SUSTAINABLE MANAGEMENT OF AFRICAN LAKES – THE CASE OF LAKE VICTORIA.

BY

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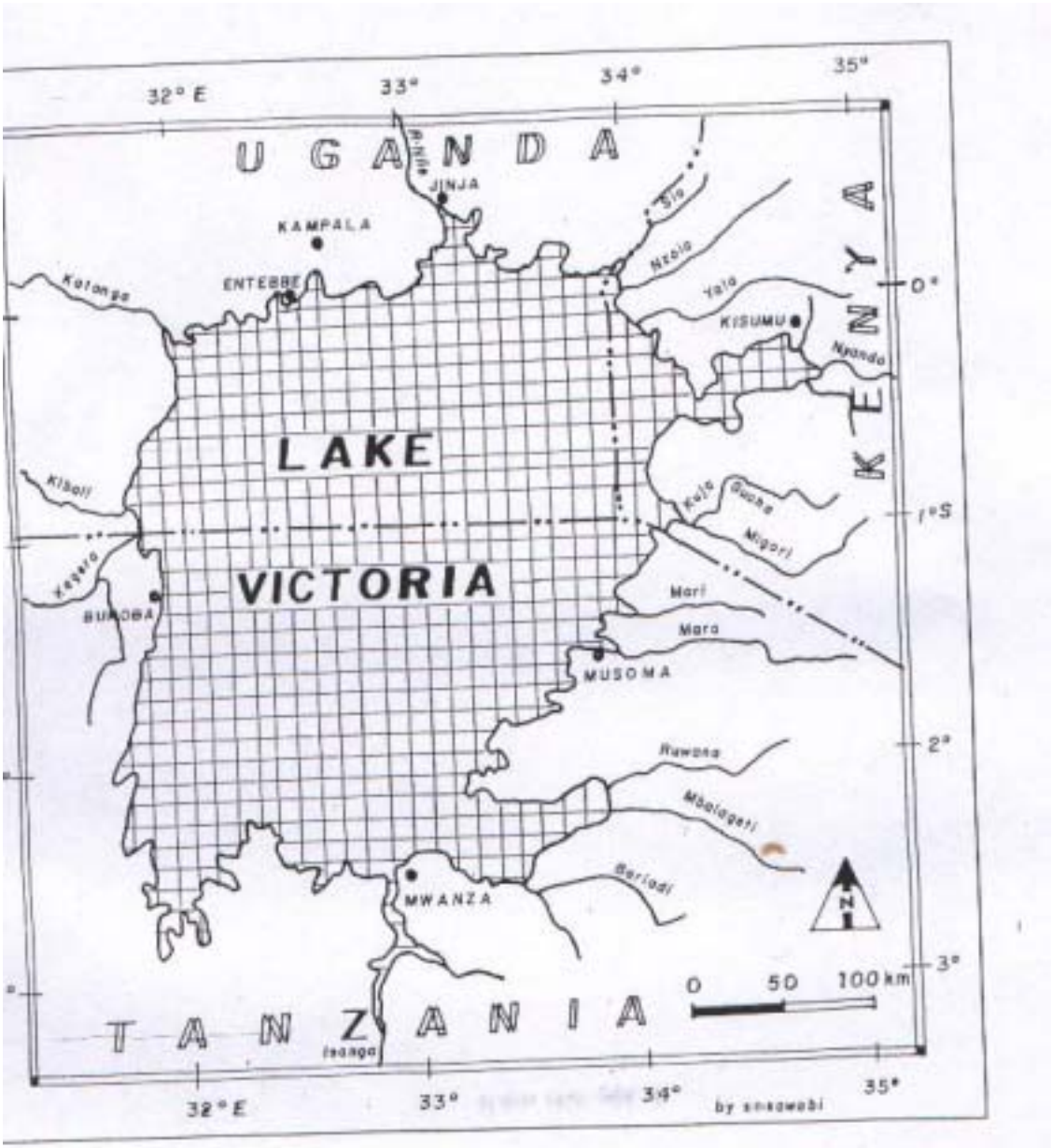

Map of Lake Victoria

...est of the native fish fauna of the lake lived between ...lion and 10 000 years ago in the west-flowing rivers

Tragically, the Lake Victoria fauna has been decimated in only 30 years. The lake lost an estimated 200 endemic

