

## 3.12 NIGERIA

### Introduction

Nigeria is the most populous country in Africa. It has an area of 923 850 km<sup>2</sup>, a population of 82 390 000 and thus a mean population density of 89 persons/km<sup>2</sup>. It extends between the latitudes 4°16'N (at the tip of the Niger Delta) and 13°52'N, and between longitudes 2°49'E (on the Okpara River) and 14°37'E (on the El Beid River). It has maximum dimensions of 1200 km from east to west and 1000 km from north to south and is bounded by Cameroon and Chad in the east, Niger in the north and Benin in the west. The coastline is 780 km long, excluding the indentations of Lagos Lagoon, the Niger Delta and the Cross River Estuary, which add at least 1300 km to this.

The principal physiographic feature is the Niger/Benue River system which separates three highland blocks. The southern coastline is dominated by the delta of the Niger River (36 260 km<sup>2</sup>), and inland from this the coastal plain, less than 100 m asl, is 75-125 km wide, except in the southeast where it contracts to 50 km. Lowlands below the 100 m contour accompany the Niger inland for 400 km to its confluence with the Benue. From here the lowlands continue northeast up the Benue for a further 550 km, and northwest up the Niger for 210 km. The lower Niger system forms a great Y shape, with the delta at the base of the Y, the Niger River forming the stem and left hand branch and the Benue, the right hand branch. The Jos Plateau (1200 m asl), which rises to occasional high peaks, e.g. 1698 m at Wadi Hill and 1781 m at Shere Hill, lies between the arms of the Y and continues northwestwards as the Funtua Plateau. To the east of the Y are the mountains along the border with Cameroon, which rise to 2419 m asl at Chappal Wade, the highest point in Nigeria. To the west of the Y are the Yoruba Highlands. Other lowland areas are the Sokoto (Rima) Basin in the northwest, and around Lake Chad in the northeast.

Drainage from the Jos-Funtua Plateau is either northeastwards to Lake Chad, via the Komadugu Yobe, or northwest, south or southwest to the Niger/Benue River. From most of the eastern highland block along the Cameroon frontier, drainage is northeastwards to the Benue, but the southernmost ranges drain to the Bight of Biafra via the Cross River. The Yoruba Highlands drain northeastwards to the Niger or southwards to the Bight of Benin.

### Climate

Mean annual rainfall decreases progressively in passing inland, but it is generally wetter in the east than the west. On the coast at the border with Benin, mean annual rainfall is close to 1750 mm, but this rises to 1836 mm at Lagos (6°27'N/3°34'E) and to 3800 mm at Forcados (5°21'N/5°25'E) on the Niger Delta but it falls to 2483 mm at Port Harcourt in the eastern delta. Forcados averages 180 rainy days each year and Port Harcourt 170. There is

less disparity in rainfall from west to east inland, however. Mean annual rainfall is 1378 mm at Makurdi (7°45'N/8°32'E) on the Benue River, and 1257 mm at Ilorin (8°30'N/4°32'E). In the centre it rises slightly to 1431 mm at Jos (9°55'N/8°53'E), which is situated in a wet pocket, and is 1000 m higher than Makurdi. From here rainfall declines to 865 mm at Kano (12°00'N/8°30'E) and 600 mm at Maiduguri (11°53'N/13°16'E) in the northeast.

The wet season is 10-11 months long on the delta, with a short dry period in December or December-January, depending upon station. On the western coast, near Lagos (6°27'N/3°24'E), the three months December-February are dry, and there is often a second dry period in August. In passing inland the August dry period is lost, but the major dry season increases in length and severity. It is 6 months long at Jos and 7 months (October-April) at Kano and 8-9 months long at Lake Chad (September-May).

Temperature ranges are lower at the coast than inland. At Lagos the mean monthly temperature of the warmest month is 27°C and that of the coolest month is 24°C, while at Port Harcourt the corresponding figures are 26°C and 24°C. The figures for Jos are 24°C and 20°C, while those for both for Kano and Maiduguri are 31°C and 22°C. The prevailing winds at the coast are from the SW, and these bring the rains to the interior as the intertropical convergence moves north and south.

## **Vegetation**

The coastal strip is Guinean, and either is, or was once, covered by Guinean rain forest. In passing north this grades through a Guinean-Soudanian transition zone, which may carry forest, into well wooded Soudanian savannas. Guinean species penetrate far into the savanna zones along the major rivers.

## **Wetlands**

Coastal wetlands are the most extensive. In the west there are large lagoonal systems with mangrove swamps, palm-pandan swamps and reed swamps. In the east the Niger Delta and Cross Estuary both carry large areas of mangrove forest, and both permanent and seasonally inundated freshwater swamp forest. Inland there are floodplains on many rivers, as a consequence of the increasing seasonality of the rainfall in passing north. For example, although mean annual rainfall is only 653 mm at Maiduguri, some 90% of this falls in two months. In the Soudanian zone, forest on the levees is inundated at the time of flooding, as are broad grasslands behind them. Elsewhere in the north, away from rivers, there are other seasonal wetlands. These are chiefly clay-based pans and ponds which fill with water in most years.

