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Title

Lake Baringo: A transient environment, diversity and livelihoods

Location

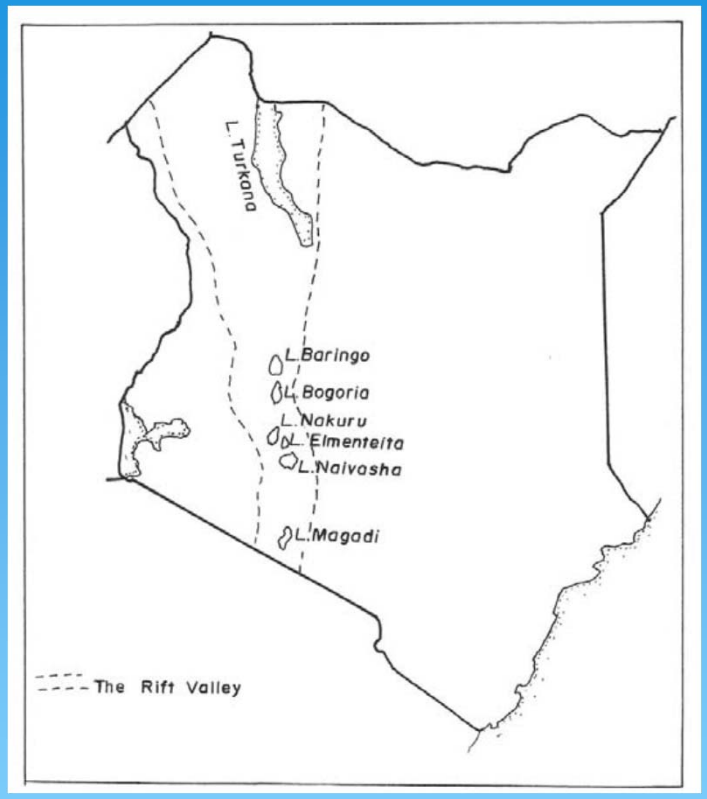


Fig. 1. Location of Rift Valley and lakes in Kenya.

- Floor of the eastern arm of East African (Gregorian) Rift Valley System in Kenya.
- ≈ 60 km north of the equator
- Latitudes 0°30’ N and 0°45’ N, Longitudes 36°00’ E and 36° 10’ E.
- Altitude: 975 m.

Location

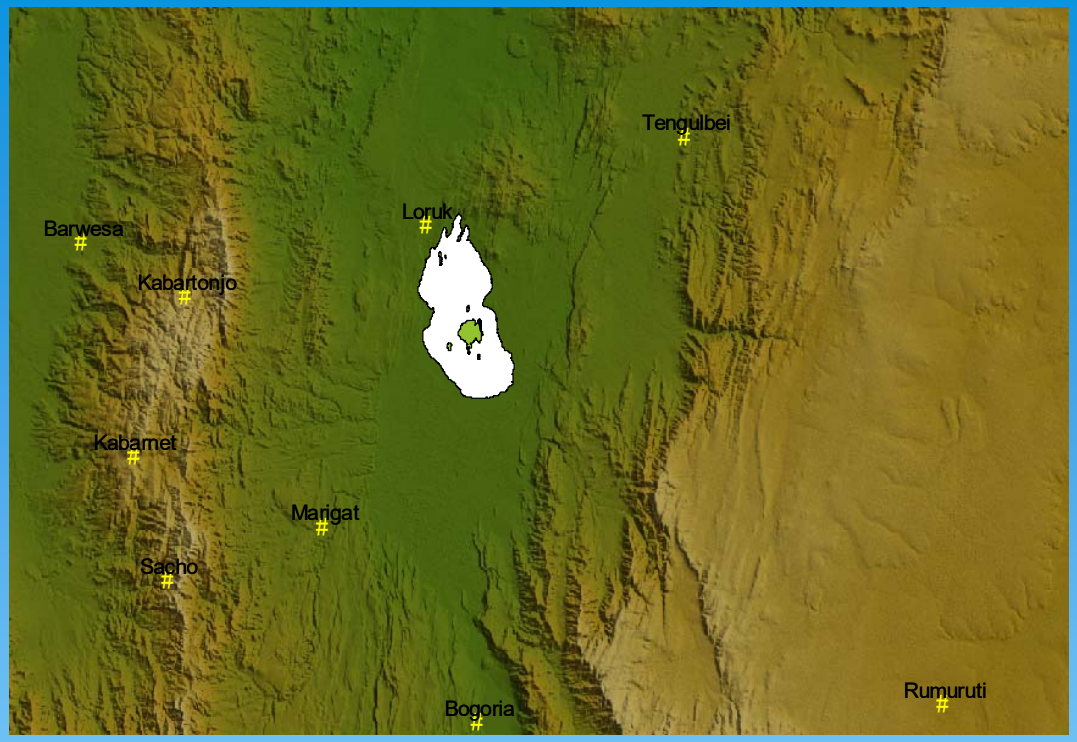


Fig. 2. Physiographic setting of Lake Baringo.

- The basin is bounded by Tugen hills in the west, Mau uplands in the southwest and the Laikipia plateau to the east.
- The highlands rise as high as 2800 m a.s.l.
- Around the lake and Marigat is a floodplain.

