

5.6 NAMIBIA

Introduction

Namibia extends between latitudes 17°00' and 29°00'S on the SW coast of Africa. It is bounded by South Africa in the south, Botswana in the east, Zambia and Angola in the north, and by the Atlantic Ocean in the west. It has a coastline of more than 1400 km, an area of 824 295 km², and a population of 1 032 000 (1981), giving an extremely low population density of 1.25 persons/km². There is a narrow coastal plain, backed continuously by a highly dissected mountain range, rising to isolated peaks of over 2000 m. The 100 m contour is seldom more than 30 km from the coast and in places, e.g. at Cape Cross (21°47'S/13°57'E) and Cape Dernberg (27°46'S/15°35'E), it approaches to within 1 km of the sea. In the northern sector, between the Cunene and Kuiseb Rivers, the high peaks of the mountains are situated 75-100 km inland. The highest point in Namibia, Brandberg Mountain, 2606 m, lies 80 km inland here. In passing southwards, from the Cunene River, the nature of the coastal plain changes from sand desert to gravel desert, but there is an abrupt change back to sand desert at the south bank of the Kuiseb River. Sand desert then persists along the southern coastal sector to the mouth of the Orange River. In the southern sector the mountains are more distant from the coast, c. 150-175 km inland.

To the east of the mountains the land falls to an interior plain which continues for distances of 300-400 km to the border with Botswana. This plain has an elevation of 1000-1300 m asl and is covered by Kalahari sands. Only along the coast and in the valleys of the Great Fish and Orange Rivers does the land surface dip below the 1000 m contour. Most of the country is extremely sparsely vegetated and the coastal strip is occupied by the Namib Desert. The southern interior is predominantly dwarf shrub savanna, with very scant grass cover. This grades through open thornbush grasslands in the central districts to open woodland with a continuous grass ground cover in the northeast.

With the exception of the Orange River on the southern border, and the Cunene, Cubango, Linyanti/Chobe and Zambezi Rivers on the northern borders, there are no perennial streams in Namibia. Drainage lines on the seaward side of the mountains are southwesterly through the desert towards the coast. Drainage from the eastern side of the northern mountains is to the NE, terminating in irregularly flooded endorheic pans, but from the central and southern

parts of the range it is SE to the Nossop/Molopo River system on the border with Botswana, or south to the Great Fish River. Many river valleys, such as those of the Kuiseb and Great Fish Rivers, are extremely deeply and dramatically incised. In places the floor of the Fish River Canyon is less than 25 m wide and 500 m below the surrounding land surface.

In the far northeast of Namibia the Caprivi Strip is a corridor, 30 km wide, between Angola and Botswana, which provides access to the Zambezi River along a short frontier with Zambia. Off the coast there are a number of rocky islands, some Namibian and some South African, all of which support large seabird communities. The coastal waters carry a wealth of fish as a consequence of the nutrient rich Benguela Current, and an exclusive fishing zone of 200 miles was declared in 1979 following overfishing by both domestic and foreign fleets between 1960-1970.

Climate

Precipitation is unreliable, being much greater in some years than others, although there is a broad pattern of long drought periods alternating with short pluvial phases, in which above average rainfall occurs for 3-5 years in succession. Mean annual rainfall for the past 60 years has been as low as 50 mm in parts of the Namib Dessert, which occupies the entire coastal strip. However, precipitation rises to 500 mm in the northeast of the country, and to 750 mm at the eastern extremity of the Caprivi Strip. Except in the southwestern corner of the country, most rain falls in the southern summer. Over most of the country rain falls on fewer than 65 days per year. However, regular morning fogs bring moisture to the coastal strip and are crucially important to its ecology. Fog develops when moist Atlantic air meets the cold Benguela Current just offshore. Fogs then drift inland for many kilometres and frequently persist until midday.

Wetlands

Florally and faunally the most important wetlands are those associated with the perennial rivers of the north, but there are numerous pans, including that at Etosha, which is undoubtedly the best known, although not the largest seasonal pan in southern Africa. In addition there are interesting and unusual coastal wetlands in sheltered bays on the Namib coast, such as those at Sandwich Harbour and Walvis Bay (the latter in the small South African enclave surrounded by Namibia, and dealt with in the account of South Africa), and others at river mouths. That at the Orange River mouth is under South African administration and is also dealt with in the national account of that country. Temporary pools and small floodplains

occur along many of the ephemeral rivers, there are some large sinkholes containing deep permanent water on the interior plain, and two remarkable lakes in the dunes of the Namib Desert. There are also a number of artificial impoundments, the largest being the Hardap Dam near Mariental.

Flora & Fauna

The wetlands are so different from each other that it is convenient to describe their floras and faunas individually in each account.

List of Wetlands Described

1. Coastal Wetlands
 - (a) Walvis Bay
 - (b) Sandwich Harbour
 - (c) Cape Cross Lagoons
 - (d) The Cunene River Mouth
 - (e) The Orange River Mouth
2. The Oshakati Pan System
3. The Caprivi Wetlands
 - (a) The Cubango Wetlands
 - (b) The Cuando-Linyanti-Chobe-Zambezi System
4. Etosha Pan
5. Lakes Guinas and Otjikoto
6. Other Floodplains and Pans
7. Sossusvlei and Tsondabvlei
8. Periodic Streams
9. Artificial Impoundments
 - (a) Hardap Dam
 - (b) Augeigas Dam
 - (c) Sartorius von Bach Dam
 - (d) Naute Dam

1. Coastal Wetlands

(a) Walvis Bay

Country: Namibia

Coordinates: 22°52' -23°01' S/14°26' -14°30' E

Area: c. 4000 ha (the bay & associated mudflats)

Altitude: sea level

Nearest Town: Walvis Bay (on bayshore)

General: The town, port and some surrounding territory form an enclave administered by South Africa, and the wetlands in this area are dealt with in the national account for that country. However, briefly, a 10 km long, northward-pointing, sandy spit shelters a lagoon adjoining the modern town and port of Walvis Bay. The whole area is situated on the delta of the Kuiseb River which seems to be, or to have been, migrating northwards up the coast. Today, surface flows in the Kuiseb do not reach the sea, but there is subterranean water. Drainage lines from the Kuiseb River lead northwestwards through the desert to the southern shore of Walvis Bay, and in places support floodplains which are vegetated after rain. One pan of complex structure is situated in the Walvis Bay enclave (23°03'-23°11'S/14°11'-14°41'E), while another, farther south is in Namibia. This latter pan/floodplain (23°20'-23°29'S/14°47'-15°01'E) is barely 1 km wide but almost 50 km long, and is surrounded by sand desert and dunes. Along the northern boundary of the enclave, the intermittent Swakop River reaches the sea and there is presently a small lagoon at its mouth. This may not be a permanent feature, however, having been formed only recently during a flood of the mid-1980s. Nevertheless it is becoming vegetated and attracts substantial numbers of birds. Another small semi-permanent pool exists a few km inland in the lower reaches of the Swakop River.