## **List of Wetlands Described**

### **1. Coastal Wetlands**

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- (b) The Niger Delta
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## 1. Coastal Wetlands

### (a) Lagos & Lekki Lagoons & Affluents

**Country:** Nigeria

**Coordinates:** 6°22'-6°38'N/2°48'-4°36'E

**Area:** 155 335 ha (99 875 ha open water + 55 460 swamp)

**Altitude:** sea level

**Nearest Town:** Lagos (on lagoon)

**General:** The lagoons lie behind the barrier beach and extend for 210 km along the coast. They are flanked by tidal wetlands and the permanent swamps at the eastern end are contiguous with those of the lower Niger Delta. There are two major lagoons, Lagos Lagoon in the west and Lekki Lagoon in the east. These are connected by a narrow channel, and Lagos Lagoon is also connected by a long narrow navigable channel with Cotonou Lagoon in Benin. The open water area given above represents that of all the lagoons and channels in the system and does not allow for islands, of which there are several. Lagos Lagoon averages 2-4 m deep, but is 10 m deep in the entrance channel. The mean depth of Lekki Lagoon is 3.1 m, and the maximum depth is 6.4 m at low tide. The complex is isolated from the sea by the beach barrier ridges. The western channels approach to within a few dozen metres of the sea, but in the east, much of Lagos and Lekki Lagoons are situated 3-4 km inland.

**Hydrology & Water Quality:** The system is tidal. Lagos Lagoon is open to the sea through a channel some 10 m deep near the city of Lagos. This is kept open, despite the powerful longshore drift, by artificial breakwaters. Normal tidal amplitude is 1.2 m, hence the tidal zones around the shores are not very wide. Tidal influence is pronounced in Lagos Lagoon, but is far less in Lekki Lagoon. The system is fed by several rivers, the most important of which are, from west to east, the Yewa, Ogun, Ona/Ibu, Oshun, Shasha and Oni. The Yewa discharges into the channel between Cotonou and Lagos Lagoons, and the Ogun and Ona/Ibu into Lagos Lagoon. The Oshun, Shasha and Oni flow into Lekki Lagoon, from where water escapes to the sea, either via Lagos Lagoon, or through the swamps to the east.

Salinity varies from site to site and with the seasons. In the wet season the influx of river water is so great that the lagoons are fresh to brackish throughout, with salinities of 5-10‰ in seaward sites and 0‰ near the river mouths. At this time of the year salinity in the main basin of Lagos Lagoon is always below 3‰, while that of Lekki Lagoon is generally 0-7‰. During the dry season however, salinities rise to 30‰ in the entrance channel, and to 8-10‰ in the main basin of Lagos Lagoon and to 5‰ in Lekki Lagoon. The surface water temperature of the main basin near Lagos varies from 26°-31.5°C throughout the year, reaching maxima during the wet season. Transparency is lowest in the wet season when Secchi depths may be less than 1 m, but it increases to as much as 3 m during the dry season. pH values are close to 7.0 throughout the system during the rains, but the values can rise to 8.0 during the dry season.

**Flora & Fauna:** Mangroves, dominated by *Rhizophora racemosa*, cover the flat shores, with *Avicennia africana* and *Hibiscus tiliaceus* other common species on the shoreline. In many of the landward sites, and in the vicinities of affluent river mouths, the mangroves grow tall and are backed by freshwater swamp forests or *Raphia* swamps. *Rhizophora* grows in sites which are never very saline, c. 10‰ maximum. There has been much clearance of the mangrove, and in many places, where the forest has been exploited for fuelwood and construction timber, or destroyed for other purposes but then left, secondary vegetation has appeared, dominated by *Cyperus articulatus* and *Paspalum distichum* (= *P. vaginatum*).

Among the fishes, there are some species which appear in the lagoons only at certain seasons of the year. Some come from the sea, others from the rivers. 79 species have been identified in the system, of which *Caranx hippos*, *Chrysichthys nigrodigitatus*, *C. walkeri*, *Citharichthys stanzfii*, *Cynoglossus senegalensis*, *Elops lacerta*, *Epinepeleus aeneus*, *Ethmalosa fimbriata*, *Gerres melanopterus*, *Ilisha africana*, *Liza falcipinnis*, *Lutjanus eutactus*, *L. goreensis*, *Mugil bananensis*, *Pellonula afeluisi*, *Polydactylus quadrifilis*, *Pontadasys jubelini*, *Scomberomorus maculatus*, *Sphyrnaena barracuda* and *Tilapia* spp. are perhaps the most important.

**Human Impact & Utilisation:** The waterway system is used for the transport of passengers and cargoes, and there is a port at Lagos. Fishing pressure in the lagoons is high and there have been clearances on the landward side for agriculture. Industrial wastes are discharged into Lagos Lagoon. Population density on the northern margins locally exceeds 250 persons/km<sup>2</sup> and the swamp forests and rain forests of these areas have been very largely destroyed.

