

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



David Ongo – RCMRD

dr.ir. Salama Suhyb – University of Twente

dr. ir. Rogier Van der Velde - University of Twente

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.



Photo Credit: Standard

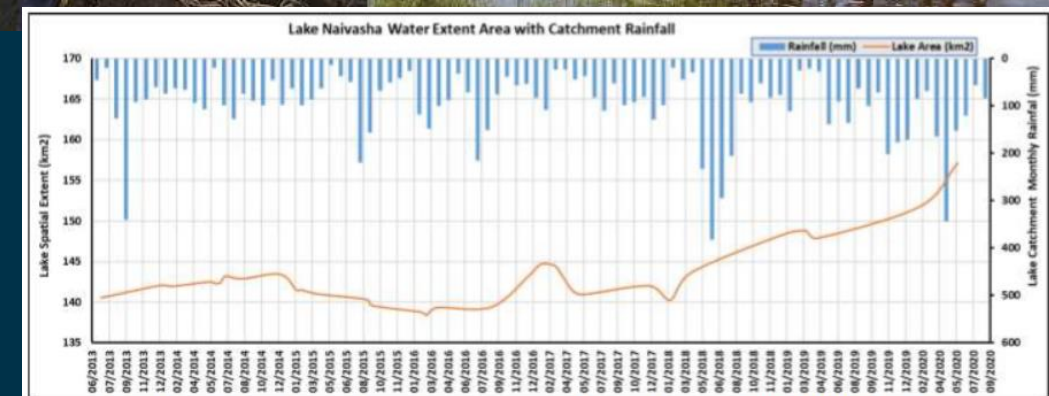


Figure 2: Evolution of Lake Naivasha's surface area, compared to catchment rainfall (CHIRPS) over time