(b) Sandwich Harbour

Country: Namibia

Coordinates: 23°19' -23°24' S/14°28' -14°30' E

Area: c. 2000 ha

Altitude: sea level

Nearest Town: Walvis Bay (40 km N)

General: Sandwich Harbour (Sandvis) is a coastal lagoon 15 km long and up to 3 km wide. It is orientated N-S, isolated from the interior of Namibia by the sand dunes of the Namib Desert, and bounded by the Atlantic Ocean on the west. It opens to the sea centrally, between sandspits, through a mouth some 200 m across. The dunes along the landward shore rise abruptly to heights of over 100 m. There are extensive, sparsely vegetated, tidal mudflats at the southern and

southwestern sides of the lagoon, covering about 2000 ha, and scant saltmarshes along the eastern landward shore, interspersed with some small freshwater springs. However, at the northern end of the lagoon, there is a freshwater marsh currently covering 150 ha, in a belt 5km long and 300 m wide. This is protected from the sea by a narrow barrier beach, although natural processes have been progressively reducing the width of the wetland since the early 1960s when it was over 1km wide. The reed beds here contain *Phragmites australis* and *Typha latifolia*, but the surrounding dunes are barren and the next nearest vegetation of any consequence is in the delta of the Kuiseb River 25 km to the NE.

Hydrology & Water Quality: Sandwich Harbour is tidal, with a maximum depth of 5 m at low tide, but a mean depth of much less than this. However, the northern wetland is supported by the upwelling of potable water from a large subterranean aquifer under the Namib Sand Sea (Hellwig, 1988), to which water from the Kuiseb River may contribute. This also supports several minor springs along the eastern shore of the lagoon. It is generally believed that the lagoon was once the mouth of the Kuiseb River which subsequently moved northwards along the shore to Walvis Bay.

Flora & Fauna: The mudflats support algae, and some 'seagrass' beds, while the saltmarshes which fringe the lagoon are dominated by the creeping succulent herb *Sarcocornia natalensis*. Water from the freshwater springs collects in pools at the foot of the dunes, but these are generally brackish due to their proximity to the lagoon. They are partially fringed by *Phragmites australis* and *Typha capensis*. Farther from the water the grasses *Eragrostis cyperoides*, *Odysea paucinervis* and *Sporobolus virginicus* intermingle in a coarse sward. Elsewhere the sedge *Scirpus dioicus* covers large areas. The narras plant, *Acanthosicyos horrida* (Cucurbitaceae), grows on small dune humps on the periphery of the grassy areas. This species has a long tap root, up to 12 m long, which penetrates to a moist horizon. Above ground there is a densely tangled and fiercely spiny greyish shrub, which develops hard, spherical, knobbly, melon-like fruits on the ground. These contain substantial quantities of potable water.

The tidal flats are rich in invertebrate life and the lagoon is an important nursery area for juvenile fish. Both these factors predispose the site to the possession of a dense avifauna, with counts of palearctic waders in excess of 7000 birds/km². Some 80 species of birds have been recorded here, in four main groups: sea birds, palearctic waders, inland water birds and land birds. Among these are at least 8 endangered species including *Hydroprogne caspia*. Sandwich Harbour and Walvis Bay together support up to 170 000 coastal birds. Several species migrate between the two lagoons and the interior pans, leaving the interior in the dry season, while others come all year from breeding colonies on the offshore islands.

Species seen here include *Acrocephalus baeticatus*, *Alopochen aegyptiacus*, *Anas capensis*, *A. erythrorhyncha*, *A. hottentotta*, *A. smithii*, *Ardea cinerea*, *A. melanocephala*, *Arenaria interpres*, *Calidris alba*, *C. canutus*, *C. ferruginea*, *C. minuta*, *Charadrius hiaticula*, *C. leschenaultii*, *C. marginatus*, *C. pallidus*, *C. pecuarius*, *C. tricollaris*, *Circus ranivorus*, *Chlidonias hybrida*, *C. leucoptera*, *C. nigra*, *Cisticola juncidis*, *Corvus albus*, *Dendrocygna bicolor*, *Egretta alba*, *E. garzetta*, *Estrilda astrild*, *Fulica cristata*, *Gallinula chloropus*, *Haematopus moquini*, *Hirundo dimidiata*, *H. rustica*, *H. spilodera*, *Hydroprogne caspia*, *Lanius collaris*, *Larus cirrocephalus*, *L. dominicanus*, *L. novaehollandiae*, *Limnocorax flavirostra*, *Limosa laponica*, *Melierax canorus*, *Motacilla capensis*, *Netta erythrophthalma*, *Numenius arquata*, *N. phaeopus*, *Oxyura punctata*, *Passer melanurus*, *Pelecanus onocrotalus*, *Phalacrocorax capensis*, *P. lucidus*, *Philomachus pugnax*, *Phoeniconaias minor*, *Phoenicopus ruber*, *Ploceus velatus*, *Pluvialis squatarola*, *Podiceps cristatus*, *P. nigricollis*, *P. ruficollis*, *Prinia flavicans*, *Recurvirostra avosetta*, *Stercorarius parasiticus*, *S. pomarinus*, *Sterna balaenarum*, *S. bergii*, *S. hirundo*, *S. paradisea*, *S. sandvicensis*, *Sula bassana*, *Tadorna cana*, *Thalassornis leuconotus*, *Tringa hypoleucos*, *T. nebularia*, *T. stagnitilis* and *Tyto alba*. In addition to these a large number of vagrants have been recorded here, and an annotated checklist is given by Berry & Berry (1975). Numbers of some species are large. The population of *Phalacrocorax capensis* may be 20 000, while that of *Charadrius marginatus* can exceed 6000, which may represent two thirds of the world population of this species.

Human Impact & Utilisation: There used to be whaling and fishing stations at Sandwich Harbour, but there have been no permanent human inhabitants since 1969, and the site is seldom visited. The area is fenced off and the entry of casual visitors is prohibited.

Conservation Status: The site is situated in the Namib-Naukluft National Park and is fully protected. It was first protected, with status as a game reserve, in 1904.

(c) Cape Cross Lagoons

Country: Namibia

Coordinates: 21°47'S/13°57'E

Area: c. 500 ha

Altitude: Sea level

Nearest Town: Swakopmund (116 km SSE)

General: A sand barrier has formed along the shore, south of the rocky cape, being continually eroded and rebuilt by the strong northward flowing longshore drift. Behind this barrier is a series of small lagoons fed by sea

water seepage and high tide washovers. They are saline and are fringed by sparsely vegetated salt flats, and the area supports a large *Arctocephalus pusillus* colony, estimated to comprise 150 000 animals. Wooden guano platforms were erected in the 1950s, to encourage cormorants to breed, and by 1991 some 30 000 pairs were breeding. Guano is still collected here. Among bird 28 species recorded here are *Anas capensis*, *Calidris ferruginea*, *Phoenicopterus ruber* and *Podiceps nigricollis gurneyi* (Williams, 1991).

