

2.8 SUDAN

Introduction

Sudan is the largest country in Africa with an area of 2 505 815 km². It had a population of 20 564 364 in 1983, as determined by a census, and thus at that time had a mean population density of 8.2 persons/km². It is bounded by Libya and Egypt in the north, by the Red Sea and Ethiopia in the east, by Kenya, Uganda and Zaire in the south, and by the Central African Republic and Chad in the west. It extends approximately 2075 km from south to north between latitudes 3°31' and 22°00'N, and 1810 km from west to east between longitudes 21°50' and 38°34'E.

The highlands of Sudan are all peripheral. Vast flat interior plains, 500-1000 m asl fall towards the Nile Valley which runs N-S through the country. In the east, mountains run parallel to the Red Sea, some 50 km inland, rising to peaks of 2217 m asl at Jebel Asoteriba (21°51'N/36°28'E), 2218 m asl at Jebel Erba (20°46'N/36°46'E), 2260 m asl at Jebel Oda (20°20'N/36°39'E) and to over 2000 m at Jebel Hamoyet (17°36'N/38°01'E) on the Ethiopian border. In the far south, close to the Ugandan border, Mt. Kinyeti (3°56'N/32°53'E), the highest point in Sudan, rises to 3187 m asl, while in the far west, Jebel Gimballa (12°58'N/24°21'E), frequently cited as the highest point, rises to 3071 m asl in the Jebel Marra. This latter range is the largest highland massif in Sudan with more than 8500 km² of land surface rising above the 1500 m contour and more than 1500 km² over the 2000 m contour.

The Red Sea coastal plain is 10-30 km wide and approximately 1000 km long. The coast is fringed by coral reefs, the inner ones raised, and is highly indented in the central section where wadis from the highest mountains of the coastal range reach the sea.

Almost the whole of Sudan drains to the Nile, except for the area east of the watershed along the coast mountains, and that part west of the Jebel Marra in Darfur, which drains to Lake Chad. The Nile Valley is broad, over 300 km at its narrowest point between the Ethiopian Highlands in the east and the high plateau of Kordofan in the west. The bed of the White Nile (Bahr el Jebel) descends below the 500 m contour about 125 km after crossing into Sudan from Uganda, at a latitude close to 4°20'N. It then flows northwards through the Sudd and the Sudanese savannas and desert, to descend below the 200 m contour, over 16° of latitude farther north. Thereafter it swells into Lake Nubia before crossing the Egyptian border at 22°N, a river distance of more than 3000 km. Drainage from the southwestern corner collects into the Bahr el Ghazal, and that from the southeastern corner into the Sobat River. Both these streams enter the Nile at the northern end of the Sudd. Drainage from the mid-west reaches the Nile via the Wadi el Malik which enters the Nile at Ed Debba (18°01'N/30°54'E). Drainage from eastern Sudan collects into the Blue Nile and Atbara Rivers which enter the Nile at Khartoum (15°33'N/32°32'E) and Atbara

(17°42'N/34°00'E) respectively, and into the Wadi Amur which reaches the Nile 240 km downstream of Atbara, and the Wadi Jabjabah which enters Lake Nasser in Egypt.

Climate

Northern Sudan is a desert with negligible rainfall and high mean daily temperatures, c. 35°C in summer and 20°C in winter. South of latitude 10°N thunder showers may fall between March and November, with the most widespread rain in mid-summer. The Red Sea coastal plain and the eastern slopes of the coast mountains have a different regime, with most rain falling in winter. Rainfall is convectional in origin and increases steadily to the south of Khartoum, amounting to 1000-1200 mm near the southern border. Potential evaporation reaches and often exceeds 3000 mm/yr in the north, and is always over 1400 mm, even in the humid south.

Vegetation

Sahelian grassland and then scrub form a belt south of the desert, situated roughly between latitudes 16° and 13°30'N, but deflected to higher latitudes in the east along the flanks of the Ethiopian Highlands. South of this, in southwestern districts, a Soudanian savanna, rich in *Isoberlinia* spp., extends to approximately 5°N. This gives way in the central south to edaphic grasslands in the Nile Basin, and these in the southeast to Ethiopian savannas around the flanks of the Ethiopian Massif. Along the borders with Zaire there is a mosaic of rain forest and secondary grassland, while towards the Kenyan border the savanna grades into a zone of bushland dominated by species of *Acacia* and *Conzmiophora*.

Wetlands

Vast swamps, known as the Sudd, occur along the Bahr el Jebel and its tributaries in upper Sudan, and these enclose several substantial lakes e.g. Lake Ambadi (8°43'N/29°21'E) on the Bahr el Ghazal, Lakes Nuong (7°23'N/30°32'E) and Fajarial (6°17'N/31°28'E) on the Bahr el Jebel, and Lake Nyubor (6°52'N/30°18'E) on the River Lau. To the north and east of the Sudd (north of the Sobat River) lie the Machar Marshes, fed by the Dagar River (Dakar Wenz) and drained by the Adar River to the right bank of the White Nile at a point (10°20'N/32°16'E) just below Melyut. Immediately south of Khartoum, a large area of land between the Blue and White Nile Rivers, above their confluence, was in the past subject to inundation when the flood on the Blue Nile caused the waters of the White Nile to back up. This area, El Geizira, is now irrigated and cultivated whenever conditions are suitable. Three different types of swamps are recognised along the Nile; (a) permanent swamps fringing rivers, lakes, lagoons, channels and subsidiary streams; (b) the most deeply

flooded landward fringes of the permanent swamps, which nevertheless experience great seasonal variations in water level and may dry completely in the dry season; and (c) extensive peripheral floodplains around the swamp margins which are flooded shallowly for a few months each year. The latter two categories are often both referred to as toiches and are heavily exploited by people and wildlife during the dry seasons.

The Jonglei Canal Project provides for a canal 360 km long, bypassing the Sudd between Bor (6°16'N/31°33'E) and the point where the Sobat River enters the White Nile. Excavation began in 1978, but was halted in 1984, for technical, financial and political reasons. However, with the completion of the canal, evaporation in the Sudd will be reduced and far less White Nile water will be lost to Egypt and Sudan. Completion of the canal will significantly alter the ecology of Jonglei Province.

There are a number of impoundments, the largest being the lake on the Nile behind the Aswan High Dam in Egypt which produces Lake Nasser, stretching back into Sudan where it is known as Lake Nubia. The Atbara was impounded (14°53'N/35°55'E) near Khasm el Girba in 1972, and the Blue Nile is dammed at El Roseires (11°49'N/34°20'E) and Sennar (13°33'N/33°37'E).