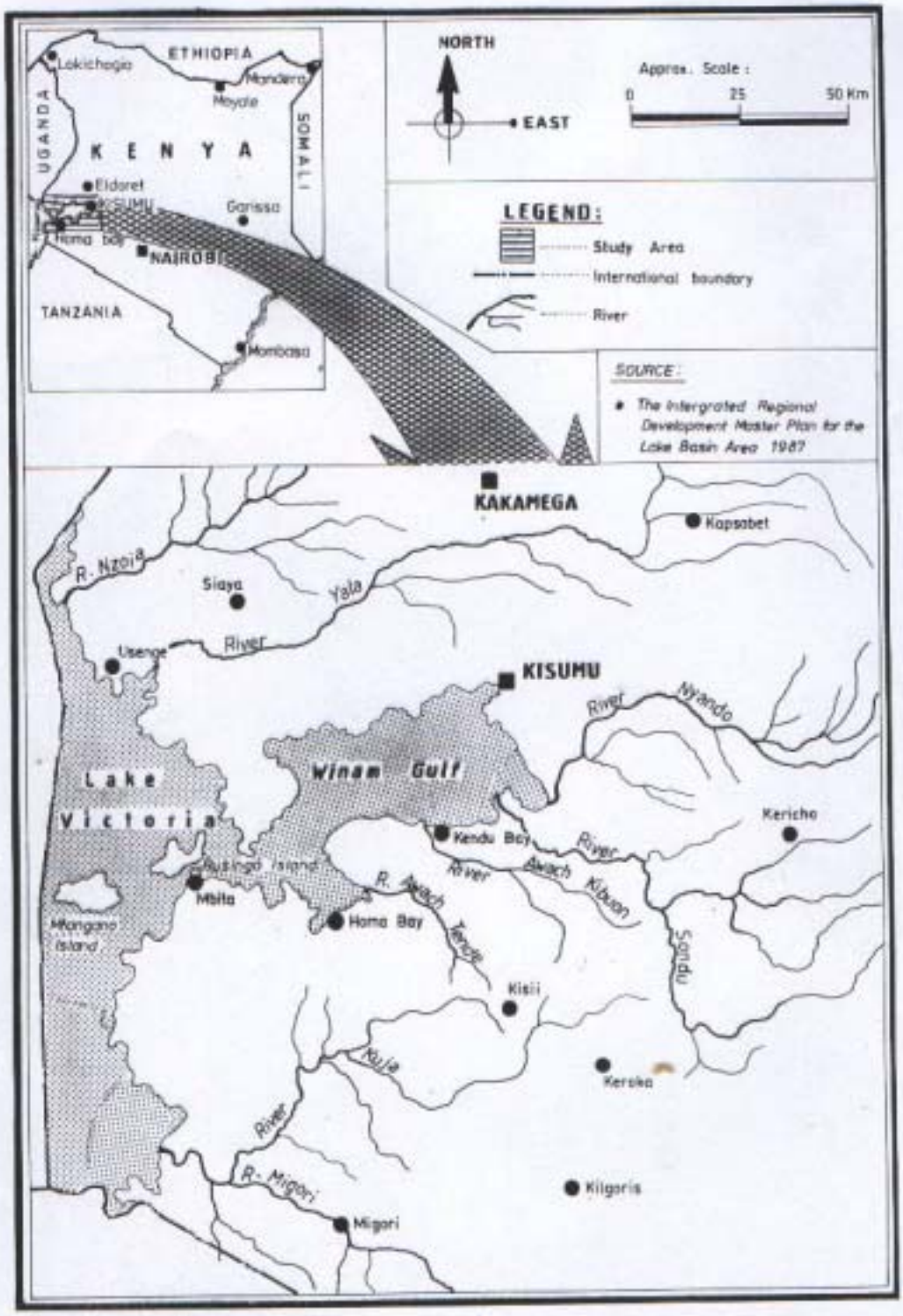

Fig.1: Winam Gulf of Lake Victoria (Kenyan Portion)

HYDROLOGICAL AND MORPHOMETRIC DATA OF LAKE VICTORIA.