**Conservation Status:** Unprotected.

## **(b) The Niger Delta**

**Country:** Nigeria

**Coordinates:** 4°16'- 6°00'N/4°45'- 8°00'E

**Area:** 3 226 000 ha (c. 2 000 000 ha wetland)

**Altitude:** 0-5 m asl

**Nearest Towns:** Lagos (325 km NW); Port Harcourt (on E delta)

**General:** The Niger Delta is of Holocene age and occupies an area of continued subsidence. It comprises an upper riverine floodplain, a lower tidal floodplain and an outer chain of barrier islands. The riverine floodplain occupies about 1 000 000 ha, and

extends seawards from the head of the delta at Onitsha ( $6^{\circ}09'N/6^{\circ}47'E$ ) for 168 km. Two local streams rise to east and west of Onitsha and flow into the delta. Their courses are parallel to that of the Niger and in the upper delta they delimit the riverine floodplain to east and west. In this region the riverine floodplain is approximately 40 km wide, but down delta it widens to 200 km where it merges into the tidal floodplain.

The tidal plain is close to 450 km long around the delta face, and slopes more gently towards the sea than the riverine plain. It is widest on the flanks of the delta, reaching 38 km in the west, near the Benin Channel, and 43 km in the east along Sombreiro Channel. Along the central sector the tide penetrates less far inland, only 16 km in places, but up the Nun River, which is considered to be the continuation of the main channel of the Niger, tidal influence extends farther upstream into the seasonally flooded riverine floodplain. In total, the tidal floodplain occupies close to 1 503 000 ha, but about 160 000 ha of this overlaps the riverine floodplain on either side of the Nun River.

The alluvium of the lower delta is less coarse than that of the riverine floodplain. Tongues of riverine sediment penetrate into the tidal floodplain along distributaries, and between distributaries the tidal plain bulges into the riverine floodplain; thus the junction between the two is deeply embayed. Tides, however, tend to penetrate up distributaries farther than the inter-distributary plain, and the zone of vegetation which is transitional between the mangrove forest of the tidal plain is most evident along these watercourses. The mouths of the distributary rivers tend to silt up, but with the development of the petroleum industry in the delta, some are now dredged. However, a detritic drainage system covers the lower (tidal) floodplain, and here the many channels are kept open by the powerful scouring action of the ebbing tides.

The outer face of the delta consists of a series of sandy barrier islands. They comprise sand brought down by the Niger and redistributed by marine processes, principally the powerful longshore drift and the frontal wave attack. There are 20 major islands with a total landsurface of close to 200 000 ha. They vary in length from 5 to 37 km and in width from 0.5 to 12 km. They are higher than the tidal floodplain behind and emerge from the sea to heights up to 4 m asl and are covered by a dense littoral forest or scrub, very rich in species by contrast with the tidal floodplain to landward.

Within the delta the Niger River breaks up into a number of distributaries. The Nun River is regarded as the direct continuation of the mainstream, while the major distributaries are the Forcados, Brass, Bonny and Sombreiro Channels. The mouths of all these tend to be obstructed by sand-bars unless dredged. Allen (1964, 1965) and Allen & Wells (1962) give useful accounts of the geomorphology of the delta.

**Flora & Fauna:** Originally the entire lower delta plain was covered by mangrove forest and the seasonally inundated portion by freshwater swamp forest, but large areas of both vegetation types have been destroyed. It is not clear exactly how much tidal forest remains on the delta. Kinako (1977) states that there are 500 000 ha of mangrove forest of different types in the delta, but in the same paper indicates over 1 100 000 ha of mangrove in the delta on a map. Bartholomew's 1982 map shows some 670 000 ha of

mangrove forest and 833 000 ha of other tidal land and this is approximately correct. Another problem arises with the distribution of mangrove forest in the delta, which is represented differently on different maps. Some maps show the mangrove belt to be more than 50 km deep on the central delta face, narrowing uniformly to a minimum depth of 12-15 km on the flanks which is incorrect. The mangrove belt is widest (c. 35-43 km) at the flanks and narrowest in the centre (c. 15 km), but there is deep tidal penetration in the central delta, up the channel of the Nun River.

Seasonal swamp forest is most extensively developed in the west and central delta regions; it is less well developed behind the mangroves of the eastern delta, which are, or were once, backed by terrestrial forest. The belt of seasonal and permanent freshwater swamp forests extends westwards from the central delta in semi-continuous fashion as far as Lagos Lagoon, the northern shores of which are fringed by freshwater swamp forests. In this type of forest inundation is mostly seasonal and the forest floor is generally dry during the dry season, but areas of permanent swamp forest do exist where distributary streams traverse depressions and the forest floor is permanently wet.

As mentioned earlier, intermediate zones between tidal forest and seasonal swamp forest occur along watercourses in the junctional area between the two zones. In this transitional zone seasonal inundation is predominant, but when the ground is flooded because the river is in spate, it is subject to tidal rise and fall because of the back up of river water behind the tides. Details of the vegetational types are as described in the regional introduction for mangrove and freshwater swamp forest. As far as the fauna is concerned, most of the Guinean forest species occur in the delta, but much of the big game has been hunted out. Almost all the small mammals associated with wetlands are present.