Surface water is scarce in the north, except in a few gueltas in canyons in rocky hills. Some of the larger wadis, e.g. Wadis Malik, Abu Hahl and Azum flow for several days in the July-September period, after which pools may persist at the surface for some time. Some pools are persistent, and those on the Wadis Umm Badr, Abu Zabad and Er Rahad may last until the following rainy season. Some pans may hold water until January or February, and brick-making activities in the vicinities of En Nahud (12°43'N/28°26'E), El Obeid (13°10'N/30°12'E) and Umm Ruaba (12°51'N/31°19'E) have created semi-permanent reservoirs or fulas.

South of the parallel 12°N there are a number of perennial lakes such as Lake Keilak (10°48'N/29°19'E) in Kordofan and Lake Kundi (10°30'N/25°15'E) in Darfur, as well as many other rain fed pools and small artificial reservoirs. Small rivers at these latitudes may hold water for parts of the year. Mangrove swamps, salt-marshes and coastal reed swamps are found along the 1000 km Red Sea Coast, reed swamps being best developed in deltas at the mouths of large wadis, e.g. Wadis Oko and Ibib.

List of Wetlands Described

1. Coastal Wetlands
2. Permanent Swamps & Seasonal Floodplains
 - (a) Lotagipi Swamp
 - (b) Kenamuke/Kobowen Swamp
 - (c) The Lotilla Swamps
 - (d) Badigeru Swamp
 - (e) The Veveno/Adiet/Lilebook Swamps
 - (f) The Sudd

- (g) The Machar Marshes
- (h) The Dinder/Rahad Floodplain
- (i) Minor Wetlands
- (j) The Nile Valley below Malakal
- (k) The Bahr el Ghazal
- (1) Floodplains of the southern rivers

3. Natural Lakes

- (a) Lake Keilack
- (b) Lake Kundi
- (c) Lake Ambadi
- (d) Lake Maleit
- (e) Lake Yirol
- (f) Lake Anyi
- (g) Lake Nyiropo

4. Artificial Impoundments

- (a) Lake Nubia/Nasser
- (b) El Roseires
- (c) Sennar
- (d) Kashm el Girba
- (e) Gebel Auliya

1. Coastal Wetlands

General: Mangrove vegetation occurs sporadically along the entire Sudanese coast, which is in many places fringed by raised Pleistocene coral reefs. Where wadis discharge, waters have cut through the raised reefs, and bays in the reefs provide sheltered habitats for mangroves. Reefs are well developed inshore of the Siyal Islands along a stretch of coast (22°38'-22°44'N/35°53'-36°16'E), and again at Halaib between 22°10' and 22°14'N and 36°40' and 36°46'E. However, the largest and most complex development is in Dungunab Bay (21°00'-21°13'N/37°06'-37°17'E) and between the mouth of the bay and Mukawar Island (20°49'N/37°16'E). Here there are several lines of raised reefs with contemporary reefs to seaward of them. From this place, reefs are apparent almost continuously south to Port Sudan (19°37'N/37°13'E) and they are 1 km wide at Suakin (19°07'N/37°22'E). South of this, reefs extend up to 16 km offshore in an area (18°43'4 8°52 'N/37°27 '-37°41'E) where the coast runs E-W for a distance. Close to the Ethiopian border, the Gulf of Aqiq and its associated lagoons also support mangrove stands (8°00 '-8°25 'N/38°05 '-38°35 'E). *Avicennia marina* is the dominant mangrove species, but *Rhizophora mucronata* also occurs here, and *Bruguiera gymnorhiza* has been reported. Salt marshes are widespread, with floras as described in the regional

introduction.

2. Permanent Swamps & Seasonal Floodplains

Wetland Name: Lotagipi swamp

Country: Sudan

Coordinates: 3°52' -5°04'N/34°18' -35°27' E

Area: c. 720 000 ha total floodplain (c. 215 000 ha in Sudan)

Altitude: 490-500 m asl

Nearest Towns: Nimule (325 km WSW); Juba (350 km W)

General: The Lotagipi Swamp, 90 km west of Lake Turkana, occupies the lowest part of an endorheic basin straddling the Kenya/Sudan border in the *Acacia-Commiphora* zone. It is a seasonal floodplain, 120 km long, oriented N-S, with a maximum E-W width of 125 km at the northern end, and a mean width of about 60 km, where it extends 85 km into Kenya. There is a large permanent swamp zone along the lowest part of the plain, traversed, from north to south, by the Tarach and Narengor Rivers. The plain is fed by drainage from the Didinga Hills in the west, the Murua Ngithigerr and Mersuk Hills in the south, the Murua Lokwana (Lokuwanamoru) Range to the east and the Ethiopian Highlands in the north. The surrounding land slopes down to the swamp fairly gently on all sides except the north. Here the swamp boundary, close to the 500 m contour, rises quite steeply over a distance of 10 km to the Morn Agippi Plateau at an altitude of 1000 m.

Hydrology & Water Quality: The swamp is flooded during the rains to depths in excess of 1 m. The 9 rivers feeding it are seasonal, but some retain pools of water in their beds during the dry season. A small lake forms in the swamp after the rains at a point 4°59'N/34°41'E in Sudan, but disappears during the dry season. Precipitation over the swamps is 250-500 mm/yr, but reaches 650 mm in the Ugandan catchments and 800 mm in those of Ethiopia.

Flora & Fauna: Essentially it is a grassy floodplain but with reeds and papyrus in the wettest sites, and scattered *Acacia* trees. See regional introduction.

Human Impact & Utilisation: Apparently little utilised. Some hunting occurs here.

Conservation Status: Unprotected.

Wetland Name: Kenamuke/ Kobowen Swamp

Country: Sudan

Coordinates: 5°17' -6°27'N/33°37' -34°06'E

Area: c. 172 000 ha

Altitude: 600-700 m asl

Nearest Towns: Juba (260 km WSW); Malakal (450 km NW)

General: The Kenamuke/Kobowen Swamp is approximately 130 km long and varies in width from 5-30 km. It is oriented N-S and is supplied by a number of rivers, the most important ones rising either in the Didinga Hills to the south or the Ethiopian Highlands to the east. The long narrow swamp occupies the floor of a valley system and drains from the northernmost end by the Kanger River to the Sobat River, and thence to the White Nile. A southeastern outlier at the head of the system is a SE-NW oriented depression, lying immediately below the western side of the Moru Agippi Plateau at an altitude close to 700

m asl. Occasionally, after heavy rains, this latter area floods, and in 1940 for example, it contained a boomerang-shaped lake 25 km long and 12 km wide (5°07'-5°16'N/ 34°16'-34°28'E). Chief among the tributary streams are the Gerra, Lomen, Chilmun, Chalbono and Nakua Rivers. Rainfall over the system is 800 - 1100 mm/yr.

