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El khuwei - mazroub - tinna study area
« North central kordofan »

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BASE LINE DATA AND POTENTIAL, PHYSICAL-BIOLOGICAL AND SOCIO-ECONOMIC INDICATORS

STUDY AREA : EL-KHUWEI-MAZROUB-TINNA
(NORTH CENTRAL KORDOFAN)

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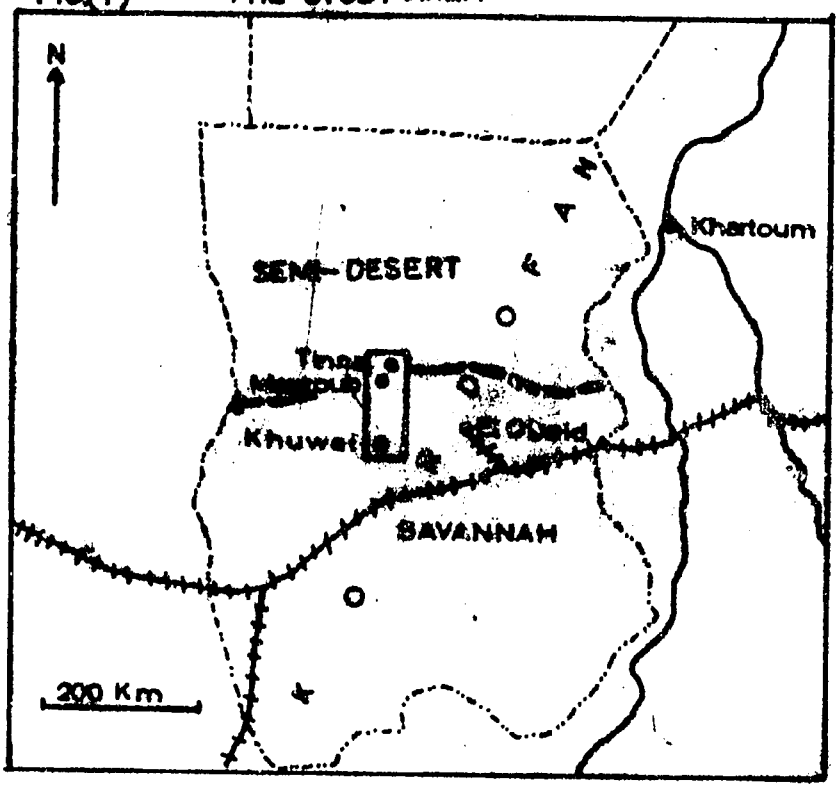
FIG(1) THE STUDY AREA



1- INTRODUCTION

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

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

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

2 - Background of Study Area

The area under consideration has recently shown symptoms of environmental distress and lack of capacity of support of its human and animal population.

1/ Environmental Training and Monitoring Programme for Africa.

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

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

In the past, this part of Northern Kordofan region has accommodated many tribes and communities. Different tribes with different life-styles were able to live near each other without much conflict between themselves, or much pressure on the environment. Economic activities that were practised most, were mainly : traditional agriculture (shifting cultivation) and nomadism. The two were complementary in many ways, and together they represented perhaps the best utilization of that type of environment. As time went by, however, this rather isolated region came into more contact with the rest of the country, and according-

accordingly, became more exposed to external effects as well as internal dynamic changes that were bound to take place. As a result, the ecosystem that was once able to accommodate different communities and different economic activities, showed all the signs of a stressed ecosystem, and one that is on the verge of collapse - if left to itself. Let us see how this process took place.

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

To satisfy their needs, livestock would have to be sold. The rate of withdrawal (off-take) from the animal population to satisfy such needs was therefore quite substantial.

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

This dual nature of the system made it something of a self-sufficient one. One activity complements the other and satisfies the needs of people practising it. The carrying capacity of the environment was not exceeded - for a long time - and no manmade

deterioration was observed. The reason was perhaps not so much the conscious good use of the environment, but rather the relatively limited intensity of its use and isolation from numerous viable market opportunities.

