12. **Human activity**

The people of the Makatini flats are descended from the Tembe-Thonga tribe, and have adopted Zulu nationality. The majority of them practise subsistence agriculture on the Makatini Flats, and come down to the floodplain to fish. Almost all their protein is derived from this fish, and they thus rely on the annual floods to maintain the pans in optimal condition for the growth of the fish. For a further descprition of these people see section 8.6.

Management: The completion of the Pongolopoort dam, higher up the river, in the Lebombo Mountains, has increased the agricultural potential of the area. However, manipulation of the water supply for irrigation programs could well have a deleterious effect on the floodplain. Pans may well dry out, or at least become so saline as to preclude survival of the life forms found there now. At the present time experimental releases of water from the dam are being carefully monitored, with a view to developing a sound policy of flood control.

8.8 LAKE SIBAYA

by J.S. MEPHAM

Lake Sibaya lies on the Maputaland Plain of northeastern South Africa as described in section 8.6. It is a fairly deep endorheic lake cut off from the Indian Ocean by high, forested sand dunes. It is poor in nutrients and consequently has low productivity. A comprehensive account is given by Allanson (1979).

1. **Geography and morphology** (Figs. 8.15 and 8.20)

Location: 27°25'S; 32°40'E.

Altitude: The surface of the lake is about 21 m asl, and at the deepest part the floor is about 20 m below sea level.

Area: Area of lake: 65 km^2
Area of drainage basin: 530 km^2 approximately.

Landscapes: The eastern shores consist of high, densely forested dunes and in places the lake approaches to within 1 km of the sea. The other shores are predominantly covered by low thornveld.

Morphometry: The main basin of the lake is 8.5 km long and 6 km wide and occupies almost 60% of the total area of the system. It has the deepest water and opens into two smaller basins in the south, a large dendritic arm to the west and another one to the north. The SE basin is virtually separated from the rest by the formation of two major sand spits. The western arm of the lake occupies a narrow valley and deepens progressively from 5 m at the western end to 25 m where it joins the main basin. The valley continues for 2 km across the main basin before it enters a deep wide trough running NW to SE. Similarly the northern arm lies in a valley and is 28 m deep where it enters the main basin. The southwestern bay has a similar profile, although it is much shorter than the western and northern arms. The southern end of the main basin is shallow, but has a maximum depth of 20 m. For further details see the table below.

Lake Sibaya: Morphometry at low (1964) and high (1977) lake levels. Datum is 16.85 m above G.M.S.L. (from Hill 1979).

	1964	1977
Surface level above datum (m)	1.7	4.6
Maximum length (km)	17.5	18.7
Maximum breadth (km)	16.3	18.3
Mean width (km)	3.3	4.1
Maximum depth (m)	40.0	43.0
Mean depth (m)	13.1	12.6
Area (km^2)	59.4	77.5
Shore length (km)	128.7	126.9
Shore development	4.7	4.1
Volume (10^6 m^3)	776	981
Volume development	0.98	0.88
Circularity ratio	0.26	0.27