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

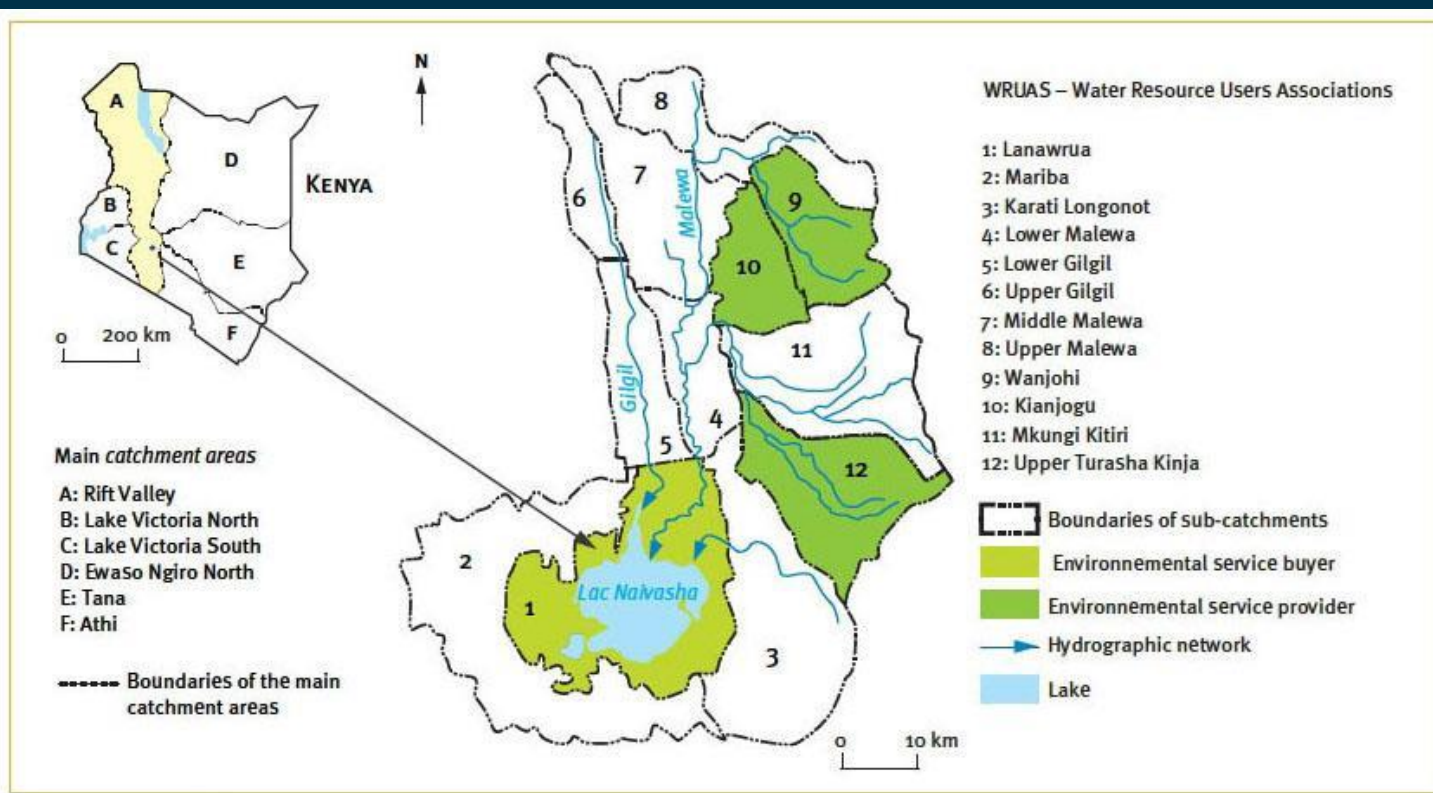
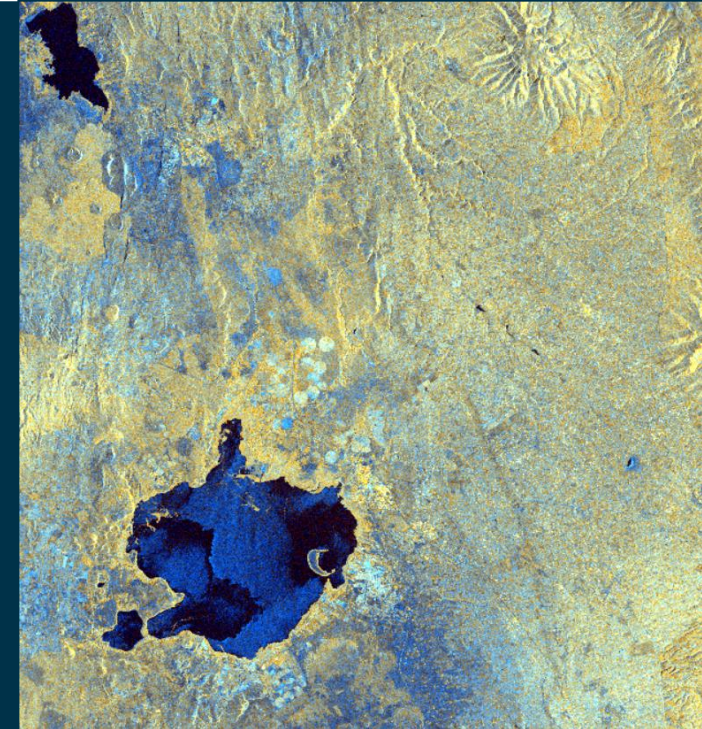


Photo credit: Abijay

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



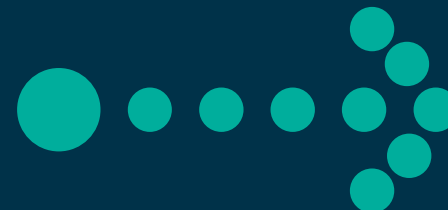
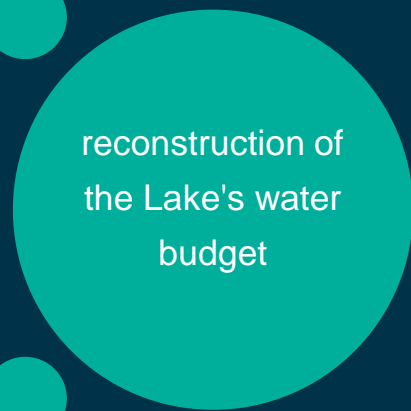
Precipitation–Evaporation



