Land Resources Development Centre

Sudan

Profile of Agricultural Potential

LRDC
Land Resources Development Centre
Overseas Development Administration

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SUDAN
PROFILE OF AGRICULTURAL POTENTIAL

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1987

SUDAN
LAND RESOURCE ZONES

EGYPT
LIBYA
CHAD
CENTRAL AFRICAN REPUBLIC
ZAIRE
UGANDA
KENYA
ETHIOPIA
RED SEA

Lake Nasser
Wadi Halfa
Dongola
Nile
Port Sudan
RED SEA HILLS
Tokar Delta
Atbara
Ed Damer
KHARTOUM
Kassala
Gash
EL GEZIRA
Wad Medani
Ed Dueim
Kosti
Rahad
Dinder
Blue Nile
El Fasher
El Obeid
JABAL MARRA
Nyala
NUBA MOUNTAINS
Kadugli
Bahr el Arab
White Nile
Malakal
Sobat
Jir
Jonglei Canal
Wau
Tonj
Sue
Rumbek
Bor
Juba
Yambio
Yei
BOMA

1 2 3 4 5 6a 6b 6c 6d 6

25° 30° 35° 20° 15° 10° 5°

0 75 90 120 150 180 210 240

SCALE 1:5,000,000

0 100 200 300km

- International boundary
- Regional boundary
- Regional headquarters
- Town
- Mean length of crop growing season (days) — 75
- Irrigated agriculture
- Tsetse-infested area
- Desert — 1
- Qoz Sands — 2
- Central Clay Plains — 3
- Southern Clay Plains — 4
- Ironstone Plateau — 5
- Green Belt — 5
- Hill Areas/Other Uplands — 6

INTRODUCTION

This Profile of the Agricultural Potential of the Sudan was prepared by the Land Resources Development Centre at the request of ODA's Chief Natural Resources Adviser to provide a physical frame of reference for the assessment of existing agricultural technologies. The Profile is the product of a rapid desk study which involved the use of satellite imagery, and existing reports and maps. Acknowledgement is due to a variety of organisations and individuals including multilateral organisations, commercial consultants and ODA staff.

Sudan sub-divides into six relatively homogeneous Land Resource Zones, which are shown on the folded map. The characteristics of each Zone are reported under 3 sub-heads: Physical Environment, Land Use, and Development Potential.

Development potential, defined as possible increases in production over existing levels, is assessed for 3 different levels of technology. No attempt is made, however, to estimate the social and economic costs and benefits associated with particular developments.