Catchment

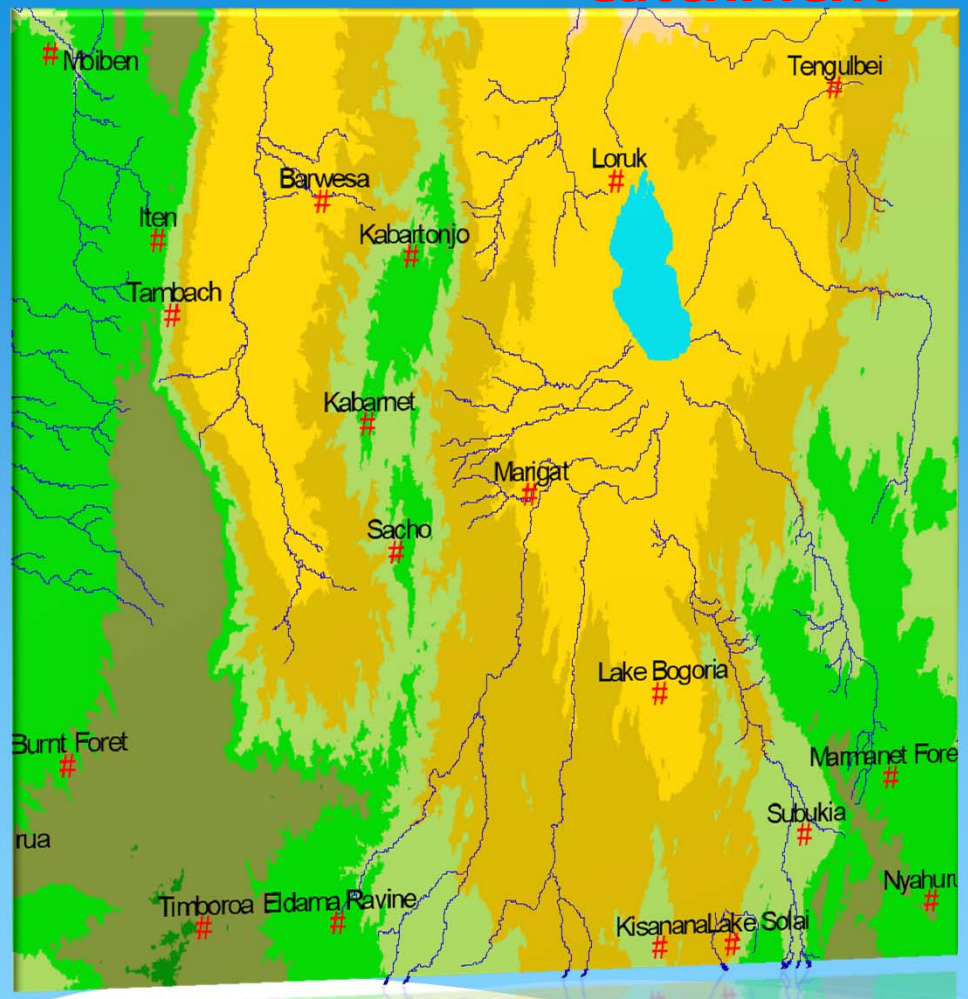


Fig. 3. A map of Lake Baringo basin showing the major rivers.

- Penerrial Rivers are Molo and Perekerra which emanate in the south west from Mau highlands and Eldama Ravine respectively. And Rivers Ol Arabel and Mukutan which originate from Arabel and Marmamet forests in the south east.
- Seasonal rivers include Endau, Kapthurin among others.
- Administratively the lake is located entirely within County of Baringo.
- The catchment lies within 3 counties: Baringo, Nakuru and Laikipia.

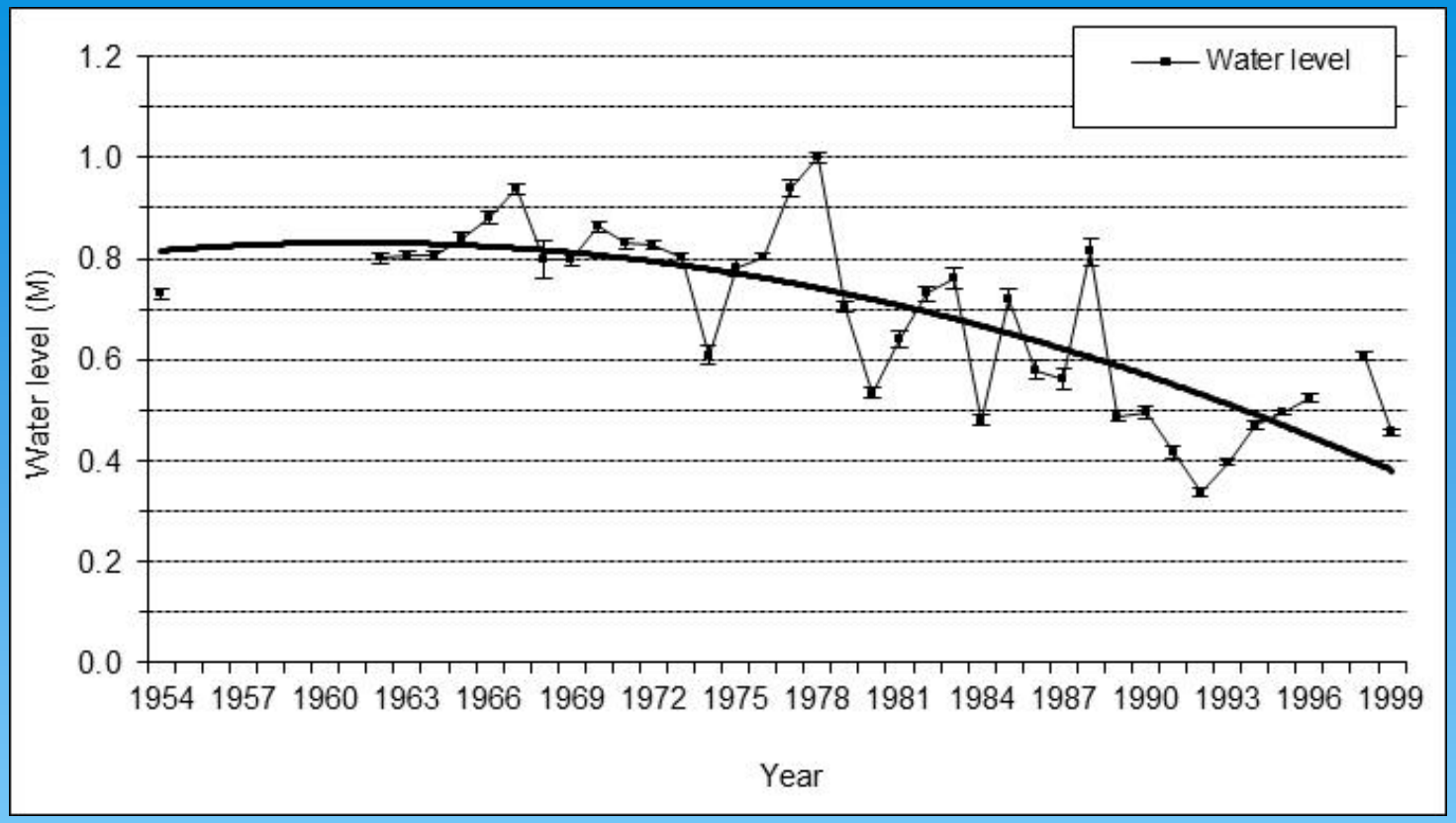


Fig. 4. River Perkerra annual mean water level as measured at river gauge station 2EE7. Error bars represent standard error of mean.