Lake extent

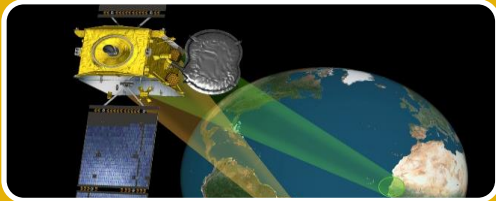


Siltation rate



Attribute fluctuations in the Lake level rise to the main hydro-meteorological drivers

Satellite Data and Products



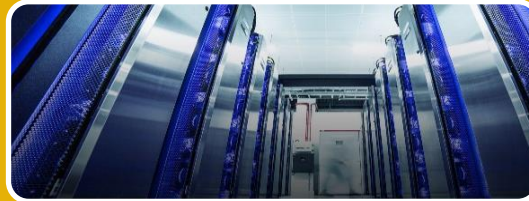
ESA Missions:

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

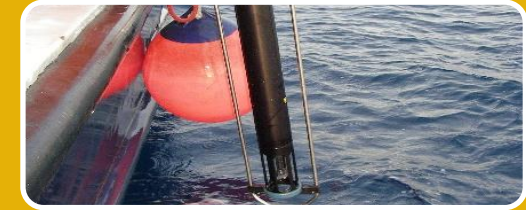
Non-ESA data to be used in the project are:
Precipitation estimates from the Climate Hazard
Group InfraRed Precipitation with Station (CHIRPS)
Radiative fluxes and surface properties
(temperature and albedo) from the EUMETSAT
Land Surface Analysis-Satellite Applications Facility
(LSA-SAF)

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

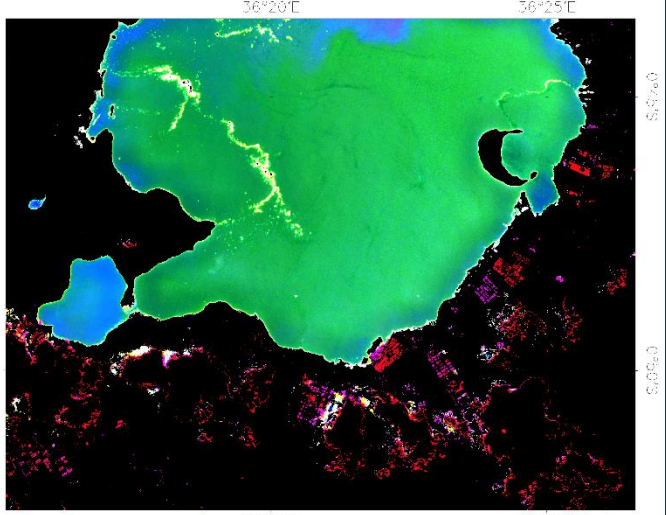
- 1- Bathymetry using Fishfinder sonar (DP0H10S10),
- 2- Water level using in-situ Solinst calibrated digital level logger,
- 3- Turbidity using the Digital Tubidiet Sensor DTS12,
- 4- Collect data from the six hydrometeorological stations (five Bowen ratio and one Eddy Covariance system) owned by ITC 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;	Light Orange	Light Orange											
A2. Mapping lake water extent;			Yellow	Yellow									
A3. Mapping suspended sediments ;				Light Blue	Light Blue	Light Blue	Light Blue						
A4. Reconstruction of the Lake's water budget.								Light Green	Light Green	Light Green	Light Green		
A5. Final report													Orange
A6. Fieldwork of Ongo						Blue							
A7. ITC staff visits to Kenya						Blue			Blue				
A8. Ongo's visit to ITC			Dark Blue	Dark Blue	Dark Blue					Dark Blue	Dark Blue	Dark Blue	
A9. Attending conferences									Grey				Grey



Project Team



David Ongo
RCMRD
davidongo254@gmail.com
dongo@rcmr.org



dr. ir. Salama Suhyb
University of Twente - ITC
s.salama@utwente.nl



dr. ir. Rogier Van der Velde
University of Twente - ITC
r.vandervelde@utwente.nl



Dr. Vincent Odongo
ILRI
v.odongo@cgiar.org



Dr. Majamabo Gamoyo
RCMRD
mgamoyo@rcmr.org