Latitude – $0^0$21’ N – 3^0 00’S

Longitude - 31^0 39’ - 34^0 53’ E

Elevation – 1,134 meters

Catchment Area – 193, 000km^2 , Kenyan side 47,000 km^2

Lake Surface Area 68,800 km^2 →
- Kenya 6% - 4000km^2
- Tanzania 43%
- Uganda 51%

Population in Catchment – over 20 million, Kenyan side 12 million (250 per km^2)

Mean depth	-	40m
Maximum depth	-	84m
Maximum width	-	240km
Maximum length	-	400km
Shoreline length	-	3450km, Kenyan side 550km
Mean volume	-	2.986 x 10^{12} m^3
Maximum volume	-	3.1 x 10^{12} m^3
Inflow rate	-	596m^3/sec, Rivers; Nzoia, Yala Sio, Nyando, Kagera,Katonga, Sondu, Kuja Migori.
Outflow rate	-	914m^3/sec – River Nile.
Residence time	-	23 years
Flushing out time	-	120 years

Average Rainfall within catchment →
- Highlands – 2000mm
- Lowlands – 1200mm

Mean day Temperatures	-	23^0C
Annual lake level fluctuation	-	0.4 – 0.7 m
Maximum lake level fluctuation	-	3m
Trophic status	-	Eutrophic
Type of basin	-	Tec tonic type
Stratification	-	Warm polymictic

SOCIO ECONOMIC USE AND OTHER FUNCTIONS.

- Being second largest fresh water lake in the world, it contributes significantly towards:
    - Ecological and biophysical processes
    - Cultural and socio – economic development
- About 2 million people in entire basin derive their “livelihood” directly or indirectly from lake resources – mainly fisheries.
- Lake is “lifeline” and relied up by riparian states for:
    - Food
    - Transportation
    - Water use (abstraction)
    - Waste disposal
    - Recreation
    - Bio diversity conservation, etc.

ENVIRONMENTAL PROBLEMS OF LAKE VICTORIA BASIN

1. Catchment Degradation
   - Forest depletion e.g Mau, Mt. Elgon
   - Devegetation, - overstocking
   - Soil erosion
   - Poverty
2. Pollution – Industrial, Municipal, and Agricultural
3. Eutrophication
4. Biodiversity Decline – Fisheries diversity and Stock
5. Introduction of Alien Species – e.g. Water Hyacinth, Nile perch
6. Wetland depletion
7. Floods
8. Poor sanitary and drainage condition – outbreak of waterborne diseases.

CAUSES OF CATCHMENT DEGRADATION.

- Increased population – pressure on land for settlement, farming, grazing, urban and infrastructure development.

- Deforestation – Encreachment, illegal and legal excisions in Mau, Tinderet, Mt. Elgon, Kakamega, Nandi forests, etc.

- Fuel wood, charcoal and building materials high demand.

- Overstocking – Reduction of vegetation cover

- Poor land use (Agricultural farming) practices. High erosion rate and sediment loads in some river basins of up to 300 tons / km^2 / yr.

- Lack of awareness on catchment conservation and management.

POLLUTION AND ITS CAUSES.

- Rivers draining in lake Victoria heavily laden with nutrients, organic and sediment pollution loads. Rivers Nzoia, Nyando and Kisat more polluted than others.
- Lake Acts as a “sink” of pollution loads from point and diffuse sources.

Industrial pollution:

- Agro based industries – Sugar, Paper, Coffee, Tea, Dairy, Fish tanneries, discharge semi-treated effluents with high BOD to rivers.
- Poorly maintained waste treatment plants releasing liquid wastes that don’t meet stipulated standards.

Municipal pollution.

- Major towns; Kisumu, Eldoret, Kakamega, Homabay, and kericho have malfunctional sewage plants.
- Plants release effluents of poor quality
- Kisat river is heavily loaded with liquid wastes from Kisumu sewage plant.

Land use pollution

- Nutrients and sediment loads from agricultural fields
- Sediment loads deposition could affect the lake depth in river mouths.
- Total phosphorus and Total nitrogen input in the lake stand at 3,860 tons/yr and 77,200 tons/yr.
- Nitrogen and phosphorus input is the major cause of progressive eutrophication in the lake.

DATA FROM MUNICIPAL WASTES

INDUSTRY	DATE SAMPLED	TEMP ^{0}C	PH	COND Umh/cm	TDS mg/l	BOD5 mg/l
KISUMU CONVENTIONAL TREATMENT PLANT	11-2-01	27.2	7.5	855	410	200
ELDORET SEWAGE LAGOONS	12-2-01	20.9	7.8	90	42	132
KERICHO CONVENTIONAL TREATMENT PLANT	18-2-01	20.4	8.17	708	335	40
KAKAMEGA SEWAGE LAGOONS	14-2-01	25.4	9.3	237	112	80
HOMA BAY SEWAGE LAGOONS	19-2-01	25	8.5	881	420	100

SOURCE OF DATA: LBDA Water Quality Surveillance Reports.