Flora & Fauna: A broad floodplain grassland swamp containing black cotton soils in the Soudanian savanna zone, with typical floodplain grasses as described in the regional introduction and *Cyperus papyrus*, *Miscanthidiunz violaceum*, *Phragmites mauritianus* and *Typha domingensis* in the wettest sites. A rich mammal flora is present including *Hippotragus equinus*, *Kobus kob leucotis*, *Loxodonta africana*, *Panthera pardus*, *Redunca arundinum* and *Syncerus caffer*. See regional introduction.

Human Impact & Utilisation: The floodplain is impassable during the wet season, but there is some fishing, and the swamp area is relatively undisturbed, although traditional hunting occurs in the surrounding *Acacia* woodlands.

Conservation Status: Largely contained within the Boma National Park.

Wetland Name: The Lotilla Swamps

Country: Sudan

Coordinates: 5°02 ' -6°43 'N/32°34 ' -33°15 'E

Area: 219 000 ha

Altitude: 415-620 m asl

Nearest Towns: Pibor (at N end); Juba (170 km W of S end)

General: The swamps are situated in the valley of the Lotilla River which has its headwaters in the Didinga Hills and flows north to join the Kanger River at Pibor Post (6°49'N/33°08'E). The swamps comprise two major blocks, a southern block 140 km long and up to 27 km wide, which contains patches of swamp forest on the plateau at about 600 m asl, and a smaller northern block, c. 95x7 km which ends some 30 km above Pibor. The course of the river is not always clear in the upper swamp, but it is well defined where it meanders through the lower northern swamp.

Flora & Fauna: This is a typical floodplain system dominated by grasses, as described in the regional introduction, with areas of permanent swamp dominated by *Cyperus papyrus*, *Phragmites inauritianus* (or *P. karka?*) and *Typha donzingensis* along the river.

Human Impact & Utilisation: This swamp is very sparsely inhabited and comparatively undisturbed. Some fishing occurs on the floodplain and in the rivers, and there is some hunting.

Conservation Status: Unprotected.

Wetland Name: Badigeru Swamp

Country: Sudan

Coordinates: 4°41 ' -5°31 'N/31°57 ' -32°31 'E

Area: 55 000 ha

Altitude: c. 480-700 m asl

Nearest Towns: Juba (75 km SW); Bor (90 km NW)

General: Badigeru Swamp is supplied by the Kinyeti River and other streams which drain the northern slopes of the Kinyeti Massif (3187 m) on the Sudan/Uganda border. The swamps are discontinuous and are oriented SSW-NNE. They are 110 km long and up to 25 km wide at high water, but have a mean width of just 5 km. Water from the

northern end of Badigeru Swamp may filter east to the Veveno River basin and thence eventually to the Sobat and White Nile, or west to the Bahr el Jebel above Mongalla (5°12'N/31°46'E). Rainfall over the swamps varies from 800-900 mm/yr but is over 2000 mm/yr in the upper catchments.

Flora & Fauna: A valley swamp with papyrus along the river and typical grasses on the floodplain. See regional introduction.

Human Impact & Utilisation: Little disturbed and little utilised except for hunting and fishing on the floodplain.

Conservation Status: Unprotected.

Wetland Name: The Veveno/Adiet/Lilebook Swamps

Country: Sudan

Coordinates: 5°27'-7°04'N/32°00'-33°03'E

Area: 645 000 ha

Altitude: 400-500 m asl

Nearest Towns: Bor (47 km W); Pibor Post (at NE end)

General: This vast area of seasonal swampland lies to the east of the Sudd and is oriented SW-NE. It is 215 km long and up to 60 km wide. Run-off, from the highlands to the south and southeast, flows northwestwards until it meets the Veveno River which crosses its path from SW to NE. The Veveno leaves the swamp at the northeastern end, to join the Lotilla River, and thereafter the combined stream joins the Pibor River. North of the Veveno, water drains north or northwestwards until it collects into tributaries of the Adiet (Manaam) River, which flows outside the swamp, on the northern side, parallel with the Veveno. The Lilebook River drains the far northeastern end of the swamp, flowing northeastwards between, and in parallel with, the Adiet and Veveno Rivers. Like them, it enters the Pibor River *en route* to the Sobat and the White Nile. Broad belts of permanent swampland occur along all these rivers.

Flora & Fauna: See regional introduction. A seasonal river valley/floodplain swamp system with large areas of permanent swampland. Papyrus, *Phragmites*, *Miscanthidium* and *Typha* dominate the permanent swamps, and floodplain grasses the seasonal swamps.

Human Impact & Utilisation: The southwestern and central parts of the system are very sparsely inhabited, but there are numerous villages along the Kangen/Pibor River at the northeastern end of the swamp. The floodplains are fished and the area is subject to hunting.

Conservation Status: Unprotected.

Wetland Name: The Sudd

Country: Sudan

Coordinates: 4°55'-9°37'N/29°59'-31°57'E

Area: c. 1 650 000 ha (permanently inundated in 1980)

Altitude: 380-450 m asl

Nearest Towns: Mongalla (at S end); Malakal (at N end)

General: Permanent swamps begin on the west bank of the Bahr el Jebel 10 km below

Juba, at a point (4°55'N/31°38'E) near Gondokora Village, and on the east bank (5°00'N/31°41'E) near the village of Tibari, some 20 km below Juba. Below Mongalla (5°12'N/31°46'E) the river channel widens in places to more than 2 km, bifurcates at a latitude of 5°30'N, and flows in three or more channels for some distance below Buka (5°47'N). The banks, which are generally clearly defined in the upper reaches of the Sudd, become lower and finally disappear below Bor (6°14'N/31°34'E). Then the swamp widens, with numerous lakes and parallel streams, all beset with islands of floating papyrus. Between Mongalla and Bor the swamps are 10-13 km wide over a straight line distance of 115 km, but below Bor they widen to 25 km and with the peripheral floodplains are wider still. Major channels occur to the east, and there are several large lakes enclosed by permanent swamps on both banks, e.g. Lakes Fajarial (6°22'N/31°26'E) and Nuong (7°26'N/30°34'E) on the west bank. Both have open water areas close to 2500 ha, and there are at least 40 other lakes between Bor and Zeraf Cuts (7°46'N/30°32'E) on this stretch of the river. At Zeraf Cuts two canals on the east bank join the main channel of the Bahr el Jebel with the Bahr el Zeraf, but only the southern canal is kept open. Here, water flows from the Bahr el Jebel to the Bahr el Zeraf, which re-enters the Bahr el Jebel near Tonga (9°22'N/31°06'E) and thus isolates Zeraf Island between the two rivers. This island, east of the Bahr el Jebel, 180 km long and up to 65 km wide, was once mostly dry land, but following the rise in water levels which has been sustained since the 1963-64 floods, it has become a seasonal floodplain. Meanwhile the seasonal floodplain on the west bank of the Bahr el Jebel is 25 km wide in places and at Lake No (9°31'N/30°27'E), 190 km due north of Zeraf Cuts, the Bahr el Jebel receives the Bahr el Ghazal. This river flows NE for 200 km through a broad swampy tract to reach Lake No, a shallow lake of some 2000 ha. From Lake No, the river, now often known as the White Nile, swings abruptly eastwards for 115 km to a confluence with the Sobat River (9°22'N/31°33'E). It then flows northeastwards, past Malakal, having left the Sudd above the Sobat. The riverine distance through the Sudd, between Gondokoro and the Sobat confluence exceeds 680 km, and the total area of permanent wetland, including lakes and open river surface, is in the region of 1 650 000 ha (Mefit-Babtie, 1983), to which can be added at least a further 1 500 000 ha of seasonally inundated floodplain.