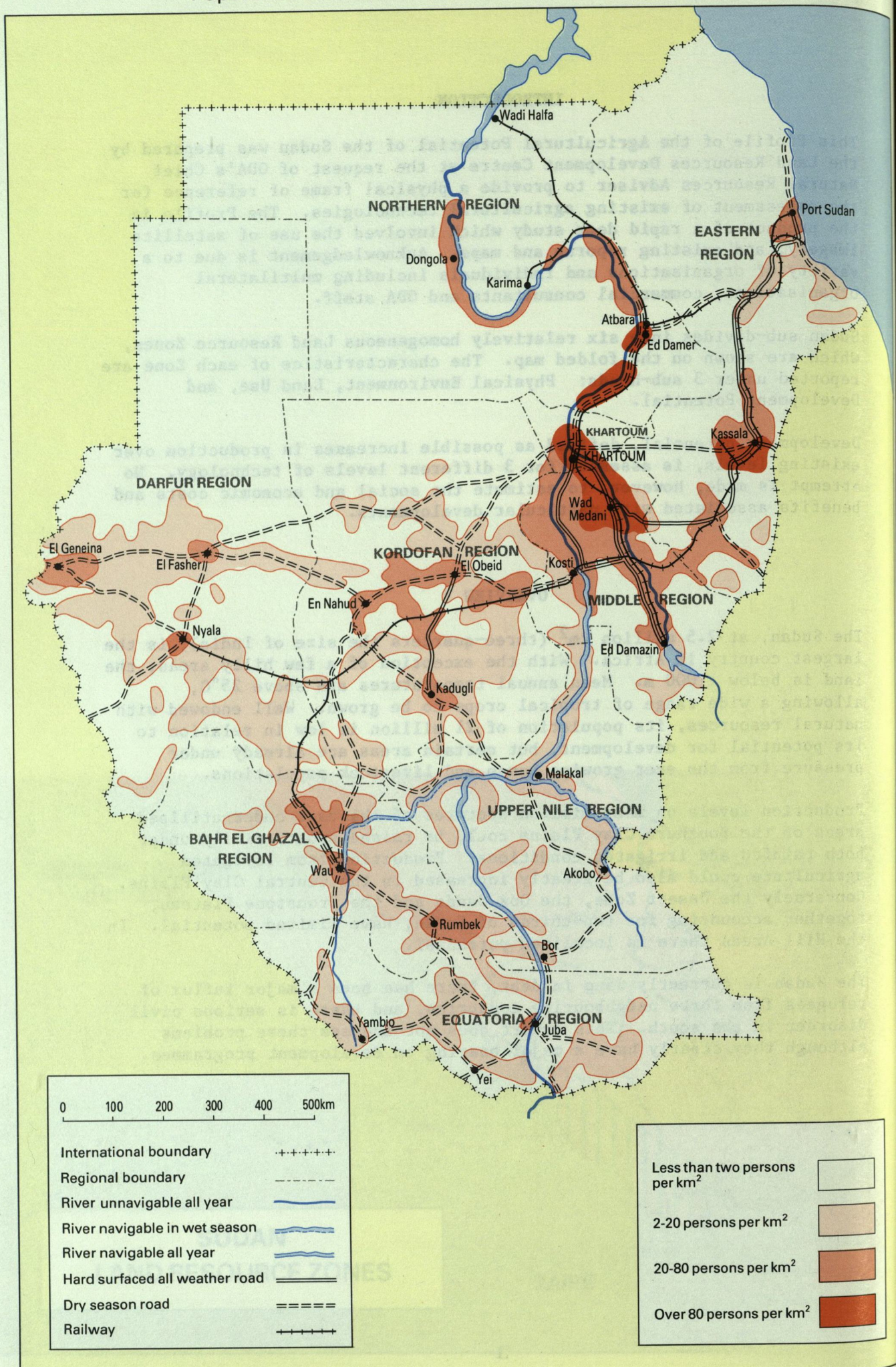
OVERVIEW

The Sudan, at 2.5 million km^2 (three-quarters the size of India), is the largest country in Africa. With the exception of a few hilly areas, the land is below 1 000 m. Mean annual temperatures are above 25°C, allowing a wide range of tropical crops to be grown. Well endowed with natural resources, its population of 21 million is low in relation to its potential for development, but certain areas are already under pressure from the ever growing human and livestock populations.

Production levels on many million hectares of the vast under-utilised areas of the Southern Clay Plains could be raised substantially under both rainfed and irrigated conditions. Production from irrigated agriculture could also be greatly increased in the Central Clay Plains. Conversely the Desert Zone, the Qoz Sands and the Ironstone Plateau, together accounting for two-thirds of Sudan, have limited potential. In the Hill Areas there is localised potential.

