the Nile. The volume of discharge of River Dinder during the said flood season was near 0.6×10^9 m^3 of water. The flow did not even "wet" the whole bed of the river (from bank to bank). The excavated feeder channels we found to be still in good condition in June 1985. We are hoping that the two maya'as will be filled during the 1985 flood season. Available reports on the present above-average flood indicate that many maya'as in the park have been already filled to capacity.

It would be interesting to follow patterns of succession and colonization of various taxa as well as the degree of use by ungulates, during the next dry season. It is a pity that the ETMA Project has to end now !

SUMMARY

The Dinder National Park is the only area, out of the seven chosen by the LTMA/IES project, to study indicators of change, that has received some form of protection of its living resources and their habitats. Furthermore the history of the area is relatively well known. Dinder is the largest National Park in the country and the oldest in the Northern Sudan. It is world famous for reedbuck and birds of prey. Like many parts of the Sudan it has increasingly been subjected to pressures from human activities, especially after the droughts of the early 1970's.

The vegetation of the Park evolved under fire conditions. The dominant trees are resistant enough to fire to cope with annual burning. However, there seems to be an increase in annual grasses at the expense of perennials. Repeated burning seems to have also affected the riverine forests and the maya'as.

Some of the wildlife species that have been recorded in the first half of the century have now completely disappeared. The total biomass of wildlife has generally decreased in the past ten years.

The preceding sections pointed out in very general terms the trends towards increase in human settlements and in commercialization of agricultural and forestry production. The emergence of urban centres and a merchant class created the urge for expansion in order to use the surpluses generated in trade for further profits-realization. Thus, there is a process of expansion in mechanized farming and charcoal production. On the other hand even the small traditional producers started to increase the area under cultivation due to commercialization of production, increase in sedentarization

and use of tractors. This competition over land use is increasing.

Thus there are more infringements into the Park's area. Because of shrinkage in grazing land, nomads are led to creep into the Dinder National Park. Mechanized farming, human settlements and poaching activities around the Park also increased considerably. This poses a great threat to the Park and its wildlife. The resolution of such conflicts will be determined through the political struggle at the regional and national levels.

We believe that what has been achieved through this project highlights the major problems threatening the existence of the Dinder National Park. We have also intervened through simple modification to the maya'a recharge systems. We have succeeded and failed in other instances due to circumstances beyond our control. There is an urgent need to extend this project to provide more detailed results through an elaborate monitoring and intervention system.

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