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

3 - Methodology

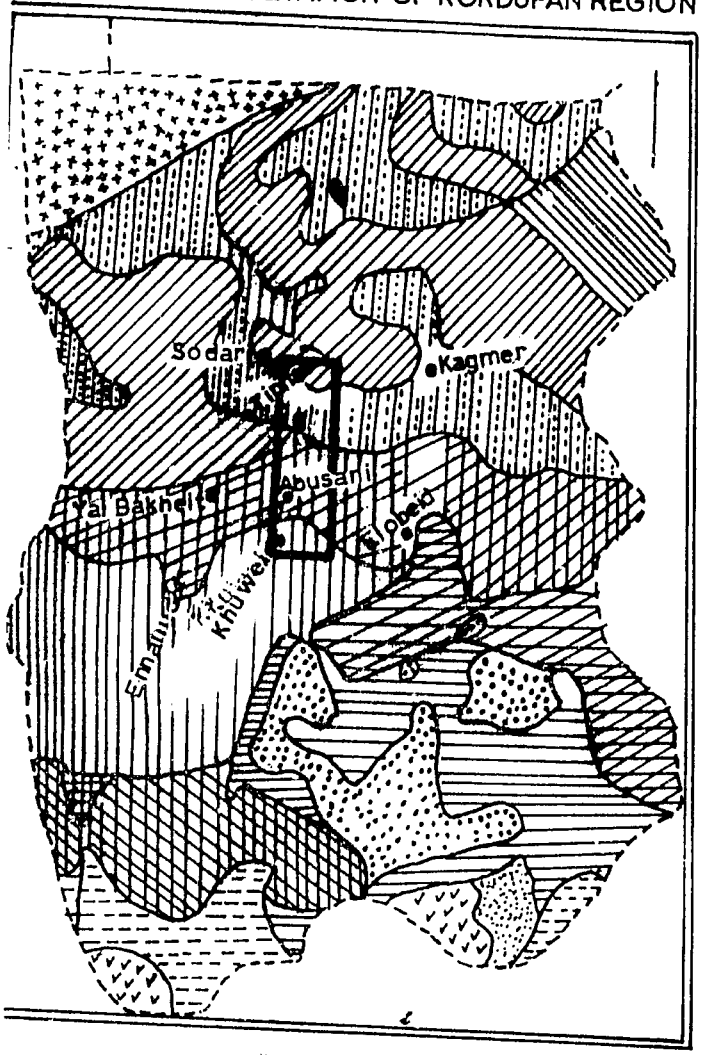
In Khuwei Area the sources of water supply are bore holes. Transects from Khuwei to nearby water-yards and their surroundings were traversed by the Survey Team. In addition to general observations to detect change in ground cover, interviewing of local inhabitants as individuals or groups was carried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

investigated and the environmental changes that have resulted from the construction of wateryards.

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

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

MAP(2) THE VEGETATION OF KORDUFAN REGION



	Desert
	semi-desert grassland on sand
	Semi-desert Acacia mellifera Commiphora Desert Scrub
	Semi-desert Acacia tortis-Maerua crassifolia Desert Scrub
	Low rainfall on sand Acacia senegal savannah
	Low rainfall woodland savannah on clay Acacia mellifera Thornland
	High rainfall woodland clay Anogeissus Khya Isoberinia Deciduous Woodland
	Special area of low rainfall woodland Hill catena
	Low rainfall woodland savannah on clay Acacia seyal Balanites savannah
	Low rainfall woodland savannah on sand Terminalia Sterocaryea Anogeissus Prosopis
	Aspecial area of low rainfall Ragaba repeating pattern
	Low rainfall on sand, Combretum cordofanum Datbergia Albizzia Sericocephein
	Tow rainfall woodland savanna on clay Anogeissus Combretum hartmannianum
	Flood region

up to the end of the dry period.

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

4 - PHYSICAL AND BIOLOGICAL INDICATORS

4.1 VEGETATIONAL TRANSECT STUDIES

4.1.1 Transects in the Khuwei Area

Fig (1) gives the vegetation of Kordofan Region, and the Study area.

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

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

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

Termite attack is another factor that affects forage and soil cover seriously. In the Khuwei area, a mass destruction of woody vegetation has occurred. This seems to have taken place about 1970 at the height of the drought. The reason for the death of trees is obscure, but it does not appear to be linked directly to the drought or to cutting and lopping for firewood and fodder. One possible explanation is that

TABLE 1.

Vegetation Sampling Along Selected Transects Near Khuwei.

Sample No.	Average Percentage of Under Story Cover	Average Percentage of Bare Soil	Average Production Lb/Feddan	Average Number of Forage trees/Feddan.	Average Number of Dead Trees/Feddan.	Remarks.
1	52	48	80	10		The samples had been taken west of Khuwei village up to 15 Kilometers. Interval of sampling being 2-5 kilometer apart.
2	60	40	65	12		
3	62	38	72	15	3	
4	58	42	60	14	3	
5	60	40	60	17	5	
6	85	15	440	15	2	Samples taken at 20 kilometers from Khuwei, taken at 10 kilometer interval in the southwest directi
7	80	20	300	14	1	
8	90	10	600	20	6	Samples taken at 10 and 20 kilometers from Khuwei in the northwar
9	85	15	700	16	5	direction.

Source: Data collected in the field by the writers.

termites are responsible for much of the widespread tree mortality. In this scenario, failure of pastures to regenerate for several years in succession would have deprived the termites of their preferred source of food. In this case, they would have turned to the woody perennial vegetation as a substitute. Changes in location of termite mounds, when combined with widespread death of trees, would then be an indicator of serious environmental deterioration. For with both perennial and annual vegetation seriously depleted, increased soil erosion could be anticipated.

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

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

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

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

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

4.1.2 Transects in Abu El Sari and Mazroub Area

The first part of Table 2 exemplifies Abu Sari area. The soil is mainly sand dunes covered by Acacia senegal, Guiera senegalensis, Combretum kordofanum, Sclerocarya birrea, Cenchrus biflorus, Oldadia senegalensis, Aristida pallida, and Eragrostis tremula,

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

The second part of Table 2 indicates a clear devastation of Mazroub to a radius of 15 kilometer due to the presence of a number of surface wells run by villagers around Mazroub. The soil is mainly sand dunes covered by Acacia tortilis, Leptadenia pyrotechnica, Acacia senegal, Cenchrus biflorus, and Eragrostis tremula. In the first five kilometers out of Mazroub, the main tree cover is Acacia tortilis, which is smashed down by browsing. It is replaced further out by Leptadenia pyrotechnica and Acacia senegal.

