Poissons: dominance d'Anguilla anguilla et des Mugilidae (essentiellement Mugil cephalus, Chelon labrosus et Liza ramada), pour les migrateurs et Aphanius fasciatus pour les sédentaires.

Oiseaux: très nombreux passages et séjours hivernaux notamment des Cormorans et des Flamants roses (présence attestée depuis le début du 17e siècle (de Brèves 1628).

5. Interventions humaines

Permanentes depuis le 8e siècle (creusement d'un canal à la mer au niveau de la Goulette et d'un chenal vers Tunis).

Dans le lac nord, présence de deux usines thermo-électriques rejetant leurs eaux dans la lagune; construction d'un canal d'assainissement dans la zone proche de Tunis; projet de comblement de près du quart du lac en vue d'y installer une zone résidentielle. Dans le lac sud, présence de deux salines; mise en place d'un port occupant environ le quart de la superficie du lac; construction en cours d'une usine thermo-électrique (canal de Radès).

Pêche: 8 "bordigues" (pêcheries fixes, Chauvet 1981); production annuelle moyenne de 500 tonnes.

1.4. COASTAL LAGOON OF LIBYA AND DELTA LAKES OF EGYPT

by Jacques LEMOALLE (Libya) & Massoud A.H. SAAD (Egypt).

1.4.a FARWA LAGOON

1. Geography

Situated in the extreme NW of The Arab Republic of Libya, at 33°05'N, 11°45'E (see figure 1.11).

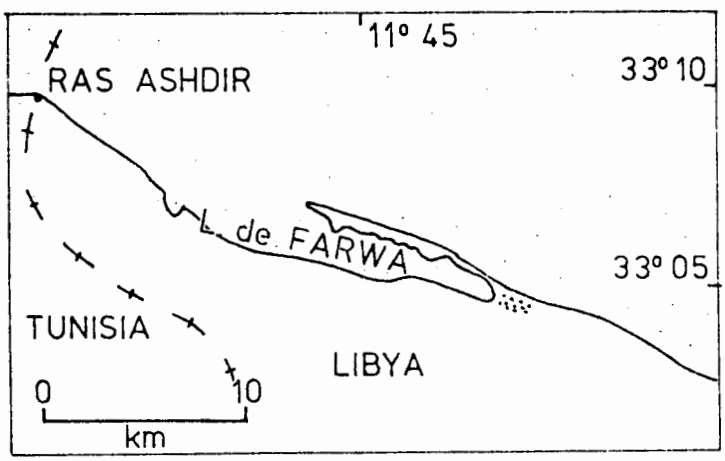


Fig. 1.11 Farwa Lagoon

Surface area 25 km^2, length 12 km, maximum width 2.5 km, width of the opening to the sea 2.5 km.

Drainage area negligible, but connected with supratidal sebkha. This lagoon which is rather a deep bay with its axis parallel to the coast, is separated from the sea by a fossil dune bar similar to that of el Bibane.

Mean depth 1 m; Z_{max} at the entrance 6 m.

2. Climate and geology

This lagoon is situated about 30 km from the Lagoon el Bibane and its climate and geology are very similar.

3. Hydrography and hydrology

Tidal range 0.8 m at spring tide, 0.2 m at neaps. No inflow, freshwater inputs are limited to rain and runoff from the banks. Occasional exchanges with a supratidal sebkha.

4. Hydroclimate

Water temperature 10°C in winter, 28°C in summer.
Composition: seawater with a relative deficit in Ca compensated by Mg.
Salinity: 40.2 - 43.1 °/oo
Alkalinity: 2.38 meq/l (June) to 3.0 meq/l (winter).
Nitrogen: NH_4 0.11 - $1.2.10^{-6}$ mole/l (min. in winter);
NO_2 0 - 5.10^{-6} mole/l (max. in winter);
NO_3 0 - 8.10^{-6} mole/l (max. in summer).

Phosphorus PO_4 - P less than $0.1.10^{-6}$ mole/l
P_{tot} up to $2.2.10^{-6}$ mole/l.

5. Flora and fauna

Posidonia oceanica very dense in the whole lagoon.
Phytoplankton: very diversified diatom - dinoflagellate community. Floristic list and counting results published (M.R.C. 1982).
Planktonic primary production: mean annual value 2 mgC $m^{-3}h^{-1}$ at the middle of the day; maximum in March.
No data on the fisheries, which are not very active. Mullet are present.

6. Human activity

Population density very low, no industry. Limited fishery on the lagoon itself, but there is a coastal fishery.

Additional reference

Marine Research Center, 1982. Environmental conditions of the Farwa Lagoon during 1981. Bull Marine Res. Center, Tripoli, 1: 23-75.

