Land use Changes and Impacts on Lake Naivasha

A review of the current status.

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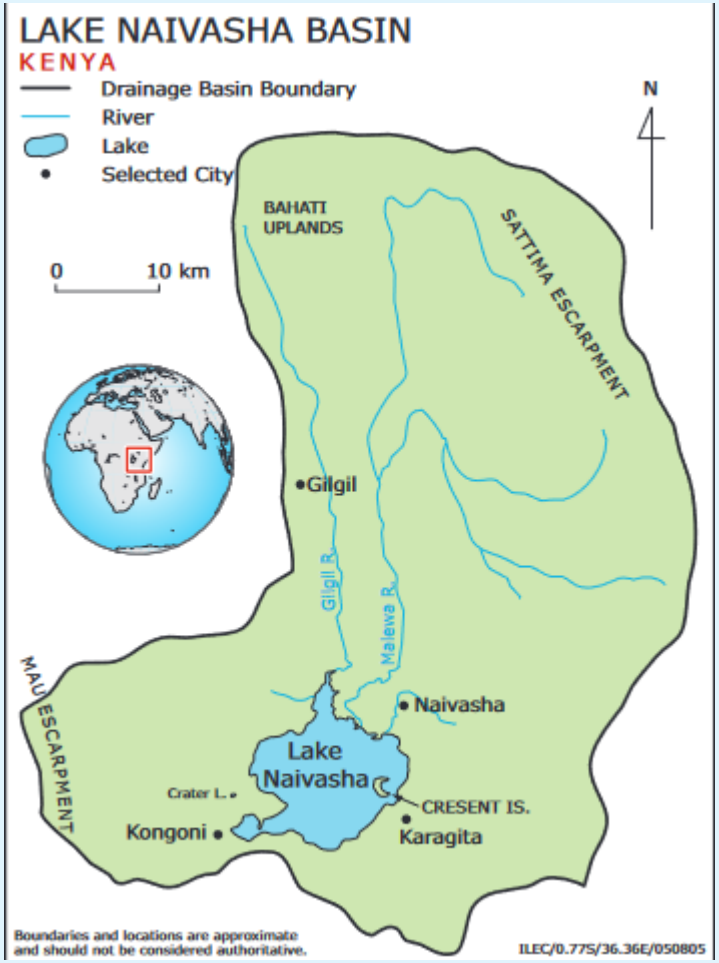
Lake Naivasha and its Basin



Located - 0.45° S, 36.26° E.
Altitude – on the floor of the EA Rift Valley.

Mean annual **lake area ~ 128.8 km²**

Basin area – 3229.2 Km^2(Yamazaki et al 2019).

– Rivers - Malewa ~ 1,730 Km^2; Gilgil ~ 429 Km^2

Riparian boundary – 1892.8 m asl with a buffer zone below 1810 m asl established in 1906, identified as an area where no permanent structures are allowed to be built on this land.

An endorheic Catchment. Freshwater Lake. Estimated – seepage 5% in 1973, 11% in 1974, 20% 1975

A designated Ramsar Site – 1995. Most of the Land within it is privately owned.
Climate- Semi-arid. (600mm – Naivasha Town to 1,700 mm on the slopes of the Nyandarua Mountains. Kinangop plateau – 1,000-1,300 mm.

Surface flow: About 25% inflow from Malewa (Discharge 80%), and Gilgil Rivers and Karati Rivers (Discharge 20%) and aquifers recharge.