Fire incidence is readily observable beyond a grazing radius of 10 kilometer from Mazroub. Pure stands of Leptadenis sp. and Aristida pallida are seriously damaged and a poor cover of annuals prevails in most of the area. Group interviewing of villagers showed that in the past fire lines were

TABLE 2.

Vegetation Transects in Abu Sari and Mazroub Areas.

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

Source: Data collected in the field by the writers.

usually constructed and vegetation was protected from damage. Organizing the construction of these barriers to the spread of fire was a characteristic feature of the rural colonial administration. Work on the barriers was carried out annually at the village level. This system has broken down completely and the new system of subcontracting the work out to private contractors does not seem to work particularly well. Frequently the fire lines are constructed, if at all, after fire damage has occurred. Fires are frequently set by nomads to remove the dead vegetation and stimulate new growth. The exact role that such burning plays in dryland ecology and range management, for good or for ill, is uncertain; it elicits strong opinions from both scientists and local inhabitants, and merits detailed investigation before fire can be considered to be an indicator of environmental decline.

The last two points in Table 2 are taken from the Tinna area. Tinna is a natural reservoir near which nomads camp in the dry season. The soil of this area consists of two main features, the clay soils and the sandy soils. The clay soil is vegetated by Acacia mellifera, Acacia nubica, Commifera africana,

Shoenfeldia gracilis, Aristida funiculata and Cymbopogon sp., while the sand dunes are covered by Leptadenia pyrotechnica, Acacia senegal, Cenchrus biflorus, Eragrostis tremula and Cyperus runditti. The area shows signs of overuse by animals around the water source. Further out on the dune areas where good grass cover is available, fire incidence is disastrous in eliminating trees and perennial grasses.

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

It is clearly noticed that most of the mounds are accompanied by living trees in the southern part of the area while in the further north the mounds are accompanied by dead trees. So from this it could be

projected that the termites are a cause of deterioration, and that the destruction is sweeping southwards where vegetation is richer, With regard to termite feeding habits, it is observed that they depend on grass in rich cover areas but they turn to trees when grass cover is seriously denuded.

4.2 SUMMARY OF BIOLOGICAL AND PHYSICAL INDICATORS

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

1. The domination of Zornia diphylla around Khuwei shows the non-diversity of the vegetation and the poverty of the pasture.

2. The disappearance of palatable annual and perennial grazing species, such as Blepharis sp., Dactyloctenum aegyptium, and Stylosanthes fruticosa around the study area shows clear degradation in grazing capacity in radii ranging from 2,5 and 14 kilometers in Khuwei, Mazroub and Tinna respectively.

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

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

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

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

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

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

5. SOCIAL AND ECONOMIC INDICATORS

5.1 Human Activity

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

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

Table 3 Major Crops and Crop Output in North Kordofan in 1974

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

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

5.2 The Impact of Water-Supply Programmes

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

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

In the two areas, during the pre-water development era, there was a better vegetation cover. This better quality vegetation included both more perennials and greater diversity in the composition of the upper and the lower story. All those interviewed confirmed the prevalence of highly valued tree and grass species.

Many of these prized species, especially those grasses valued for their palatability and nutrition as fodder, no longer exist or have diminished in area.

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

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

The growth of Khuwei illustrates how such centres develop in time. The village was founded on a "rahad" (i.e., water that collects in a depression and that lasts for a short time after the rainy season) and on

rain water that was stored in tebeldi (Adisonia digitata) trees. The art of excavating tebeldi for the purpose of conserving rainwater for use during the dry months was discovered some time about the beginning of the 19th century, when the Hamar occupied their present territory. Therefore the distribution of tebeldi and its intensity influenced to some degree early habitation in this area. Khuwei is an illustrative example. Tebeldi run from north to south following the bed of a depression which is possibly a buried drainage system.

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

Khuwei remained a small village up to 1938 when two bore holes were drilled at the site. This marks a new era in the development of the site. The bore holes began attracting human and animal populations to Khuwei from its surroundings. However, this did not lead to heavy concentrations and severe deterioration, as is presently the case, due to a number of factors. Among these factors we mention : (1) the small sizes of animal populations, since the rise in animal numbers began in the late 60's; and (2) the restriction of tribal nomadic movements as much as possible to the administrative boundaries of each tribe. These migrations were managed through annual tribal conferences in which the chiefs were present. The purpose of these conferences was to direct movement and minimize conflicts. One exception to the above picture was a massive movement of population from Dar Hamid Area, particularly from the surroundings of Mazroub, and Umm Shugeria Area to the west of Mazroub that led to the rise of a number of villages of Maganeen origin, and other Dar Hamid minorities, to the south of Khuwei.

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

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

presently it has 3 hafirs. Moreover, a new well field area has been developed in the inlet area of the new hafirs to the north of the settlement. Tinna up to 1976 had a limited supply that barely met the requirements of its village population. From that date on, and because of the embankment constructed by Rural Water and Development Corporation which retained the flood water for a longer period, the water table at the site has risen considerably. As a result, the place has become a reliable water source for its population and for the nomads visiting it from distant areas.