- Rivers are characterized by high variation in annual discharge. In very dry years, however, discharge is significantly reduced.
- Long-term declines in discharge of particularly, River Perkerra, has been observed since about 1970.

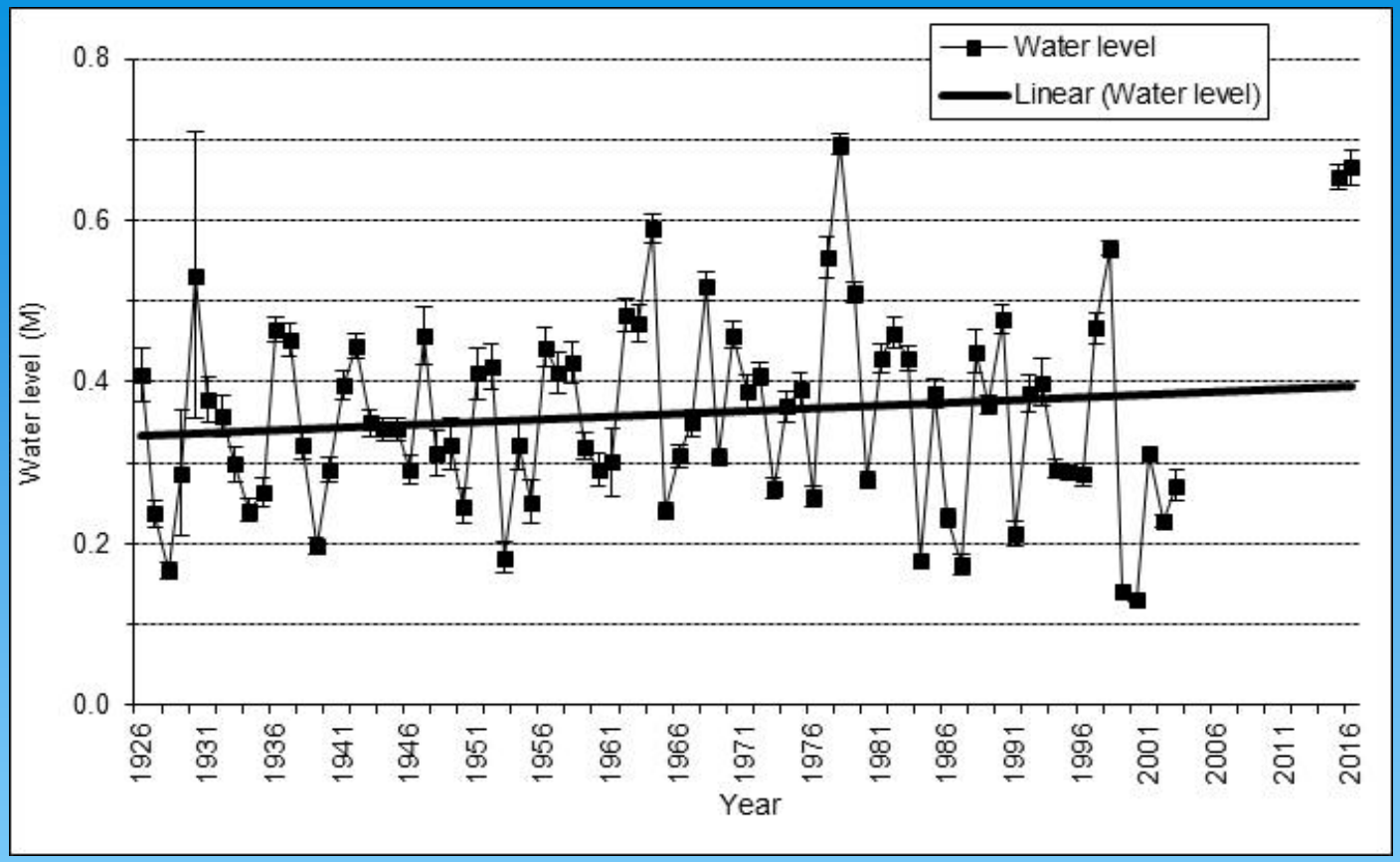


Fig. 5. River Molo annual mean water level as measured at river gauge station 2EGO1. Error bars represent standard error of mean.

Origin of Lake Baringo

- The lake is tectonic in origin and also known as fault lake, where water is tapped in a axial graben.
- Formed during Palaeogene period, 43 to 23 million years ago.
- Since its formation, the basin has evolved over time, hosting a series of lakes that have emerged and declined over geological time.
- The current Lake Baringo is the remnant of a larger lake known as Lake Kapthurin which developed in the lower middle pleistocene period (700-200 Ka).
- Lake Kapthurin started to recede around 200 Ka.