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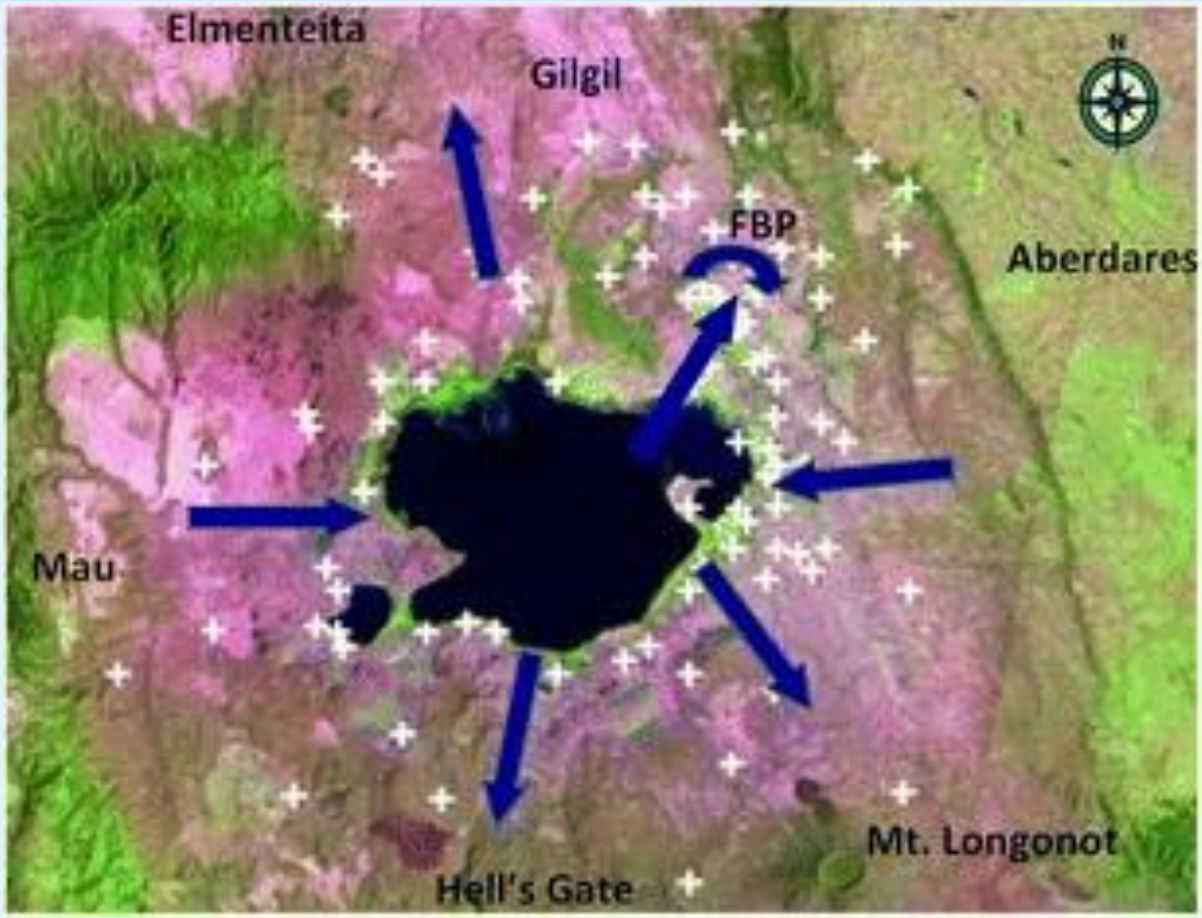
Groundwater flow directions around Lake Naivasha



Groundwater flow:
Recharges aquifers in the North and South.

More water to the South than to the North.
Flow rates to the:
North ~ 0,97 m3 s -1,
South ~ about 2,58 m3 s -1 (Reta, 2011; Hernandez, 1999).

Lake receives groundwater recharge: – from East and West.

Water flows vertically into deep geothermal layers and horizontally through shallower layers - Becht et al. (2006).

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Services and Products

Fish

Horticulture, agriculture (~ 3,966 ha – Irrigated area.) **& livestock grazing.**

Geothermal power – Ol karia -122 kW,

Water for domestic and irrigation use.

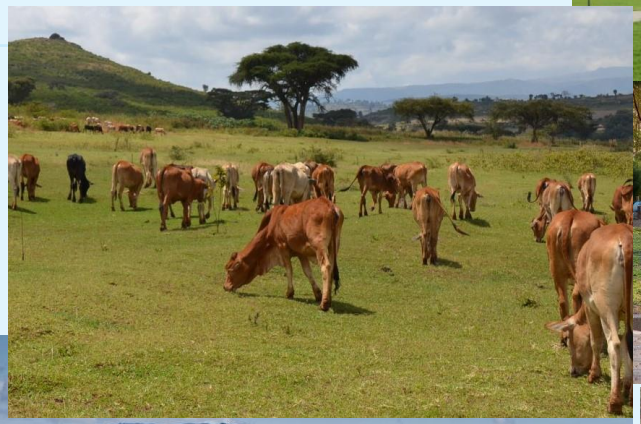
Tourism

Boat rides and water sports.

National parks

Holiday and school tours.

Hotels – Number has steadily increased, 1982 - 2023



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Why the use of GIS

Information based on remote sensing has exploded. This presentation is based on GIS of the land use a coupled with some water information – to explain the impacts of **Land use on the lake** which have occurred over the past 38 years –1982 - 2023

Challenges:

Land use change

Horticulture

Increase crop acreage in the catchment and over grazing

Wetland removal/degradation,

Sewerage effluent in the lake.

Invasive species – plants and fish.

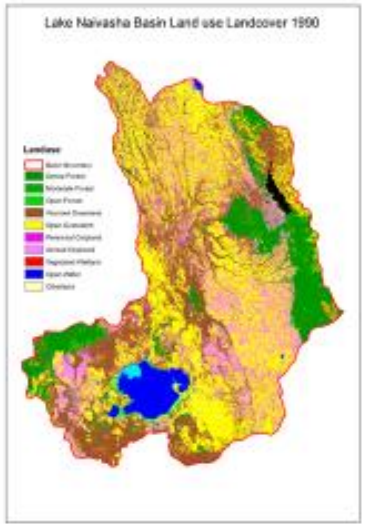
Climate change

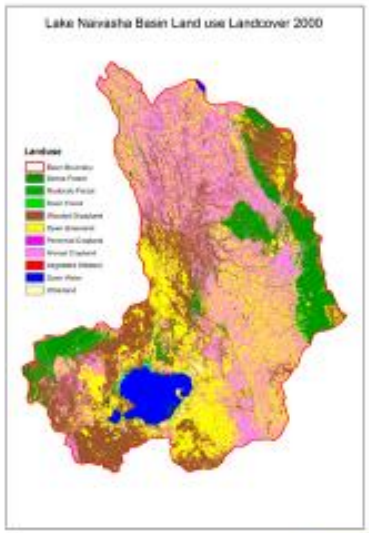
Impacts:

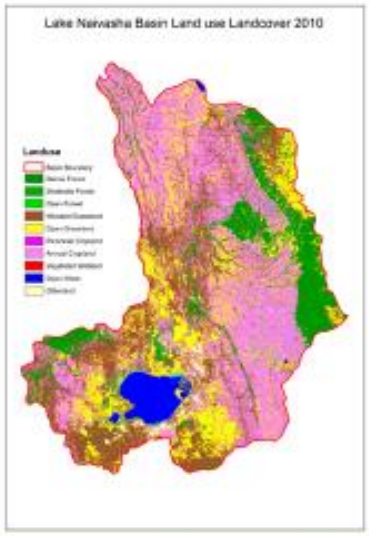
- Increase population – urban, peri-urban, and rural areas.
- Water over abstraction
- reduced quantity quality of water
- High levels of erosion
- increased siltation/sedimentation and pollution
- high levels of N & P, BOD, TDS.
- Reduced biodiversity and other ecological changes

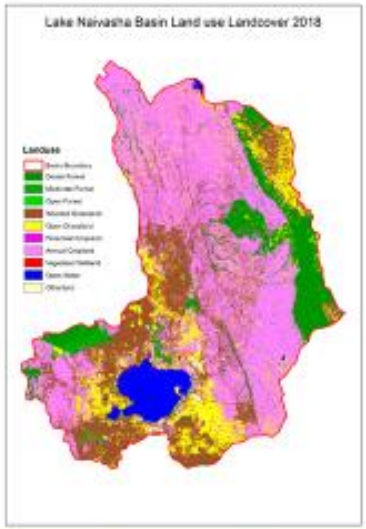
Land use and land cover 1990-2018

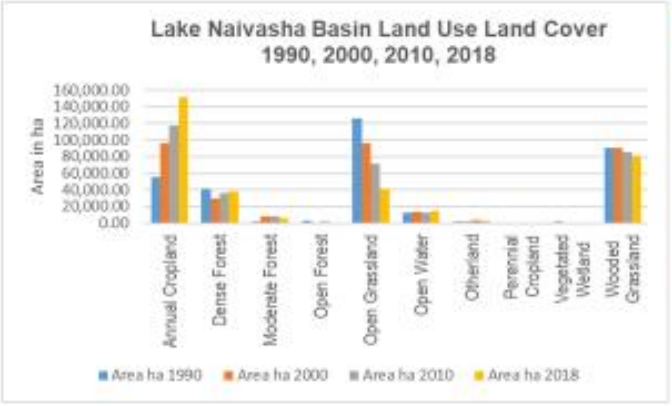
by David Ongo - RCMRD











Class Name	Area ha 1990	Area ha 2000	Area ha 2010	Area ha 2018
Annual Cropland	55,294.92	95,658.12	117,464.40	151,205.40
Dense Forest	41,103.27	29,526.93	35,971.38	37,576.26
Moderate Forest	1,369.53	7,971.48	7,836.66	5,813.46
Open Forest	3,200.58	883.17	1,659.33	691.38
Open Grassland	126,347.67	95,881.41	71,411.13	41,615.73
Open Water	12,405.15	13,567.95	11,985.66	14,755.14
Otherland	2,211.12	2,100.78	3,574.62	3,322.08
Perennial Cropland	211.95	282.06	487.89	17.46
Vegetated Wetland	1,923.48	282.15	777.96	424.80
Wooded Grassland	90,310.59	90,157.86	85,142.79	80,890.20