**Human Impact & Utilisation:** The eastern side of the delta is more densely populated than the western sector, but there are many centres of population throughout the delta above the tidal zone. The waterways have always been fished intensively, and the mangroves and other forest types have been exploited for fuel and lumber. Mangroves and seasonal swamp forest have been cleared extensively in places, and seriously disturbed in others, but particularly along the landward side of the tidal zone, so that the mangrove belt has been shrinking in width for many years. The lost mangroves have been replaced by agriculture, or have given way to secondary vegetation, much of which is herbaceous, or have been cleared for communications or destroyed in the wake of oil exploration. Almost all the Nigerian oil palm plantations are situated in the delta, having replaced seasonal swamp forest, and much rice is also grown there. The delta is the centre of the Nigerian oil industry which has been developed since the early 1950s, and it is now criss-crossed by oil and gas pipelines. There are more than 30 oil fields in the delta, and as many more offshore. There are two major gasfields in the delta, at Rumuekpe (4°59'N/6°42'E) and Teeba (4°34'N/7°18'E). Four tanker ports have been constructed at the delta face, at Delta South (5°29'N/5°08'E), Forcados (5°21'N/ 5°21'E), Brass (4°19'N/6°14'E) and Bonny (4°27'N/7°10'E), and there has long been a major shipping terminal at Port Harcourt (4°43'N/7°10'E). Oil pipelines cross the tidal and seasonally flooded zones of the central delta, but the western delta is comparatively free of installations. Bonny has been a trading port since before colonial times.

**Conservation Status:** Unprotected.

### **(c) Wetlands of the Cross River**

**Country:** Nigeria

**General:** The Cross River has sources north of Enugu (6°27'N/7°27'E) and in the high mountains of western Cameroon. Seasonally inundated areas occur on the branch entering the country from Cameroon, and reach a maximum width of 5 km at a point 6°04'N/8°15'E. Farther downstream there is a series of lakes or lagoons on the floodplain which are isolated from the river during the dry season. These are best developed south of Afikpo (5°53'N/7°57'E) and extend downstream to 5°35'N. The river receives several west bank tributaries and then enters a mangrove covered delta below Niwaniha (5°03'N/8°02'E) at the head of a broad (8 km wide) estuary. Other minor streams enter the east bank of the estuary from Cameroon. The mangrove forest extends around the estuary in a belt 7-8 km wide on both sides, deepening to 26 km in the deltaic zone at the head of the estuary. Altogether there are some 58 900 ha of mangrove forest on the system. The tidal plain on the western side of the Cross River Estuary is 6-9 km wide between landward and seaward faces and is continuous with the tidal plain of the Niger Delta 75 km to the west. There is a total of 45 000 ha of tidal land between the two systems.

**Flora & Fauna:** As detailed in the regional introduction. The mangrove and freshwater swamp forest floras are richer here than elsewhere in West Africa and correspond quite closely with those described for the northwestern Cameroon coast in Section 4.1. *Osteolaemus tetraspis* is reputedly still quite common in the swamps around Calabar where the habitat is still intact.

**Human Impact & Utilisation:** Calabar (4°57'N/8°19'E) is an ancient pre-colonial trading town situated against the mangroves near the head of the estuary on the east bank, and the small fishing port of James Town (4°40'N /8° 18'E) is situated near to the sea on the west bank of the estuary. Goods from the interior have long been transported down the Cross River to Calabar, and the estuary has traditionally been the scene of shipping activity. Modern roads connect both banks of the estuary with the road system serving the eastern part of the Niger Delta, and because of the density of population on the periphery of the swamps, the mangrove forest of the Cross River estuary is disturbed, but probably less so than in most other districts. The mangrove creeks are fished intensively, and crabs and shellfish are also regularly obtained from tidal creeks.

**Conservation Status:** Unprotected.

## **2. Riverine Wetlands**

### **(a) The Niger/Benue River System**

**Country:** Nigeria

**General:** The Niger River rises in the Fouta Djallon Mountains of Guinea and is 4180 km long, the lower third of its course being through Nigeria. It has a drainage basin of nearly 1 890 000 km<sup>2</sup> and most of the tributaries are extremely seasonal in their flow so that the river floods extensively in places throughout its course. The Niger/Benue System has a bankful open water area of 258 500 ha in Nigeria at a conservative estimate, excluding Lake Kainji, and floods over 1.3 million ha of land in that country in a wet year.

Welcomme (1972) gives a figure of 480 000 ha for the total area inundated, but this seems too small.

The Niger enters Nigeria at an altitude of 161 m asl and a broad floodplain on both banks accompanies the river for 162 km downstream to Yelwa (10°51'N/4°46'E) through Soudanian savanna country. Some 75 km below the border it receives a major tributary on the north bank, the Sokoto River, which has several sources on the northwestern slopes of the Funtua Plateau. Another floodplain extends back up the Sokoto River for 387 km above the confluence. This latter floodplain is continuous over the lowest 263 km and has a mean width of 11 km over this section, but in the upper section it is discontinuous and seldom more than 6 km wide. Minor floodplains occur on all the left bank tributaries of the Sokoto, but a large floodplain and permanent swamp area is situated upstream on the Zamfara River, 75-120 km above the confluence of this stream and the Sokoto. Altogether there are close to 470 000 ha of seasonal floodplain on the Niger/Sokoto system in this district. The rivers have pronounced levees locally, and carry levee and riverine forest, with floodplain grasses behind.