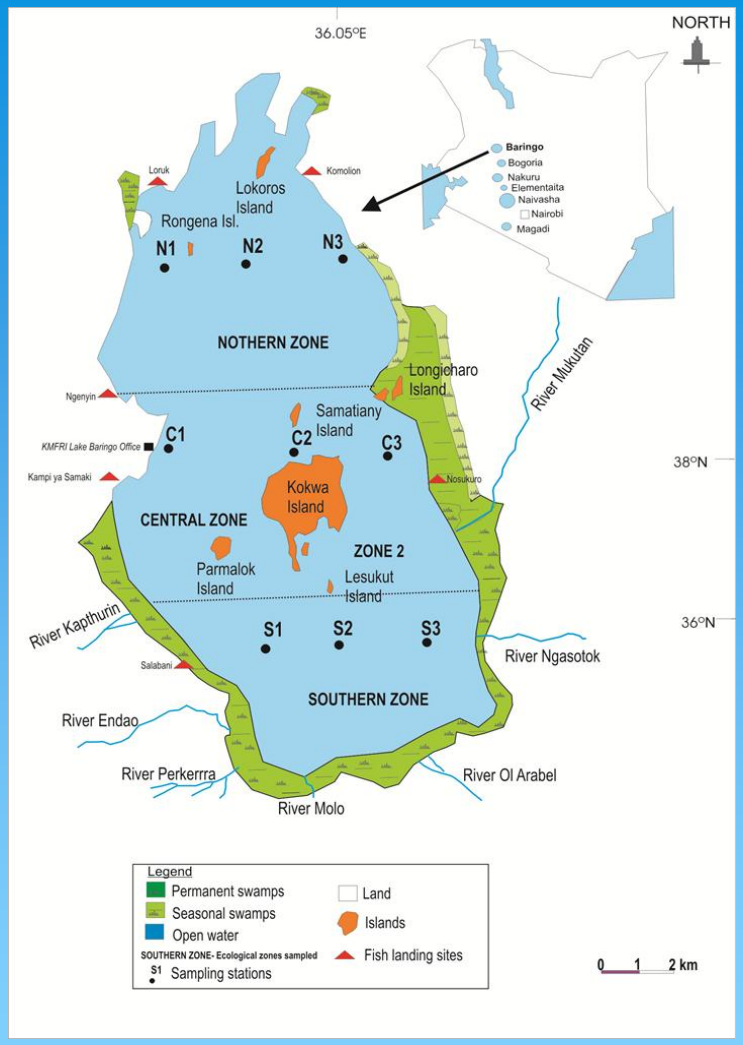


Fig. 6. A map of Lake Baringo showing affluents, Islands and sampling stations.

- 7 Islands are located in lake.
- Largest island is the Kokwa which is a small relic volcano.
- Others islands are Lekoros, Rongena, Longicharo, Samatiany, Parmalok and Lesukut ('Devil island').
- On Kokwa Island are a number of alkaline hot springs that discharge into the lake.

Table 1. Morphometric and hydrological characteristics of Lake Baringo.

Feature	Level	Feature	Level
Surface area	130-199 km^2	Rainfall	400-1000 mm
Mean depth	≈ 3.4-10.6 m	Evaporation	1500-2000 mm
Lake length (L)	≈ 22 km	Annual inflow from the rivers	R. Molo 126 x 10^6 m^3, R. Perkerra 39 x 10^6 m^3
Lake width (W)	≈ 13 km	Ground seepage	50-150 m^3 s^1
Catchment area	≈ 6,820 km^2	Residence time years	12.7 years
Maximum elevation Catchment	≈ 2500 m		
Lake Water volume	726 x 10^6 m^3		
Annual mean temperature	26° C		

Morphometric and hydrological characteristics of L. Baringo

- The lake has a variable surface area, water depth and physical chemical characteristics e.g. 5.6m in the 1960s, over 8m in the late 1970s, 3 m in 1994, 10.6m in 2013.
- A reflection of the high dry and wet seasonal influences in the semi-arid climatic zone.
- Long term trend in the lake level follows a similar pattern as the rainfall pattern in catchment. Thus the lake is climate sensitive.

Land use pattern

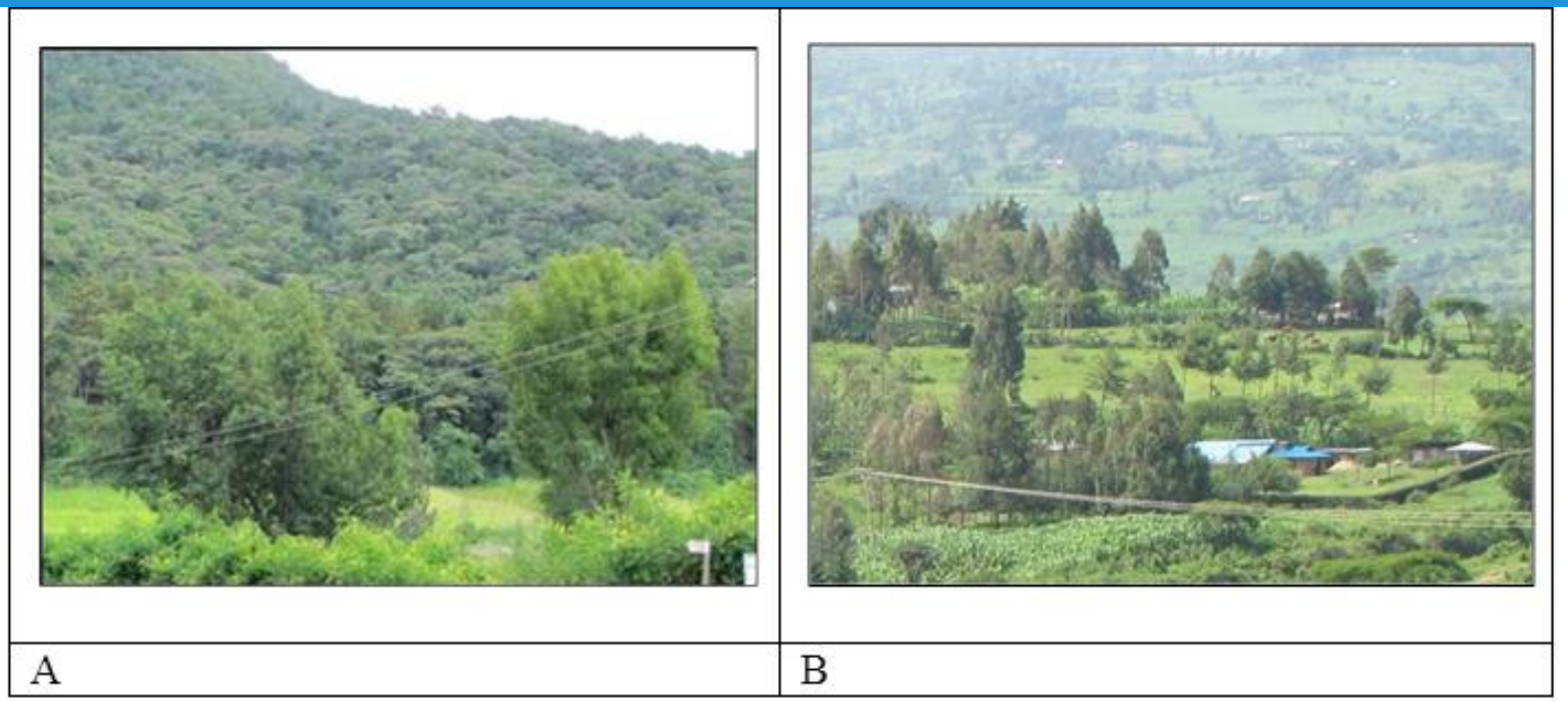


Plate 1. Typical Land use/Land cover in humid highland zone: A) conserved forest B) human settlement and agriculture.