1.4.b-f. DELTA LAKES OF EGYPT

Five water bodies lie adjacent to the Mediterranean Sea on the fringe of the Nile Delta: Lake Mariut and Nozha Hydrodrome, L. Edku, L. Brollus and L. Manzalah (figure 1.12). The current configuration of these lakes is changing rapidly, due to natural processes and, mostly, to man's activities; fishing, agricultural practices and the construction of the Aswan High Dam in 1964 appear to be the driving forces of a continuous evolution of the Delta Lakes. As a result, the descriptions given here, although using the latest information available to the author, may rapidly become obsolete in some aspects.

Climate

Data for Alexandria are considered representative of the western Delta Lakes (fig. 1.13).

The climate of L. Edku (Saad 1976 b for years 1969-70) is characterised by a dry summer and rain in winter (maximum 57.7 mm during October); evaporation: 2.1 - 5.1 mm per day; wind is NW-SE, ranging from 7.4 - 10.7 km/h.

The climate of L. Manzalah is close to that of Damietta. Rainfall occurs in winter, from October to March. Average wind (1967) is 357 $km.d^{-1}$ (or 4.1 m/s), from N-NW in summer (maximum speed in spring). Relative humidity between 65 and 75% at L. Manzalah.

Insolation: 195 h in December and 380 in July (1957-58).

1.4.b. LAKE MARIUT

1. Geography and morphology

SW of Alexandria, separated from the sea by a limestone ridge (figure 1.14).
Altitude: -3 m
Initially an elongated lake with an area of 110 km^2; area reduced by half between 1950 and 1980, now about 27.3 km^2 for L. Mariut proper.
Water depth: 0.9 - 1.5 m.
Sediments of silt and clay with shells.
Mostly fed by drainage water (Qalaa drain).
Outflow: water pumped to the sea.

2. Physico-chemical characteristics

From Saad (1973) for the period 1969-70.
Temperature 12.7 - 29.0°C
Transparency 10 -105 cm, Secchi disc.
pH: 7.3 - 9.7. Low pH near industrial inputs.
Total residue: 1,758 - 11,434 mg/l
Chloride 1.09 - 2.63 g/l (but 1.5 - 6.5 g/l in 1960).

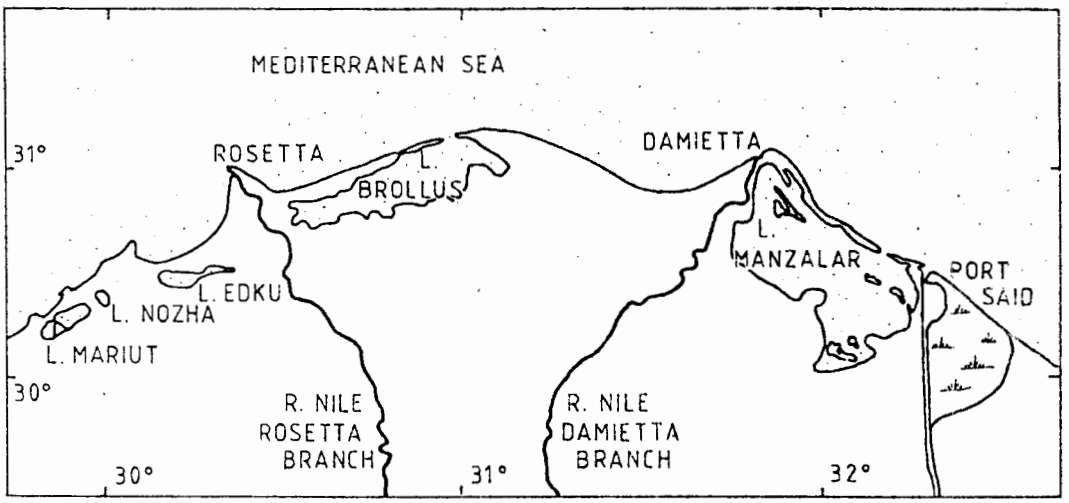


Fig. 1.12 Nile Delta lakes

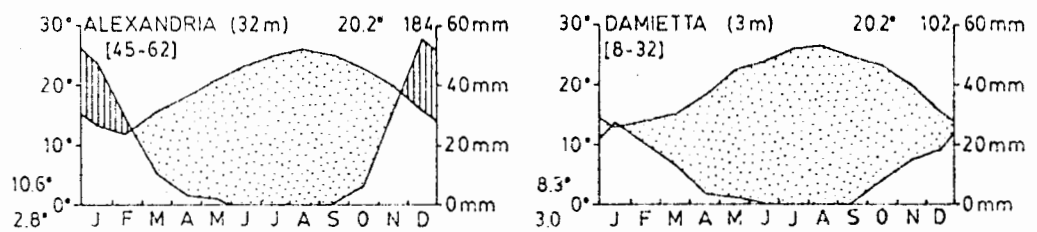


Fig. 1.13 Climatic diagrams for the Nile Delta (after Walter & Lieth 1960-67)