DATA FROM INDUSTRIAL WASTES

INDUSTRY	DATE SAMPLED	TEMP ^{0}C	PH	COND Umh/cm	TDS mg/l	BOD5 mg/l
MUMIAS SUGAR COMPANY	12-2-01	25.6	7.8	1064	686	180
CHEMELIL SUGAR COMPANY	17-2-01	26.7	6.2	1142	549	670
EAST AFRICA SUGAR INDUSTRIES (MUHORONI)	17-2-01	28.3	6.8	955	459	350
WEBUYE PANPAPER MILLERS	13-2-01	24.5	8.9	1440	786	240
AGRO-CHEM. & FOOD ALLIED COMPANY	17-2-01	27.6	7.6	8350	4650	3850

SOURCE OF DATA: LBDA Water Quality Surveillance Reports.

EUTROPHICATION

- Increased nutrient input has led to Eutrophication in Winam Gulf.

- In the last 4 decades, there has been:

    - Increased primary productivity and biomass
    - Phytoplankton pop build up
    - Decline in water transparency
    - Increased nutrient (N&P) concentrations.

  Talling (1960), Mavuti (1984), Calamari et al (1995), Njuru & Hecky (2005).

- Marked difference between water quality in the open lake and Winam Gulf.

- N, P, TSS, TDS, turbidity and conductivity are higher in concentration in Winam Gulf.

- Blue green algae (cyanobacteria) is dominant to other phytoplanktons, standing at approximately 3,000 counts ml^{-1}.

- Algal blooms caused by high densities of blue green algae cause Anoxic conditions. Anoxic can result in massive fish kills as witnessed in the late 1980s. Ochumba P (1987).

- Some blue green algae produce phycotoxins that are harmful to zooplankton and other aquatic organisms.

Comparative Data of Water quality in Kisumu bay, Winam Gulf and Open Lake.

PARAMETER	TEMP ^0C	PH	SECCHI DEPTH (m)	COND μscm^{-1}	TDS (mg/l)	TURB (NTU)	D.O (mg/l)	NH_3 (mg/l)	NO_3-N (mg/l)	PO_4-P (mg/l)
Kisumu bay	26.49	8.3	0.47	176	113	25	5.83	0.025	0.055	0.054
Winam Gulf	26.68	7.8	1.0	167	83	10	7.30	0.015	0.040	0.022
Open Lake	25.70	7.4	3.1	104	57	1.5	6.63	0.003	0.025	0.052

Source: LVEMP (2002). Integrated Water Quality / Limnology Study for Lake Victoria.

PHYTOPLANKTON OF L. VICTORIA.

Cyanophyta (Blue Green Algae)

Microcystis aeuginosa *xx*

Lyngbya limetica *x*

Anaebena circinalis *x*

Spirulina

Merismopedia

Chlorophyta (Green algae)

Scenedesmus sp

Staurastrum sp

Ankistrodesmus falcatus

Coelastrum sp

Pediastrum sp

Bacillariophyta (Diatoms)

Nitzchia sp ++

Navicula sp +

Synedra sp +

Melosira sp

Phyrophyta (Dinoflagellates)

Ceratium sp

NOTE:

xx – Most dominant species in Winam Gulf

x - Dominant species in Winam Gulf

++ - Most dominant species in open lake

+ - Other common species in the open lake

Effects of increased phytoplantons on water quality of Lake Victoria

I. The Lake water transparency has been reducing

II. The Lake Biomass has increased drastically

III. The lake primary productivity has increased.

FISHERIES OF LAKE VICTORIA

Of the many fishes that exist in the World, Lake Victoria habours:

6 – Orders

14 – Families

34 – Genera

Over 300 – Species

Changes in fisheries:

Previously, the fishery of Lake Victoria was multispecies but has experienced some changes in the recent past.

Presently only three fisheries are of commercial value:

I. Nile perch

II. "Dagaa" – Omena

III. Tilapia fishery – *Oreochromis niloticus*

I. Nile perch (*Latus niloticus*)

Was introduced in the Lake in 1950s

It is a predator fish

It is the backbone of the commercial fishery

Forms 60% of the total fish catch in the lake.

II. "Omena" *(Rastrineobola argentea*)

Second ranked fish of commercial value

Fisherman use laterns to catch it

Contributes about 30% of the total catch from the Lake.