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

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

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

Table 4

Services Provided at Khuwei and Mazroub

A. Khuwei

1964 Services	Services Added by 1981
3 bore holes	1 general secondary school for boys
2 primary schools for boys	1 general secondary school for girls
1 primary school for girls	1 bore hole
1 dispensary	1 local Government Council
1 public health office	1 plant Protection Office
1 police post	1 co-operative
1 court	1 flour mill
1 veterinary dispensary	10 coffee places
1 marketplace	
1 co-operative	
1 flour mill	
10 coffee places	
1 mosque	
1 club	

Cont/...

B. Mazroub

1964 Services	Services Added by 1981
1 harir	1 primary school for boys
2 primary schools for boys	1 primary school for girls
1 primary school for girls	1 intermediate school for boys
1 dispensary	1 intermediate school for girls
1 public health office	2 harirs
1 police post	a new well field site
1 court	1 hospital under construction
1 veterinary dispensary	1 local Government Council
1 Marketplace	3 co-operatives
3 co-operatives	2 flour mills
1 flour mill	
4 coffee places	
1 mosque	

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

5.3 The Socio - Economic Indicators

5.3.1 Improper Planning and Management of Water Supply Centres

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

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

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

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

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

For the location of new water yards certain criteria are applied to guide the preparation of the regional and national programs of water provision. Aspects such as existing supply centers at the local level, general physical environmental conditions of the proposed area, settlement distribution and expected future demands on the site, the seasonal load, if any, that might be put on the resource by nomads, the human and livestock population sizes, etc., are surveyed for every site proposed for water provision. These studies are carried out by interdisciplinary teams, mostly formed of agriculturists and socio-economic specialists. Based on the findings at each site, the different proposals are rated, and finally the program is prepared.

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

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

2.3 Location and Its Impact on the System

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

The two sites have village populations depending on them. This can be broken into: (1) the close villages reached on foot or by donkeys; and (2) the distant ones to which water is carried by trucks. There are about 8 villages under the first category depending on Khuwei, and about 13 villages in the same category depending on Mazroub. The ones of Khuwei, for illustration, are shown in Figure (3).

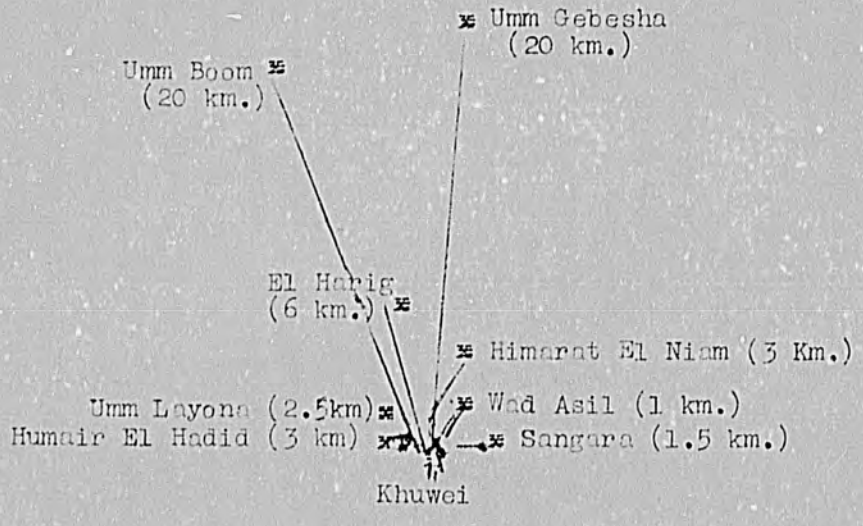


Fig. 3 Khuwei and dependent villages.

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

This is further exacerbated by the fact that from the beginning of the dry season, as from December and on, much of the population of these thirsty areas desert the villages. People move to Khuwei and

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

Finally, there are the adverse impacts that result from the relationship of water centres to the movement of nomadic populations between their dry season and wet season pastures. Up to the mid sixties, both Khuwei and Mazroub acted as dry season centres of nomadic concentrations. Here the migrations of some

Hamar and Maganeen ended respectively. At that time they were the most southern points on the migration routes for some sub-tribes.

With the extensive provision of more water yards and the continuous translation of range land to the nor north, some of the "Abalia"* nomads of northern and central Kordofan (mainly Kababesh, Kawahla, Hamar, Dar Hamid, Maganeen, and Shanabla) began pushing further southward than had previously been usual. As a result, Khuwei and Kasroub assumed the additional role of watering places on the route to dry season grazing areas in the Nuba Mountains to the south. Not only does this influx of nomadic herds place increased pressure on local rangeland, but also it increases the social conflict. The inhabitants of Khuwei, for example, are not in favor of nomads entering the area. They view the nomads as outsiders whose animals consume pasture that otherwise would be available to support local herds. These conflicts increase as a function of declining pasture quality, increased water availability, changing environmental conditions elsewhere in the region, and expansion in the size of herds controlled by settled populations. Niches once available for exploitation are rapidly becoming filled,

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* Camel - raising nomads

and activities that were symbiotic have become increasingly competitive and tense.

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

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

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

Table 5

Daily Average Income (LS) by month for Khuwei Water Year 1 - 1980

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

Table 6

Water Year 1 Consumption Rates

Unit	Official price M/25	Self-help Contribution Collected from Buyer M/25
1 tin (4 gallons)	5	5
1 skin	20	20
1 big skin	30	30
1 camel (to drink)	40	40
1 donkey (to drink)	10	10
1 cow (to drink)	10	10
1 sheep (to drink)	10	10
1 goat (to drink)	10	10

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

water. The income from October to January reflects Khuwei plus nearby villages' human and livestock consumption. That of the period February up to June stands for the total water requirements of all categories of population: Khuwei village, the nearby village, the "damara" and the nomads.