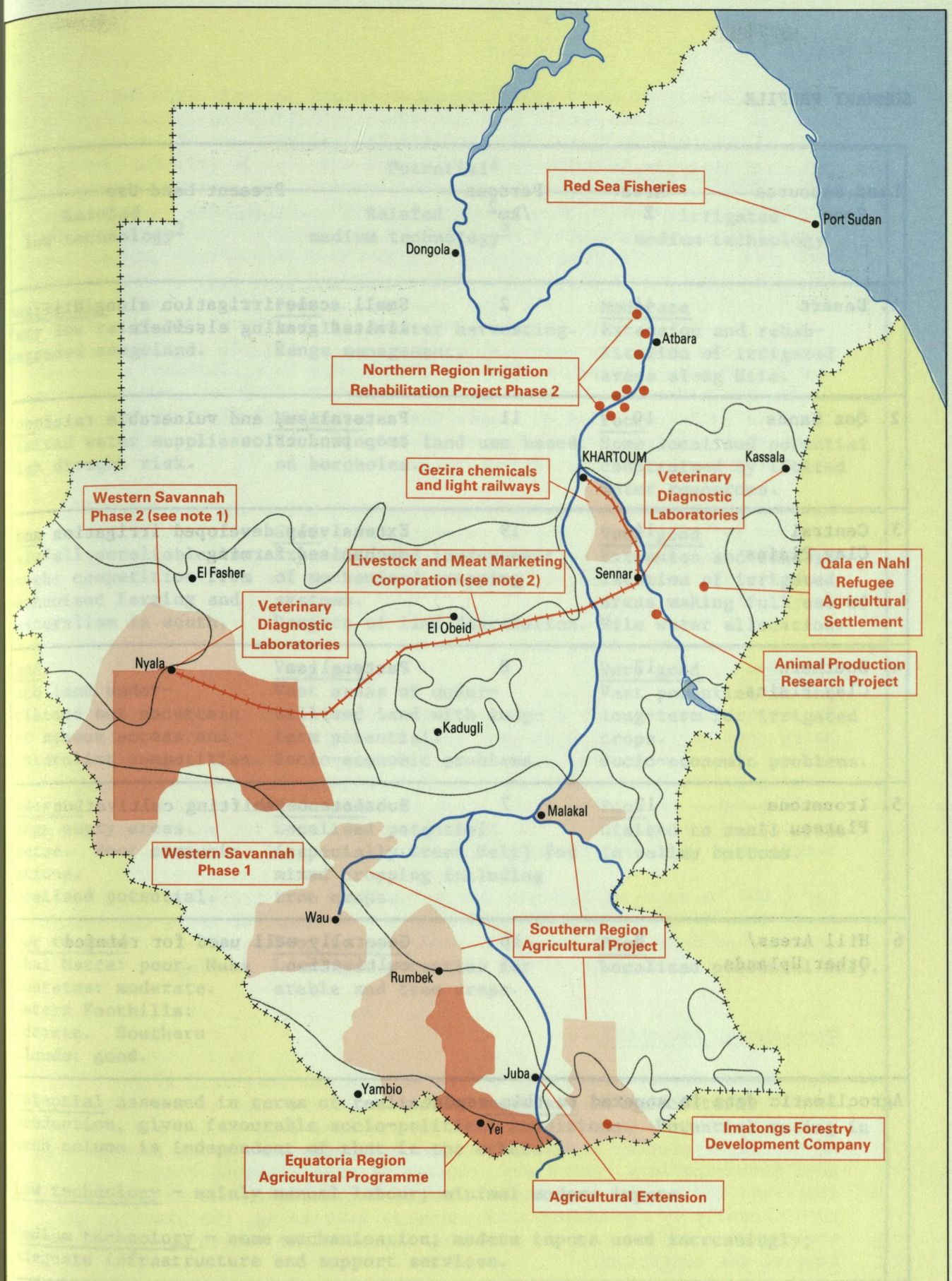
The Sudan is currently deep in debt, there has been a major influx of refugees from three neighbouring countries, and there is serious civil disorder in the south. This report does not address these problems although they clearly have a major bearing on development programmes.