(d) Cunene River Mouth

Country: Namibia

Coordinates: 17°15'S/11°46'E

Area: c.500 ha

Altitude: Sea level

Nearest Town: Swakopmund (675 km SSE)

General: There is a small freshwater lagoon at the mouth of the Cunene River which supports lush emergent vegetation and is often visited by the desert dwelling elephant, *Africana loxodonta*. There are islands in the lagoon on which *Crocodylus niloticus* breeds and *Chelonia mydas* is also quite common. So far as is known, this lagoon provides the southernmost known population of the Nile soft-shelled turtle, *Trionyx trianguis*, and a freshwater prawn, *Macrobrachium bollenhoveni*. According to van Zyl (1991) there are 7 endemic fish species present. Bird recordings have not been made here regularly, but in recent years *Calidris pusilla* has been the only species seen in significant numbers. However, other species of interest include *Pandion haliaetus*, which is resident, flocks of migrating *Sterna balanearum*, and a gull, *Larus cirrocephalus*. Proposed dam building activities at Epupa Falls may well destroy this wetland, as it is anticipated that the mouth might become dry for 4 consecutive years while the reservoir is filling. At present the lowest 40 km of the south bank of the river is protected by the Skeleton Coast National Park of Namibia, while the northern bank is protected by the Iona National Park of Angola.

(e) The Orange River Mouth

Country: Namibia

Coordinates: 28°34'-28°38'S/16°28'-16°29'E

Area: c.700 ha

Altitude: Sea level

Nearest Town: Luderitz (250 km NW)

General: There is a lagoon with islands and some vegetated wetlands, but these are currently under South African jurisdiction and are dealt

with in the account of that country.

2. Oshakati Pan System

Country: Namibia

Coordinates: 17°23'-18°00'S/14°50'-15°56'E.

Area: c. 60 000 ha pans

Altitude: 1109-1136 m asl

Nearest Town: Grootfontein (125 km SE)

General: In the northwest of Namibia, fossil drainage lines, inter-connecting many long linear pans, extend southwards from the Cunene Flats of Angola into Namibia. Here there is a system of over 100 partially inter-connected pans, almost all of which are oriented NW-SE. The system occupies an area approaching 5000 km², but less than 20% of this is pan or drainage channel. The pans are part of an ancient system which is believed to have carried water from the Cunene River, across the Cunene Flats to a vast lake in the Etosha region, before the Cunene suffered river capture in Angola and began to flow to the sea. The pans lie in a broad shallow trough which slopes gently south-southeast-wards. Water enters the northern sector, in Angola, from the Mui and Cuvelai Rivers, and at high flood from the Cunene. It then spreads over the flats in Angola and in wet years penetrates far down the drainage lines into Namibia. Several drainage lines extend from the southern edge of the Oshakati Pan System towards the Etosha region, the largest of which, the Ekuma Channel, still carries water into Etosha Pan where it has formed a delta on the northwestern shore.

3. The Caprivi Wetlands

(a) The Cubango Wetlands

Country: Namibia

Coordinates: 18°02'S/21°25'E-18°15'S/21°47'E

Area: c. 2000 ha total

Altitude: c. 3400 m asl

Nearest Town: Bagani (on Okavango River in Caprivi)

General: Some small discontinuous swampy areas occur along the Cubango River where it crosses the Caprivi Strip from Angola to Botswana to become the Okavango River. In places the river flows in several channels and papyrus and *Phragmites* fringe the banks. To landward of the reed beds there are, in places, small semi-permanent ponds, the water levels of which may fluctuate by as much as 3.5 m during the course of a year. There are gallery woodlands here containing *Hyphaene*

benguellensis, strangler figs, and many trees common to the upper Okavango Delta.

(b) The Cuando-Linyanti-Chobe-Zambezi System

Country: Namibia

Coordinates: in area 17°39'-18°40'S and 23°18'-25°10'E

Area: c. 393 000 ha total wetland in Namibia

Altitude: 973-935 m asl

Nearest Towns: Congola (at W end); Kasane (at E end)

General: The Cuando River, which rises in Angola, has a swampy floodplain some 5 km wide for over 65 km where it traverses the Caprivi Strip and thereafter forms the border between Namibia and Botswana. Here it provides about 33 500 ha of wetland (17°39'-18°12'S/23°18'-23°26'E). The river then forms a delta 35 km deep and 65 km wide at its base, with an area of about 90 000 ha, known as the Linyanti Swamp (18°11'-18°40'S/23°23'-23°55'E). This is mostly wetland, and is mostly situated in Namibia, but small southwesterly and southeasterly extensions cross into Botswana, and the Selinda Spillway from the Okavango Delta of Botswana enters the southwestern extension. Through this spillway the Okavango River has at times made contributions to the hydrology of the Linyanti system, although this is by no means common nowadays. Structurally the Linyanti. Swamp is similar to the Okavango Delta. It is situated in a depression at the southernmost extremity of the Caprivi Strip, and on entering the depression the Cuando River divides into distributaries with levees which spread from an apex into a typical delta comprising shallow inter-distributary floodplains or melapo, and deep permanent lakes. The largest lakes are Saraugxa Lediba (18°35'S/23°34'E), which covers 400 ha, and Zibadianga Lediba (18°40'S/23°32'E) of equivalent size. Water reaching the base of the delta is collected into the Chobe River which then flows sluggishly northeastwards.

After leaving the Linyanti Swamp the Chobe River forms the border with Botswana for a distance of 200 km, as far as the town of Kasane (17°50'S/25°05'E), but for some of this distance it may also be known as the Linyanti River. Wetlands are virtually continuous along the Chobe River from the Linyanti Swamp to Kasane, reaching their greatest width in the vicinity of Liambezi, where the river broadens northwards to form Lake Liambezi (17°59'S/24°15'E). This is a shallow water body, 15 km long and 10 km wide, with a maximum open water surface of some 7850 ha. Here the river may rise 15 m in flood, inundating a floodplain up to 60 km broad which extends on both sides of the river, over flat sandy lands. In some places, during the dry season, the river flows in multiple channels between sandy

islands, but for most of its length it flows in a single channel between quite steeply sloping banks. Towards the confluence of the Chobe and Zambezi Rivers, near Kasane, the flood waters of the two streams jointly inundate the intervening plain of 170 000 ha (17°30' 17°50' S/24°20' -24°36'E) if their floods are in phase, but if not, if the Zambezi alone is in flood, flow in the Chobe may be temporarily reversed. Rainfall increases northeastwards along the Chobe River, the mean annual receipt being 580 mm at Linyanti Swamp but over 700 mm at Kasane.