Hydrology & Water Quality: Long term variations in the amount of water discharged from the East African lakes are well documented. Prior to 1960 the mean annual inflow to the Sudd at Mongalla was 26 831 billion m³, but between 1961-1980 it was 50 324 billion m³, while the respective mean annual outflows at Malakal were 14 158 and 21 387 billion m³. The high water levels after 1961 led not only to a great increase in total wetland area, but also to a corresponding increase in loss by evaporation. While current outflow is 58% of inflow, the apparent reduction of 42% does not take account of the input by direct precipitation. This ranges from 780-910 mm/yr over the swamps, and thus amounts to between 23.4 and 27.3 billion m³/yr assuming a swamp area of 3 million ha. The total loss by evaporation and seepage can thus amount to as much as 56 237 billion m³/yr, considerably more than the riverine inflow at Mongalla, and the total input from all sources can exceed 77 624 billion m³/yr. The extent of the permanent swamp reflects annual riverine inflow closely, since this has proved more variable than direct precipitation over the past 82 years. During the low water phase of 1950-52, the area of permanent swamp was reduced to about 300 000 ha, while by 1980 it had increased to 1 650 000 ha. During these 30 years, riverine inflow increased by some 24 000 billion m³,

but outflow only by about 7250 billion m³, i.e. approximately 66% of the additional riverine inflow was lost in the swamps.

The annual input from the Bahr el Ghazal is of the order of 925 million m³, with normal peak flow rates of 46 m³/sec, although rates of 92 m³/sec occur in exceptional years. This is only a fraction of the volume carried by the Bahr el Jebel at Lake No, but the waters of the White Nile back up to Lake No, and even above it, when the Sobat River is in flood. The seasonal floodplain area is greater in the east than the west. Often direct precipitation seals the black cracking clays of the floodplains before the riverine flood. Often the flood first begins to rise as a consequence of surface run-off from local rain which moves on a front in a northwesterly direction down very shallow gradients. It is the seasonal floodplains which account for the great evaporative losses from the system, since comparatively little water returns from the floodplains to the river as the flood subsides, and the eastern areas at least, dry very quickly. Nevertheless, there are many isolated pools on the floodplain which persist well into the dry season.

Water quality varies seasonally and spatially. In the main channels water temperatures vary between 22 and 30°C, but higher temperatures are recorded on the floodplain as the water is receding. Transparency is greatest during the dry season, and over the year Secchi depths in the channels range from 17-150 cm, while conductivity ranges from 150-370 μ Siemens/cm at 20°C. The waters are generally well oxygenated in the channels, but decomposition in the swamps invariably leads to low oxygen concentrations. River water has been found to have lowered oxygen concentrations during the flood, possibly because organic materials are flushed out of the swamp at this time. The river water and swamps become more alkaline in the dry season over a pH range of 6.7-8.4. The principal cation concentrations are calcium 4-9 mg/l; magnesium 3-10 mg/l; silicon 1-14 mg/l and iron 0.05-1.3 mg/l, while the principal anion concentrations are chloride 4-12 mg/l; sulphate 0.5-10 mg/l; phosphate 0.005-0.14 mg/l; nitrate 0.0060-0.06 mg/l and ammonium 0.006-0.11 mg/l. The concentrations of silicon, iron and ammonium increase northwards, i.e. downstream, whereas those of nitrate, phosphate and sulphate decrease.

In the Sudd, every gradation from riverine to lacustrine conditions may be found. There are widenings of river channels, through which flow rate is reduced, extensive basins with tenuous river connections with long retention times, and apparently isolated shallow water bodies. Few of these 'lakes' have depths greater than 3 m at high water. Lakes enclosed by papyrus tend to have clear water throughout the year. Shallow lakes, with much submerged vegetation, become saturated with oxygen, but the interstitial waters of the swamps are strongly reducing.

Flora & Fauna: *Cyperus papyrus* is dominant at riversides, forming a riparian belt which extends right through the swamps. *Phragmites karka* and *Vossia cuspidata* are associated with the papyrus and, in places, *Phragmites* dominates swamps behind the papyrus. Elsewhere, *Typha dontingensis* forms enormous pure stands behind the papyrus, and this species has probably shown the greatest increase since the water level rise of 1961-62. *Eichhornia crassipes*, which was first recorded on the Nile in 1950, occupies the niche formerly held by *Pistia stratiotes*. However, this latter species is still present in the Sudd although diminished in importance. Other common macrophytes are *Ceratophyllum demersum*, *Najas pectinata*, *Nymphaea lotus*, *Ottelia* spp., *Potamogeton* spp., *Trapa natans* and *Vallisneria spiralis*. *Oryza longistaminata* is the predominant

floodplain grass, with *Echinochloa pyramidalis* and *Vossia cuspidata* its most widespread associates.

The invertebrate zooplankton is abundant and rich in terms of species, but the zoobenthos is impoverished and comprises mainly oligochaetes, but molluscs are important in the lakes.

Just under 100 species of fish have been recorded from the Sudd including 31 siluroids, 16 characoids, 14 cyprinids, 11 mormyrids, 8 cichlids and 7 cyprinodonts. Many species leave the rivers and move onto the floodplains to spawn as the flood rises, returning to the permanent watercourses when it recedes. The most numerous species are *Alestes dentex*, *Auchenoglanis biscutatus*, *Chelaethiops bibie*, *Citharinus citharus*, *Distichodus rostratus*, *Eutropius niloticus*, *Heterotis niloticus*, *Hydrocynus forskalii*, *Labeo niloticus*, *Lates niloticus*, *Micralestes acutidens*, *Mormyrus cashive*, *Oreochromis niloticus* and *Synodontis frontosus*. *Aplocheilichthys* spp., *Clarias* spp., *Epiplatys* spp., *Gymnarchus niloticus*, *Heterotis niloticus* and *Polypterus bichir* are associated with the papyrus and *Typha* swamps.