Population Distribution and Communications in Sudan



CRP\SUD\2

Location of Major ODA Natural Resource Projects in Sudan



Notes

1. Phase 2 includes the area covered by Phase 1
2. Livestock and Meat Marketing Corporation; development of marketing facilities on the Nyala-Khartoum rail link

0 100 200 300 400 500km

Land Resource Zone boundary

International boundary

SUMMARY PROFILE

Land Resource Zone	Area %	Persons /km^2	Present Land Use
1. Desert	44	2	Small scale irrigation along Nile; limited grazing elsewhere
2. Qoz Sands	10	11	Pastoralism, and vulnerable rainfed crop production
3. Central Clay Plains	14	19	Extensively developed irrigation and mechanised farming
4. Southern Clay Plains	12	8	Pastoralism
5. Ironstone Plateau	12	7	Subsistence shifting cultivation
6. Hill Areas/ Other Uplands	8	16	Generally well used for rainfed cultivation
Agroclimatic data is annexed to this report.			

Potential[1]		
Rainfed low technology[2]	Rainfed medium technology[3]	Irrigated medium technology
Negligible Very low rainfall. Degraded rangeland.	Poor Localised water harvesting. Range management.	Moderate Extension and rehabilitation of irrigated areas along Nile.
Poor Limited water supplies. High drought risk.	Moderate Extension of land use based on boreholes.	Poor Some localised potential constrained by limited water resources.
Poor Rainfall unreliable in north; competition from mechanised farming and pastoralism in south.	Good Expansion and improvement of mechanised cropping systems. Dangers of land degradation.	Very good Extension and rehabilitation of irrigated areas making full use of Nile water allocation.
Good Much land underutilised but uncertain wet season access and pastoralist competition.	Very good Vast areas of underutilised land with long-term potential. Socio-economic problems.	Very good Vast potential in the long-term for irrigated crops. Socio-economic problems.
Moderate Large empty areas. Tsetse. Poor communications. Localised potential.	Moderate Localised potential (especially Green Belt) for mixed cropping including tree crops.	Poor Limited to small areas in valley bottoms.
Poor to good Jabal Marra: poor. Nuba Mountains: moderate. Eastern Foothills: moderate. Southern uplands: good.	Poor to good Localised potential for arable and tree crops.	Poor Localised potential only.

[1]Potential assessed in terms of realisable increases in agricultural production, given favourable socio-political conditions. Potential rating in each column is independent of that in the others.

[2]Low technology - mainly manual labour; minimal modern inputs.

[3]Medium technology - some mechanisation; modern inputs used increasingly; adequate infrastructure and support services.

1. DESERT

Physical Environment

Rainfall in the Desert Zone is negligible in the north but increases to about 200 mm in the south.

The Zone consists of three main units: rock and sand west of the Nile, the Nile Valley, and a hilly zone between the Nile and the Red Sea.

The rock and sand area west of the Nile supports little vegetation except towards the south.

The Nile Valley upstream of Atbara lies in a 5-10 km wide floodplain of calcareous alluvial soils. Downstream of Atbara, the floodplain is intermittent, having its largest extent at Dongola.

East of the Nile, the Red Sea Hills rise to 2 000 m and have very shallow soils. Limited winter rainfall allows some grazing. A narrow coastal plain between the hills and the Red Sea largely consists of gravel and coarse sands, with finer deposits in the deltas formed by the larger rivers.

Land Use

The Desert Zone is very sparsely populated, most of the agriculture being confined to irrigated land along the Nile and the Tokar inland delta. The southern fringes, or semi desert, are thinly occupied by nomadic tribes which graze their herds over vast areas and cultivate small patches of rainfed grain crops in wadis and depressions. Goats and camels predominate in the drier pastoral areas but sheep and cattle become more important in areas of better grazing in the hills.

For 1 600 km north of Khartoum along the Nile, the irrigated land is restricted to a narrow strip producing a wide range of crops including cereals and faba beans, dates, cotton, fruit and vegetables. Cultivation takes place as the flood recedes, or by pumping.