Below Yelwa the Niger expands into Kainji Lake, an artificial lake, dealt with in a subsequent section. Below Kainji Dam the waters of the river tend to be confined to their banks, but below Jebba (9°08'N/4°50'E) the river once again overflows its banks. From here the floodplain stretches to the confluence with the Benue River, a distance of over 300 km by river. The floodplain is widest in the upstream section where it reaches widths of 20 km, but it has a mean width of 15 km for the upper 225 km, then narrowing to 10 km over the final section. In this district the floodplain usually expands to 385 500 ha in most years. Minor floodplains and swamps occur on the tributaries in this district, but none is extensive.

Another extensive floodplain occurs above Onitsha at the head of the delta. Between Idah (7°07'N/6°43'E) and Onitsha (6°09'N/6°47'E) the river traverses a flat swampy plain. Affluent streams flow southwards, parallel with the Niger on either side of this plain, and the entire area, from western to eastern affluents, is subject to seasonal inundation. The floodplain is 100 km long with a mean width of 16.25 km and a maximum width of 22 km, and in most years provides a wetland of 165 000 ha.

**Human Impact & Utilisation:** The Niger River Commission was formed in 1963 by Cameroon, Chad, Benin, Burkina Faso, Guinea, Ivory Coast, Mali, Niger and Nigeria to co-ordinate efforts to develop the system. The river is navigable by ocean going vessels for 373 km above the mouth throughout the year, but above this point ocean going vessels are restricted to times of high water. Nevertheless they can reach the confluence of the Niger and Benue Rivers for 10 months each year. From here to Jebba the Niger is open to large craft only from October to the middle of November, but the river is an important thoroughfare for small craft for 60% of its length above Jebba.

Other floodplains occur on the Benue, right up to the Cameroon border, but these are discontinuous. After entering Nigeria at an altitude of 161 m asl, the Benue flows southwestwards between the Muri Mountains to the north and the Shebshi Mountains to the

south. In this sector it receives many tributaries draining the mountains and the floodplain is almost continuous from the border, for 187 km. The upper floodplain varies in width from 3-10 km. Below this is a stretch of nearly 100 km where the river is confined to its banks, but then on either side of the confluence with the Taraba River, a floodplain, up to 10 km wide and best developed on the south bank, extends for 50 km along the river. Another large floodplain occurs on both banks of the Benue near Ibi (8°12'N/9°45'E). On this system the total floodplain area is approximately 312 000 ha, giving a figure of 1 333 400 ha for the entire system above the delta, but excluding Lake Kainji.

**Hydrology & Water Quality:** The Niger carries a suspended load of 5 000 000 tonnes/yr and has a mean year round discharge rate of 6092 m<sup>3</sup>/sec at the mouth. The flood regime in Nigeria is bi-modal. A flood from the headwater regions reaches Nigeria in January and February, and another flood rises from local rains between August and October. The floods reach mean depths of 2 m over the floodplains, but deeper than this towards the lower end of the southernmost floodplain above Onitsha. The temperature of the river water varies between 22-28°C while the pH is consistently close to 6.7.

**Flora & Fauna:** The Niger and Benue Rivers traverse Soudanian savanna, but below the confluence the Niger traverses a Guinean-Soudanian forested zone. The flora and fauna are as described in the regional introduction for floodplains in these zones. *Crocodylus niloticus* survives throughout the system but is now rare and endangered. The status of *Crocodylus cataphractus* is not certain; it occurs in the system but is also rare.

**Human Impact & Utilisation:** The floodplains have traditionally been used to graze cattle and for shifting cultivation, and have always been fished. The estimated catches from the Niger (in Nigeria) up until 1970 were 13 450 tonnes fish/yr, but it seems likely that they are now much larger than this.

**Conservation Status:** The Upper Ogun Game Reserve incorporates a stretch of the right bank of the Niger below Lake Kainji, but in an area that is essentially unflooded. There are other proposed game reserves along the river, some of which will incorporate floodplain, but none has yet obtained legal status. There are three proposed game reserves along the Benue River, which will, if established, extend to the river bank and include some floodplain areas. These will be the Ankwe and Pai River Game Reserves and the Damper Game Reserve.

## **(b) The Komadugu Yobe**

**Country:** Nigeria

**General:** The Yobe Basin in the far northeast of Nigeria is almost entirely situated in Nigeria although the lower course of the Yobe River above Lake Chad marks the border with Niger. The basin is very flat and covered by formations of fluvial or lacustrine origin, sandy in some areas and clayey in others. Rainfall varies from about 850 mm/yr in the vicinity of Kano, and 1300 mm/yr in the vicinity of Jos, to 350 mm/yr at Lake Chad. It rains from May-September inclusive, with the heaviest falls in August. The basin is drained by several rivers which ultimately unite to form the Komadugu Yobe which discharges into Lake Chad. All rivers in the basin flood.