Several occasions of O_2 depletion due to organic matter decomposition
Phosphate: 2.3 - 10.9 mg PO_4/l (Saad 1973)
Silica: 8.2 - 15.9 mg SiO_2/l
Nitrite: 108.6 - 659.7.10^{-6} g NO_2/l (Saad 1980)
Pesticides: 2.1 ppb Lindane, and DDT compounds with high values near drainage water (Saad et al. 1982).
Mixing regime: wind action in this shallow lake prevents any stable stratification.

3. **Macrophytes**

The lake shores, particularly along the southern part, near the drainage water discharge, are thickly covered with Phragmites communis, Cyperus and Juncus. In general, Najas sp. and Ceratophyllum sp. are abundant in the central region of the lake, whereas fixed vegetation is generally absent (Elster and Jensen 1960).

4. **Phytoplankton**

L. Mariut is considered highly eutrophic and productive: Production (1960-61): 7.5 gC/m^2/d in polluted zone;
5.2 gC/m^2/d in central zone.

5. **Fish and fisheries**

The fishery on the lake proper (27.3 km^2) is highly productive yielding 17,000 tonnes per year (6,200 kg/ha); the proportion of Tilapia has decreased (77%) and that of catfish (Clarias sp.) (17%) increased.

6. **Human activity and management**

The lake is fed by drainage, as well as domestic and industrial waste water.
Evidence of pesticide and heavy metals accumulation in fish (Saad 1973b, 1973c, 1980; Saad et al. 1982; Elster & Jensen 1960).

1.4.c. NOZHA HYDRODROME

The Nozha hydrodrome was isolated from L. Mariut in 1939, it is now surrounded by a concrete embankment 9 km in length, and used as a fish farm.

1. **Geography and morphology**

Situated east of Alexandria airport; 3.3 km in length and 2.4 km wide, area 4.8 km^2 (figure 1.14).
Altitude (bottom): - 3.65 m
Mean depth: 3 m
Main water supply from Rosetta branch of the Nile via Mahmoudia canal
Lake sediments: silty clay with shells in the central zone

2. Physico-chemical characteristics

Temperature: close to mean air temperature: 15.5°C (January 70) to 27.5°C (September)
Secchi disc.: 37 - 51 cm
pH: 7.45 - 8.85
Chloride: 0.12 - 0.48 g/l controlled by Nile water discharge and evaporation.
Oxygen: well oxygenated, average monthly observations between 6.3 and 10.7 mg/l.
Total residue: 488 - 6,134 mg/l
Alkalinity: 2.1 - 4.3 meq/l
Nutrients: 45 - 720.10^{-6} g PO_4/l, 12.4 - $52.3.10^{-6}$ g NO_2/l, 8.2 - $15.9.10^{-6}$ g SiO_2/l.

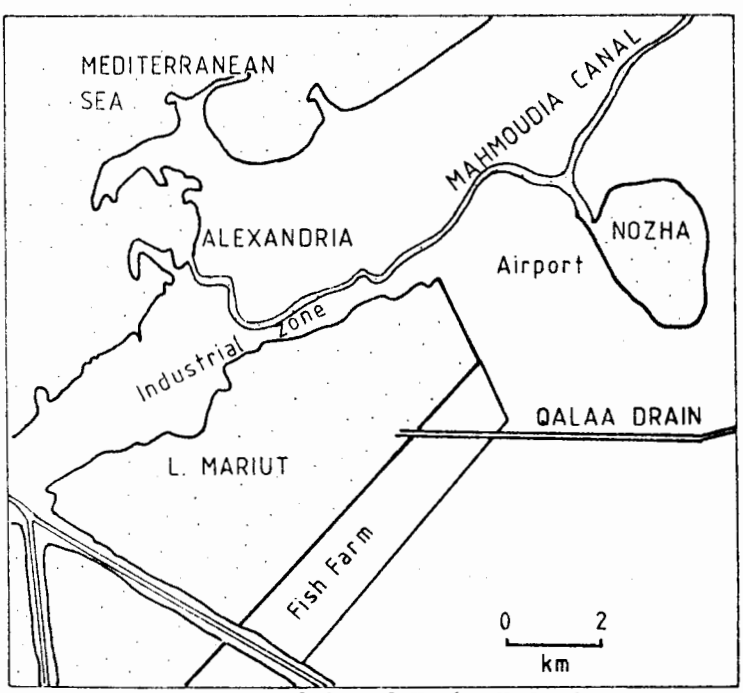


Fig. 1.14 Lake Mariut and Nozha Hydrodrome

3. Macrophytes, Zooplankton, Benthos

The following brief biological information was obtained from Elster and Jensen (1960). Potamogeton pectinatus formed a belt along the shore line and P. crispus was present in restricted areas. Najas armata covered about 70% of the total lake area. Arctodiaptomus salinus and Diaphanosoma excisum dominated in the zooplankton, whereas Mesodopsis slabberi and Leander squilla were common. The only bottom fauna occuring in considerable amounts were Corophium volutator and C. multisetosum, Gammarus locusta and G. oceanicus.