Development Potential

Most of the desert has little potential. In the less arid areas, improved livestock and rangeland management could lead to increased offtakes provided further overstocking and land degradation are avoided. In the major grazing areas of the east and south east which benefit from good communications, there are problems of wind erosion, fodder shortages and scarcity of fuel. Limited improvements can be brought about locally by techniques such as water harvesting, the planting of shelterbelts and the use of mesquite, leucaena and native species to improve the rangelands.

Along the Nile, further expansion of irrigated areas is probable in view of acute local population pressure and land fragmentation, but is constrained by the high cost of pumping river water or groundwater and the availability of suitable land. Rehabilitation of existing irrigation systems and improved husbandry could contribute significantly to increased production. Shelterbelts to protect land and crops from wind and sand encroachment and to provide timber, fuelwood and fodder are needed, together with measures to control gully erosion on the river banks.

The desert has extensive untapped aquifers with hydrological characteristics that favour borehole development. The technical and economic feasibility of groundwater development schemes in such areas has, however, yet to be proven and implementation and maintenance of such schemes would pose serious problems.

2. QOZ SANDS

Physical Environment

The Qoz Sands are an ancient belt of stabilised sands which are extremely permeable. The sands lack fertility, but as they are easily worked by hand and allow crops to exploit fully the limited available moisture, they are widely cultivated. More fertile alkaline clays occur in some lower-lying areas but these are difficult to cultivate with traditional hand implements.

The natural vegetation of the Qoz Sands is open woodland with grass.

The length of the growing season doubles from north to south with increasing rainfall (200-800 mm) and rainfall reliability, though in general rainfall is very unreliable. Seasonal surface water for irrigation is limited to the largely unused Bahr el Arab area in the south west. Groundwater resources are generally abundant but often difficult to reach by means of hand dug wells, the water table being over 200 metres beneath the surface in places.

Land Use

This Zone is peopled by nomadic pastoralists, principally the Baggara cattle people, who migrate considerable distances in response to seasonal and sometimes yearly variations in rainfall, water supply and pests. In the dry season cattle move south, depending on the availability of grazing, but movement out of the Zone across the Bahr al Arab watercourse is regulated to reduce conflict with other pastoralists already there.

Also occupying the Zone are livestock-owning sedentary people who practise shifting agriculture round watering points, growing pearl millet, groundnuts and sesame and tapping gum arabic from acacia trees. Devegetation, shortening fallows and falling crop and herd productivity resulting from increases in the human and cattle populations have been accentuated by the 20 year period of below average rainfall.

In consequence private enclosure of the more valuable common rangelands is occurring, and clearing and cultivation of land is spreading from the preferred drier central-northern sector into areas where domestic supplies of water are less well developed and biting flies more prevalent. Water from subsurface sources may be pumped for domestic and livestock use but pumping is unlikely to be economical for substantial irrigated crop production.

Infrastructure in the remoter parts of this Zone is poorly developed and the railway is less reliable than formerly.

Development Potential

Population pressure and overstocking are already acute in certain localities and the Zone appears increasingly vulnerable to drought and land degradation. Agricultural potential largely depends on opening up unutilised or under-utilised land. This requires a more extensive network of settlements based on water points (wells, boreholes and wateryards) to provide water for people and livestock. The rehabilitation of existing wells by overcoming problems of fuel shortages, water charges and operational difficulties is a priority.

There is also scope for improving farming systems by better integration of crops and livestock, veterinary services, improved primary tillage equipment to raise productivity of the underutilised heavier soils, the use of fertiliser (especially phosphorus), the introduction of short-duration sorghums and improved varieties of other crops. The prevalence of the parasitic weed, Striga, in pearl millet, is an important reason for the regular abandoning of land and its underutilisation.

Production of gum arabic in specific areas and the planting of woody species as shelterbelts, fuelwood and fodder should be promoted.

In view of the high drought risk, crop storage and food security are priorities to prevent widespread starvation.

Improvement of railways, communications generally, and other market-related services for disposal of livestock, cash crops and forestry products should also have high priority.

3. CENTRAL CLAY PLAINS

Physical Environment

The Central Clay Plains are flat to very gently sloping with scattered rocky hills.