The Hadejia River has sources near Kano (12°00'N/8°30'E) and an intermittent source near Jos (9°55'N/8°53'E). It meanders for 500 km past the town of Hadejia (12°30'N/9°59'E) to a

confluence with the Bunga River which drains the plateau near Jos. Towards the confluence, channels criss-cross the intervening land and the confluence is swampy. On the Hadejia River a floodplain begins 127 km above the confluence, and almost 100 km above it on the Bunga River. At the confluence the floodplain reaches a maximum width of 62 km, but quickly contracts to about 5 km and persists at this width for 135 km, to a point 105 km below Gashua (12°54'N/11°00'E). This area, which has many interlacing shallow watercourses running parallel to the main river channel from above the confluence to the end of the floodplain, has often been referred to as an inland delta. It provides a wetland of approximately 337 000 ha, with a further 89 000 ha on the Hadejia River and 63 000 ha on the Bunga River above the confluence. The first of the areas given is only approximate because many patches of higher, unflooded, ground occur within the floodplain, making accurate determinations of the inundated area difficult.

Another floodplain, the main part of which is 180 km long and 7 km wide (73 500 ha), occurs on the Komadugu Gana. This river also drains the Jos Plateau and joins the Hadejia/Bunga 30 km above Diffa (13°28'N/12°35'E) a town on the river across the border in Niger. From this confluence the river is known as the Komadugu Yobe, and a small floodplain on this, some 7 km wide and 20 km long, occurs immediately upstream of Diffa. No other major wetland occurs on the river until just before it enters Lake Chad, which it does through an extensive swamp zone which spreads on either side of the border with Niger. On the Nigerian side the swamp and floodplain system reaches southeastwards for 66 km behind the Lakeshore, and later along it. There are some 10 100 ha of swamps along the lakeshore here, and a further 38 000 ha behind, separated from the lake by several kilometres of sandy country. There are thus no less than 610 500 ha of seasonal and permanent swamp lands on this system.

**Hydrology:** Mean discharge rate from the so-called 'inland delta' is 21 m<sup>3</sup>/sec, but it is considerably less than this at Lake Chad. Flooding of the various wetlands occurs during the September-November period and seldom exceeds 1 m in depth.

**Flora & Fauna:** The western end of the basin is covered by Soudanian savanna, but this grades into Sahelian savanna in the vicinity of Diffa. The floodplains are covered by typical floodplain grasses, and trees occur on the river levees. Occasional trees of *Acacia nilotica* and *Acacia seyal* occur on the floodplain proper, usually on slightly elevated sandy patches. These species also occur on the levees together with *Diospyros mespiliformis* and *Mitragyna inermis* as described in the regional introduction. *Crocodylus niloticus* is now uncommon in the area although some re-stocking has taken place in recent years. Bird life is prolific and typical of floodplains, but large mammals have largely been replaced by domestic cattle.

**Human Impact & Utilisation:** Many cattle, probably 500 000, are grazed in the basin, moving onto the floodplains as the flood recedes. There is a deal of recession agriculture, and the area is fished. The largest catches are made while the flood recedes and the fish return from the shrinking floodplain to the watercourses. Large numbers of fish are stranded in pools of various sizes, and these are taken by birds and other piscivores as well as by man.

**Conservation Status:** The Baturiya Wetlands Game Reserve, which includes 29 700 ha of floodplain near Hadejia, was gazetted in 1985.

### (c) The Ngadda Yedsardam & El Beid Rivers

**Country:** Nigeria

**General:** These three rivers all rise in the Mandara Mountains on the Cameroon border and flow into Lake Chad. Both the Ngadda and Yedseram Rivers rise to the north of Mubi (10°18'N/13°20'E) and initially flow due north in parallel some 20 km apart. The western stream, the Ngadda, traverses a large depression (11°33'N/13°14'E) containing 31 000 ha of permanent swamp south of Maiduguri. From this place it flows 120 km NE to reach Lake Chad in a great seasonal floodplain which extends around the southwestern corner of the lake.

The Yedseram sweeps east of Maiduguri and enters the floodplain 50 km SE of the Ngadda. The El Beid rises in Cameroon and forms the border between Cameroon and Nigeria for 400 km between Madagali (10°56'N/13°35'E) and Lake Chad. It has a floodplain over most of this distance, narrow in the upper reaches, but broadening towards the lake, and this lower portion is described in some detail in section 4.1 Cameroon. Two large permanent swamps occur in depressions between the El Beid and Yedseram Rivers, one at 11°53'N/14°19'E and another at 11°19'-11°41'N/14°16'E.

The great floodplain area around the southern tip of Lake Chad, which these three rivers traverse, is continuous with that in Cameroon and Chad supplied by the Chari/Logone system, and described in detail in sections 3.3 Chad and 4.1 Cameroon. In Nigeria the floodplain reaches 90 km south of Lake Chad and 112 km west. An arm of it fringes the lakeshore northwards, almost meeting the swamps of the Komadugu Yobe system. The main floodplain however, is south and southwest of the southern extremity of the lake and covers approximately 1 100 000 ha. The area subject to inundation is difficult to determine because it is repeatedly interrupted by patches of high ground which are never flooded.