Flora & Fauna: The river channels of Linyanti Swamp are fringed by *Cyperus papyrus*, up to 4 m high, in belts 15-20 m wide. In patches papyrus may be replaced by *Phragmites mauritianus* or *Typha capensis*, or these species may occur on the landward side of the papyrus. *Miscanthidium junceunz* occurs on less deeply inundated sandy substrata and in places there are dense groves of *Phoenix reclinata*. These species also fringe Lake Liambezi, and long stretches of the Chobe River and its backwaters.

Where the Chobe river banks are subject to periodically strong currents, they slope steeply, or may be undercut, and are covered at the top by dense forest or riverine thicket. The dominant species of riverine forest, often with a canopy over 15 m high, are *Acacia albida*, *A. erubescens*, *A. nigrescens*, *Allophyllus africanus*, *Berchemia discolor*, *Combretum imberbe*, *C. zeyheri*, *Croton megalobotrys*, *Diospyros mespiliformis*, *Erythrophleum africanum*, *Garcinia livingstonei*, *Homalium abdessanzmadii*, *Kigelia africana*, *Lonchocarpus capassa*, *Pteleopsis myrtifolia*, *Strychnos potatorum*, *Syzygium cordatum* and *S. guineense*. Other species found at the waterside or in riverine thicket, 5-9 m high, are *Cassine transvaalensis*, *Clerodendrum glabrum*, *C. myricoides*, *Combretum albopunctatum*, *Cordia sinensis*, *Ehretia amoena*, *Euclea divinorum*, *Ficus verruculosa*, *Friesodielsia obovata* (syn. *Popowia obovata*), *Gardenia jovistonantis*, *G. resiniflua*, *Grewia bicolor*, *G. flavescens*, *G. schinzii*, *Hibiscus diversifolius*, *Markhamia acuminata*, *Maytenus senegalensis*, *Myrica serrata*, *Oncoba spinosa*, *Pappea capensis*, *Premna senensis*, *Rhus quartiniana*, *Salix subserrata*, *Sesbania sesban*, *Tarenna luteola*, *Vangueria randii*, *Vernonia amygdalina*, *Ziziphus abyssinica* and *Z. rnucronata*. Woody climbers or scandent shrubs are locally abundant, and they include *Acacia schweinfurthii*, *Artobotrys brachypetalus*, *Byrsocarpus orientalis*, *Combretum inossarnbicense*, *Dalbergia martinii*, *Feretia aeruginescens* and *Phyllanthus reticulatus*. On the landward sides of the riverine vegetation, on higher grassy floodplains, and on the margins of marshes and pans, there are tall trees such as *Acacia polyacantha*, *A. sieberana*, *Combretum hereroense*, *Peltophorunz africanum* and *Terrninalia sericea*, all of which can exceed 15 m in height and occasionally reach 20 m. *Ficus natalensis* and *Parinari curatellifolia* are common on elevated sandy ridges in the river and

on abandoned levees.

Lake Liambezi supports a diverse aquatic flora. *Cyclosorus interruptus* and *Vossia cuspidata* are abundant in the water at the bases of the papyrus culms, and floating-leaved aquatics occur around the outer margins of the tall communities, between rafts of floating vegetation, and over shallow patches in the lake. *Brasenia schreberi* and *Nymphaea caerulea* are the commonest species, covering large areas, but they have numerous associates, e.g. *Caldesia reniformis*, *Nymphaea lotus*, *Nyrnphoides brevipedicellata*, *N. indica*, *Potamogeton schweinfurthii* and *Trapa ratans*. Where the water is too deep for rooted species, and where it is kept clear of floating species by virtue of wind and wave action, submerged aquatics form dense beds. Here *Ceratophyllum demersum*, *Lagarosiphon ilicifolius*, *Limnophila ceratophylloides*, *L. indica*, *Najas pectinata*, *Nesaea crassicaulis*, *Ottelia* spp., *Rotala myriophylloides* and *Vallisneria aethiopica* are common. Under the open water, in mid-lake, small free-floating, but totally submerged species occur, the most important of these being *Aldrovanda vesiculosa* (Droseraceae) and *Utricularia* spp. (Lentibulariaceae). Areas of shallow water, away from the lake-shore, support rooted emergents, among which *Eleocharis* spp., *Eriochrysis pallida*, *Phragmites mauritanus*, *Sacciolepis africana* and *Typha latifolia* are prominent. Free-floating aquatics are numerous and include *Azolla pinnata*, *Lonna perpusilla*, *Salvinia molests* and *Spirodela polyrhiza*.

In the peripheral swamps, and in the Linyanti Delta, lower lying areas which are inundated for long periods each year, yet which become dry seasonally, are covered by a dense *Scirpus inclinatus*-*Cyperus articulatus* association, reaching 2 m in height.

The permanent swamps and channels have a resident fauna, but a range of other animals moves between the wetland and the adjacent savannas. The fish fauna of the Chobe River and associated lake/pan/swamp system is typical of the upper Zambezi Basin, and includes *Clarias gariepinus*, *C. nganzensis*, *Hepsetus odoe*, *Hydrocynus vittatus*, *Labeo lunatus*, *Oreochromis macrochir*, *Schilbe inystus*, *Serranochromis angusticeps*, *S. macrocephalus*, *Synodontis woosnami*, *Tilapia andersoni* and *T. sparrmanii*. A wealth of animal life is associated with the riverine forests, the reed beds and river banks. This includes an abundance of frogs and toads and many reptiles. Among the latter are *Crocodylus niloticus*, *Pelusios* spp., *Varanus exanthematicus*, *niloticus* and some 25 species of snakes. These include arboreal forms such as *Dasypteltis scabra*, *Dendroaspis angusticeps*, *Philothamnus semivariiegatus* and *Thelotornis kirtlandii*, terrestrial species such as *Naja mossambica* and

N. nigricollis, and the semi-aquatic types *Dromophis lineatus*, *Limnophis bicolor* and *Natriciteres olivacea*. *Python sebae* is found in the trees, on the ground and in the water.

At least 200 species of birds are associated with the river and its peripheral vegetation, among which *Merops nubicoides*, which nests in holes in the river banks, and *Quelea quelea*, are the most numerous. Both appear in vast numbers each year. The latter species frequents pan and reed swamp margins, often bending the reeds to the ground by virtue of the weight of birds perched on them. Other important birds seen here are *Ardeola ralloides*, *Asio capensis*, *Chalcomitra senegalensis*, *Cisticola rufilata*, *Ephippiorhynchus senegalensis*, *Glaucidium capense*, *Grus carunculata*, *Haliaeetus vocifer*, *Hieaaetus spilogaster*, *Kaupifalco monogrammicus*, *Leptoptilos crumeniferous*, *Lophaetus occipitalis*, *Necrosyrtes monachus*, *Pelecanus onocrotalus*, *Phalacrocorax africanus* and *Polyboroides typus*. *Egretta vinaceigula*, which is endemic to a small area, including SW Zambia, Ngamiland and the Caprivi Strip, is still moderately abundant here, but its range has contracted markedly in recent years and it must be regarded as vulnerable.