The predominant soils are deeply cracking clays. They are very hard in the dry season and are impermeable and difficult to work when wet.

The residual natural vegetation of the Zone is sparse woodland with grass.

Rainfall varies from 200 to 800 mm and is not reliable, but there are large unused surface water resources, Sudan not yet having taken up its allocation of Nile water under the agreement with Egypt.

Land Use

Excluding Khartoum from the calculations, about 33% (6.2 million) of Sudan's population is concentrated in the centre and east of this Zone. Abundant surface water and level land favour controlled irrigation and mechanised cultivation. Traditional agriculture is practised, wherever drinking water allows. Pastoralism is widespread, while mixed rainfed farming based on sorghum is concentrated in areas of more reliable rainfall although it extends to all but the northern desert fringe. Traditional agriculture is suffering from competition with more intensive methods in the form of the vast irrigation schemes (run by public corporations with tenant farmers) and large mechanised rainfed farms (largely run by private entrepreneurs) which together account for about half the regularly cultivated land in the country and support the main population centres. These are essentially capital intensive projects but nevertheless they employ a mobile labour force of well over one million to help with the harvesting of irrigated cotton and rainfed sorghum.

The shrinking woodland resources provide fuelwood and charcoal which are transported more than 400 km to Khartoum. In some areas gum arabic production is important.

Irrigated farming Irrigated areas extending to about 1.5 million hectares are served by the Blue and White Niles and their tributaries. Storage dams date back to 1925 when the Sennar dam was constructed; this and more recent dams serve the Gezira and other irrigation systems. Cotton, wheat and fallow each occupy about 25% of the irrigated area, the remainder being under sorghum and groundnuts, but the proportions vary in response to relative prices.

Recently the schemes have not been working very effectively, and rehabilitation, revised crop pricing and taxing policies have been called for by the World Bank. Desilting of dams for better water storage and hydropower development are important current activities.

Mechanised rainfed farming Over one million tons of sorghum, about half of Sudan's crop, is produced on 2.5 million hectares by about 4 000 large farmer/merchants using mechanised cultivation. Most of this activity is located where the length of growing season is between 90 and 120 days (see large map), and already much of the best and most accessible land for large-scale mechanisation has been exploited. However, yields drop from 1 900 to 700 kg/ha with continuous cultivation; farmers sometimes react by illegally opening further blocks of land, which often amounts to mechanised shifting cultivation as areas are abandoned with no attempt being made to rehabilitate them.

Development Potential

There is potential for increasing irrigation in three main ways:

(i) Rehabilitation of existing schemes, giving a 30% increase in cropped area

(ii) Implementation of projected schemes (25% increase)

(iii) Jonglei canal Phase 1 (15% increase).

Groundwater is also abundant and accessible, especially near both Niles, and could be used to open up new areas or for supplementary irrigation within present agricultural systems.

There is considerable scope for expansion of mechanised rainfed sorghum production but the reasons for the drop in yield with continuous cropping are not fully understood and require further investigation.

By comparison the potential for increasing production under low input farming systems is small. While large portions of the Zone are still used mainly by pastoralists, further large scale conversion of suitable land to mechanised or low input rainfed agriculture is likely to exacerbate existing social problems.

4. SOUTHERN CLAY PLAINS

Physical Environment

Most of this Zone has flat terrain and clay soils like the Central Clay Plains but it receives more rainfall (800-900 mm) and considerable overflow from the White Nile and other rivers. In consequence there is poor surface drainage and widespread shallow seasonal flooding which greatly expands the area of permanent swamps. In the sparsely populated south east corner of the Zone, the rainfall declines sharply below requirements for reliable crop production.

The vegetation in the perennial swamps is typically papyrus. Short grasses grow on the seasonally flooded areas and tall grasses and patches of woodland (sometimes with tsetse fly) occur on the higher ground. The Zone is noted for the numbers and variety of its wildlife.