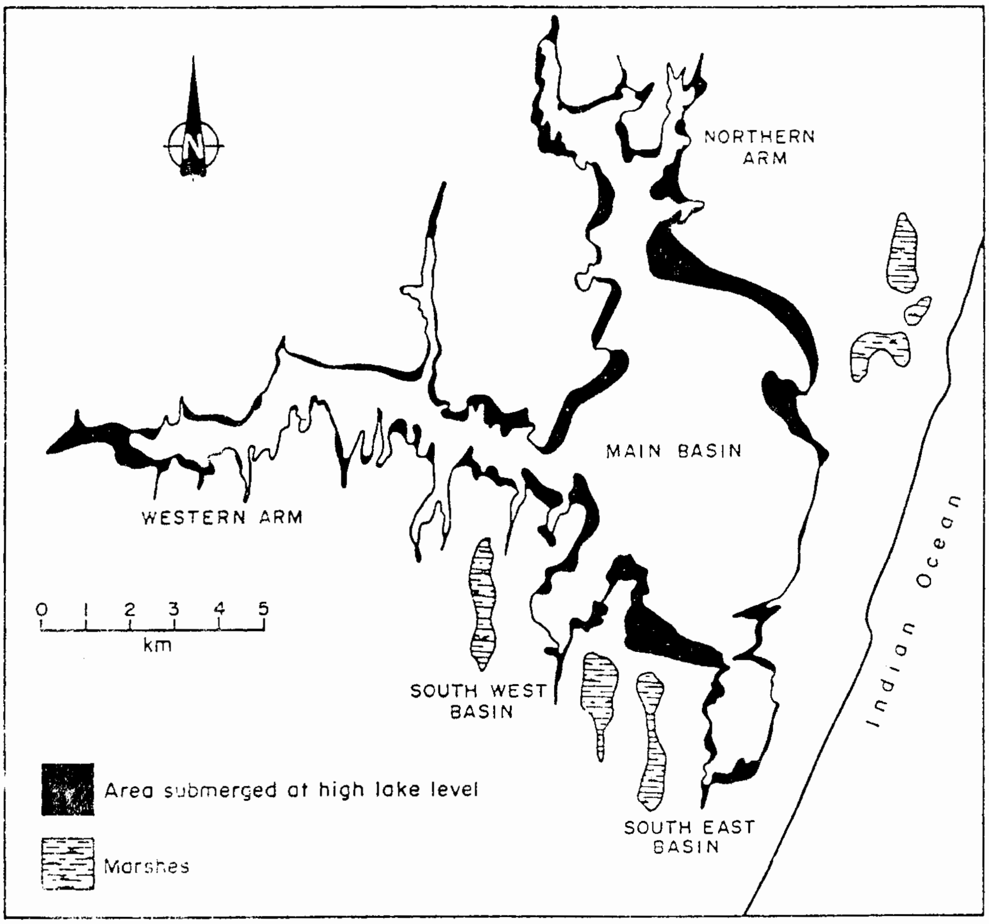


Fig. 8.20 Map of Lake Sibaya showing high and low lake levels

2. Geology

Lake Sibaya is situated on the Recent and Tertiary sands as described in section 8.6. The shores are sandy with only one small outcrop of lateritic ironstone on the northeastern shore.

3. Climate

This area has hot wet summers from September to March, and warm wet winters from April to August.

Type Code: BSfa (Köppen)

Insolation:

mean solar radiation:	April to August	10 730 $kJ.m^2.d^{-1}$
	September to March	28 330 $kJ.m^2.d^{-1}$

Wind:

strength	16-30.6$km.h^{-1}$, greater during cyclones
seasonality	windiest time, November to January
prevailing direction	mainly from N and S in response to cyclonic and anticyclonic activity.

Rainfall:

on lake, annual mean	1030 $mm.y^{-1}$
catchment area, annual mean	900 $mm.y^{-1}$
months of highest	January to March

Evaporation from lake surface:

annual, mean	1420 $mm.y^{-1}$
winter, mean, monthly	50 $mm.month^{-1}$
summer, mean, monthly	175 $mm.month^{-1}$

Air Temperature:

hottest month, February	mean 25°C
coolest month, July	mean 18°C

Cloud cover:
In summer there is more than 50% cloud cover nearly every day.
In winter there is more than 50% cloud cover on 6 days per month.

4. Hydrography and hydrology

Lake Sibaya is an endorheic system, and the water level reflects climatic variations. Oscillations of over 4 m have been shown to occur over a period of a few years. Groundwater inflow has been estimated at 21 x 10^6 $m^3.y^{-1}$ and seepage from the lake into the sea has been estimated at 1-4 x 10^6 $m^3.y^{-1}$ (Hill 1980).