**Hydrology:** The floods rise in August-September and areas close to Lake Chad are flooded to maximum depths of 2.5 m.

**Flora & Fauna:** As described in the regional introduction for Soudanian-Sahelian floodplains. A detailed description of the El Beid-Chari-Logone Floodplain is given in section 4.1 Cameroon. *Crocodylus niloticus* has become virtually extinct in the area.

**Human Impact & Utilisation:** The area is grazed intensively as the floods recede and this is perhaps the most important industry of the floodplain. Cattle move onto the floodplain from distant areas, and also move across the national boundary into Cameroon. There is also a large fishing industry, and a deal of small-scale recession agriculture.

**Conservation Status:** A substantial area of the southwestern side of Lake Chad is protected in the Lake Chad Game Reserve.

## 3. Lake Chad

**Country:** Nigeria

**Coordinates:** 12°29' -14°29' N/13°02' -15°21'E

**Area:** 2 500 000 ha at high water (c. 670 000 ha in Nigeria)

**Altitude:** 282 m asl (when lake surface covers 2 000 000 ha)

**Nearest Towns:** Maiduguri (110 km SW); Lagos (1360 km SW)

**General:** A description of Lake Chad is given in Section 3.3 Chad. Published accounts of the area of the lake vary between 1 379 200 ha (5325 square miles - Welcomme, 1972) and 2 500 000 ha (Beadle, 1981). Beadle states that the open water area has fluctuated between 1 000 000 ha and 2 500 000 ha this century. However, between July 1973 and November 1975 it had fallen below 250 000 ha, and in 1908 it was not much greater. Only the southwestern part of the lake is situated in Nigeria, with a shoreline of approximately 260 km.

**Hydrology & Water Quality:** The lake water is well mixed and well oxygenated, and has a salinity of less than 1‰. The lake is endorheic and occupies part of a great inland basin of more than 2 500 000 km<sup>2</sup>. The basin and lake are shallow which is why the surface area of the lake is so variable. Rainfall presently averages about 300 mm/yr over the lake, which nowhere nearly balances evaporation, estimated at 2000 mm/yr by Dussart (quoted in Beadle, 1981). Of the total riverine inflow, 95 % comes from the Logone/Chari system, the catchments of which lie in the humid highlands of Cameroon, Chad and the The Central African Republic, and represent about 25% of the total catchment. The contribution of the El Beid River is minimal, possibly 2.5% of the total inflow, while the remaining 2.5% is contributed by the Komadugu Yobe, Yedseram, Ngadda and several ephemeral streams. A brief account of the hydrology, geomorphology and history of the lake is given by Beadle (1981), who refers to more detailed studies.

**Flora & Fauna:** As described in the regional introduction, but see the account in Section 3.3 Chad.

**Human Impact & Utilisation:** The lake is fished from villages in Nigeria, particularly Baga (13°06'N/13°54'E) on a peninsula extending into the lake. We do not have details of estimated annual catches.

**Conservation Status:** The Lake Chad Game Reserve occupies 704 480 ha with a frontage of over 150 km along the western shore of the lake, rather more than half the shoreline of the lake in Nigeria.

#### 4. Other Interior Wetlands

**Country:** Sierra Leone

**General:** Seasonal wetlands, not associated with rivers, occur throughout the Soudanian zone. They are mostly clay based pans. Large shallow basins, almost plains, on impermeable clay, are known as firiki. They are grass covered, and only the tips of the grasses emerge above the water during the rains. Other depressions known as fako, are also clay based, but are deeper than firiki. They support no grasses, and are devoid of vegetation except for stunted bushes. Semi-permanent pools are known as tabki.

Clay-pan wetlands are well developed to the north of Kano (12°00'N/8°30'E) and between Kano and Katsina (13°00'N/7°32'E). A collection of large shallow pans southeast of Katsina forms a mosaic over an area 61 km x 55 km, which contains a seasonally inundated area close to 190 000 ha. The shape of some pans, e.g. 57 km long by 3 km wide, suggests that they are depressions in fossil watercourses. Those for which the coordinates are given are the largest in the district, but there are several smaller ones, measuring

about 15 km in length and 3 km in width, and a host of little pans.

**Flora & Fauna:** As described in the regional introduction.

**Human Impact & Utilisation:** Firiki may be cultivated, but fako are unproductive. Tabki (ponds) are utilised as waterholes for domestic cattle.

**Conservation Status:** Small clay-pans and ponds occur in several of the game reserves of Nigeria but none of the large areas between Kano and Katsina is protected.