Mammals resident in, or visiting the wetlands regularly, are *Aepyceros melampus*, *Aethomys chrysophilus*, *Aonyx capensis*, *Damaliscus lunatus*, *Dasymys incommutatus*, *Dendromus mesomelas*, *Hippopotamus amphibius*, *Hippotragus lager*, *Kobus ellipsiprymnus*, *K leche*, *K vardoni*, *Loxodonta africana*, *Lycaon pictus*, *Manis temmencki*, *Mus minutoides*, *Otomys angoniensis*, *Panthera pardus*, *Paraxerus cepapi*, *Pelomys fallax*, *Praomys shortridgei*, *Saccostomus campestris*, *Syncerus caffer*, *Tragelaphus spekei* and several bats, including fruit bats.

Human Impact & Utilisation: The river and Lake Liambezi are fished by local people, but there are no commercial fisheries. Hunting occurs throughout the Caprivi Strip. Because of the regular high floods the wetland area *per se* has not yet been developed and is little exploited by the indigenous population, although the adjacent lands are to be opened up to agriculture. Supplies and passengers are transported up and down river between Kasane and Liambezi, and even farther west, but at times in the dry season the density of *Salvinia nzolesi* in the main channel has been known to make the river temporarily unnavigable.

Conservation Status: Some small areas of wetland in the western Caprivi are protected in the Caprivi Game Reserve, established in 1963, and four specific wetland reserves have been proposed for the eastern Caprivi, where the land is being opened for agriculture. However, as these have

not yet been formally proclaimed the important wetlands of the Caprivi are still unprotected.

4. Etosha Pan

Country: Namibia

Coordinates: 18°30'-19°28'S/14°20'-17°10'E

Area: 460 000 ha main pan + 55 000 ha subsidiary pans

Altitude: 1073-1086 m asl

Nearest Towns: Windhoek (400 km S); Namutoni; Okaukuejo (at pan margin)

General: Etosha Pan, together with numerous subsidiary pans, is situated on the interior plain of Ovamboland in the north of Namibia. It is a shallow saline depression which has not been fully flooded during the past 50 years. In most years it contains water for 4-6 months, but it is dry and salt-encrusted at other times. The smaller pans contain standing water for much shorter periods. During the Pliocene the Cunene River formed a lake in the region, but it was subject to river capture upstream which left its lower course dry, and Etosha Pan as the remnant of a once great lake.

The Etosha Pans lie on the Kalahari Beds, which comprise limestones, calcareous sands and gravels. The floors of the pans are made of clay, silt and fine to coarse sand. Water drains into the pans and remains there until it finally evaporates, leaving salty deposits. Where it is regularly flooded the floor of the main pan is a hard, salt-encrusted, cracking clay, but towards the western end, where it is seldom flooded, it is a sandy plain. Small depressions in the pans, known locally as 'fountains', provide more or less permanent water-holes which are heavily utilised by animals during the dry seasons.

Published estimates of the area of the main pan exceed 600 000 ha, but measurements from satellite images show that it is in fact about 460 000 ha, with maximum extents of 128 km from west to east and 52 km from north to south. The total area of subsidiary pans is approximately 55 000 ha. The main pan lies in flat to gently undulating savanna country. The minimum altitude of the pan floor is 1073 m near the Ekuma River mouth in the NW corner, while the maximum is 1086 m in the SW.

Climate: There are usually three distinct seasons; wet and hot (January-April), dry and cool (May-August) and dry and hot (September-December). January is the hottest month with mean maxima and minima of 38.3 and 11.8°C respectively, while July is the coldest month with corresponding figures of 28.9 and 1.5°C. Precipitation during the wet season is unreliable and varies considerably from year to year, e.g. only 90 mm in 1946, but 975 mm in 1950. In most years more rain falls on the eastern edge of the pan than on the

western edge, and mean annual figures are 440 mm at Namutoni and 418 mm at Okaukuejo. In the wet season sudden thunderstorms lash the pan, often followed by prolonged periods of intensely hot sunshine when temperatures may exceed 40°C. In winter, nights are cold with occasional mild frosts, and days are warm, although desiccating winds may gust across the pan at speeds up to 56 km/hr.

Normally evaporation exceeds precipitation by a factor greater than 6:1. During the 5 years (60 months) from 1974 to 1978, rainfall exceeded evaporation in only 2 months, February and March 1976. Mean class A pan evaporation is 2662 mm. Prevailing winds are from the NE, except during the hot dry months of September-December when they may swing round to SW.

Hydrology & Water Quality: Direct precipitation accounts for only a small proportion of the pan's water, most being supplied by three periodic rivers, the Ekuma, the Oshigambo and the Omurambo Ovambo. The first two of these drain the plains to the north of the Pan, and the Ekuma may carry water from southern Angola. The mouths of these streams have formed deltas in the northwest of the pan. The Omurambo Ovambo drains an area to the east of the pan, which it enters at its eastern extremity. Several small pans and narrow floodplains are associated with these three drainage lines before they reach the main pan. In addition there are other pans immediately west of the main pan, the largest of which is Natukanaoka Pan. In the wettest years Etosha Pan is partially flooded from January to April or even June, but droughts are frequent, and during dry cycles (e.g. in 1980) there may be no standing water away from water holes. During these periods the rivers do not flow at all and their courses consist of a series of pools and ponds. In 1971, a moderately wet year, some 250 000 ha of the pan was flooded with water ranging in depth from 1 m at the Ekuma Delta to 1 cm at the SE edge. The SW sector of the pan was not flooded at this time, and indeed it is doubtful if it has been fully flooded this century. The small pans along the major drainage lines leading to the main pan hold water for short periods in wet years when the rivers flow, but the western pans are much drier.

River water flowing into the main pan early in the wet season has a pH close to 7.6, whereas pan water is always more alkaline, the pH rising as the pan dries. It has been measured as 9.2 in July, 9.4 in September, and over 10.0 before finally drying. In 1971 incoming river water had the following respective concentrations, expressed in ppm, successively for July and September: sodium 482 (July) and 12 800 (September); potassium 10 and 106; sulphate 104 and 2790; nitrate 7 and 0; silicate 25 and 40; and chloride 600 and 15 800 (Berry 1972). Corresponding pan water concentrations, in ppm, were: sodium 7820 and 22 650; potassium 111 and 300; sulphate 890 and 3700; nitrate 0 and 0; silicate 40 and 40; and chloride 10 400 and 29 850.

