Rising with temperature! Reconstructing the hydroclimatic record of Lake Naivasha with Earth Observation

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Scientific background

The water level of Naivasha Lake has been rising at unprecedented rates, damaging the Lake's ecosystem services and social-economic goods.

The leading hypothesis is climate change (e.g. increase in precipitation) but also changes in land use/land cover (e.g. increase in siltation and change in hydrology) may have an effect.

This project will study the climate change hypotheses by use Earth Observation (EO) data and models to map the distribution of precipitation, evaporation, water extent and level, and the sedimentation rate.

ITC and RCMRD will develop a framework integrating these EO-products to reconstruct the Lake's hydroclimatic record and attribute the Lake's water level fluctuations to the different hydro-meteorological drivers.

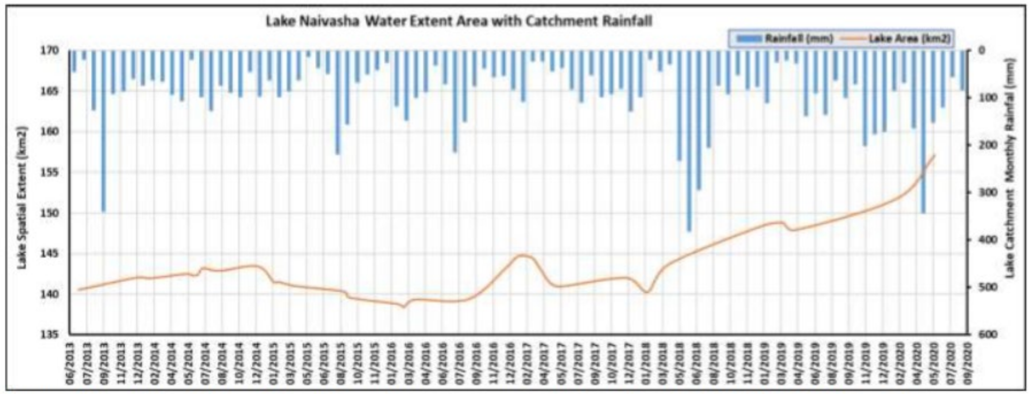


Figure 2: Evolution of Lake Naivasha's surface area, compared to catchment rainfall (CHIRPS) over time

Study Area

- Naivasha is RAMSAR site classified as wetland of international importance – High number of Hippos, Flamingos, Variety of Birds
- An important source of fresh water in the area
- Horticultural farms – Source of vegetable, flowers
- High population, pollution, High water abstraction - Rapid increase in the spatial extent