## 5. Artificial Impoundments

### (a) Lake Kainji

**Country:** Nigeria

**Coordinates:** 9°49'9"49'-10°40'N/4°19'-4°40'E

**Area:** 123 000 ha (water surface at capacity)

**Altitude:** 142 m asl (water level at capacity)

**Nearest Towns:** Ibadan (285 km SW); Lagos (405 km SSW)

**General:** The Niger River was dammed at Kainji (9°49'N/4°35'E) in 1968 and the reservoir created is some 135 km long at capacity, with a maximum width of 24 km, giving an open water surface close to 123 000 ha. The lake has a maximum depth of 59 m, a mean depth of 11 m, and a shoreline of 716 km at capacity. The lake occupies the site of a previous Pleistocene lake and the central section has submerged a large flat island which once divided the Niger into two branches. At both ends of the lake the river passes through narrow steep-sided valleys with widths of 1-5 km. The large seasonal draw-down results in the exposure of much land, both around the periphery and in the centre of the lake, where the top of the old island is uncovered. A general account of the lake is given by Imevbore & Adegoke (1975).

**Hydrology & Water Quality:** There are two floods each year. The so-called 'white flood', rich in suspended matter, lasts from August-October, and derives from local catchments. All the minor affluents are in flood together and at this time the Oli River, for example, discharges into the lake at a rate of 600-700 m<sup>3</sup>/sec, while it ceases to flow altogether in the dry season. High water is attained in November-December and persists until April, being maintained by the so-called 'black flood' which derives from catchments on the Niger outside Nigeria. The waters are then virtually free of suspended matter, but are stained by humic compounds. The water level begins to fall noticeably in May, and by August it has fallen by 10-11 m to reach a minimum. The volume at peak water level is approximately 4.25 times greater than it is at low water level, and the throughflow to volume ratio is thus close to 4:1.

**Flora & Fauna:** The lake is not rich in macrophytes. The large draw-down each year, of 10 - 11 m, and the very large areas exposed on the margins have predisposed the periphery to floodplain vegetation. Imevbore & Adegoke (1975) discuss the vegetation of the lake. The lake is however, rich in invertebrates (Bidwell, 1976; Bidwell & Clarke, 1977). Of 113 fish species recorded in the Niger River locally, 82 species, belonging to 18 families were recorded in the lake in its early years. The most common species in the lake at this time were *Alestes barernose*, *Hydrocynus brevis*, *H. forskali*, *Labeo senegalensis*, *Lates niloticus* and *Synodontis membranaceus*. Less abundant species were *Alestes dentes*, *A. macrolepidotus*, *A. nurse*, *Chrysichthys nigrodigitatus*, *Citharinus distichodus*, *C. latus*, *Synodontis clarias*, *S. ocellifer* and *S. resupinatus*. Comparatively uncommon were *Auchenoglanis* spp., *Gnathonenzus senegalensis*, *Hyperopisus bebe*, *Synodontis budgetti* and

*Tilapia galilaea*. Reptiles associated with the lake and its affluents include *Crocodylus niloticus*, *Varanus niloticus*, and several aquatic snakes. An avifauna is still developing in association with the lake. Mammals present on the lake fringes, or in the gallery forests of affluent streams include *Felis caracal*, *F. lybica*, *Kobus ellipsiprymnus*, *K kob*, *Manis gigantea*, *Redunca redunca*, and *Syncerus caffer*. Bidwell (1976) discusses the effect of water level fluctuations on the biology of the lake, while Lelek (1973), Lewis (1974) and Blake (1977a,b) discuss the changes that have occurred in the fish populations since impoundment.

**Human Impact & Utilisation:** The population density of the Kainji Basin was low prior to flooding, due to intertribal wars and disease, principally yellow fever, bilharzia and river blindness. Resettlement problems were therefore less great than those encountered in other parts of Africa, and a new town, New Bussa, has been created. However, cattle were brought into the basin each year by nomadic Fulani herdsmen, and these people still enter the area, including the National Park. It has been estimated that their arrival may increase the number of cattle in the area tenfold. The dam is used to generate hydroelectric power and has a planned capacity of 960 MW. A fishing industry has been established on the lake and total annual catches were at first very high, e.g. 17 000 tonnes in 1969 and 28 639 tonnes in 1970, but thereafter the catch declined dramatically to 11 037 tonnes in 1971 and 6048 tonnes in 1974. It had fallen to 4500 tonnes/yr by 1978.

There were said to be 4867 fishermen operating 3331 boats on the lake in 1978-79, and it was recommended that the lake be closed to fishing for a period to allow fish stocks to recover. We do not have figures for subsequent years. It has been suggested that control of *Simulium* spp., by spraying with DDT, may be detrimental to fish in the lake and the Oli River, but no studies have been carried out so far as we are aware.

**Conservation Status:** Lake Kainji National Park protects a stretch of lakeshore and sections of several affluent streams, principally the Oli River. However, the lake as such, is not protected. Some account of the protected areas is given by Brown (1967), while Wells & Walsh (1969) report on the avifauna.

## **(b) Other Impoundments**

**Country:** Nigeria

**General:** There is a large reservoir (11°15'-11°27'N) on the Kano River at Tiga, with 48 600 ha of peripheral land under cultivation in the dry season. Another impoundment exists in Dedin Kowa Lake, and there are plans to generate hydroelectric power at Jebba and Shiboro.