- The Kipsigis, Tugen and Kikuyu communities, who live in the highlands, practise mixed agriculture (growing crops and raising livestock).

Land cover/land use pattern

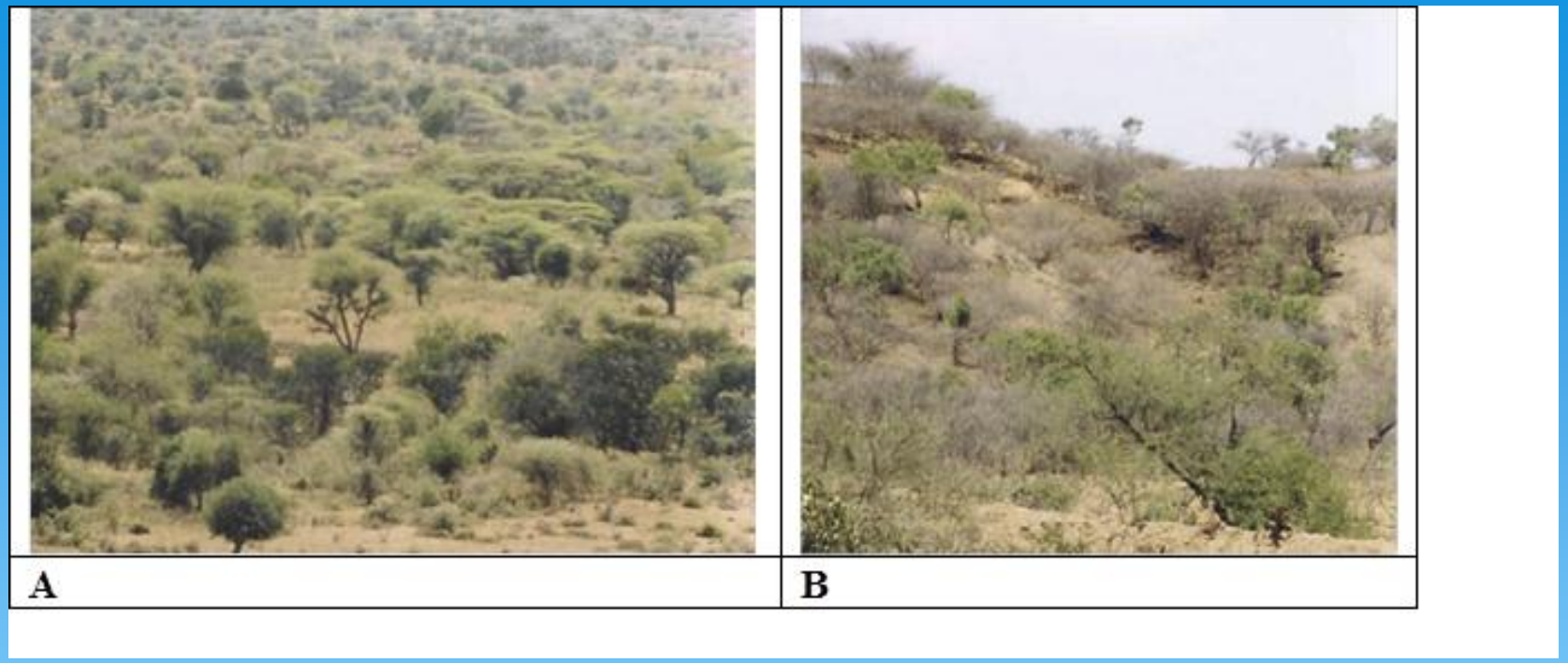
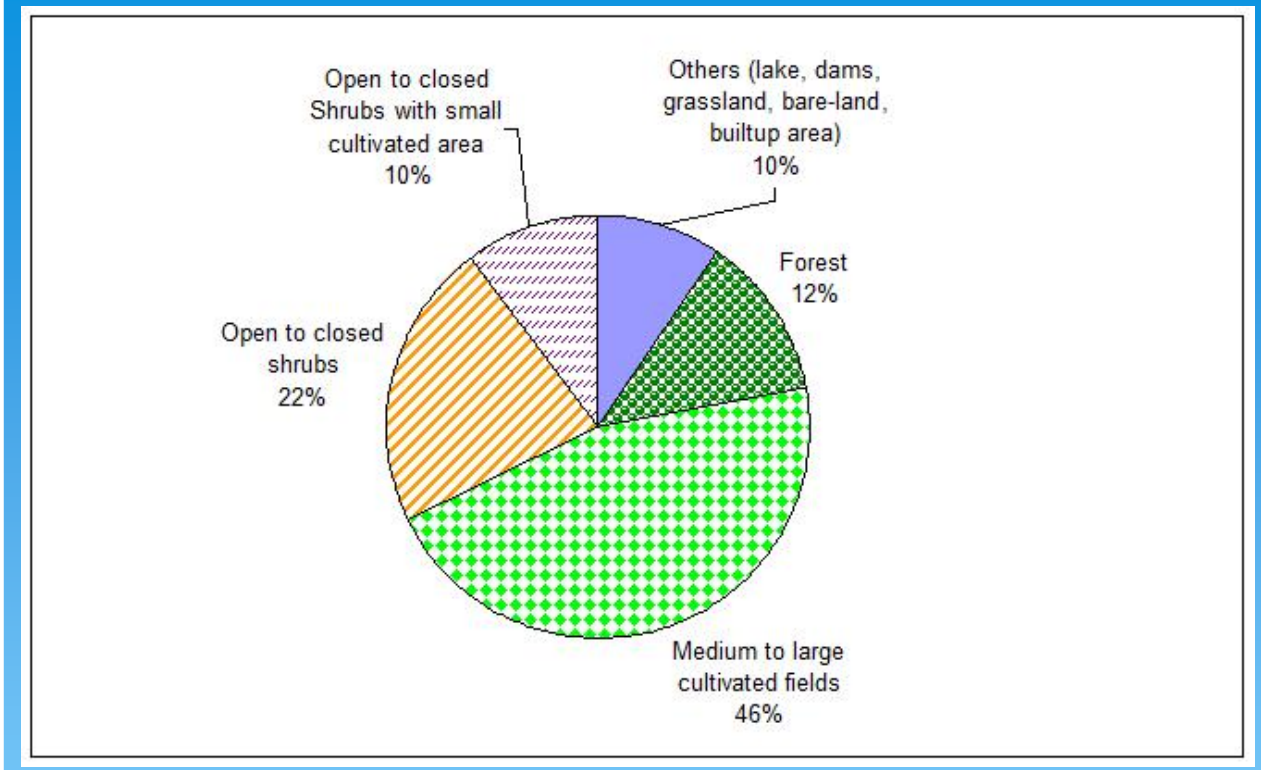