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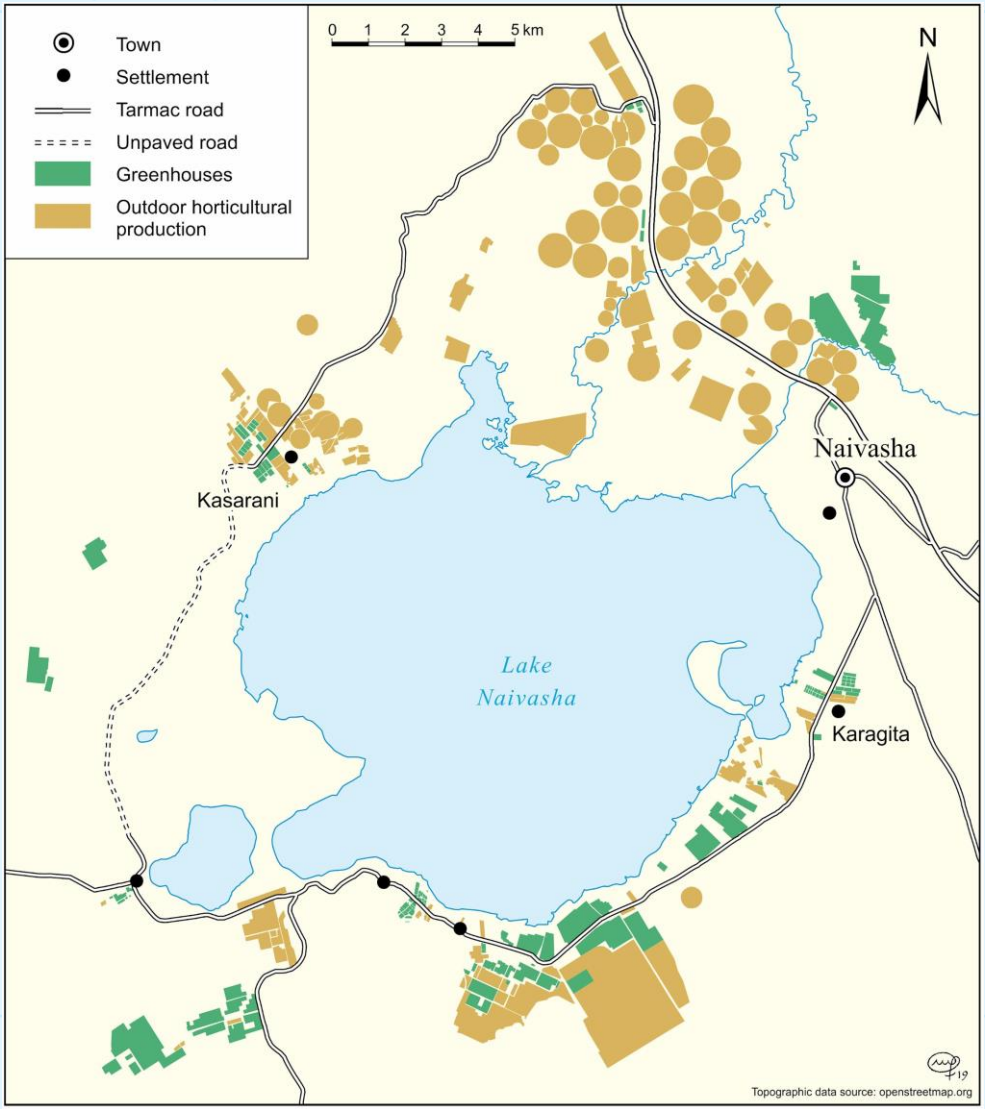
Horticulture & irrigation 1982-2023



1982 Horticulture are the Lake began.

By 2019 – area under horticultural and irrigation activities increased from 45 Km^2 to 92 Km^2 (103%).

This led to a population increase from concurrent with the commercial activities

3 major population settlements formed

a) **Karasani**/North Lake 1990s, North of Naivasha Town – 2000s & South Lake.

b) **Karagita and Mirera** ~ 61, 201 – on small plots and work and benefit from the horticultural farms.

c) **The town**

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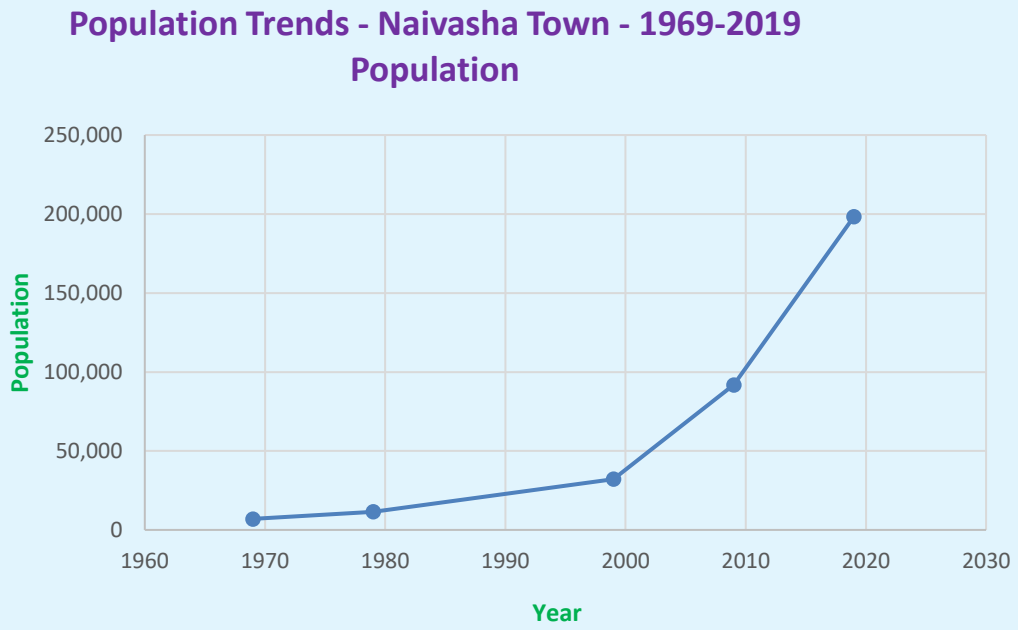
Population trends verses growth of Horticulture (Flowers & Vegetables).