III. Tilapia *(Oreochromis)*

The third important fishery of the lake

This contribute about 10% of the total fish catch

Oreochromis niloticus ("Nyamami")

Was introduced in Lake Victoria in early 1950s (others *O. leucoticus, T. zilli* and *T. melanoplera).*

Two indigenous species of tilapia, *Oreochromis esculentus* (“ngege”) and *Oreochromis variabili*s (“mbiru”) previously the mainstay of commercial fishing industry have virtually disappeared from fish catches.

Numerous other native fish species that have lso decined drastically include:- *Haplochromis, Labeo, schilbe, Synodontis,Barbus, Clarias, Alestes* and *Protoptenus.*

Reasons for decline of fisheries

1. Local over – fishing, including fishing patterns.
2. Predation on various species by predators e.g Nile perch feeding on small indigenous fish.
3. Competition for space and food among the endemic and exotic species.
4. Environmental changes (Pollution, Eutrophication, Catchment degradation etc.)
5. High demand for fillet (proteins) – Overseas Market.

WETLAND DEPLETION AND THREATS

- Basin has Riverine wetlands, and Deltaic wetlands (marginal flood plains swamps at river mouths), River Nzoia, Yala, Sondu Miriu and Sio.

Threats:

- Reclamation for agricultural development leading to loss of habitats, bio diversity and buffering potentials, e.g Yala swamp.

- Hydraulic alterations – diversions

- Pollution – Agricultural, organic, sediments and heavy metal pollution loads.

- Urban expansion and infrastructure development

- Alien species invasion (e.g. water hyacinth)

- Over exploitation of wetland resources (harvesting and grazing).

ALIEN SPECIES (WATER HYACINTH) THREATS

- Weed invaded the lake in early 1990s with a peak of population build up in 1997.

- Through the use of biological control, *Neochetina bruchi* and *N. eichhornia*, KARI was able to reduce the weed from 18,000 ha to 400 ha, (85% reduction of the infestation).

- Weed levels have reduced drastically in the lake.

- Weed has invaded inland water bodies, small ponds, pans, swamp, rivers, etc.

- Weed is associated with resurgence of certain fish species, *Protopterus, Clarius*, etc.

ENVIRONMENTAL RESTORATION MEASURES FOR SUSTAINABLE MANAGEMENT OF LAKE VICTORIA (WAY FORWARD).

- Catchment protection – re- afforestation, agro forestry, soil and water conservation and good agricultural practices promotion in the catchments.

- Develop a sustainable regional conservation and management plan for fishery resources. Enhance environmental – friendly fish harvesting practices, protection of breeding sites, enforcement of quality control and all other fisheries regulations.

- Rehabilitate and maintain waste treatment facilities in all municipalities and industries in the region, so as to reduce pollution and eutrophication in the lake. Industries should endeavour to initiate cleaner production technologies as a way of safeguarding and protecting the environment.

- Develop a long term comprehensive and well coordinated river and lake water quality monitoring programme as a tool for water quality management. Regional water quality standards should be adopted and enforced.

- Enhance water hyacinth control, and eradication of other abnoxious weeds e.g. Striga weed in the region. A long term regional monitoring programme for this invasive aquatic weed is important.

- Communities should be made aware on the significance of environmental management and conservation. As stake holders they should participate in decision making and implementation of environmental conservation and management projects in the basin.

- Provision of alternative life supporting activities e.g. fish farming, agroforestry practices, irrigation farming. Provision of these livelihood will ease pressure on the heavily exploited resources in the lake and its basin. It also helps in alleviating poverty.

- Bring into enforcement all environmental related laws. The ENMCA of 1999 should be used to protect and conserve the lake waters, fisheries, wetlands and natural resources within the basin, including undertaking of EIA in all projects implemented in the region.

- Need to enhance institutional capacity building in all areas in the region, for effective management of the lake and its basin resources.

- Regional Cooperation – The three riparian states should recognize and work as one entity in utilization, conservation and management of lake Victoria and its resources on sustainable basis, e.g. LVEMP (being implemented) ,Lake Victoria Commission (proposed).

CONCLUSION

As sometimes been portrayed, all is not lost in Lake Victoria. In order to safeguard and sustain the social, economic and ecological functions of the lake, its important for partnerships to be strengthened, and stakeholders to participate in all activities geared towards the lakes restoration.