Plate 2. Typical vegetation of ASAL zone dominated by Acacia species with little or no underground vegetation A) lowland plain B) steep areas.

- The Ilchamus community, live along the south and eastern shorelines of the lake and the Tugens live to the east of the lake, mainly practice pastoralism, and to a lesser extent, agro-pastoralism. Pokots who live in north of lake are primarily pastoralists



Land use pattern
(considering the basin as whole)

Fig. 7. Land use pattern of Lake Baringo basin (Based on 2009 analysis).

- Forests decreased by ca. 50% since 1976 following deforestation to create land for farming.
- Land use change of the forest land was illegal. Now government wants to revert the forest land.
- Communities who grabbed the forest land are resisting.

Social Condition

Low cooperation and harmony among Indigenous communities around the lake due to cattle rustling which affects the fishery.

Livestock rustling due to:

i) i) Culture which honours rustling.

ii) ii) Cartels which sponsor rustling for commercial gain.

iii) Cold war in world which led arms race in horn of Africa.

iv) Unstable socio-political environment in the horn of Africa resulting in smuggling of small arms.

v) increasing human population resulting decreasing community grazing land.

vi) Climate change resulting in frequent droughts,

Lake Water quality

Plate 3. Left pane: Paleo-turbidity and decreasing depth is visible on the rocks. Right pane: Note the high turbidity (photos taken in 2004).

- Earlier years of the 2000 millennium, the water of Lake Baringo had very low aesthetic value as its water was deep tea brown in color with a crust of the same color covering the stony banks around the lake.
- Low lake depth mean 3.4 (2.1-4.5) m) Low transparency (mean 6 (5-7) cm) and high turbidity (mean of 560 (382-936) NTU), High conductivity (mean 658.4 (389-762) μScm^{-1}).

Lake Water quality

Plate 4. High transparent and low turbidity lake during a period of high lake depth (2013)

- High lake depth (mean 10.6 (9.3-11.4) m), High transparency (mean of 100 (80-120) cm) and low turbidity (mean 10 (3.9-17.3) NTU), medium conductivity (mean of 366 (351-388.1) μScm^{-1})

Lake water quality

High rate of soil erosion in catchment was attributed as the proximate cause of sedimentation in the lake and ultimately resulting in very high turbidity and low transparency of the lake water in earlier years of the 2000 millennium.

A review of long term data indicates that sedimentation plays a role when the lake level is low (circa ≤ 5 m)

Climate change has an impact on the lake depth
Generally, long term trend in the lake level follows a similar pattern as the rainfall pattern in catchment.

Biodiversity

Lake is characterized by low diversity and abundance of phytoplankton, zooplankton, zoobenthos and macrophytes except for aquatic birds

Phytoplankton

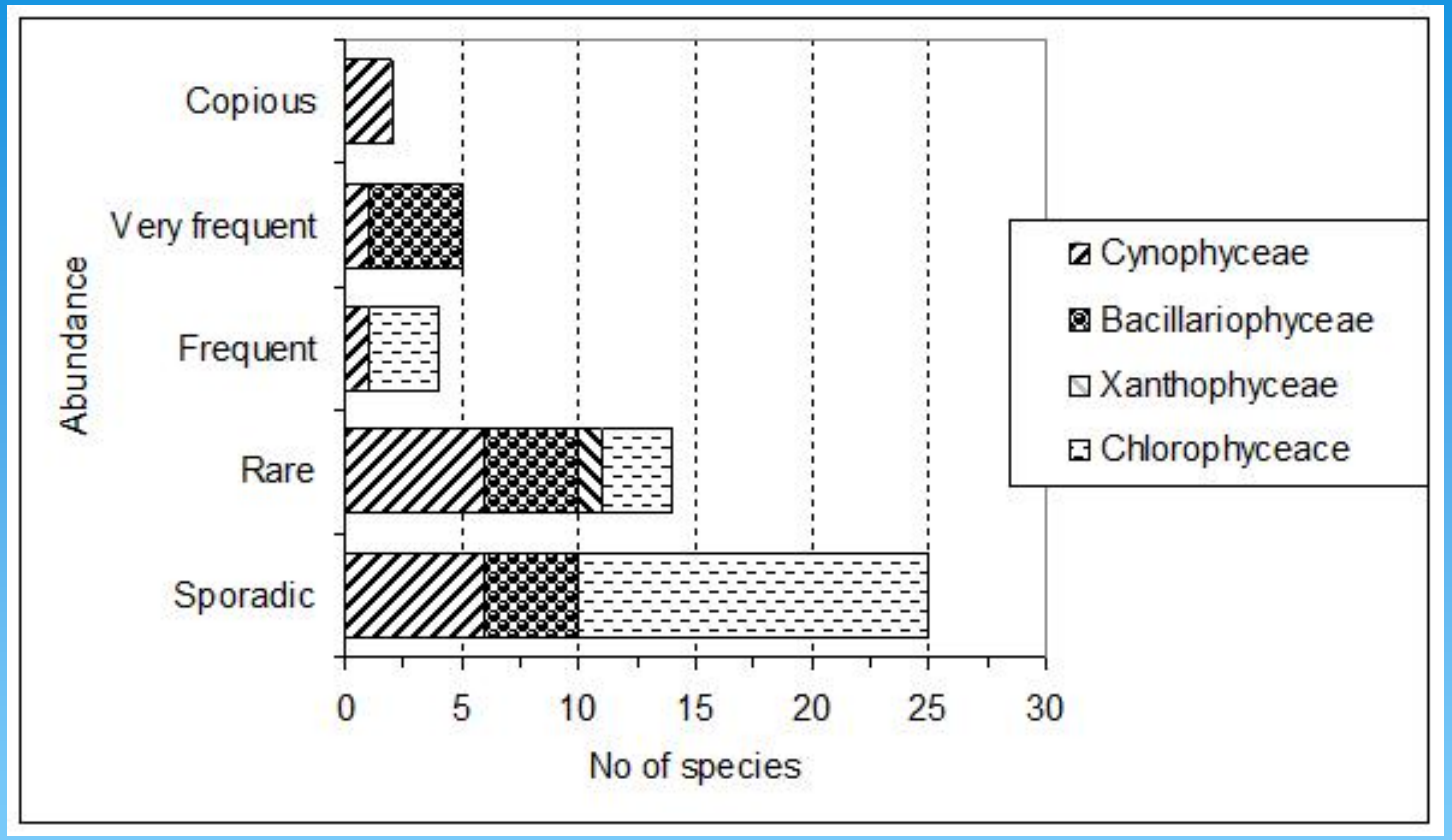
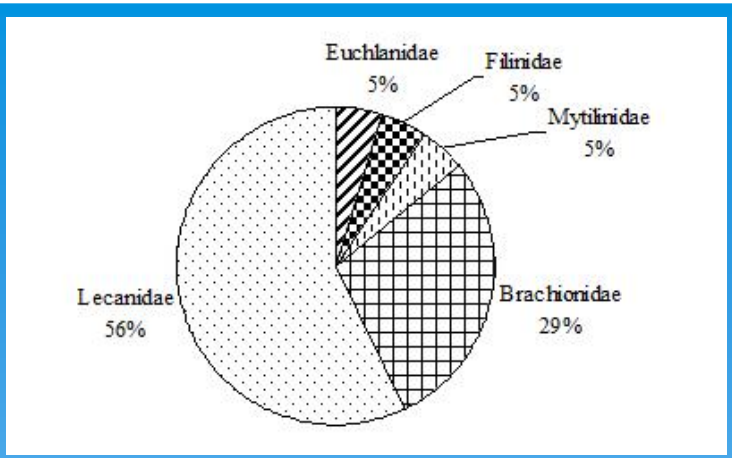