4. Human activity

The lake is used as fish farm, and all Nile fishes, especially Tilapia sp. are cultured in it (Saad 1973a).

1.4.d. LAKE EDKU

1. Geography and morphology

Situated half way between Alexandria and the Damietta Branch of the Nile, 30 km to the NE of Alexandria (figure 1.15).
Area 126 km^2, a great proportion of which is covered with macrophytes. Many islets dividing the lake into several regions.
Depth: from 0.5 to 1.5 m
Sediments: muddy in the S and SE, where drainage water discharges into the lake; sandy mixed with silty material at the N and NW borders.

2. Hydrology

Increasing drainage inputs with progress of time. Exchange of water between the lake and the sea through Bougaz el Maadiah, with sea water inflow during winter.

3. Physico-chemical characteristics

For the year 1969-70 (Saad 1976)
Water temperature 14.5 - 28.5°C (January and August)
pH: 7.63 - 9.50
Cl^-: 0.44 - 23.24 g/l; controlled by drainage and sea water influx.
Alkalinity: 183 - 235 mg/l
Total residue: 1,096 - 45,182 mg/l
PO_4 - P: 9 - 840.10^{-6} g PO_4/l;
NO_2: 4.9 - 204.10^{-6} g NO_2/l;
SiO_2: 0.6 - $7.5.10^{-6}$ g SiO_2/l (Saad 1978)

4. Macrophytes

According to Nasr et al. (1963), Eichhornia crassipes and Ceratophyllum demersum formed the main cover of the lake area, where fresh or slightly brackish water dominated. Potamogeton pectinatus and P. crispus predominated in areas with relatively higher salinities. The growth of these plants may be so dense as to hinder navigation.

5. Fish and fisheries

During year 1982, percent amounts in total catch were: Tilapia sp. 82%, A. anguilla 10% and Mugil sp. 6%.

1.4.e. LAKE BROLLUS (see Darrag 1974, Saad 1976, 1979)

1. Geography and morphology (from Saad 1976, 1979)

This second largest delta lake is situated in the northern part of the Nile Delta (figure 1.16).