5. Physico-chemical characteristics of the water

The lake shows substantial current movements because of the stresses set up by the strong northerly and southerly winds. Wind stress and surface heating ensures that effective mixing occurs at all levels and this means that in the hot season the lake is not thermally stratified into a distinct epilimnion and hypolimnion. This lack of hypolimnion may account in part for the low production of the pelagic zone.

	Minimum	Maximum
Temperature:		
overall mean	18°C July	27°C January
shallows mean	13°C	41°C
Transparency: (Secchi disc)	2.7 m	3.4 m

	Mean
pH	8.2-8.3 all year
Conductivity	584-598 $.10^{-6}S.cm^{-1}$ at 20°C (winter 1967)
Na^{+}	86.1 $mg.l^{-1}$
K^{+}	7.3 $mg.l^{-1}$
Ca^{2+}	27.5 $mg.l^{-1}$
Mg^{2+}	9.0 $mg.l^{-1}$
HCO_3^-	135.8 $mg.l^{-1}$ (higher in summer)
Cl^-	131.3 $mg.l^{-1}$ (poss. due to sea spray)
Oxygen at surface	7.6 $mg.l^{-1}$ (January 1967)
Oxygen at 15 m	8.1 $mg.l^{-1}$ "
Oxygen at 30 m	6.9 $mg.l^{-1}$ "

6. Macrophytes

Long term variations in the water levels of Lake Sibaya are reflected by changes in the vegetation. During low water periods, such as were experienced in 1964, the predominant emergent plants on the exposed shores tend to be *Scirpus litoralis* and *Phragmites mauritianus*. In sheltered areas *Typha latifolia*, *Cyperus papyrus* and the grasses *Sporobolus virginicus* and *Dactyloctenium geminatum* are abundant. Submerged macrophytes ring the entire lake in a narrow band from 1-7 m wide, with *Potamogeton* spp. predominating in exposed areas and *Myriophyllum spicatum* and *Ceratophyllum demersum* in the sheltered shallows.

During high water periods the tall emergents *Typha* and *Phragmites* almost entirely disappear and the shoreline becomes ringed with *Cyperus natalensis*, which is frequently associated with the grasses *Hemarthria altissima* and *Ischaemum arcuatum*. *Juncus krausii* and *Panicum meyerianum* are found on wave washed terraces in very shallow water. *Eleocharis* sp. and *Scirpus litoralis* are found mainly in the north and west arms.

The floating species *Nymphaea capensis* and *N. caerulaea* create dense beds in the N and W arms, while in the bays of the SE and SW basins the shallow water is dominated by floating *Leersia hexandra*.

The submerged macrophytes *Potamogeton schweinfurthii*, *Potamogeton pectinatus* and *Myriophyllum spicatum* are found in depths of 2-5 m. In the SW and SE basins *Utricularia inflexa* and *Najas pectinata* occur in the deeper water, whereas *Ceratophyllum demersum* occurs from 3-5 m in the N and W arms.

Table 8.1 Mean biomass of major macrophytes in Lake Sibaya ($g.m^{-2}$ $\pm$ standard error)

	Main Basin		S.E. Basin		S.W. Basin		North Arm		West Arm	
	($g.m^{-2}$	$\pm$SE	$g.m^{-2}$	$\pm$SE	$g.m^{-2}$	$\pm$SE	$g.m^{-2}$	$\pm$SE	$g\ m^{-2}$	$\pm$SE
<u>Ceratophyllum demersum</u> (submerged)	6	2.5	228	220.0	8	–	196	190.0	829	449.0
<u>Myriophyllum spicatum</u> (submerged)	48	29.6	47	20.5	30	17.7	13	18.9	11	4.6
<u>Potamogeton schweinfurthii</u> (submerged)	22	12.4	59	25.3	44	23.6	22	11.1	26	10.0
<u>Cyperus natalensis</u> (emergent)	193	54.5	144	–	197	124.4	252	71.1	217	30.1
<u>Leersia hexandra</u> (emergent)	1	–	16	–	11	10.3	151	85.4	15	8.0
<u>Ischaemum arcuatum</u> (floodplain grass)	258	25.4	–	–	25	10.7	112	1.0	121	45.8
<u>Panicum repens</u> (floodplain grass)	–	–	–	–	–	–	528	–	38	22.5