5.3.2 An Increase in Population, Without a Corresponding Increase in Yields

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

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

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

Table 7

Population of Major Settlements in the Khuwei Area

Place	Size of Population	Size of Other Populations Dependent on Place
Khuwei	6000	1500
Masharbe	1500	2500
Dediya	1500	3000
Ankoosh	1500	1000
Daw El-Beit	500	500

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

(1) natural growth in population size;

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

(3) progressive settlement of nomadic families.

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

The situation can be summarized as follows: increase in human population through natural growth and migration leads to expansion of the use of the oecumene which, if not coupled by raising the yields of the ecosystem, produces environmental degradation. The evidence that the system is not yielding adequately is indicated by the fact that: (1) the area is not producing enough staple food crops and is importing from other parts of the country; (2) milk and meat supplies are only occasionally available (3) incomes are very low, the general standard of living

has not changed substantially during the last 20 years, and the two areas are experiencing mass migration to central Sudan and the oil states.

5.3.3 Increases in Animal Numbers, Especially cattle and sheep

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

(1) Expansion in water supply programs which have enabled both villagers and nomadic groups to base their economic activities on reliable water sources.

(2) The progressive resettlement of population from the norther areas to near the southern bore holes, as well as the settlement of nomadic families, has resulted in increasing the number of cattle around these water yards.

(3) The risk of agricultural failure has encouraged people to invest to livestock as a more profitable enterprise.

(4) Livestock, particularly cattle, provides the family with milk, and is a ready source of cash to which the family can resort in times of need.

(5) Furthermore, in this society, which has its origin in nomadic cultures, breeding animals is prestigious, and is valued as a way to achieve social distinction.

(6) People invest capital generated by other activities in animals, many claimed that up to 1967 hashab (acacia senegal) was productive and the surpluses raised from gum were invested in building herds. The savings of those permanently employed in government is mostly invested in sheep which have great commercial value. Finally, these areas witnessed recently investments in both cattle and sheep from savings raised in Li bya, and the other oil states.

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

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

(1) It is less costly to invest in sheep. The value of one cow is equivalent to that of many sheep;

(2) There are more investors among the nomads than the settled cultivators, and the former tend to invest more in sheep;

(3) Under declining grazing conditions, especially around water yards, sheep are less difficult to maintain since they graze over a wider area compared to cattle and require less fodder to maintain one unit than is the case for cattle;

(4) Sheep reproduce more rapidly than cattle because the duration of pregnancy is shorter and the number of offspring per year, as well as the frequency of multiple births, is greater.

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

5.3.4 Opening of New Land

With the natural increase in population, the provision of new water sources, the rise of new settlement, and the expansion in old ones, more lands are brought under cultivation. This entails removing the vegetation to make room for the newly added agricultural areas. This is normally carried out in two types of land: (1) the Qoz which is sandy soil; and (2) the Juraba or Sisa which is a sandy clay soil. The average farm size in the Qoz is about 10 makhamas, while it is in the range of 3-5 makhamas in the juraba. A makhamas as a unit of measurement varies from one part of the country to the other. In Kordofan it is 6300 M^2, nearly 1.5 acres.

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

In the past, land was plentiful, and the fallow rotation which set aside exhausted land was a lengthy one. Individual families owned cultivable lands ranging from 80-100 makhamas in the Qoz areas, and about 10 makhamas in the Jumaba or Sisa areas. At any one point in time, average area actually cultivated was 10 makhamas in the former and about 3-5 makhamas in the latter. Since the most common cropping pattern adopted rotated the same piece of land under two crops for 4 years, and then left it fallow for another 4 years, the production of the area actually put under cultivation in relation to the total land property of the family allowed a reasonable margin for carrying out an efficient system of shifting cultivation.

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

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

5.3.5 Declines in Yields

To use the declines in yields as an indicator, especially in old agricultural areas, needs to be proven by research findings, comparing production in those areas to newly opened ones. The yield of such crops as hashab, sesame, groundnuts and so on can be

an indicator on the premise that putting the same piece of land under cropping for many years leads to decline in soil fertility and a drop in yields. Interviews held with the local communities in the areas studied confirm the above observation especially around old water centres like Khuwei, Mazroub and Tinna.

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

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

Table 8

Yields per Makhamas in Sacks for Different Crops

Crop	Old Area	Newly Opened Area
Dura	2	5
Dukhun	2	4
Groundnuts	4	10
Sesame	1	3

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

5.3.6 Number of Tankers Carrying Water from a bore-hole to Nearby Areas

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

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

Provision of water by tankers can be considered as an environmental indicator that points to negative as well as positive environmental impacts. Of the latter is the fact that areas that are served by tankers experience limited use of their natural resources, since the populations inhabiting such areas are existing on very meagre sources of water. These are just adequate for the continuity of human habitation in these areas. At the same time, they are not open to heavy grazing for two reasons. First, the animals raised by the local population are present only during the rainy season. Second, the nomads do not utilize them except when in transit between rainy and dry season pastures because of lack of water. In fact, due mainly to water scarcity, these "problem areas" reflect

the best environmental conditions in central Kordofan with the vegetation cover still intact. They give point to the argument that rural areas should be denied sources of water supply unless they come as a component of a total land use plan.