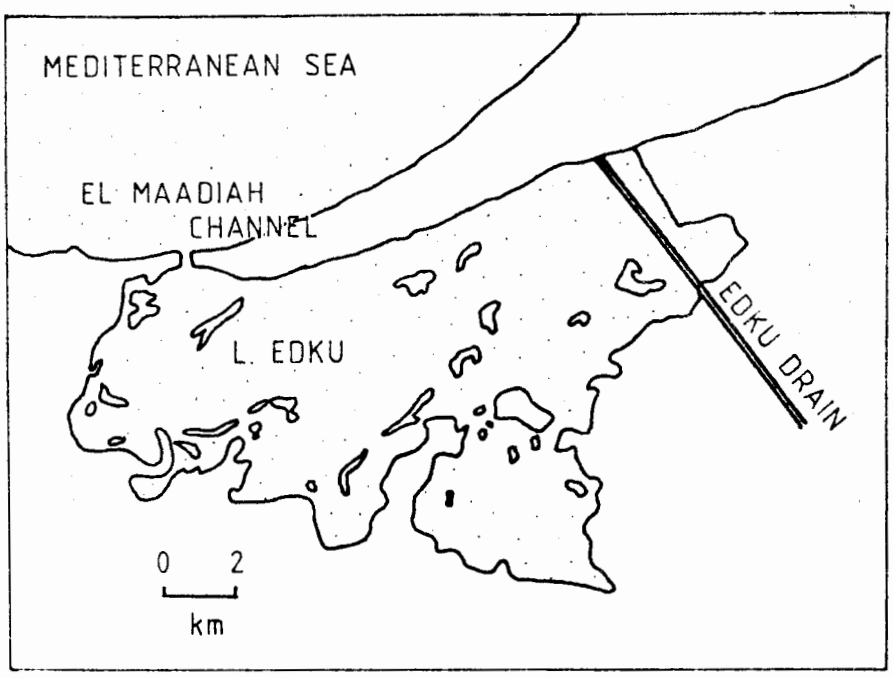


Fig. 1.15 **Lake Edku**

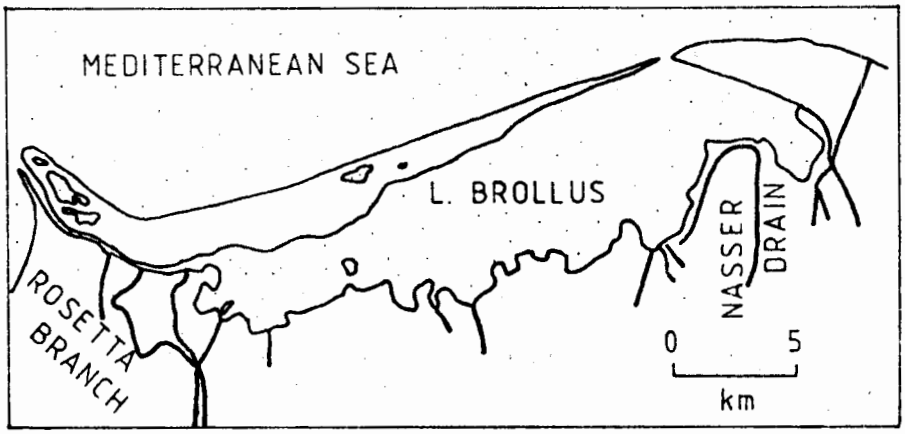


Fig. 1.16 **Lake Brollus**

Area about 7,100 ha, depth 0.7 - 2.4 m
Changes in the water level expose or flood extensive parts of the lake shores.
The northern border is separated from the sea by a strip of land covered with sand bars and dunes, and the southern shore is irregular.

2. **Hydrology** (from Saad 1976, 1979)

Large amounts of drainage water enter into the lake via seven drains on its southern border. These plus other water sources (small amounts of fresh water from Rosetta branch of the Nile, rainfall and seepage of underground water) cause the lake level to rise inducing a flow from lake to sea. As in case of Lake Edku, exchange of water between Lake Brollus and the sea occurs through a narrow channel. The lake bottom varies in structure from sandy mixed with silty material in the region of the lake-sea connection to muddy at the southern side of the lake.

3. **Physico-chemical characteristics** (from Darrag 1974 for the period 1970-71)

Water temperature 11.0°C (February) to 29.5°C (August)
Secchi depth 8 - 37 cm
pH 8.08 - 8.72; O_2 2.7 - 11.8 mg/l;
Cl^- 0.36 - 13.5 g/l, controlled by drainage and sea water inputs.

The values of dissolved phosphate, nitrate, nitrite and silicate varied from depletion to $1.74.10^{-6}$ g-at/l, from depletion to 240.10^{-6} g-at/l, from depletion to 73.10^{-6} g-at/l and from 125 to 399.10^{-6} g-at/l respectively.

4. **Flora and fauna**

Darrag (1974) reported some biological information on the lake: Phragmites communis dominated the emergent plants, Potamogeton pectinatus and P. crispus constitued over 90% of the submerged plants, Ceratophyllum demersum and Eichhornia crassipes were generally found drifting in all drains, causing a severe problem for the lake. Lemna gibba formed a mat on the surface of stagnant water. In the phytoplankton, diatoms dominated. The dominant zooplankton species belonged to the Copepoda, Cladocera and Decapoda. About 30 fish species were found in the lake, with different tolerances towards the salinity.

1.4.f. LAKE MANZALAH

The largest of the delta lakes, with a marked evolution towards lower salinity and strong nutrient inputs during the past 60 years, due to increase in agricultural drainage inflows (figure 1.17).

1. Geography and morphology

Located 31°15'N, 32°E between the Damietta branch of the Nile, to which it is connected by the small Enaneya canal, and the Suez

canal. It has several connections to the sea, the largest being El Gamil. Inputs by numerous drains on the SE coast, the most important being Bahr el Bagar drain (1.7 $10^9 m^3$/year) and Hadous drain (3.3 $10^9 m^3$/year).
Water area decreasing with time from 1,700 km^2 during early 1900's to 1,260 km^2 in 1960. Present open water area: 900 km^2 (1980).
Dimensions: 64 x 49 km.
Mean depth: 1 m
Numerous islands, enclosures and fish farms
Evaporation: 1.5 to 2 m/year
Sediments: silty clay with high organic content (1 to 7%) on the periphery; mixed sand-clay-silt in central region.
Phosphorus content of sediment: 0.016 to 0.1%