Flora & Fauna: The floors of the pans are largely unvegetated, but areas which remain moist support algal and bacterial growth, comprising species of *Anabaena*, *Nodularia*, *Nostoc* and *Oscillatoria*. Low islands, subject to partial inundation during floods, support perennial grasses, including *Odyssea paucinervis*, some reeds and sedges, and occasionally some of the scrubby trees which occur on the periphery and along incoming drainage lines. These include *Acacia ataxacantha*, *A. erioloba*, *A. erubescens*, *A. hereroensis*, *A. kirkii*, *A. luederitzii*, *A. mellifera*, *A. nebrownii*, *A. reficiens*, *A. tortilis*, *Combretum apiculatum*, *C. engleri*, *C. hereroense*, *C. imberbe*, *Dichrostachys cinerea*, *Elephantorrhiza suffruticosa*, *Erythrina decora*, *Olea africana*, *Sclerocarya caffra*, *Spirostachys africana*, *Terminalia brachystemma* and *Terminalia prunoides*. The surrounding vegetation is chiefly *Colophospermum ntopane* scrub savanna with a ground cover of grasses in which species of *Anthepera*, *Aristida* and *Enneapogon* predominate. *Colophospermum nzopatte* is deciduous and is mostly bare by the end of the dry season.

Over 300 bird species have been recorded on the pan which is the largest known breeding area of the two flamingoes, *Phoeniconaias minor* and *Phoenicopterus ruber*, in southern Africa, and in some years the combined flamingo population of the pans is said to reach 1 million birds. Other species recorded include *Aquila rapax*, *Ardea cinerea*, *Corvus alba*, *Larus cirrocephalus*, *Leptoptilus crunzeniferus*, *Lophotis ruficrista*, *Pelecanus onocrotalus*, *Platalea alba*, *Plegadis falcinellus*, *Struthio camelus*, *Terathopius ecaudatus*, *Threskiornis aethiopicus* and *Torgos tracheliotus*. Accounts of flamingo and pelican breeding on the main pan are given by Berry (1972) and Berry *et al.* (1973).

Most of the larger mammals of the southern savanna plains of Africa occur in Etosha National Park, which is one of the largest and most renowned game parks in the world. Few of these species do not utilise the pans, and among the more noteworthy are *Acinonyx jubatus*, *Aepyceros melampus petersi*, *Alcelaphus buselaphus*, *Connochaetes taurinus*, *Damaliscus lunatus*, *Diceros bicornis*, distinctive races of zebra, *Equus burchelli antiquorum* and *Equus zebra hartmannae*, *Giraffa camelopardalis*, *Hippotragus equinus*, *Loxodonta africana*, *Madoqua kirki*, *Oryx gazella*, *Panthera leo*, *P. pardus*, *Taurotragus oryx* and *Tragelaphus strepticerus*. Smaller mammals comprise *Canis nzesomelas*, *Felis silvestris*, *Ictonyx striata*, *Lycaon pictus*, *Mellivora capensis*, *Otocyon nzealotis*, *Papio ursinus*, *Pedetes capensis*, *Suricata suricata*, *Vulpes charna* and *Xerus inauris*.

Human Impact & Utilisation: Most pans in the area provide waterholes and salt licks for wildlife, and in consequence attract large numbers of tourists. There are three camp sites in the Etosha National Park offering bungalows, cabins and tents for rental. During 1983 a total of 51 834 people visited the park; 13 959 from overseas, 18 583 from Namibia and 19 292 from South Africa. No other people live in the park apart from park staff, and the grazing of domestic animals is prohibited. However, the use of anti-malarial agents in the catchment areas in recent years has potassium 10 and 106; sulphate 104 and 2790; nitrate 7 and 0; silicate 25 and 40; and chloride 600 and 15 800 (Berry 1972). Corresponding pan water concentrations, in ppm, were: sodium 7820 and 22 650; potassium 111 and 300; sulphate 890 and 3700; nitrate 0 and 0; silicate 40 and 40; and chloride 10 400 and 29 850.

Flora & Fauna: The floors of the pans are largely unvegetated, but areas which remain moist support algal and bacterial growth, comprising species of *Anabaena*, *Nodularia*, *Nostoc* and *Oscillatoria*. Low islands, subject to partial inundation during floods, support perennial grasses, including *Odysea paucinervis*, some reeds and sedges, and occasionally some of the scrubby trees which occur on the periphery and along incoming drainage lines. These include *Acacia ataxacantha*, *A. erioloba*, *A. erubescens*, *A. hereroensis*, *A. kirkii*, *A. luederitzii*, *A. mellifera*, *A. nebrownii*, *A. reficiens*, *A. tortilis*, *Combretum apiculatum*, *C. engleri*, *C. hereroense*, *C. imberbe*, *Dichrostachys cinerea*, *Elephantorrhiza suffruticosa*, *Erythrina decora*, *Olea africana*, *Sclerocarya caffra*, *Spirostachys africana*, *Terminalia brachystemma* and *Terminalia prunoides*. The surrounding vegetation is chiefly *Colophospermum mopane* scrub savanna with a ground cover of grasses in which species of *Anthephora*, *Aristida* and *Enneapogon* predominate. *Colophospermum mopane* is deciduous and is mostly bare by the end of the dry season.

Over 300 bird species have been recorded on the pan which is the largest known breeding area of the two flamingoes, *Phoeniconaias minor* and *Phoenicopterus ruber*, in southern Africa, and in some years the combined flamingo population of the pans is said to reach 1 million birds. Other species recorded include *Aquila rapax*, *Ardea cinerea*, *Corvus alba*, *Larus cirrocephalus*, *Leptoptilus crumeniferus*, *Lophotis ruficrista*, *Pelecanus onocrotalus*, *Platalea alba*, *Plegadis falcinellus*, *Struthio camelus*, *Terathopius ecaudatus*, *Threskiornis aethiopicus* and *Torgos tracheliotus*. Accounts of flamingo and pelican breeding on the main pan are given by Berry (1972) and Berry *et al.* (1973).

Most of the larger mammals of the southern savanna plains of Africa occur in Etosha National Park, which is one of the largest and most

renowned game parks in the world. Few of these species do not utilise the pans, and among the more noteworthy are *Acinonyx jubatus*, *Aepyceros melampus petersi*, *Alcelaphus buselaphus*, *Connochaetes taurinus*, *Damaliscus lunatus*, *Diceros bicornis*, distinctive races of zebra, *Equus burchelli antiquorum* and *Equus zebra hartmannae*, *Giraffa camelopardalis*, *Hippotragus equinus*, *Loxodonta africana*, *Madoqua kirki*, *Oryx gazella*, *Panthera leo*, *P. pardus*, *Taurotragus oryx* and *Tragelaphus streptoceros*. Smaller mammals comprise *Canis mesomelas*, *Felis silvestris*, *Ictonyx striata*, *Lycaon pictus*, *Mellivora capensis*, *Otocyon megalotis*, *Papio ursinus*, *Pedetes capensis*, *Suricata suricata*, *Vulpes charma* and *Xerus inauris*.