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

On the negative side, the operation of tankers from a source of water supply is an indication that environmental conditions around that source are exposed to some degree of devastation. The dependence of tankers on a source means that the latter offers a

surplus that can be transported to other areas. Yet the same source acts as a magnet attracting the poor sector of the population from the "problematic areas" that cannot afford to buy water from lorries in the villages. It also is a point of attraction to the large herds and flocks owned by rich families, as it is expensive to pay for their water requirements in the villages during the dry season. Therefore the dependency of tankers on a water centre as a source of supply indicates that the area in which this centre falls is open to environmental degradation, due to overexploitation of its resources.

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

5.3.7 Number of Charcoal Burning and Wood cutting Permits

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

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

of the wood cover in the areas of supply, depends very much on the geographical location and accessibility of supply areas to centres of demand.

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

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

Permits for charcoal burning are issued by the Administration for Forestry at En Nahud. Usually the application for the permit does not specify the purpose as cutting wood for charcoal burning, but as requesting permission for clearing land for agricultural purposes, and indirectly using the cleared tree cover for the production of charcoal. Very often people

exceed the area allowed. A well known case in the area is that of a merchant who violated the license issued to him to clear a limited area, by denuding a whole tract of country in Umm Layouna Area, producing 2000 sacks of charcoal.

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

5.3.8 Number of Lorry Loads of Charcoal rom an Area

Besides the amounts that are consumed locally, there are those produced for export to El Obeid and the other centres outside the province. The Forestry Clerk at Khuwei collected in 1980 a sum of LS 600 as local taxes on forestry products, including items such as charcoal, fuelwood, ropes, palm leaves, wooden handicrafts, and so on. Of this amount about LS 400 are believed to be the royalties from charcoal. Divided by 11 P.T., the tax per sack, this indicates a local production of 4000 sacks for which taxes were paid at Khuwei. This does not include that amount for which

taxes were paid at En Nahud, and other places like Bebanousa. Nor does it account for the possibility that some producers avoided paying taxes altogether on some portion of their output.

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

Lorry owners do not produce charcoal themselves, but normally obtain the license to export charcoal after paying a nominal tax of 1 P.T. per sack. It is the producer who must pay the much more substantial 11 P.T. per sack tax. The shipper buys from the producer at any average price of LS 1.00 per sack, which indicates the profit margin open to him, when he sells at El Obeid or Khartoum.

5.3.9 Selective Use of Plant Cover

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

(1) Construction Purposes:

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

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

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

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

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

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

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

(ii) Fodder Purposes:

The nomads, when moving in and out of dry season grazing areas, immediately after the rains and during late dry season, cut the branches of trees to supply green fodder to their herds. The species preferred

are: Subbagh, Humeid, (Sclerocarya birrea) Daroot, (Terminalia brownii) Hashab, Layon, Hegleig (balanites aegyptiaca), and Tebeldi. This lopping, if repeated too frequently or carried out too comperhensively, effects the life and the reproduction of these species. It is probably one of the factors behind the failure of tebeldi trees in the area to regenerate. It reduces seed propagation, since at flowering time buds are cut by the nomads to feed their animals. When this is repeated, it results in the tree failing to produce fruits. This has been the case with most of the tebeldis that are distant from settlements. The ones owned by families are in a better shape, since the owners protect them from the lopping activities of the nomads. This illustrates the effectiveness of individual rights to the use of resources as compared to communal rights, since under individual ownership conditions tebeldi has fared better than other species. Nonetheless, even under individual ownership tebeldi is not reproducing, a fact that appears to result from other pressure mechanisms that prevent seedling establishment.

(iii) Perfume Purposes:

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

(iv) Handicrafts and Other Special Purposes:

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

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

(v) Production of Charcoal:

The most preferred species for the production of of charcoal is Sirel (Albizzia sericocephala) and next it is Kolol (Dichrostachys glomerata), then Hegleg (Balanites aegyptiaca), and finally Hashab (Acacia senegal).

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

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

5.3.10 Increasing Distance From Settlement One must Travel to Obtain Specific Products

Nearly all of the preferred species mentioned in previous sections once were obtained from close to settlements. This is still the case in Mazroub and Tinna areas in comparison to Khuwei. The location of Khuwei on the main road to western Sudan has encouraged depletion of the resources in its immediate vicinity. In particular, the traffic travelling eastwards carries wood and wood products from the area. Presently the village depends on distant resources because the woody vegetation adjacent to the settlement has been seriously depleted. Subbagh and Kolad, important as construction material, are good examples of this process. Once found close to Khuwei, both now are obtained after travelling 5 hours from Khuwei by carts.

Fuel wood and charcoal used to be available close to the settlement. Now they are brought from a distance of about four hours by carts. Again, the same is true for the straw material required for buildings, and the grass fodder for the animals, which were discussed earlier.

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

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

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

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

Intthe Khuwei area from the beginning of March, the village livestock's natural grazing must be supplemented by one or the other of the above feeds. Dura, cotton and cotton seed cakes are purchased locally in the village. Hay is brought by carts and on donkeys and sold to animal owners. A cart load of Shelini (Zornia diphylla) fetches up to LS 4.00, while a donkey load of the same grass sells for LS 2.00. People prefer Shelini, but haskaneit (Cenchrus spp.) is in wide use as well.