It's also reflected in the increased Kenyan flower exports.

1973 – 3,624 m tons,

2006 - 86, 490 m tons,

2017 - 156, 961 m tons – (KFC, 2019, Mwembe, 1979).

Population increase accelerating from 1982 at the start of intensive horticultural activities.

The population increase mirrors the increase in horticultural industry and the area of grassland converted to crop land and the town.

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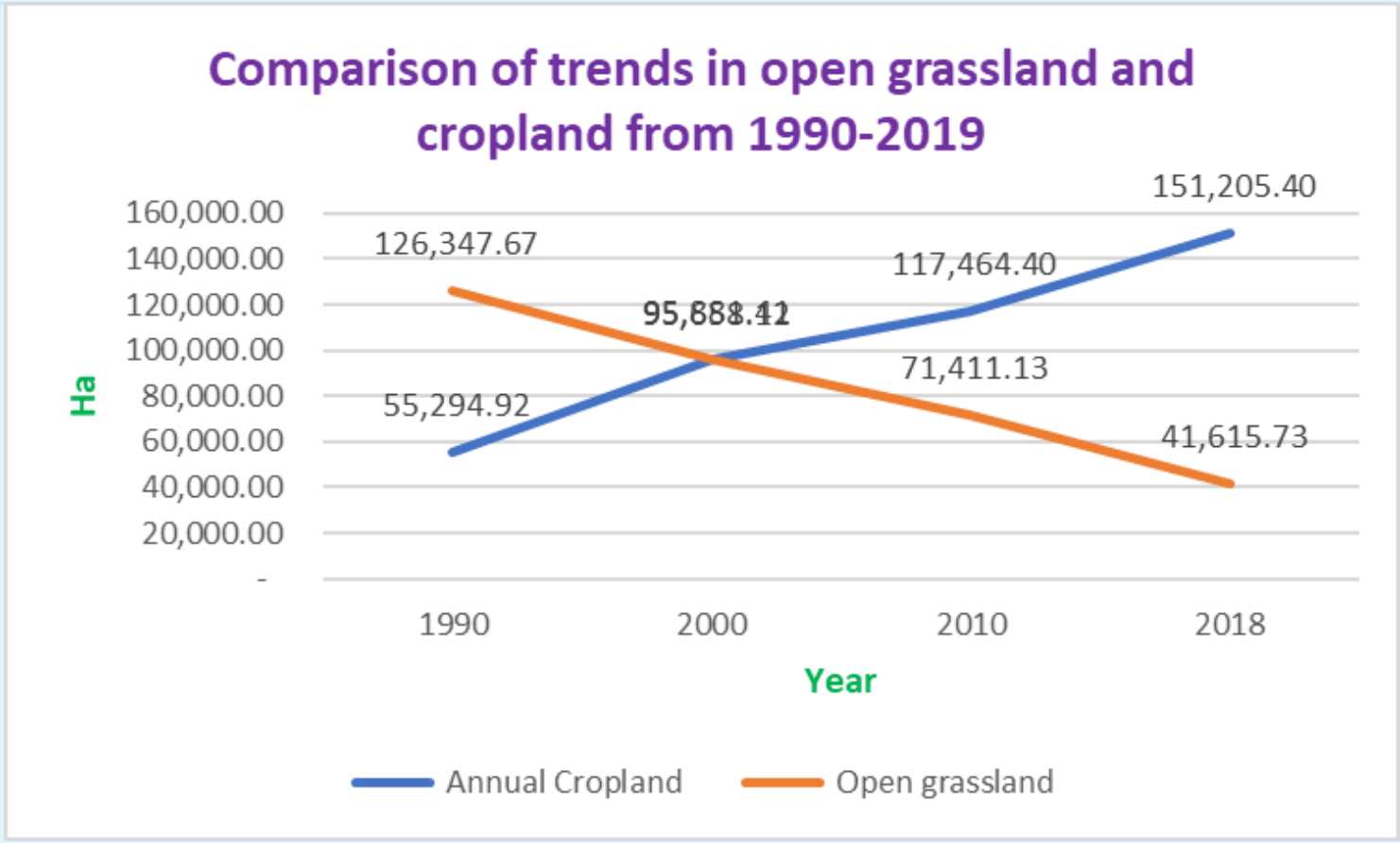
Area of Cropland vs Grassland