Frogs are abundant. There are several species of snakes in the swamps, and *Crocodylus niloticus* is still widespread. The Sudd is important to migratory birds, and has a rich avifauna, including numerous water birds and species associated with reeds as listed in the regional introduction. Numerous weavers, warblers, flycatchers (including *Alseonax aquatica*), kingfishers, ducks, herons, ibises, egrets, storks (including *Balaeniceps rex*), kites, crows and vultures (*Necrosyrtes monachus*) are found here. Large mammals found in the wetland system include *Alcelaphus buselaphus*, *Damaliscus korrigunz*, *D. lunatus*, *Hippopotamus amphibius*, *Hippotragus equinus*, *Kobus ellipsiprymnus*, *K. megaceros*, *Loxodonta africana*, *Panthera pardus*, *Redunca redunca* and *Syncerus caffer*.

Human Impact & Utilisation: Traditionally cattle are driven onto the floodplains for grazing as the floods recede. The cattle and their herders follow established routes and set up cattle camps along the way, from which they hunt and fish in the swamps. Fishing is mostly spear fishing, and *Clarias*, *Gymnarchus*, *Heterotis*, *Polypterus* and *Protopterus* are prominent in the catches. It is estimated that some 400 000 people live in the Sudd area. There are few villages and communications are seriously disrupted during the flood season, and, since the 1960-61 water level rise, the area available for seasonal grazing has decreased while that available for permanent fishing has increased. Hence, in recent years, the number of permanent fishing camps in the Sudd has increased greatly. Here fishing is chiefly by staked gill nets, but cast nets, seines and drift nets are also used. Fish to be sent to market are mostly sun-dried, but a salt-fish industry, operated by Arab merchants and the Government Fisheries Department has recently been established. The catches comprise, in decreasing order of importance, species of *Distichodus*, *Citharinus*, *Heterotis*, *Oreochromis*, *Lates*, *Gymnarchus*, *Mormyrus*, *Clarias* and *Labeo*. Nomadic fishermen also visit the swamps. Coming from the western provinces they set up temporary camps on the west bank, often on lakes shores such as those of Lake No. An FAO/UNDP Sudd Fisheries Development Programme has been established with a base at Bor, but at present, reliable predictions as to the maximum sustained yield from the Sudd are unavailable. Certainly the Sudd is presently underfished, and equally certainly some past estimates of MSY (e.g. 200 000 tonnes) are too high.

Hunting has always been an important activity on the floodplains, being concentrated around the villages, with *Alcelaphus buselaphus*, *Damaliscus lunatus* and *Gazella dama* the principal species taken.

It is intended to reduce water loss from the Sudd by channelling water around the swamps through the Jonglei Canal, which will run from a point below Bor, near Jonglei Village, to a point on the Sobat River, just above its confluence with the White Nile. The canal will be 360 km long, 50 m wide and 4 m deep and will divert some 20 million m³ of water per day, or 7.3 billion m³/yr, around the swamps. The canal will be navigable and will be constructed beside an allweather road, both of which will improve communications in the area. However, it is clear that the canal will bring about a diminution of the Sudd and a change in the distribution of wetlands in the area. Predictions are that the permanent swamps will shrink by 21-25% and the floodplains by 15-17%, provided that the flow of the Nile does not fall from its present high levels. Should it decline to its 1950-52 level however, an operational Jonglei Canal would bring about a drastic reduction in the size of the Sudd. Drijver & Marchand (1985) analyse the present and future consequences of the construction of the Jonglei Canal.

The Nile is of great importance for navigation and the main waterways are kept clear of sudd by cutting or by the use of explosives. *Eichhornia crassipes* obstructs minor waterways and passages have to be cleared by local fishermen, but in addition weevils, *Neochetina* spp., have been introduced as a biological control. Harvesting and utilisation of *Eichhornia* has also been suggested.

Conservation Status: The Sudd is one of the most important wetlands in Africa and three areas have been designated as game reserves. These are Zeraf Island (675 000 ha), Shambe (100 000 ha) on the west bank and Mongalla (7500 ha) on the east bank.

Wetland Name: The Machar Marshes

Country: Sudan

Coordinates: 8°27' -9°58'N/32°11' -34°09'E

LocationArea: c. 900 000 ha (500 000 in Sudan)

Altitude: 290-600 m asl

Nearest Town: Malakal (60 km W)

General: The Machar Marshes are not well mapped. They comprise a vast area of swamps and seasonal floodplains interlaced by an intricate reticulate system of watercourses and numerous lakes. Run-off from direct precipitation, and drainage from the Ethiopian Highlands, tends to move across the 'marshes' to, or towards, the White Nile below Malakal. The wetland system extends at least 200 km from north to south and 180 km from east to west and is situated north of the Sobat River. Streams from the Ethiopian Highlands descend quite abruptly to a very flat area around 300 m asl, and on this plain the rivers break up into the complex of minor watercourses mentioned above, often losing their integrity in the swamps. The wetland system extends over the border into Ethiopia in the SE, where there is at least 400 000 ha of wetland, much in the valley of the Gambela River. The major river in Sudan is the Daga, which becomes the Khor Daga and then the Khor Adar.

Flora & Fauna: There are extensive grassy floodplains and permanent herb swamps dominated either by papyrus along the innumerable watercourses, or by *Phragmites* and

Typha away from them. See regional introduction for details of species found in the area.

Human Impact & Utilisation: Little utilised. The area is sparsely populated. Cattle are grazed on the floodplain areas during the dry season, and hunting and fishing occur in the wetland system.

Conservation Status: Unprotected.

Wetland Name: The Dinder Floodplain

Country: Sudan

Coordinates: 11°45'12"N/34°46'35"E

Area: c. 500 000 ha

Altitude: 700-800 m asl

Nearest Towns: Sennar (130 km NW); Khartoum (360 km NW)

General: The floodplain occupies the land between the Dinder and Rahad Rivers which flow down from the Ethiopian Highlands to a flat plain, sloping gently northwestwards towards the Blue Nile. A number of tributary rivers, e.g. the Galegu, with numerous ox-bow lakes, lie between the two major rivers, and much of the intervening land may be flooded during the rainy season in the mountains. Direct precipitation over the floodplain amounts to 800 mm/yr in the south and 600 mm/yr in the north, and is received between June and October. Daily maximum temperatures range from 20°C in January to 44°C in May.