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

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

6 A FUTURE STRATEGY

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

The physical, biological, social and economic indicators identified above point clearly to the occurence of many processes of environmental degradation, which have drastically changed the conditions of the ecosystems of these two vast belts. The changes observed at present started at variant dates. There

is much evidence to indicate that their effects have accelerated with the programmes of water supply launched in the last 30 years, more specifically in the period after the mid 1960s. An attempt to assemble the indicators examined in a time scale, according to the year each phenomenon is believed to have started affecting the ecosystem points to the strong relationship between the expansion in water provision and the state of deterioration reached (Table 9, and 10, and Fig. 4)

Table 9

Indicators Effect in Time Prospective

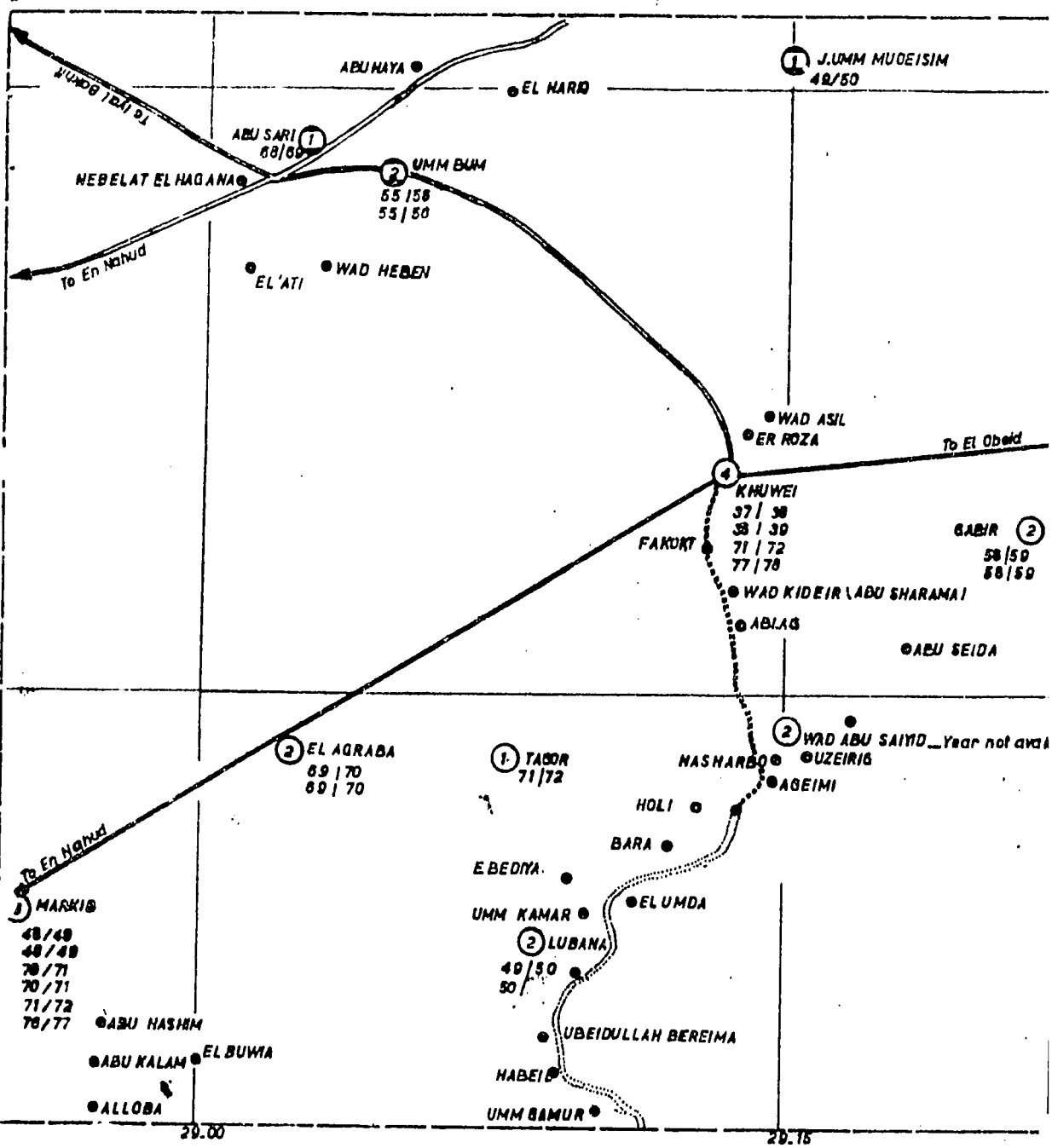
Time scale, traced back to :

Indicator	First Time indicator began operating	Time the effect accelerated
1. Change from a balanced to a stressed eco-system	1950	1967
2. Improper planning and management of water sources	1956	1967
3. Location and its impact on the system	1938	1960
4. An increase in population without a corresponding increase in yields	1960	1970

Cont/...