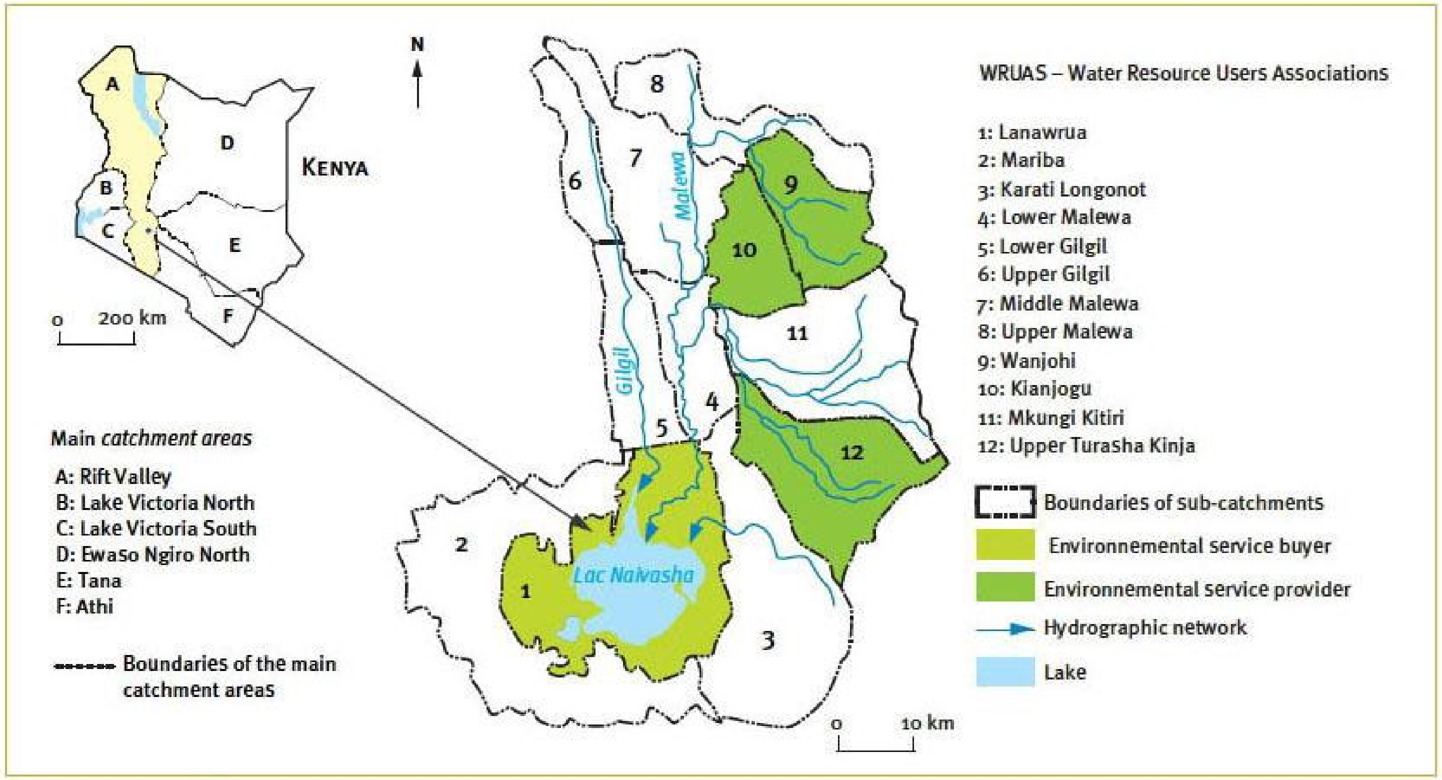
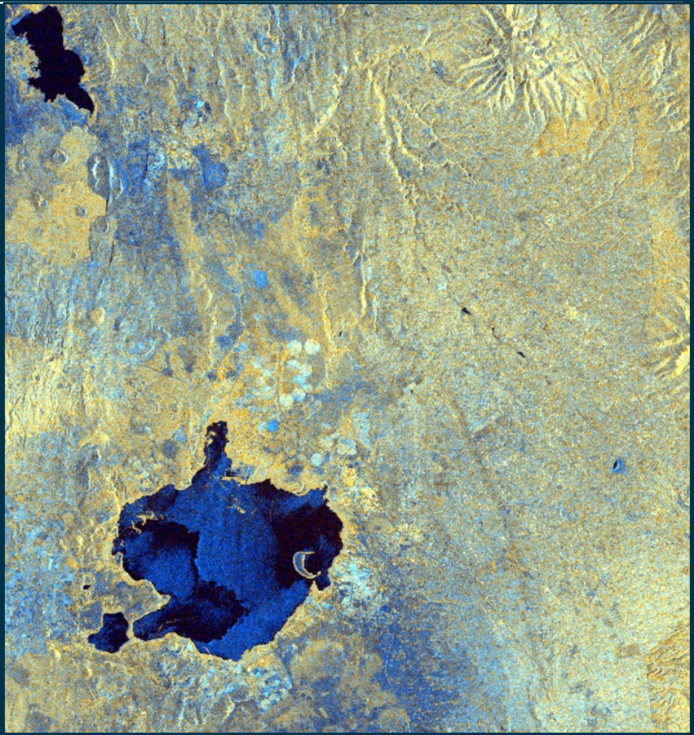