Flora & Fauna: Gallery forests subject to inundation, occur along the watercourses and contain *Acacia sieberana*, *Ficus* spp., *Mimosa pigra*, *Tamarindus indica* and *Ziziphus abyssinica*, or in places stands of *Hyphaene thebaica*. Areas of thornbush savanna are also subject to inundation and are covered by *Acacia seyal* and *Balanites aegyptiaca*, with *Sorghum* and *Brachiaria* spp. the dominant grasses. In swampy lakes *Echinochloa* spp., *Ipomoea aquatica*, *Leersia hexandra* and *Nymphaea* spp. are dominant. *Oryza longistaminata* and *Echinochloa pyramidalis* occur on the most deeply flooded parts of the plain, but with *Cynodon dactylon*, *Hyparrhenia* spp., *Panicum* spp., and *Themeda triandra* covering those parts of the floodplain which are less deeply inundated. The swampy areas around lakes, lagoons, pans, pools and depressions are very important grazing sites for wildlife during the dry season. Large mammals present include *Dama-liscus lunatus*, *Hip potragus equinus*, *Kobus ellipsiprynzus*, *Redunca redunca*, *Syncerus caffer*, *Tragelaphus scriptus* and *T. streptoceros*. *Panthera pardus* is the chief predator. *Acinonyx jubatus*, *Crocota crocuta*, *Giraffa camelopardalis*, *Ourebia ourebi*, *Hyaena hyaena* and *Panthera leo* are present in the dry season, as is *Struthio canzelus*.

Human Impact & Utilisation: While the area is fully protected, poaching and illegal herding are threats to both the vegetation and wildlife.

Conservation Status: The entire wetland system is protected in the Dinder National Park, which has also been designated a Biosphere Reserve. There is an extensive (270 000 ha) buffer zone immediately to the west, but illegal farming has penetrated this latter zone, and up to 60% of the park is burnt each year, either by park rangers or nomadic herdsman. The combination of burning and grazing by cattle has altered the flora significantly in recent years. The dry season is very harsh and the wildlife in the park (wetland) has always depended upon adjacent grazing areas, which the buffer zone helps to

protect. Thus the additional pressure created by the presence of herds of cattle is very detrimental, in addition to which it is believed that serious outbreaks of disease among the wildlife have been introduced by cattle driven onto the floodplain in the dry season.

(I) MINOR WETLANDS

General: Seasonally flooded areas with some permanent swampland occur at innumerable sites on the plains on either side of the White Nile below Malakal. The principal wetlands known on the eastern side occupy 50 000 ha (10°30'-10°46' N/32°45' - 33°00'E); 15 000 ha (10°32'-10°37'N/33°16'-33°29'E); 5250 ha (10°57'-11°00'N/33°00'-33°08'E); 9750 ha (11°49' -11°55' N/33°01' -33°10'E) and 5000 ha (11°50' 11°58' N/32°51' -32°55' E). On the western side they occur at 10°08'-10°18'N/31°48'-31°57'E (9000 ha); 10°09'-10°19'N/31°35'-31°49'E (18 000 ha); 10°31'-10°37'N/31°52'-32°00'E (6600 ha) and 11°02'-11°05'N/31°39'-31°46'E (7500 ha). Some of these wetlands contain permanent or semi-permanent lakes. They are little utilised and most occur in very sparsely populated areas. None is protected.

South of Malakal there are numerous swamps on the plateau to the west of the Nile Valley, i.e. west of the Sudd at altitudes between 400-600 m asl. Wetlands, most incorporating areas of permanent swamp have been mapped around the centres 5°05'N/31°18'E (5000 ha); 5°10'N/31°06'E (1200 ha); 5°11'N/29°13'E (3000 ha-720 m asl); 5°19'N/31°25'E (4500 ha); 5°25'N/31°33'E (2000 ha); 5°25'N/31°24'E (5200 ha); 5°27'N/31°29'E (4000 ha); 5°34'N/30°07'E (3000 ha); 5°36'N/31°13'E (1500 ha); 5°48'N/30°03'E (5500 ha); 6°05'N/29°52'E (6800 ha); 6°14'N/29°46'E (3500 ha); 6°36'N/29°41'E (3200 ha); 6°41'N/29°55'E (5600 ha); 6°48'N/28°45'E (2500 ha); 6°51'N/29°46'E (16 000 ha); 6°52'N/29°35'E (2000 ha); 6°52'N/29°59'E (9000 ha); 6°54'N/29°11'E (4000 ha); 6°55'N/29°56'E (4000 ha); 7°02'N/29°13'E (3000 ha); 7°05'N/29°04'E (4000 ha); 7°12'N/30°11'E (31 500 ha); 7°29'N/29°37'E (8400 ha); 7°45'N/29°43'E (5000 ha); 7°46'N/29°35'E (6000 ha); 7°52'N/29°51'E (6000 ha); 7°53'N/29°57'E (4000 ha) and 8°00'N/29°38'E (9600 ha).

(J) THE NILE VALLEY BELOW MALAKAL

General: The Nile flows in a broad sandy trough below Malakal, descending northwards at a mean gradient of 1:19 000. Within the trough, which may be 6 km wide in places, the river channel is accompanied by old abandoned channels on both banks. During the flood the entire trough is inundated, but in dry season the river is confined to its incised channel. Swamps, 200-300 m wide, line the riverside, but in places these may expand, and between 11°03' and 11°52'N for example, the swamp belt reaches 20 km in width locally. The channel is island-studded between latitudes 12°30' and 15°00'N, but then bifurcates and even trifurcates. The incised sandy trough flattens and the river develops a floodplain at latitude 13°30'N which persists, 3-10 km wide, to latitude 15°00'N, after which the river broadens into the lake behind the Jebel Auliya Dam (15°15'N). In total the floodplain covers 113 000 ha. Below the dam there is another floodplain which leads into Khartoum and the confluence with the Blue Nile. When the latter stream is in flood, water in the White Nile backs up; hence the floodplain above Khartoum. The Jebel

Auliya Reservoir contains and regulates the flow of the White Nile when the Blue Nile is in spate. Below Khartoum the Nile receives the Atbara River on the right bank, its final major tributary, and follows a course locally and narrowly fringed with swamps through the desert until it enters Lake Nubia at Ambikol (21°24'N/30°54'E), just above the Egyptian border.

(K) THE BAHR EL GHAZAL

General: Swamps and floodplain accompany the Bahr el Ghazal from Meshra' er Req (8°26'N/29°16'E) through Lake Ambadi virtually continuously to Lake No and the confluence with the Bahr el Jebel. The perennial swamp belt is 10 km wide from Meshra' er Req downstream for 70 km, but it then tapers over the succeeding 60 km, while a floodplain behind the swamps widens and eventually, to the south of Lake No, merges with the floodplain of the Bahr el Jebel. There are some 90 000 ha of perennial swamps on the river, the flora and fauna of which are similar to that of the Sudd. No part of the Bahr el Ghazal is protected. Artisanal fisheries occur on the river.