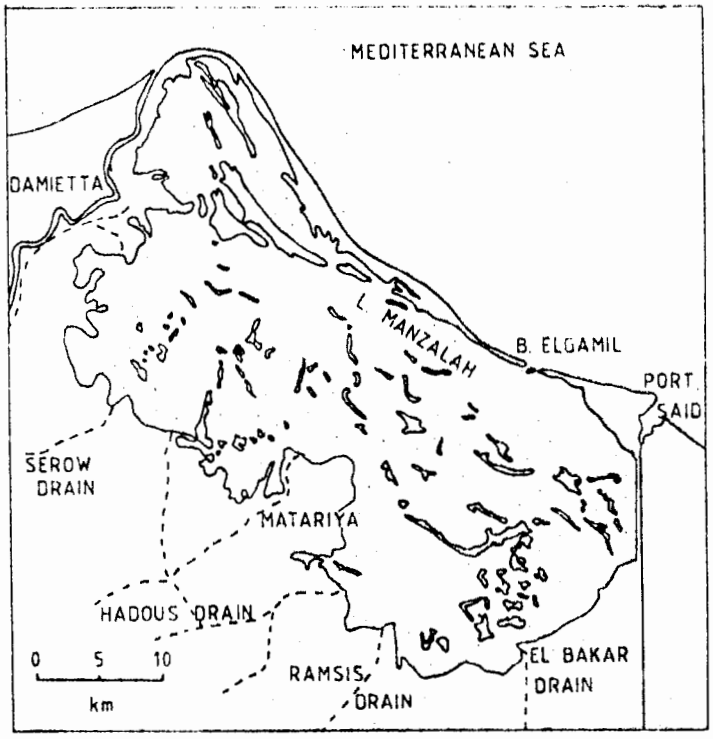


Fig. 1.17 Lake Manzalah

2. Physico-chemical characteristics

Pronounced N-S and less pronounced E-W salinity gradients, and increasing eutrophication since 1960 by the S-E drains.
Mean salinity decreasing from 1921-26 (16.7 g/l) to 1962-63 (9 g/l) and now 2.9 g/l due to restriction of lake-sea connections and drainage inputs. Range 2 - 15 g/l.
Salinity is lowest after peak drainage inflow in September and October.
Oxygen low during night in S sector, elsewhere over 5 mg/l at all times.
PO_4 - P: 0.129 mg/l annual mean (1979)
NO_2 - N: 0.627 mg/l annual mean
Nitrogen is depleted in spring while phosphate remains always lower than 15.10^{-6} g P/l.

3. Macrophytes

Emergents dominated by Phragmites and Typha. The southern half of the lake is covered by Potamogeton pectinatus, P. crispus and Ceratophyllum demersum, with a mean annual production estimated at 1.3 g/m^2/d, and diurnal variations of pH from 7.5 to 9.
Diatom and blue green epiphytes are found on these submerged macrophytes, e.g. Campylodiscus, Mastogloea and Navicula on which feed Gammarus locusta and the small snail Theodoxus nigricans. Eichhornia crassipes is fought by aeral spraying.

4. Phytoplankton

The main species ubiquitous in the lake are Cyclotella meneghiniana, Melosira granulata and Ulothrix sp. About twenty euglenophyte species are indicative of the lake eutrophic status.
Primary production 6 - 23 gO_2/m^2/d in the eastern eutrophic zone. Total lake: 2-23 gO_2/m^2/d.

5. Zooplankton

Population typically estuarine with nilotic freshwater Cladocera and Copepoda, brackish rotifers and coastal mediterranean forms: Brachionus calyciflorus, Diaphanosoma excisum, Moina micrura present several peaks in the year. Dominants: rotifers in winter, Cladocera in warm season, Copepoda during May and June.

6. Fish and fisheries

Fish catch statistics have increased with eutrophication. Annual figures for 1979-80 amount to 40,000 t for open water fisheries and 20 to 25,000 t for hoshas (enclosures) and fish farms. This is to be compared to 20,000 t in 1960-70. Commercial fish catch is mainly tilapia (85%) in which Sarotherodon niloticus is the most abundant, with S. aureus, S. galileus and T. zillii in smaller numbers. Liza ramada, historically dominant, has decreased to 2% of the total catch.

Also present in the catch: the crustacean Palaemon elegans, Anguilla anguilla, Mugil cephalus, Liza saliens and other marine species in smaller numbers as Dicentrarchus labrax, D. punctatus, Sciena aquila, Sparus aurata. Freshwater species also present include Clarias lazera, Bagrus bayad, Labeo niloticus while Lates niloticus has almost disappeared.

7. Human activities and management

About 17,000 people are fishing the lake, using 4,000 boats.
Hoshas are enclosures with small openings, situated in the lake. There also exists a wide variety of enclosures between the water-based and land-based aquaculture. Approximately 143 km^2 of hosha-type enclosures are in operation, managed by 9,000 people.
The general evolution has been increased fishing of the lake with decreasing salinity and increased nutrient inputs.