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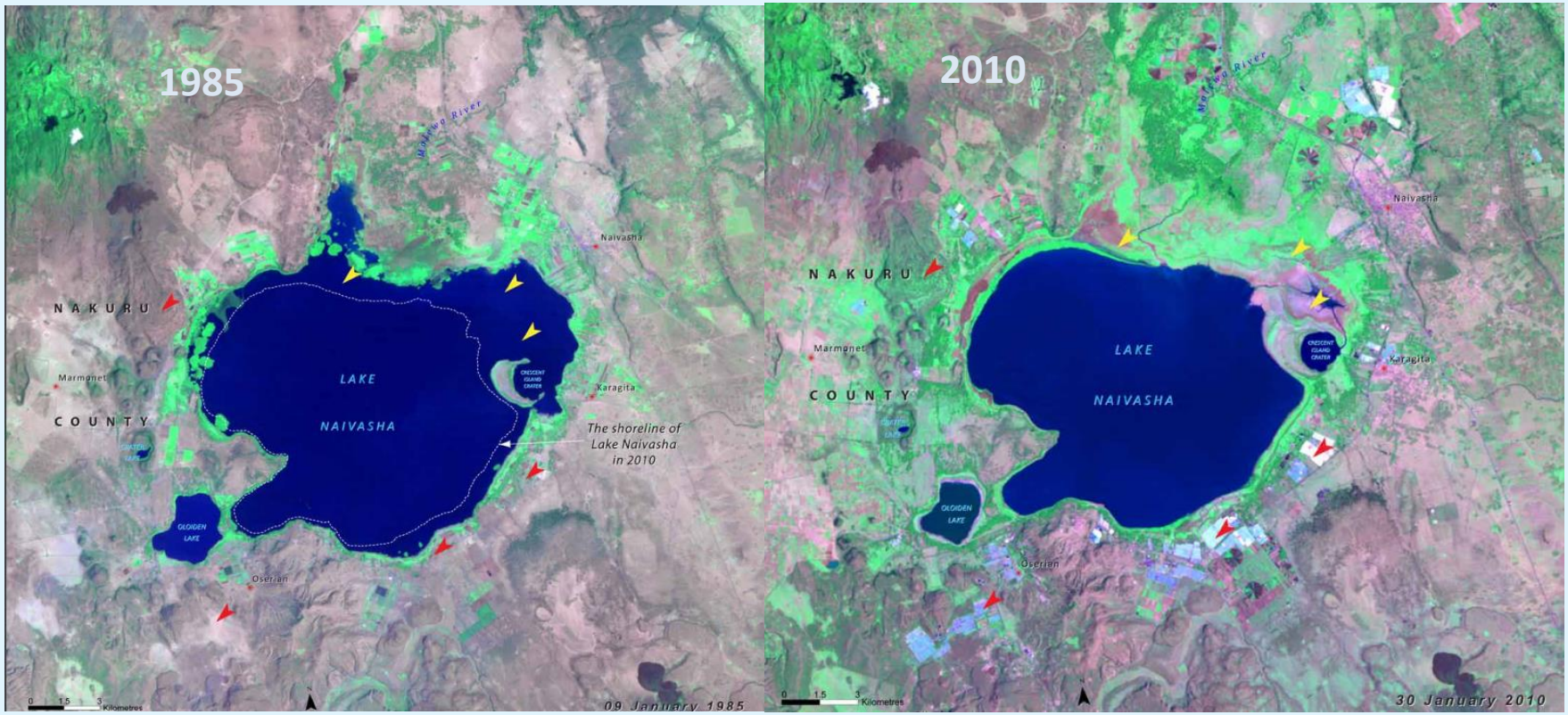
Lake water levels 1985-2010 lowest levels



The lake areas and levels closely follow the rainfall fluctuations, both the wet and dry season. However, the horticulture and agricultural activities also influence the lake levels (Onywere et al., 2013), which may also explain the lower levels seen in 2009 and the drier year of 2010.