(L) FLOODPLAINS OF THE SOUTHERN RIVERS

General: Mean annual rainfall over the provinces of Western Equatoria and El Buheyra in southern Sudan ranges from 800 -1400 mm and, because most of this is received over a period of just a few months, the intensity of precipitation is high and the rivers rise rapidly and overtop their banks. Thus there are floodplains on the Pongo, Busseri, Wau, Numatinna, Yabu, Mbungu, Biki, Sue, Lesi, Ibba, Maridi, Era, Lau and Gel Rivers. These rivers all flow through the Soudanian Savanna zone down to the Nile Valley and the Sudd, their waters reaching the Nile on the west bank, largely by diffuse drainage through the swamps. Rainfall decreases to the west in these provinces and the western rivers are not perennial, while those of the east are. *Andropogon gayanus* and *Setaria sphacelata* are important grasses in the headwater floodplains, where *Mitragyna inermis* and *Terminalia macroptera* are scattered trees. The latter may however, fill depressions, and is then usually accompanied by *Brachiaria jubata* as the dominant grass. Long stretches of these rivers are fringed by gallery forest, subject to seasonal inundation, carrying trees such as *Acacia sieberana*, *Diospyros mespilifonnis*, *Khaya senegalensis*, *Ficus sycomorus*, *Tamarindus indica* and *Syzygium cordatum*, behind which there are areas of floodplain which carry savanna vegetation where *Hyparrhenia cyanescens*, *Pennisetum polystachion* and *P. unisetum* are the dominant grasses and *Borassus aethiopum*, *Mitragyna inermis* and *Terminalia macroptera* are common but scattered trees. The floodplains in these provinces have not been mapped comprehensively, but there are more than 4250 km of major river channels, and from the few areas indicated as subject to inundation on available maps an estimate of 500 000 ha of floodplain appears conservative.

3. Natural Lakes

Wetland Name: Lake Keilack

Country: Sudan

Coordinates: 10°49'N/29°19'E

Area: 3000 ha (at high water)

Altitude: c. 450 m asl

Nearest Towns: El Obeid (277 km NNE); Malakal (300 km ESE)

General: This endorheic lake is situated on the plateau of Kordofan. It is perennial but shrinks to about 500 ha in the dry season and expands to over 3000 ha in the wet season. Maximum depth is about 4 m at high water and 2 m at low water. The lake is often turbid with Secchi depths averaging 50 cm. It is generally well oxygenated, but little is known of its water chemistry. The floor of the perennial lake is covered by beds of *Ceratophyllum demersum* and *Najas pectinata*, with carpets of waterlilies, both *Nymphaea caerulea* and *N. lotus*, and with *Aeschynomene elaphroxylon* and an emergent species of *Polygonum* around the margins, together with reeds and sedges. 94 invertebrate species have been recorded, together with a number of fish, including *Clarias lazera*, *Schilbe mystus* and *Tilapia zillii*. Frogs, toads and snakes are also present and a number of birds have been recorded, the latter including 6 herons and *Haliaeetus vocifer*. There is an artisanal fishery and the lake is an important watering site for nomadic cattle herders, reputedly from as far away as Nigeria, as well as for large mammals of the Soudanian savannas. The lake is unprotected.

Wetland Name: Lake Kundi

Country: Sudan

Coordinates: 10°30'N/25°16'E

Area: c. 1200 ha (at high water)

Altitude: c. 460 m asl

Nearest Towns: El Fasher (350 km N); Khartoum (1225 km NE)

General: This endorheic lake is situated in Southern Darfur below the mouth of the Wadi Ibra, the headwater tributaries of which drain the southern slopes of the Jebel Marra. The lake is perennial, but contracts to a very small size, c. 100-200 ha in the dry season. Details of its hydrology are not known. It probably has a maximum depth of about 3 m in the wet season and 2 m in the dry. The waters give an almost neutral reaction, but details of the water chemistry are not known. The perennial lake flora is covered by beds of *Ceratophyllum deinersuni*, *Najas pectinata* and other submerged aquatics, and there are waterlilies at the surface. Among the fishes, *Clarias lazera* and *Tilapia zillii* have been recorded and some 30 birds, including several anatids (*Nettapus auritus*, *Plectropterus gambensis*, *Sarkidiornis melanotos*), *Haliaeetus vocifer*, *Mycteria ibis*, and herons, egrets and sandpipers. There is an artisanal fishery, birds are hunted by local villagers, and the lake is a watering point for wildlife and for the cattle of nomadic herders. The lake is unprotected.

Wetland Name: Lake Ambadi

Country: Sudan

Coordinates: 8°38'-8°43'N/29°17'E

Area: c. 1000 ha

Altitude: 388 m

Nearest Towns: Malakal (280 km ENE); Juba (500 km SE)

General: The lake is formed by a widening of the channel of the Bahr el Ghazal. It is 10 km long, 1-3 km wide, and has a maximum depth of 3 m. It is set in perennial herb swamps on an otherwise featureless plain. The Bahr el Ghazal flows in at the south and out at the north, while the River Jur flows in on the western side. The principal input is from the Jur, a seasonal stream, the flow rate of which may reach 35 million m³/day in September. The water of the lake is generally clear with Secchi depths exceeding 2 m. It is acidic, with a pH range of 6.4-6.8, and moderately well oxygenated. The floor is covered by a mat of vegetation dominated by *Ceratophyllum demersum*, *Myriophyllum spicatum*, *Najas pectinata* and *Potamogeton pectinatus*. The peripheral vegetation is dominated by *Vossia cuspidata*, with some *Echinochloa*, and floating carpets of *Eichhornia crassipes*. It has a distinctive fish fauna, supports an artisanal fishery, and is unprotected.

Wetland Name: Lake Maleit

Country: Sudan

Coordinates: 7°52'-8°03'N/28°33'-28°40'E

Area: 25 000 ha (5000 ha maximum open water)

Altitude: c. 400 m asl

Nearest Towns: Wau (65 km WSW); Bor (380 km SE)

General: This lake occupies the floor of a small endorheic basin. At high water in a wet season it may exceed 25 km in length and 4 km in width, developing an open water surface in excess of 5000 ha. The lake is surrounded by a perennial swamp and a broad floodplain, the entire wetland having an area of approximately 25 000 ha, with a maximum width of 12 km in the south. The lake is oriented SW-NE and is shallow, with maximum high water depths in the vicinity of 4 m. Details of its water chemistry are not known. The bed of the perennial lake is densely vegetated, and the surrounding swamp contains *Aeschynomene elaphroxylon*, *Cyperus papyrus*, *Phragmites karka*, *Typha domingensis* and several minor sedges. It contains several species of fish, including *Clarias lazera*, *Gymnarchus niloticus*, *Polypterus bichir* and *Protopterus aethiopicus*, and has a rich amphibian fauna. It is visited by typical reptiles and the avifauna includes ducks, geese, herons, egrets, weavers, warblers, kingfishers and *Haliaeetus vocifer*. The mammals are similar to those found in the Sudd swamps (see regional introduction) and there is an artisanal fishery. The lake is not protected.