Oil has been located in the north not far from the Nile.

Land Use

The Zone is remote and has very little infrastructure. It is peopled by Dinka-related transhumant tribes who own 50% of Sudan's cattle and 30% of sheep and goats. The Dinka adapt to seasonal changes in water availability and flooding. During the peak of the rains they occupy permanent settlements where they concentrate their cattle and cultivate sorghum, particularly along the border with the Ironstone Plateau. At the end of the rains (November) they follow the receding floods, finally establishing their cattle camps on the fringes of the permanent swamps. Unpalatable grass of the intermediate land is burnt to promote a valuable regrowth on residual moisture. Migration back to the permanent villages starts with the next flood in June or July.

Development Potential

The Jonglei Canal will, when complete, cut off a huge loop of the White Nile and increase water flow to the North, so reducing the present overflow onto the Southern Plains. Large parts of the Zone will then have the capacity to support mechanised rainfed agriculture; controlled irrigation with double cropping will become feasible, although the associated land development costs may be high.

The Nilotic people fear that the canal will destroy their livelihood, and their vigorous opposition to this and other developments has brought construction to a halt. There is therefore an urgent need to resolve the conflict between the interests of the local people and the wish to achieve greater control over water resources.

Without the canal there are still large areas of land suitable for rainfed agriculture, particularly under high input mechanised systems. However reliable wet season access would have to be developed and conflicts with pastoralists resolved.

5. IRONSTONE PLATEAU

Physical Environment

The rolling Ironstone Plateau rises from about 500 m to over 1 000 m at the southern border which forms the Nile-Congo watershed. The higher lying and consequently wetter strip of land along the southern border is commonly known as the Green Belt.

Much of the Plateau is affected by a thick layer of hard ironstone within 1 metre of the soil surface. In the north, where the Zone borders the Southern Clay Plains, the ironstone is almost continuous; consequently land with soil of sufficient depth for cultivation is limited. Further south the Plateau becomes more dissected and the ironstone occurs more as concretions within a typically leached tropical soil. In the Green Belt, soils are more varied, relatively deep and more productive.

The natural vegetation is mainly woodland with tall grass with a mosaic of disturbed lowland rain forest in the Green Belt.

Despite the relatively high rainfall (800-1 600 mm and locally more in the Green Belt) and long growing season, crop production is often adversely affected by dry periods. Surface and groundwater resources are not readily available for irrigation.

Land Use

Large areas of the Ironstone Plateau are inaccessible and effectively unpopulated. Elsewhere shifting cultivation, hunting and gathering are the main activities. Because of tsetse on the plateau, cattle are confined to the area bordering the Southern Clay Plains. This limited area is particularly favoured for arable cropping and supports a relatively high population. On the plateau itself the predominantly subsistence agriculture is based on mixed cropping of cereals, legumes, oilseeds, cassava and other crops, together with small livestock.

In the Green Belt cultivation is more developed because the longer, more reliable, wet season allows regular double cropping. Coffee is doing well with marketing encouragement, and production of other cash crops (food and tobacco) would respond to more favourable market conditions.

Forestry operations are limited to a few scattered sawmills and plantations.

The Zone contains the Rumbek National Park.

Development Potential

Outside the extensive areas with shallow soils unsuitable for cultivation, there is potential for development of low input agriculture

on a significant scale. The long wet season and poor but well drained soils are ideally suited to many tree crops. In the Green Belt the potential is appreciably higher because of the significantly better rainfall distribution and also because areas in use are still only a small proportion of total cultivable area.

However, the potential of these soils under high input farming has yet to be determined. That there is considerable scope for intermediate intensification of farming systems is demonstrated by successful continuous cultivation near the towns.

Irrigation potential is constrained by lack of water; the more favourable sites in small valley bottoms are already well exploited.