Human Impact & Utilisation: Most pans in the area provide waterholes and salt licks for wildlife, and in consequence attract large numbers of tourists. There are three camp sites in the Etosha National Park offering bungalows, cabins and tents for rental. During 1983 a total of 51 834 people visited the park; 13 959 from overseas, 18 583 from Namibia and 19 292 from South Africa. No other people live in the park apart from park staff, and the grazing of domestic animals is prohibited. However, the use of anti-malarial agents in the catchment areas in recent years has led to the appearance of chlorinated hydrocarbons in the food chains of the pan. Most river water originates in Ovamboland and since 1965 indoor sprays have been applied to the roofs and upper walls of tribal huts. Today some 120 000 kg of 5% DDT solution is used annually for this purpose in the pan catchments, and eggs of the lesser flamingo were found to contain traces of the following compounds in ppm: DDT 0.013; TDE 0.097; DDE 0.19; dieldrin 0.03; and BHC 0.03 (Berry, 1972).

Conservation Status: The pans are situated in the Etosha National Park and are fully protected, being covered by a Nature Conservation Ordinance of 1975. However, the area has been protected as a game reserve since 1907.

5. Lakes Guinas and Otjikoto

Country: Namibia

Coordinates: 19°18'S/17°22'E (Guinas); 19°14'S/17°33'E (Otjikoto)

Area: c. 3 ha (total)

Altitude: c. 1250 m asl

Nearest Town: Windhoek (390 km WSW)

General: Lake Otjikoto, or Otjikoto Fountain as it used to be called, is a dolomite sink hole on the Waterberg Plateau, ESE of Etosha Pan. It is filled with clear hard water at least 36 m deep and is set about with cliffs and steep walls some 20 m high. It is situated in level ground in bush

country and as the explorer Charles Andersson wrote 'a person might pass within fifty paces of it without being aware of its existence'. It measures about 120 m across, and there are caves in its walls just above water level, in which bats and owls live. The water has been used as a town supply for Tsumeb, and for irrigation by local farmers, and the lake is fenced off to prevent animals falling in. Lake Guinas is another, larger, but less spectacular sink hole, 19 km WSW. Lake Otjikoto is of scientific interest because of its fish fauna. Originally it contained a unique dwarf cichlid species, which possibly still survives, but another species, *Tilapia guinasana*, was introduced from Lake Guinas and this species quickly became predominant and is now referred to as 'Otjikoto cichlid'. Subsequently, *Oreochromis mossambicus* was introduced illegally, in 1980, and this species has increased quite dramatically at the expense of the others.

Conservation Status: Unprotected. Lake Otjikoto is a popular venue for tourists because of its semi-desert and therefore spectacular setting, and its accessibility from the road between Tsumeb and Ondangwa. It has therefore been despoiled to some extent. A great deal of rubbish has been tipped into it over the past 100 years. Lake Guinas is also easily accessible from the Otavi-Ondangwa road.

6. Other Floodplains and Pans

Country: Namibia

General: Small swampy areas, dominated by *Phragmites mauritianus*, occur along the Cubango/Okavango River where it forms the border between Angola and Namibia. A section of this river is protected in the Mahango Reserve, in Kavango District.

Extensive grass covered floodplains occur on the interior plains to the east of the town of Grootfontein (19°33'S/18°05'E) centred on a complex of drainage lines related to the Omatako River system. The area may remain unflooded for many years at a time, but during wet cycles it provides an important habitat for wetland birds. No precise information is available concerning the area inundated, or its fauna and flora. The area is unprotected.

There is a major pan system north of Grootfontein in the Bushmanland District. The pans are linear and arranged in parallel lines oriented WNW-ESE. Some individual pans exceed 25 km in length and 1 km in width. The system covers an area from 18° to 19°S, and from 18° to 19°E. Precise information is unavailable concerning the area subject to

flooding, and the fauna and flora of the pans. Flooding may not occur for several successive years, yet when it does the area becomes an important wetland habitat. The northernmost pans of this system may come within the boundaries of the proposed Bushmanland Reserve.

Other pans exist north of Grootfontein, near Tsintsabis, 18°50'S/17°58'E. Again precise information regarding the frequency with which these pans are flooded is not available, but it is believed that, in wet years, some wetland birds breed there. These include *Pelecanus onocrotalus*, *Phoeniconaias minor*, *Phoenicopterus ruber* and *Podiceps nigricollis*, together with several herons, ibises and storks. The area is presently unprotected.

A further group of pans is situated in eastern Bushmanland near Tsumkwe (19°40'S/20°30'E). These hold water infrequently after storms. An extensive but infrequently inundated pan/floodplain system occurs on a group of anastomosing streams which drain the eastern slopes of the Tsarisberge Mountains. Here, several converging streams carry broad pan-like floodplains, up until their joint confluence at a point 24°50'S/16°54'E near Maltahohe. The entire system probably extends for 170 km with an average width of 5 km, giving it a total area in the region of 85 000 ha. Parts of the system hold water after storms in the adjacent mountains.

Immediately to the north of this a large but infrequently flooded pan marks the outflow of a stream draining the eastern slopes of the Naukluft Mountains to the basal plain. The rectangular pan (24°01'-24°11'S/16°22'-16°24'E) covers some 15 000 ha and is 30 km long.

7. Sossusvlei and Tsondabvlei

Country: Namibia

Coordinates: 24°40'S/15°24'E (Sossusvlei); 23°55'S/15°23'E (Tsondabvlei)

Area: c. 3000 ha (maximum inundated area - both pans)

Altitude: c. 600 m asl (Sossusvlei); c. 700 m asl (Tsondabvlei) Nearest Town: Mariental (130 km NE)

General: The Naukluft Group of Mountains (24°14'S/16°11'E) is part of the main range, but is isolated from it by deep valleys. They are situated about 175 km inland and some 200 km SW of Windhoek, and comprise gorges, caves and springs, which have deeply eroded the dolomite formation. Two ephemeral rivers rise here, the Tsondab on the northern side of the group, and the Tsauchab on the south. When they carry water both streams flow coastwards into the sand desert of the Namib, where

each terminates in a vast clay pan surrounded by dune summits 300 m asl. Once it has left the mountains, the Tsauchab disappears abruptly down a narrow gorge in the plain which then becomes progressively wider and shallower until it has lost altitude and opens into the sand desert. Here it discharges into Sossusvlei, a clay pan, with a maximum area of c. 2000 ha, which may, in parts, retain water for several months after a flood. However, it does not receive water regularly, and when it does, only small areas of the total pan may be covered. Ridges and fingers of dune sand intrude onto the pan, and these, and the shallowly flooded periphery, carry a scant fringe of trees (many dead) and grassy vegetation. In some places, at high water, tree bases are inundated for weeks on end, and the trees emerge from the temporary lake as green islands set in from its banks. Some small watercourses within the dry pan have semi-permanent pools, fringed by reeds and sedges, and a variety of animals, including gemsbok, springbok and ostriches, feed and drink at these pools. A wealth of wetland birds utilise the pan when it holds water. Sossusvlei is open to the public and is a popular tourist attraction, but access is only by 4 wheel drive vehicles and permits are valid only for one day.