(Adapted from Howard-Williams 1979)

Productivity: Primary production in the lake is low and approximates 1847 mg $C.m^{-2}.day^{-1}$ in the pelagic zone and 1630 mg $C.m^{-2}.day^{-1}$ in the epipsammic diatom community of the terrace sands in summer (Allanson 1979). The emergents make up 25% of the total macrophyte biomass of Lake Sibaya. The most important individual species in terms of biomass are summarised in Table 8.1. There is no appreciable trapping of organic debris by the macrophytes, because of the strong currents in the lake. Neither do the macrophytes supply much in the way of nutrients to the lake nor food for the most abundant fishes. However they may be important as nursery areas for young fish. Howard-Williams (1979) considers that macrophytes play an insignificant rôle in the ecology of the lake.

7. Phytoplankton

The algal community comprises Closterium spp. Synedra acus, Anabaenopsis sp., Melosira granulata and Anabaena sp. in order of importance. Hart and Hart (1977) consider that nanoplankton plays an important rôle in the operation of the community. For individuals less than 20 $10^{-6}.m$ diameter they estimate a count of 4 190 to 16 760 $mm^3.m^{-3}$, which is greatly in excess of the total volume of the principal net phytoplankton. It has also been shown that bacteria are important in the community.

8. Invertebrates

Both standing stocks and levels of production are low in this system.

Zooplankton: The major species are entomostracan Crustacea; copepods and cladocerans. Rotifers occur, but apparently contribute little to the overall biomass of the zooplankton. Hydracarina (water mites) and zoeae larvae of the benthic brown crab Hymenosoma orbiculare are among the largest forms, and occur in moderate densities. Seasonally, insect larvae and larvae of the pelagic fish Gillchristella aestuarius contribute to the zooplankton community (Hart 1980).

Hart and Allanson (1975) estimate that secondary production by the dominant copepod Pseudodiaptomus hessei is 28 mg dry $mass.m^{-2}.day^{-1}$ throughout the year, which gives a result of about 0.5 tonnes dry matter per day, over the whole lake.

Zoobenthos: A variety of benthic organisms are found, principally members of the Crustacea and Mollusca. The crustacean component is dominated by small burrowing, and tube dwelling amphipods and tanaids, normally restricted to estuarine conditions. The marine crab Hymenosoma orbiculare and a fresh water shrimp Caridina nilotica are both found here. The molluscs are typical freshwater forms and include the intermediate snail hosts for human bilharzia. Other invertebrates include coelenterates, nematodes, a marine polychaete worm and many insect larval forms. The littoral benthos is particularly diverse with the aquatic larval stages of aerial insects such as chironomids, mayflies, caddis flies, dragon flies and damsel flies, together with the larvae of water boatmen and water bugs.

Several aquatic molluscs are found in association with marginal vegetation. The fresh water crab Potoman sidneyi and the shrimp Caridina nilotica dominate the littoral fauna in terms of biomass (Hart 1980).

9. Fish

In Lake Sibaya some of the fish present reflect the marine origin of the lake, e.g. Gilchristella aestuarius, while others indicate its tropical affinities. A total of eighteen species are found in the lake including four cichlids (Pseudocrenilabrus philander, Oreochromis (=Sarotherodon mossambicus, Tilapia rendalli swierstrae, and Tilapia sparrmanii); and three gobiids (Croilia mossambica, Glossogobius giuris, and Silhouettea sibayi). The most abundant and successful fish are those with wide habitat and food preferences, which make use of the occasionally rich, but variable littoral zone. The extensive deep offshore and open water zones of Lake Sibaya are comparatively lifeless compared with the littoral fringe. Fluctuations in lake level have a marked effect on the species composition of the fish fauna, with only Oreochromis (= Sarotherodon) mossambicus common on the littoral terraces at times of low level, but with all species abundant when lake levels are high (Bruton 1980). Oreochromis tends to feed solely on detritus so that the adults of these fish tend to be small and in poor condition, which Bowen (1976, 1978) attributes to the poor quality, rather than the quantity, of the food available. As a consequence of this the lake has negligible fisheries potential.