Within the Ironstone Plateau, as elsewhere in the south, realisation of agricultural potential is restricted by poor rural infrastructure, including lack of markets and roads, high transport costs and weak government services; scattered populations; and crop damage by wild animals.

6. HILL AREAS/OTHER UPLANDS

This Zone comprises four Sub-Zones: Jabal Marra, Nuba Mountains, Eastern Foothills, and Southern Uplands. Although widely separated geographically, these areas have in common relatively high rainfall, relatively fertile although complex soils, and hilly topography. The natural vegetation in the four Sub-Zones varies from woodland types on the Nuba Mountains and Eastern Foothills, through scrub forest high on Jabal Marra, to rain forest on the Imatong Mountains and neighbouring ranges in the south.

(a) The Jabal Marra Sub-Zone in Darfur forms a plateau at 1 000-1 300 m surmounted by a volcano that rises to over 3 000 m. On the west, rainfall is relatively high, giving rise to flood waters and perennial streamflow. Productive volcanic soils, terraced where necessary, support a fairly dense settled population depending on mixed farming, and livestock. The recent droughts in Darfur put the area under increased pressure from immigrant pastoralists seeking grazing and loppings of fodder trees.

Most available land is already occupied and efficiently cultivated. There is little potential for expansion of low input rainfed agriculture in this Sub-Zone. Unreliable rainfall and risks of crop failure renders higher input farming systems relatively unattractive.

(b) The Nuba Mountains rise to about 1 300 m and have rainfall up to twice that of the surrounding clay plains. At higher altitudes soils are mainly shallow and stony, terraced in places, while in valley bottoms they tend to clay. The better areas already support a productive agriculture based on rainfed cotton, sorghum and sesame, and expansion will be limited to less favourable areas. However, farmers responded well to the introduction of rainfed cotton and further significant improvements to the farming system appear possible.

(c) The Eastern Foothills rise from 300 m altitude in the west to 2 000 m on the Ethiopian border. Both the basaltic soils occurring in the northern unit and the less fertile acid soils are widely cultivated. The area appears to be less densely populated than would be expected from the relatively good soils and rainfall (800-1 000 mm). Sources of drinking water are a major limitation to settled agriculture. In the most northerly part of this Sub-Zone near Kassala, where the terrain is a sloping plain rather than hills, mechanised farming is reported to be successful, replacing grazing and shifting cultivation, and there is potential for further development. The other two areas of the Eastern Foothills have more severe slopes which limit high input agriculture. They are also infested with tsetse.

The Boma Plateau in the extreme south lies at the altitude of 1 000-1 500 m; there are no signs of cultivation in this remote tsetse infested area and there is a proposal to establish a national park.

(d) The Southern Uplands rise from 1 000 to 3 200 m. With high rainfall over a long season and reasonably fertile soils, a wide range of food and cash crops could be grown (including coffee and tea), but

steep slopes and accessibility to markets limit expansion possibilities.

Most of the upland areas have good potential, though high input agriculture is restricted to the more gently sloping areas. Timber production is possible from the rain forests and from plantations of broad-leaved trees and high-yielding conifers.

Annex: Agroclimatic data

Zone[1]	Mean annual rainfall range (mm)	Mean length of crop growing season[2] (days)	Mean annual temperature and monthly range (°C)	Proportion of optimum crop water requirement[3] supplied by summer rainfall
Desert	0–200	0–50	28° ± 7	0–20%
Qoz Sands	200–800	50–150	27° ± 4	30–100%
Central Clay Plains	200–800	50–150+	28° ± 4	25–100%
Southern Clay Plains	800–900[4]	150–180	27° ± 2	100%
Ironstone Plateau	800–1400+	150–240+	25° ± 2	100%

[1] The Hill Areas Zone is too heterogeneous to be included.
[2] July or August is in most instances the wettest month.
[3] A crop growing season of 120 days, with rainfall regularly distributed.
[4] Except in the extreme south-east corner where rainfall abruptly declines below levels suitable for cultivated agriculture.