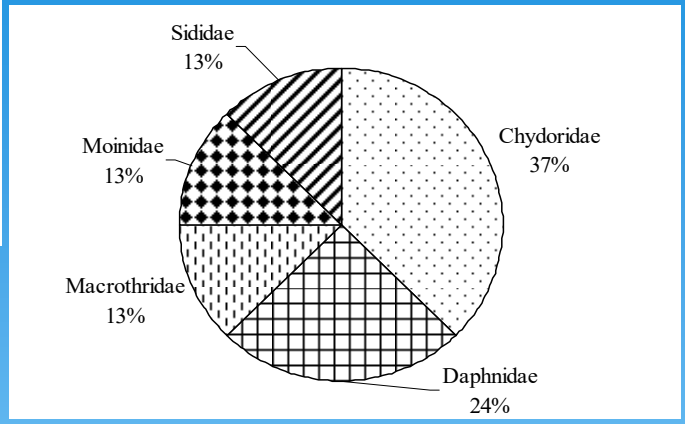
Fig. 8. Abundance of various phytoplankton families of Lake Baringo

Lake characterized by low phytoplankton species richness. Chlorophyceae was recorded as the most speciose family . Chlorophyll *a* concentration is significantly higher during wet season than in the dry season.

Zooplankton

A) **Rotifera**





B) **Cladocera**

C) **Copepoda**

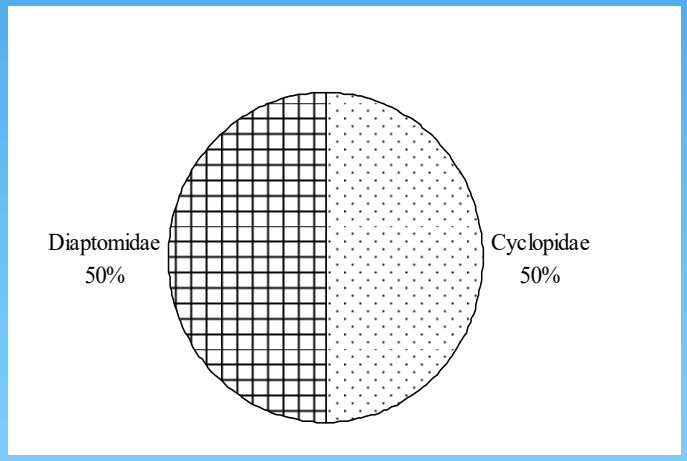


Fig. 9. Species richness of various zooplankton taxa of Lake Baringo

31 species zooplankton spp recorded.
Zooplankton abundance is low. Mean density range between 56.37±6.58 individuals L^{-1} and 79.09±7.95 individuals L^{-1}

Zoobenthos

Mollusc species dominated the species composition and abundance

The species richness per station ranged from 1 to 3.

The density per station was low. It ranged from 4 to 64 m^{-2}

Cleopatra bulimoides was the only species found on *Ceratophyllum dersum*

Bulinus scalaris and *Bulinus trigonus transversalis* were associated with *Pistia stratiotes*

Macrophytes

8 species of macrophytes belonging to 9 families were listed.