10. Other vertebrates

Amphibia: Twenty-two species of frogs have been recorded from Lake Sibaya, of which twenty are tropical forms near the southern limit of their distribution. They include two species of Xenopus, two Bufo, two Rana, three Ptychadena, two Kassina, two Afrilaxus, five Hyperolius, one Chiromantis, one Phrinobactrachus, one Pyxicephalus and one Leptopelis. They are all associated with densely vegetated swamps and bays and only Xenopus ventures far from the shore. They feed on littoral invertebrates and themselves fall prey to at least four species of fish, 15 species of reptiles and at least 37 species of birds.

Reptiles: Eight species of reptiles are associated with the lake itself, although another 59 have been recorded in the adjacent dune forest, grassland and savanna (Bruton and Haacke 1980). Among the snakes, the African python (Python sebae) is found around the lake and has been caught in fish traps laid at a depth of 2 m. Their prey include fishes as well as small mammals. The green water snakes Philothamnus hoplogaster and Philothamnus irregularis are common here, and forest cobras, Naja melanoleuca reaching up to 2.3 m in length are found along shores fringed with trees.

Water monitors, Varanus niloticus are the most commonly observed reptiles. In 1980 it was estimated that there were about 60 crocodiles (Crocodylus niloticus) over 1 m long in the lake (Bruton 1980).

Birds: Cyrus et al. (1980) recorded 279 bird species in the area and Bruton (1979) maintains that 62 of these are closely associated with the lake in one or more ways. From 1970 to 1976 the most numerous species were white breasted cormorants and reed cormorants, which consume gobies and small cichlids. Other fish eaters include pied, giant and malachite kingfishers, fish eagles, various large herons, darters and grey headed gulls. African jacanas, black crakes, purple gallinules, moorhens and little bitterns are found in the sheltered bays. Sandy beaches are inhabited by white fronted sand plovers which breed at Lake Sibaya. The commonest waders include black winged stilts, avocets, greenshanks, and the purple, great white and goliath herons (Bruton 1980).

Mammals: Only six mammal species are consistently associated with Lake Sibaya: *Ichneumia albicauda* (white tailed mongoose), *Atilax paludinosus* (water mongoose), *Hippopotamus amphibius*, *Redunca arundinum* (reedbuck), *Otomys irroratus* (vlei otomys) and *Dasymys incomptus* (African marsh rat). In 1973 Bruton estimated that there were 95 hippopotamuses in the area, which probably play an important rôle in the transfer of nutrients from land to water and in the stirring up of sediments by their trampling.

11. Human activities and management

This is largely dealt with in section 8.6. The lake supplies fish to the local inhabitants throughout the year, but most fish are taken in the summer, when large numbers of breeding *Oreochromis mossambicus* and *Clarias gariepinus* are speared and netted.