Part of the El Baqar Drain inflows, rich in Cairo sewage water, are being diverted to the close Um el Rish Lake where a similar increase in production and exploitation is starting.
A general danger for the delta lakes lies in coastal erosion which has become rather pronounced since the building of the high Aswan Dam. Thinning of the lake-sea barrier may lead to change in salinity and biota.

1.5. EAUX INTERIEURES D'ALGERIE ET DE TUNISIE

par Neville C. MORGAN & Jacques LEMOALLE

1.5.a. CHOTT ZAHREZ CHERGUI

C'est un exemple intéressant des grands chotts d'Afrique du Nord, à la limite septentrionale du Sahara; il est caractérisé par une altitude assez élevée et une surface inondable importante. Il est complété à l'Ouest par le chott Zahrez Rharbi. Le bassin versant total est de 5000 km^2.

1. Géographie et morphologie

Latitude: 35°14'N; Longitude: 03°32'E, à environ 160 km au SSE d'Alger (Algérie).
Altitude: 900 m
Surface: 250 km^2; la surface en eau maximale observée n'atteint que 66% de la surface totale. Z_{max} = 3 m.
Le chott est situé dans les Hauts Plateaux, entre les chaînes de l'Atlas saharien et de l'Atlas du Tell.
C'est une cuvette plane, allongée d'E en W, formée d'un substrat argilo-sableux, bordée au nord par une garrigue halophile, et des dunes de sable au sud. Il y a trois îles principales.

2. Climat

Evaporation moyenne annuelle estimée à 1050 mm par an, et pluviométrie de 280 mm (figure 1.4).