Submerged macrophyte is *Ceratophyllum demersum* (Ceratophyllaceae) species while **Free floating** is *Pistia stratiotes* L (Araceae)

Floating leaved is *Nympheae lotus* L. (Nymphaceae)

Emergents are *Sesbania sesban* and *Aeschynomene indica, Ipomoea aquatica Azzola pinnata, Typha domingesis*

The macrophyte groups form a continuum of clear zones : From the land towards deeper waters the emergent plant zone is successively replaced by floating plant-leaved and submerged plants zones

Fisheries

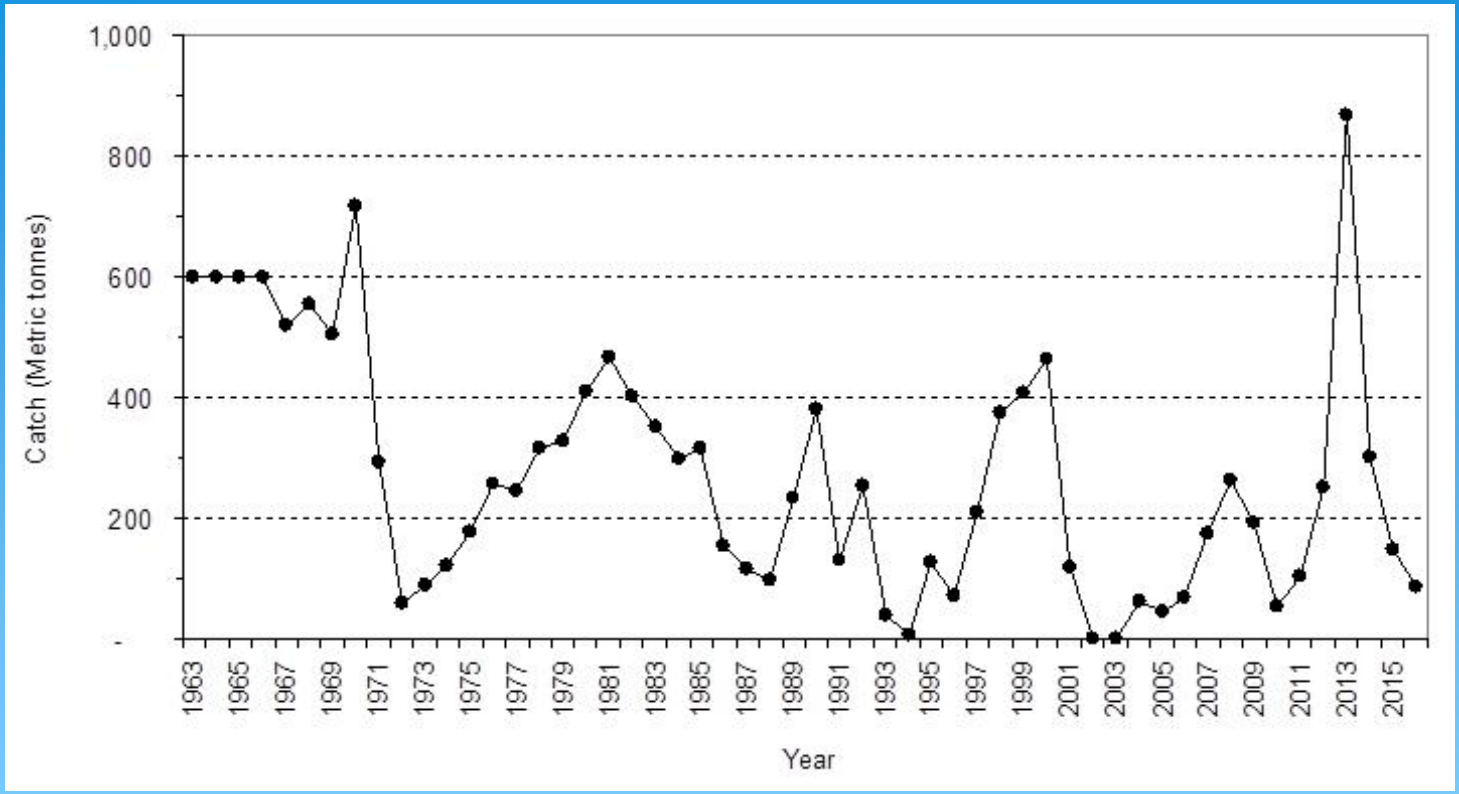


Fig. 10 Total annual catch in the Lake Baringo fishery, 1963 to 2016.

- Fluctuations in the fish catch are caused by corresponding changes in lake level not by fishing effort.

Resource conflicts

- Conflict over the excision of parts of Ol Arabel forest in 1983 and Marmanent forest in 1993, 1995, 1998, 1999 and 2001.
- Major conflicts in the fishery are between wildlife conservationist, hospitality industry players and fishermen on the other hand.
- Water abstraction from rivers by farmers for irrigation farming is another conflict. Most of farmers are not licensed. Therefore, they do it illegally.

Lake Baringo Resource Values

- Fish exploited as food product and income resource
- Diverse birds and high population of large vertebrates. The high diversity of animals attracts many tourists who tour the lake to view them in their natural environment.
- A diversity of communities who still live their tradition lives is an attraction especially to foreign tourists. Indigenous communities include the Pokot, IIchamus and the migrant Turkana.
- Tourism is major source of income to the local community who has invested in tour guide services.

Lake Baringo Resource Values

- Water is resource which the lake and its rivers provide for human and livestock use.
- Water abstraction from rivers by farmers for irrigation farming is another resource.
- The lake is platform for pleasure activities by both local and foreign tourists. These include water sports: speed boating, jetski, yachting, skiing, and kayaking. There are annual boat and raft ('Ng'adich') competitions
- The lake is used for transport of people as well as goods to and from various markets and human settlement across the lake.
- Baringo-Silali geothermal electricity development project is using water from the Lake Baringo to enable the geothermal well drilling.
- The lake is an education resource.

MAJOR "IMPACT STORIES" REGARDING THE LAKE

i) Water Hyacinth invasion.

ii) Fishermen involvement was strengthened by legalizing Beach Management Units (BMUs).

iii) Increase in lake depth since last lake brief is major story about the lake. The lake depth level increased from a mean of 3 m in 2003 to mean of 10.6 m in 2013.

iv) Climate change/variability.

MAJOR LAKE BASIN GOVERNANCE ISSUES

- The approach to the management of Lake Baringo has been sectoral, with each organization implementing its plans according to its mandate.
- No management plan for the lake for all the stakeholders to rally around.
- There is no national or county strategy or plan for managing the lake.
- Not adhering to policies and laws which have been enacted for the governance of lake.
- Funding for public participation is channeled through fisheries county offices to ensure accountability of public funds.
- Vandalism of scientific equipment used to measure water variables is a common feature in the basin..

The End

* Thank you for your attention