The Tsondab River terminates in Tsondabvlei, a similar but smaller system covering some 1050 ha. This pan is more heavily wooded than Sossusvlei, and supports a large indigenous population of *Torgos tracheliotus*. This area is reserved for scientific research and is not available to the public.

Human Impact & Utilisation: Virtually none, the systems are so remote.

Conservation Status: Both systems, pans and rivers, are located within the Naukluft Mountain Park, established in 1979, and are fully protected.

8. Periodic Streams

Country: Namibia

General: Throughout northwestern Namibia the most densely vegetated sites are areas of river bed in the valleys of watercourses which rise in the eastern highlands and traverse the desert west-southwestwards towards the Atlantic Ocean. Between the Angolan border and Walvis Bay several such watercourses reach the sea, while others become lost in the dunes of the Namib Desert. All of these have some deeply entrenched sections, and all have sections with braided channels and narrow floodplains. From north to south the most important are the valleys of the Khumib, Hoarusib, Hoanib, Uniab, Huab, Ugab, Omaruru, Swakop and Kuiseb Rivers. Storm rains in the eastern catchments cause these streams to flow vigorously for a few days at a time and they may sometimes come down in flood, inundating their discontinuous floodplain sections. The valley

floors quickly become green, and the grasses covering them grow to be 2-3m tall at maturity 3 months later. In some years the river channels carry water more than once, but at other times they may remain unflooded for several consecutive years. After a flood a river quickly dries to a series of pools and moist depressions. Pools tend to be most persistent in deeply shaded gorges or canyons, especially where a depression is occupied by a superficial fill of gravel or rock debris. The river bed sands remain moist below the surface, even in dry years, at depths of 50 cm to 1 m. The floors of the canyon sections may be very hot and exceptionally humid. For example, daytime temperatures of 45°C and night-time temperatures of 35°C are not uncommon in the canyon of the Great Fish River, which is a tributary of the Orange River and the only important river in southern Namibia.

Oases of vegetation occur in the vicinity of springs which trickle from steep canyon sides, or which well up in the stream beds to form permanent waterholes. Many small wetland sites exist along the northern rivers, where pools are usually fringed by *Phragmites mauritianus*, *Cyperus* sp., *Juncus* sp., *Scirpus* sp., and various grasses. Most pools have limited fish faunas, which include barbel, yellowfish, and sometimes bream. Most support small resident bird communities, and act as waterholes for a variety of mammals. Some support a few gnarled *Acacia albida* trees or bushes, but arborescent vegetation is scarce, normally being destroyed when the rivers come down in flood. Some *Phoenix dactylifera* palms flourish at Ai-Ais (27°56'S/17°30'E) in the lower Fish River Canyon, but were doubtless planted. Sandy patches overlying moisture may support straggling vines of the wild prickly cucumber, *Cucumis africanus*, which provides another source of moisture for animals. Adjacent to some of the rivers, patches of xerophytic vegetation emerge from the surrounding sands, over rocky structures which retain moisture.

After a flood, the temporarily lush northern river valleys are visited by several large mammal species, including *Antidorcas marsupialis hofmeyri*, *Diceros bicornis*, *Giraffa camelopardalis*, *Loxodonta africana*, *Panthera leo* and *Tragelaphus strepsiceros*. Lions range along these valleys as far west as the coast where they are known to have killed seals, while jackals (*Canis mesomelas*) which will eat dead seals, crabs, and young and dying seabirds, are common all along the Skeleton Coast. Black rhinoceroses are now very uncommon in the river valleys, but have been recorded in the Hoanib Valley in recent years.

Hot springs, rich in fluoride, chloride and sulphate, occur at two points along the Great Fish River, as it traverses its 160 km long canyon. The

best known is at Ai-Ais (27°56'S/17°30'E) near the mouth of the canyon, which has been turned into a spa, but another, some 65 km upstream (27°40'S/17°36'E) forms a large warm pool, with water temperatures close to 60°C and this is relatively undisturbed. After a normal flood on the Great Fish River, a series of long narrow pools remains on the rock strewn floor of the canyon. These are remarkably persistent, despite high ambient temperatures. Humidity is always high in the canyon which in places is only 27 m wide and up to 550 m deep. *Alopochen aegyptiacus* is quite common, and is said to breed in the canyon.

Human Impact & Utilisation: The more isolated northern rivers are virtually undisturbed, except by farmers and herders who occasionally visit them about their duties, but the Great Fish River Canyon is the scene of foot safaris, organised from the resort at Ai-Ais. However, since the full traverse of the canyon takes about 20 days, this is not frequently undertaken. The lower pools of the canyon are, nevertheless, often the scene of bathing parties and picnics.

Conservation Status: Most of the Kuiseb River valley and canyon is contained in the Namib-Naukluft Park and is fully protected. The lower 40 km or so of a number of other streams cross the northern desert region of the Skeleton Coast Park, and are also protected. However, most of the course of the Great Fish River is unprotected.

9. Artificial Impoundments

Country: Namibia

(a) Hardap Dam

General: The principal impoundment is the Hardap Dam 24 km north of Mariental (24°36'S/17°59'E) at the head of the Great Fish River. The dam is set in the Hardap Recreation Resort and the lake covers 2500 ha at capacity and stores 323 million m³ of water behind a dam wall 39.2 m high. Hotels, restaurants and other tourist facilities are available and the lake caters for all manner of aquatic sports from water-skiing and wind-surfing to swimming and angling. The dam is well stocked with fish and there is a fish research unit in the park. There is also a substantial and well stocked game reserve, animals from which utilise the lake.

(b) Augeigas Dam

General: The Augeigas Dam, a smaller dam, is set in the Daan Viljoen Game Park, 2000 m asl in the Khomas Highlands, 24 km west of

Windhoek (22°34'S/17°06'E). The lake has been made into a tourist venue, with hotels and restaurants, and the shores have been planted about with exotic trees. The waters are well stocked with fish and a variety of game animals roam freely in the park. Some 200 species of birds have been observed on the lake, and there are resident populations of coot, wild ducks and geese.

(c) Sartorius Von Bach Dam

General: This is situated close to Okahandja (21°59'S/16°58'E), 1500 m asl, in a Recreational Resort some 75 km north of Windhoek. No permanent accommodation exists in the park but camping is permitted, and angling in the lake is by license.

(d) Naute Dam

General: The LOwen River is impounded to form the Naute Reservoir (26°57'S/ 17°58 '-18°01 'E) south of Keetmanshoop.