FIG.(4) IN PART I

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



LEGEND

- WATER COURSE
- ROAD
- EXISTING VILLAGE
- SUCCESSFUL BORE-HOLE
- FAILURE BORE-HOLE
- (2) (1) NUMBER OF BORE-HOLE AT SITE
- 37/38 76/77 DATE OF ESTABLISHMENT OF BORE-HOLE

NOTE:- The information is supplied for the southern part of the study area, since only one borehole exists at Mazroub in the northern part of the area

Indicator	First Time indicator began operating	Time the effect accelerated
5. Increase in animal numbers, especially cattle and sheep	1950	1967
6. Opening of new land	1955	1967
7. Decline in yields	1960	1967
8. Number of tankers carrying water from a borehole to nearby area	1955	1967
9. Number of charcoal burning and wood cutting permits	1960	1970
10. Number of lorry loads of charcoal from an area	1970	1970
11. Selective use of plant cover	1900	1960
12. Increase in distance from settlement-one must travel to obtain specific products	1960	1970
13. Presence or absence of purchased fodder: cotton seeds cakes, dura straw, or hay	1970	1970

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

Table 10

Total Number of Boreholes.

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

Total number of bore-holes prior to 1950 :

Sudan	Kordofan Region	The Study Area
138	059	004

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

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

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

Therefore a new approach to water programming is highly needed, and now. This approach should embody one basic concept not given priority in the current planning of water sources : the control of the use of the renewable resources through more comprehensive planning and monitoring of the ecosystems at the macro, meso, and micro levels. This will require adopting the following strategy of action, especially by the newly created regional governments:

At the Macro Level

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

At the Meso Level

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

At the Micro Level

9. Develop village land use plans that aim at organizing the usage of the land resources around the villages, and to enable rehabilitating effected areas.
10. Introduce strict tenure rights so as to define village land property for different uses, and as well meet the grazing requirements of the outsiders
11. Specify kind of use for different water points i.e. strictly for settled population; for local villagers' animals, for nomads, for commercial livestock, etc.
12. Separate the water supply requirements for humans from that for animals, through effective distribution systems.
13. Adopt a system of alternating use of water points to enable the closing down of those centres which show signs of deterioration of the ecosystem.

14. Involve the local communities in the planning and running of the water points and in the management of the ecosystem affected by them.
15. Re-educate the local leadership and the village communities in management aspects.
16. Raise the water prices and use the revenues generated in financing ecosystem management projects.
17. Improve the maintenance and the running of water yards through further disintegration of the regional and sub- regional maintenance centres, to enable this service to function effectively at village level.
18. Work towards diffusing maintenance technology to be assimilated in time as part of the local technical know-how.
19. Up-grade the prevailing traditional economics through improved inputs to raise the levels of production so as to meet the basic requirements of the population; food, fodder, fire wood, charcoal, etc; which consequently leads to improvements in the standard of living of the local population.

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

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

Bibliography.

1. Andrews, G., 1948,
"Geology of the Sudan" in: J.D. Tothill (ed.) Agriculture in the Sudan, London, Oxford University Press; Geofferey Cumberlege, 1948.

2. Baumer, M.,
"The Ranges of Dar Maganin," Sudan Notes and Records, Volume XLIV, 1963, pp.120-135.

3. Booth, G.A., 1966,
"Land and Water Use Survey in Kordofan Province of the Republic of the Sudan", Forestry Report, pp.1-26.

4. Edmonds, J.M., 1942,
"The Distribution of Kordofan Sands", Geological Magazine, 79, 111-113.

5. El Sammani, M.O.,
Inventory of Existing Services by Rural Council Kordofan Province, Ministry of Co-operation and Rural Development, 1971.

6. El Sammani, M.O.,
Survey of Dry Season Nomadic Concentrations with an Emphasis on the Hamar Tribe, Document Box-Sud-A-55, Prepared for the Food and Agriculture Organization, 1966.

7. El Sammani, M.O.,
The Magnitude of the Drinking Water Problem in the Sudan, Economic and Social Research Council 1976.

8. FAO,
Land and Water Use Survey in Kordofan Province, The Sudan Final Report, Rome 1967.

9. First Agricultural Conference, 1975,
Report on North Kordofan.

10. Harrison, M.N. and J.K. Jackson, 1958,
Ecological Classification of the Vegetation of the Sudan, Forests Bulletin No.2, Khartoum; Ministry of Agriculture.

11. Knight, C.G.,
Ecology and Change, Rural Modernization in an African Community, Academic Press, Inc., 1974.

12. Land and Water Use Survey, Kordofan Province, 1967 Final Report.

13. MacMichael, H.A., 1920, "The Kheiran", Sudan Notes and Records, 3, pp.231-244.

14. Mansour, A.O., 1963, "Sources of Water Supply as Related to Geology in Kordofan Province", in: Ninth Annual Conference on Surveying for Development in Sudan. Philosophical Society of the Sudan printed by the Sudan Survey Dept. in October 1963.

15. Project of the Government of the Democratic Republic of the Sudan, Model Womens Rug-Making Co-operative, Northern Kordofan Province on Behalf of Ministry of Co-operation, Commerce and Supply and International Labour Organization, Associated Consultants, 1981.

16. Southern Darfur Land-Use Planning Survey, Development Plan Annex 3, Animal Resources and Range Ecology, Hunting Technical Services Ltd. and Sir M. Macdonald & Partners, 1974.

17. Sudan Government, Soil Conservation Committees' Report, 1944.

18. The Republic of the Sudan, Ministry of Social Affairs, Population Census Office, Notes on Omodia Map, First Population Census of Sudan, Printed by R. Kiesel, Salzburg, Austria, 1958.

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