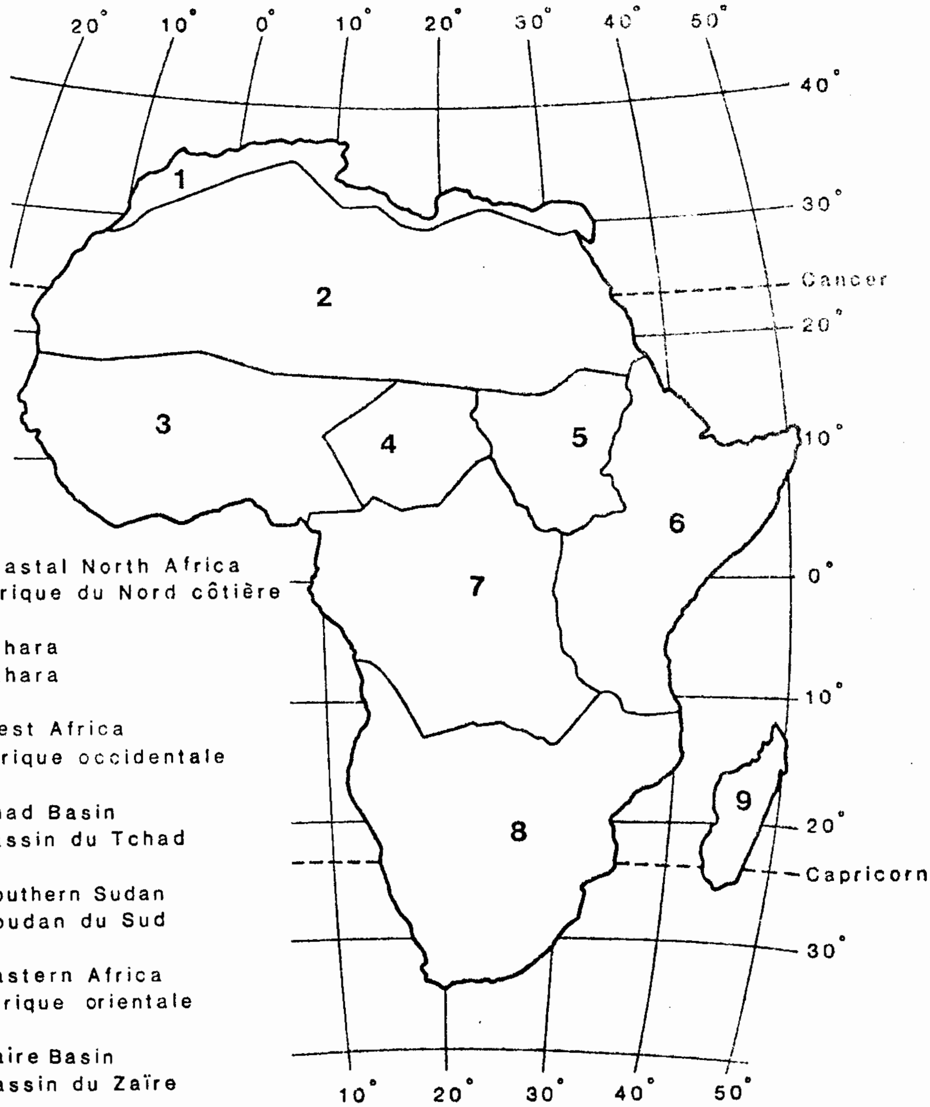
8.9 THE SAINT LUCIA LAKE SYSTEM

by J.S. MEPHAM

The St Lucia System lies on the Maputaland Plain on the north eastern coast of South Africa. It consists of an estuarine lake system which drains via a narrow outlet, 'The Narrows', to the Indian Ocean. The system is subject to extreme climatic variations, and as a result the lake experiences dramatic changes in salinity, in some parts from 0-120°/₀₀. This propensity for internal change makes it difficult to derive meaningful generalisations about the system, and even its status oscillates between lake, lagoon and estuary.

1. Geography and morphgology

Location: The St Lucia Lake System (Fig.s 8.15 and 8.21) is situated on the Maputaland coastal plain with the Lebombo Mountains lying to the NW and the Indian Ocean to the east, between 27°52'-28°24'S: and 32°21'-32°34''E. This excludes the extensive Mkuzi Swamps, which lie to the north of, and drain into the lake. Although these swamps are an integral part of the St. Lucia System virtually no research has been carried out on them.



1 Coastal North Africa
Afrique du Nord côtière

2 Sahara
Sahara

3 West Africa
Afrique occidentale

4 Chad Basin
Bassin du Tchad

5 Southern Sudan
Soudan du Sud

6 Eastern Africa
Afrique orientale

7 Zaire Basin
Bassin du Zaïre

8 Southern Africa
Afrique australe

9 Madagascar

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