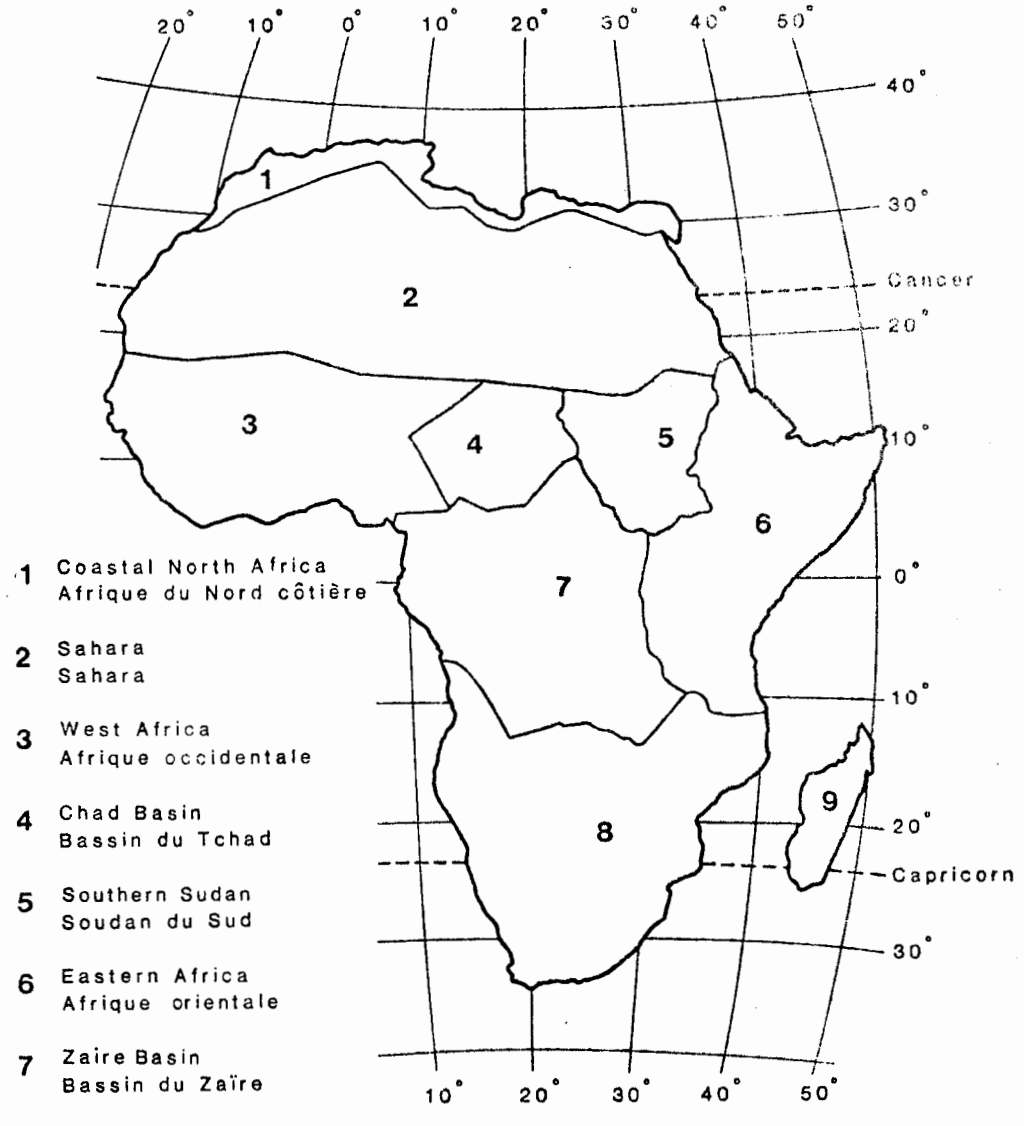
3. Hydrologie et chimie

Pas d'exutoire. Les apports proviennent du ruissellement superficiel, convoyé par les oueds après des orages ou de fortes pluies. Au cours d'une période de 30 mois, la plus grande période en eau a été de 4 mois consécutifs,et la plus grande sècheresse totale a duré 14 mois.

C'est un lac salé dans lequel la concentration augmente jusqu'à la saturation quand le chott s'assèche.

4. Flore et faune

Pas de macrophytes; pas de données sur le phytoplancton.
Pas de poissons. Présence d'Artemia salina. Le chott est probablement utilisé par Phoenicopterus ruber et Tadorna tadorna lorsque les conditions s'y prêtent.



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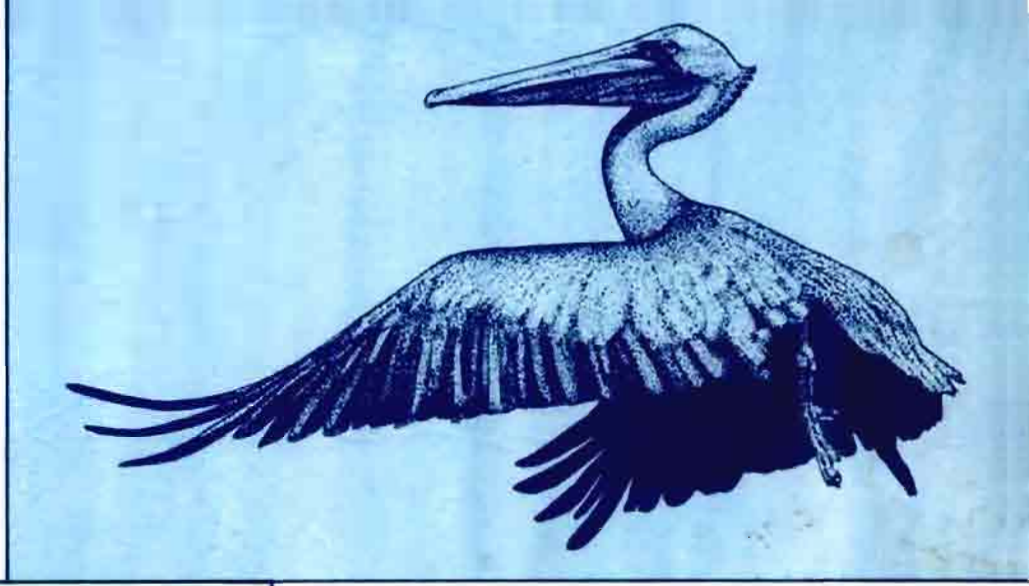

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African wetlands and shallow water bodies

Zones humides et lacs peu profonds d'Afrique

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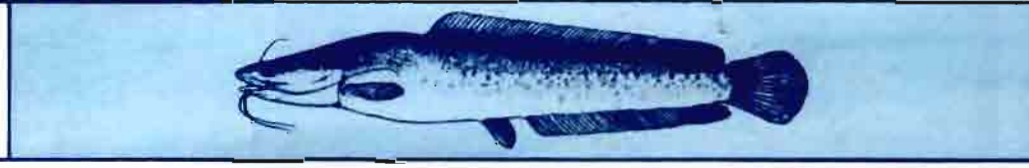

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Collection **TRAVAUX et DOCUMENTS** n° 211

PARIS 1987

This work was completed with financial assistance of :
Ce travail a pu être réalisé grâce au support financier de :

Council for Scientific and Industrial Research (South Africa)
Fonds de la Recherche Fondamentale Collective (Belgique)
Ministère de l'Environnement (France)
Royal Society (Great Britain)
IUCN and WWF

Funds and facilities for the preparation of camera ready text were made available by IUCN and WWF

L'UICN et le WWF ont procuré les fonds et les facilités pour la préparation des manuscrits définitifs

L'ORSTOM en a assuré la publication

ISSN : 0371-6023
ISBN : 2-7099-0881-6 (Édition complète)
ISBN : 2-7099-0882-4