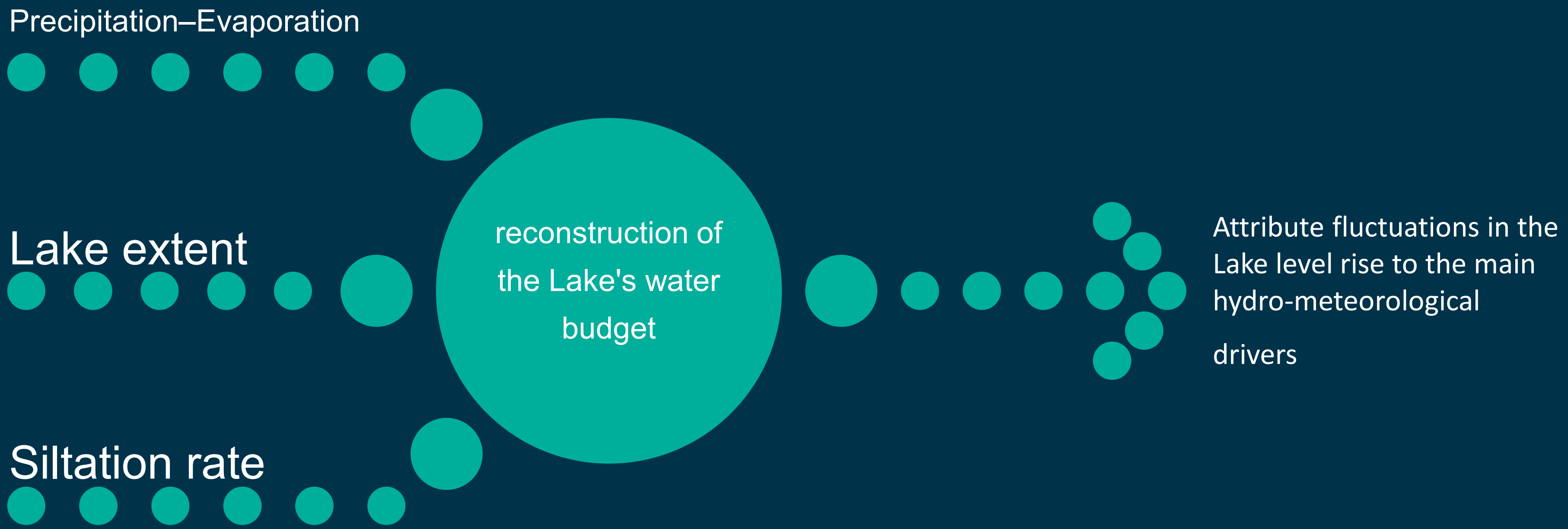
Photo credit: Abijay

Breakdown structure

To achieve the project's aim the research, is broken down into four main work packages (WPs):

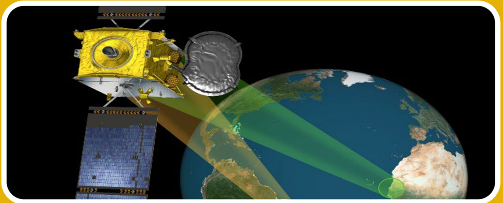
- WP1*: Mapping Precipitation – Evaporation distributed over the Lake*
  - *CHIRPS rainfall will be combined with LSA-SAF derived evaporation*
- WP2: Mapping lake water extent
  - ESA CCI Lake water extent product will be validated using Sentinel-1 and -2 extents
- WP3: Mapping siltation processes
  - Siltation processes will be reconstruction using Sentinel-2 MSI and modelling
- WP4: Reconstruction of the lake's water budget
  - Annual freshwater budget is determined using the outcomes of WPs 1, 2, and 3





Data Sources

Satellite Data and Products



ESA Missions:

Sentinel-1, data product: IW Level-1 GRD,

Sentinel-2 data product: 1C, temporal range:

Products under ESA's Climate Change Initiative Lakes project,

Non-ESA EO Data

Non-ESA ESA data to be used in the project are:

Precipitation estimates from the Climate Hazard Group InfraRed Precipitation with Station (CHIRPS)

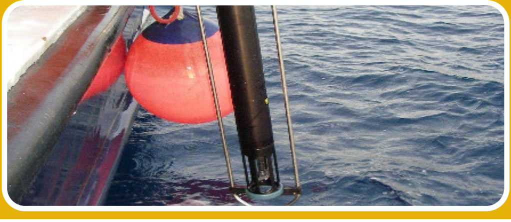
Radiative fluxes and surface properties (temperature and albedo) from the EUMETSAT Land Surface Analysis-Satellite Applications Facility (LSA-SAF)

Model Output

Soil and Water Analysis Tool – SWAT

(EO based data inputs – Long term trajectory)

In-Situ Measurements



In-situ and Ancillary Data:

Field excursion will be carried out to measure

1- Bathymetry using Fishfinder sonar (DP0H10S10),

2- Water level using in-situ Solinst calibrated digital level logger,

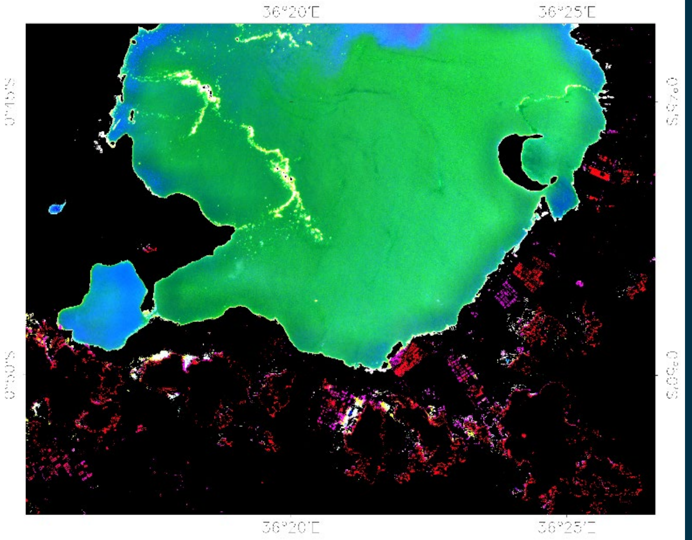
3- Turbidity using the Digital Tubidiet Sensor DTS12,

4- Collect data from the six hydrometeorological stations (five Bowen ratio and one Eddy Covariance system) owned by ITC around the Lake.

used to check the current state of the Lake and validate EO products

Research activities

Activity	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
A1. Mapping Precipitation–Evaporation distribution over the Lake;												
A2. Mapping lake water extent;												
A3. Mapping suspended sediments ;												
A4. Reconstruction of the Lake's water budget.												
A5. Final report												
A6. Fieldwork of Ongo												
A7. ITC staff visits to Kenya												
A8. Ongo's visit to ITC												
A9. Attending conferences												



Measuring light intensity

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