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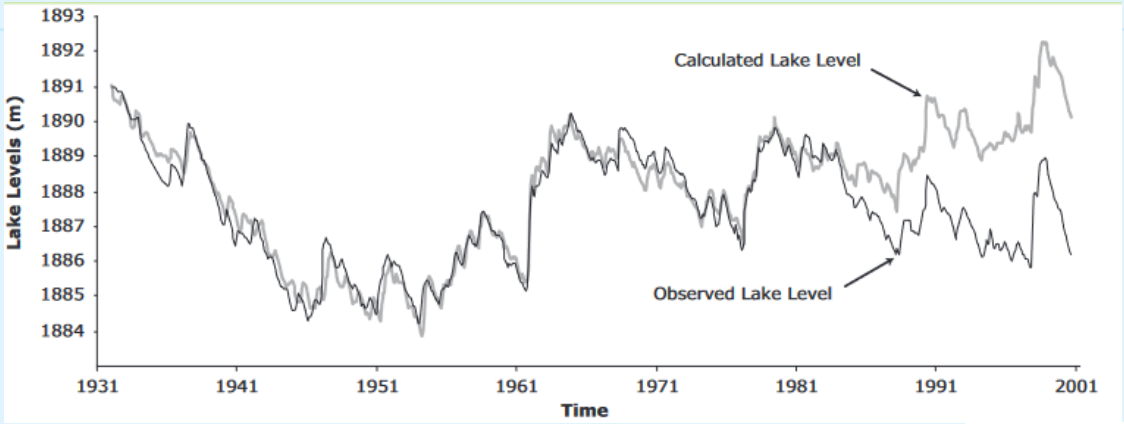
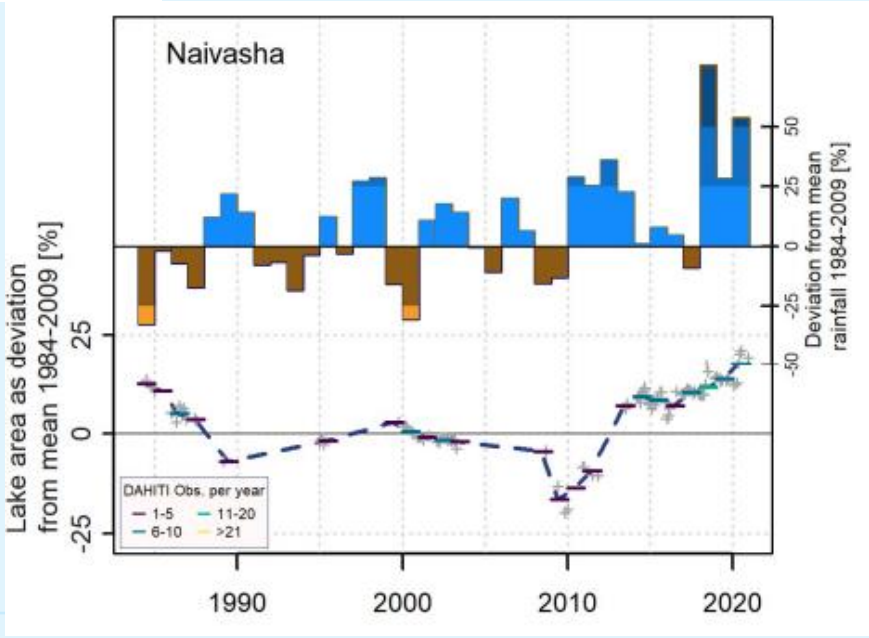
Long-term Water Level in Lake Naivasha – 1932-2001 (Becht and Harper 2002)



From 1982 -2001 the calculated annual water shortfall (deficit) by 1997 of 60 x 10^6 m^3 was calculated as equal to the area occupied by horticulture and the crops grown. These findings were widely accepted by all users and stakeholders.



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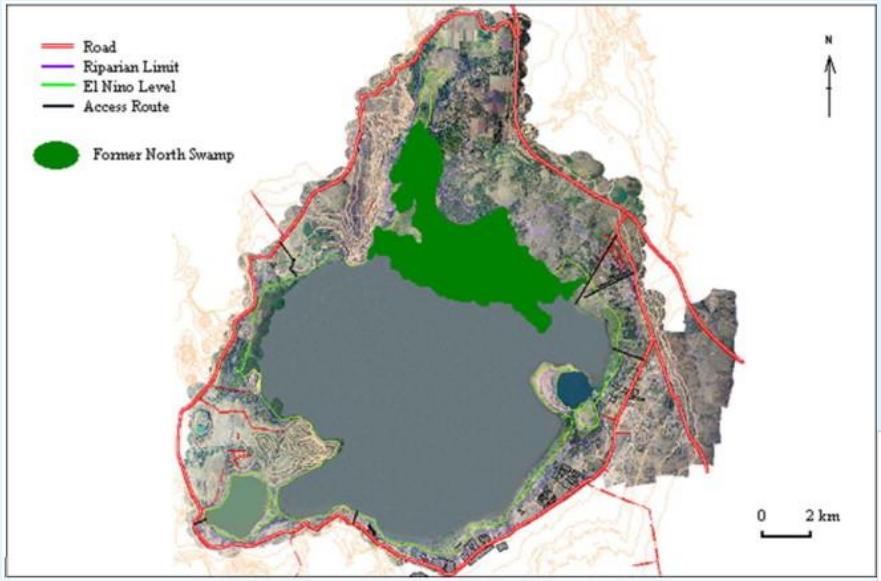
Diminishing Swamp areas on Lake Naivasha