Wetland Name: Lake Yirol

Country: Sudan

Coordinates: 6°33'-6°37'N/30°27'-30°31'E

Area: 1600 ha

Altitude: c. 440 m asl

Nearest Towns: Shambe (65 km NE); Juba (230 km SE)

General: Lake Yirol is 9 km long, 2.5 km wide at maximum, and is fed by a local stream. It is shallow, swamp-fringed, has a peripheral floodplain and drains from its southern end to the Lau or Yei River, which eventually peters out in the Sudd. The

lake supports a small artisanal fishery, is an important watering point for wildlife and is unprotected.

Wetland Name: Lake Anyi

Country: Sudan

Coordinates: 6°25'-6°28'N/30°34'-30°38'E

Area: 1400 ha

Altitude: c. 450 m asl

Nearest Towns: Shambe (75 km NE); Juba (210 km SE)

General: This lake is shaped like an inverted L, with each arm 6.5 km long and 1-2 km wide. It is shallow, swamp-fringed, and has a peripheral foodplain. It has a rich avifauna and supports a small artisanal fishery. It is fed by two streams at the southern end, the largest of which, the Rara River, is 40 km long and rises only a few metres higher than the lake. It appears to drain to the Lau or Yei River from the northwestern end. It is unprotected.

Wetland Name: Lake Nyiropo

Country: Sudan

Coordinates: 6°08'N/30°11' E

Area: c. 700 ha

Altitude: 500 m asl #

Nearest Towns: Bor (150 km W); Juba (210 km SE)

General: This small lake is 5 km long and 1.5 km wide at high water, and is oriented SW-NE at an altitude of 500 m. It is a shallow lake, probably not exceeding 3 m in depth, and drains to the Lau River, 2 km distant from its northern end. It is situated 150 km west of the Bahr el Jebel as it flows past Bor. It is a permanent lake, with dense beds of aquatic vegetation and fringing swamps. It has a narrow peripheral floodplain and is unprotected.

4. Artificial Impoundments

Wetland Name: Lake Nubia/Nasser

Country: Sudan

Coordinates: 20°27' -23°58'N/30°07'-33°15' E

Area: 685 000 ha (104 000 in Sudan)

Altitude: 183 m asl (at capacity)

Nearest Towns: Dongola (260 km S); Khartoum (632 km SSW)

General: This is the southern (Sudanese) sector of the Lake created by the construction of the Aswan High Dam, full details of which are given in section 2.3 Egypt. The lake is set in the desert and the surrounding country is virtually unvegetated. It can be divided into three sectors. The northern sector (in Egypt) is fully lacustrine and extends south from the dam to Tushka. The middle sector, which extends from Egypt into northern Sudan, is lacustrine in character for most of the year, but exhibits riverine features during the flood. The southern sector, which is entirely within Sudan, is essentially riverine. The fish

fauna of the lake changes progressively in moving north, because of the changing character of the lake, and hence although the commercial fishery in Sudan produces a similar spectrum of species to that in Egypt, the proportions of each species in the catch tends to be different. As in Egypt, the relative importance of different species in the catch has changed from what it was immediately after impoundment, because the fish fauna of the lake has now stabilised and the number of species regularly recorded in the Sudanese part of the lake has decreased, from 40 in 1967 to 20 in 1979.

Flora & Fauna: The fishes now common in the lake are *Alestes baernose*, *A. dentex*, *A. nurse*, *Bagrus bayad*, *B. docmac*, *Barbus bynnie*, *Distichodus niloticus*, *Eutropius niloticus*, *Hydrocynus forskalii*, *Hyperopisus bebe*, *Labeo coubie*, *L. horie*, *L. niloticus*, *Lates niloticus*, *Oreochromis galilaeus*, *O. niloticus*, *Schilbe uranoscopus*, *Synodontis batensoda*, *S. schall* and *S. serrata*. Species which have become scarce are the swamp/marsh and shallow water species, including *Auchenoglanis* spp., *Clarias* spp., *Gymnarchus niloticus*, *Heterotis niloticus*, *Malapterus electricus*, *Marcusenius* spp., *Polypterus* spp. and *Protopterus aethiopicus*.

Human Impact & Utilisation: Construction of the dam necessitated the resettling of people but led to the establishment of a more productive fishery. Today cichlids (*Oreochromis* spp.) comprise 64% of the annual catch by weight. Thereafter *Lates* comprises 14%, *Labeo* 11%, *Barbus* 7%, *Synodontis* 2% and *Bagrus* 2%. An account of the fishery, containing many references, is given by Ali (1984).

Conservation Status: Unprotected.

Wetland Name: El Roseires

Country: Sudan

Coordinates: 11°47'N/34°23'E

Area: 29 000 ha

Altitude: 480 m asl (at capacity)

Nearest Towns: El Roseires (10 km N); Khartoum (475 km NW)

General: The dam across the Blue Nile just above El Roseires was closed in 1966 to produce the 17th largest artificial lake in Africa, having a volume of 3 billion m³ at capacity. When full, the reservoir has a maximum depth of 67.7 m and a mean depth of 10 m. Lacustrine conditions pertain for 120 km upstream of the dam, and the lake has a maximum width of 26.5 km at the northern end. There is a commercial fishery on the lake.

Wetland Name: Sennar

Country: Sudan

Coordinates: 13°36'N/33°37'E

Area: 16 000 ha

Altitude: 422 m (at capacity)

Nearest Towns: Sennar (on lake); Khartoum (260 km NW)

General: The Sennar Dam on the Blue Nile was closed in 1925 and subtends an artificial lake of 16 000 ha, the 25th largest impoundment in Africa. It has a maximum depth of 26 m at capacity, with an annual fluctuation of surface level of up to 17 m.

Wetland Name: Kashim el Girlba

Country: Sudan

Coordinates: 14°55'N/35°55'E

Area: 12 500 ha

Altitude: c. 420 m asl

Nearest Towns: Kassala (75 km NE); Khartoum (380 km ENE)

General: The Kashm el Girba Dam on the Atbara River was closed in 1964, producing a long (55 km), narrow (4 km) lake oriented N-S.

Wetland Name: Gebel Auliya

Country: Sudan

Coordinates: 15°15'N/32°28'E

Area: 150 000 ha

Altitude: 377 m asl (at capacity)

Nearest Town: Khartoum (25 km N)

General: This barrage across the White Nile above Khartoum was constructed in 1937 to hold back the flow of the White Nile during the period when the Blue Nile is in spate. Lacustrine conditions extend a very long way back up the valley of the White Nile, so that its lake is deemed to cover 150 000 ha and to form the 7th largest artificial impoundment in Africa. Water is used for irrigation and a commercial fishery operates on the lake.