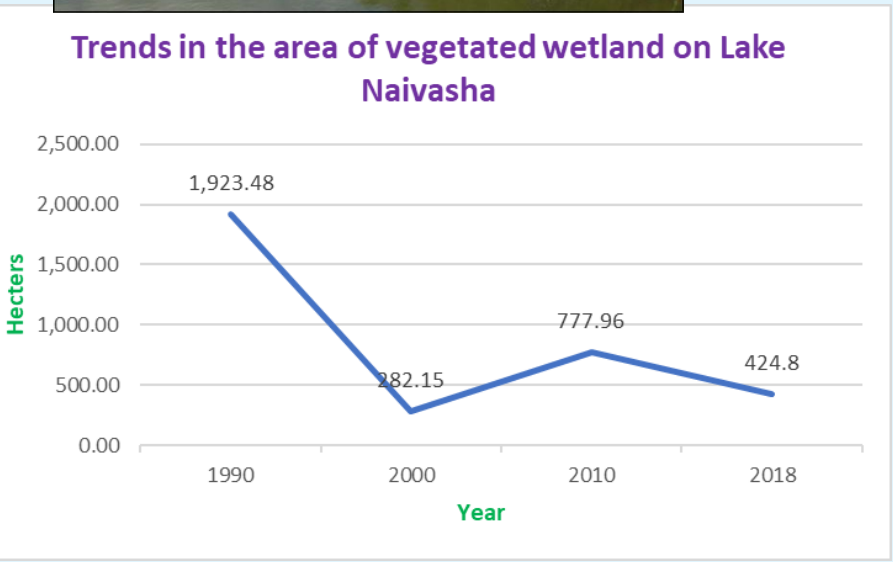
Northern part of swamp in the 1970s,

Was a buffer against - Non-point source of pollution from Erosion from cropland & catchment deforestation.

Gilgil and Malewa river water from basins - entry points.

Decline in the total area means Increased siltation.

Some - Alien species



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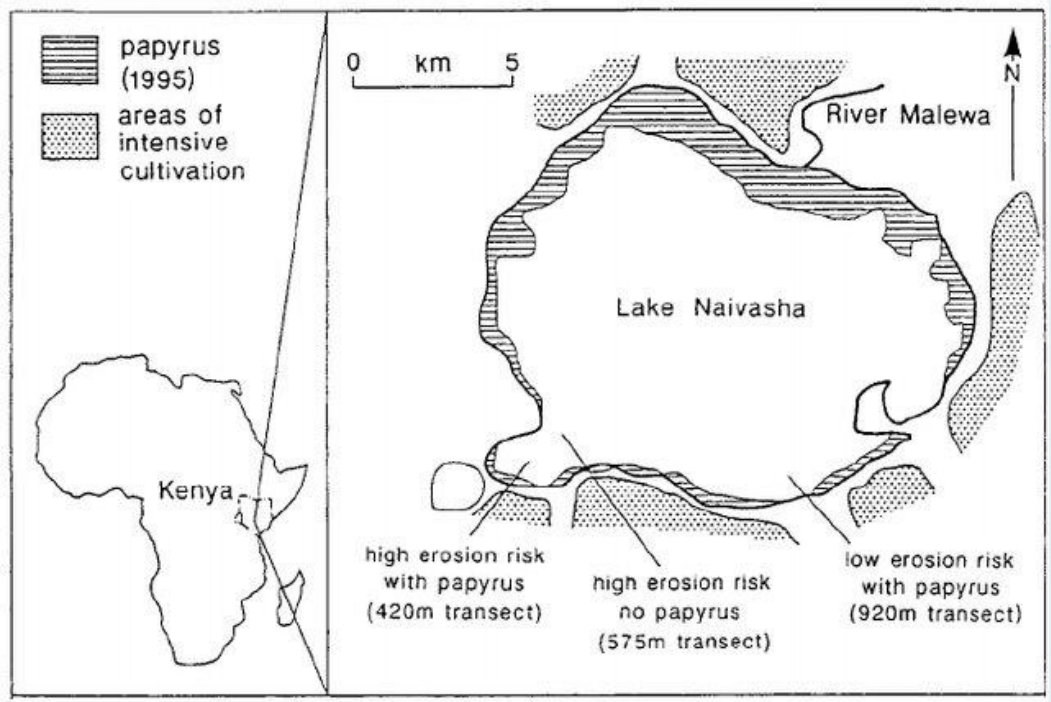
Water Quality sampling – Sediments.



With the removal of the papyrus

- 3 high levels of Silt and gravel, sand and stones are deposited far way in the Lake.
- Healthy papyrus swamps act as ecological buffer zones, moderating changes occurring along the shores and also regulating nutrient flow and recycling.
- Point source pollution from Naivasha Municipal sewerage when it is not working.
- Non-point sources through open areas where there is no papyrus fringing the Lake.

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Management strategies

Strategies analyzed GIS information coupled with water information to determine what to manage.

What exist around Lake Naivasha

Governance: An Environmental Management & Coordination Act (EMCA) passed 1996. **T**he Lake Naivasha Management Implementation Committee (LNMIC), formed but has no executive powers.

Participation: The LNMIC, comprises of several stakeholder both in Government, NGOs, CBOs and private business.

But missing the active participation of the pastoralist and those small-scale farmers in the Malewa and Gilgil catchment.

Institutions: KMFRI, Fisheries Dept, Water ministry, Universities both local and foreign, GIS experts and Institutions like the Regional Center for Management and Resource Development (RCMRD)

Technology: Adoption of hydroponics in horticulture, New farming methods, use of GIS. Drones to determine extent of problems, use of latest water sampling and analytical equipment etc.

Information: Scientific information to guide decision making available from – many research organizations. The current trends in water use, growth of cropland and decrease in open grasslands define the current problems facing the lake.

Confidentiality information (if required)
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Finance: LNMIC has no formal budget.

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Thank you

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