



# EO for Africa Symposium 2024

23 - 26 September 2024  
ESA | ESRIN, Frascati (IT)

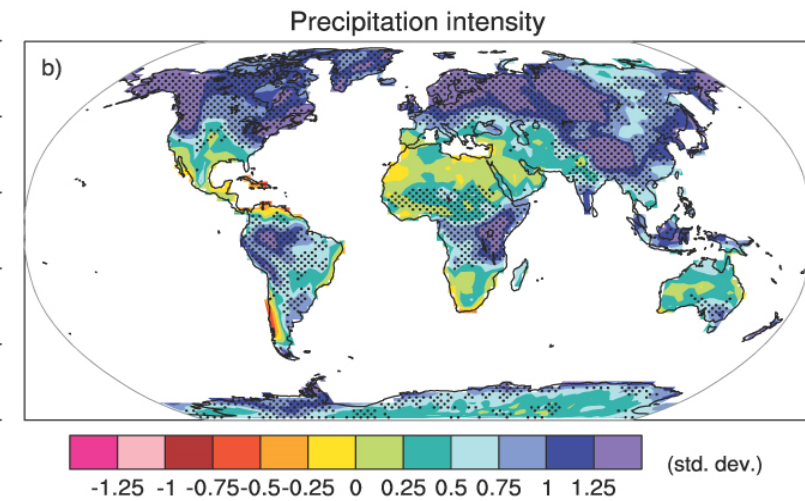
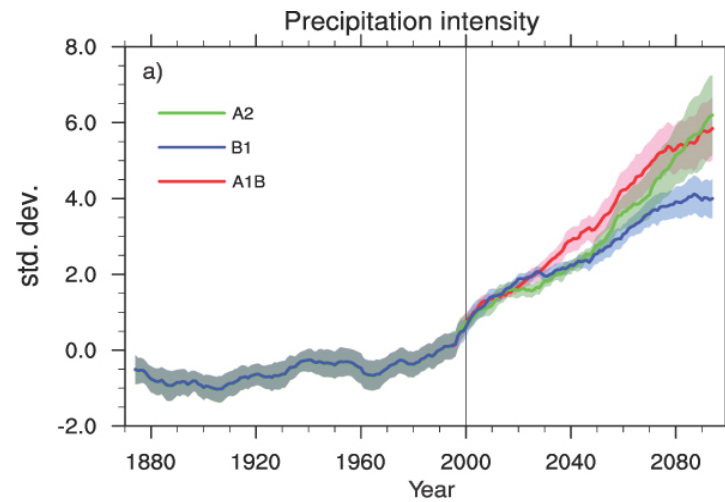
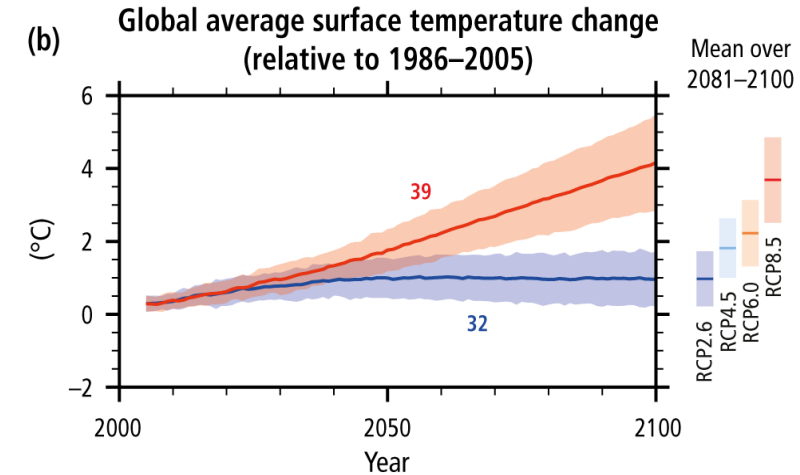
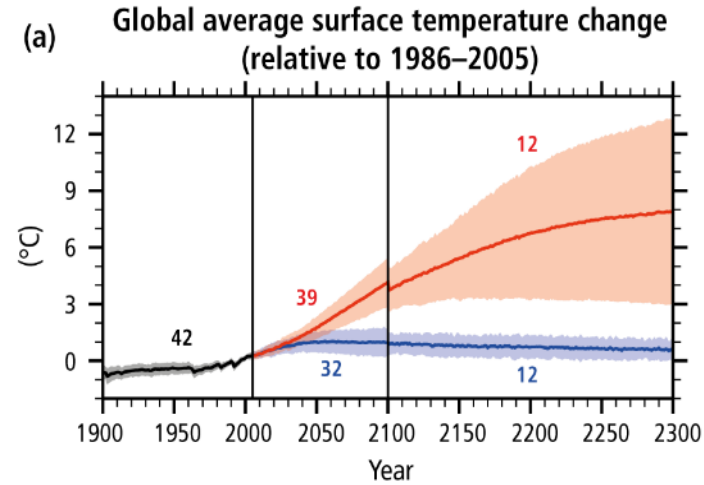
# Assessment of water quality changes in African lakes in response to climate trends and extreme events using satellite and meteo-climatic data



25/09/2024



# Lake Ecosystem Services & Extreme Events



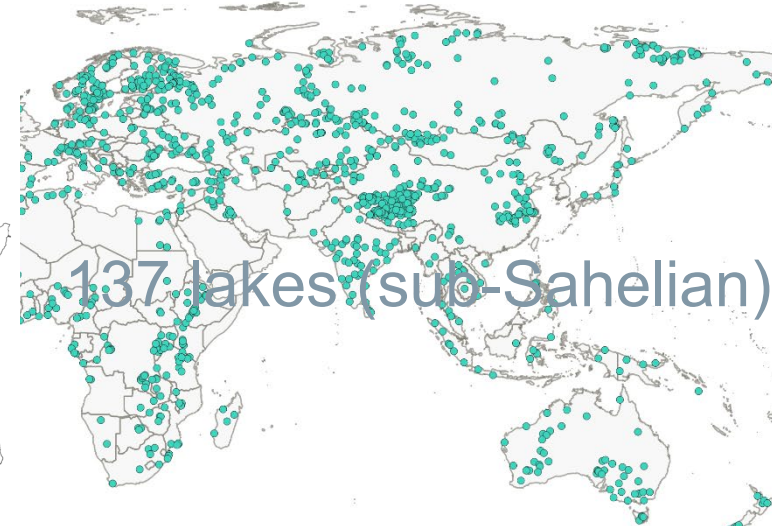
Source: IPCC





The **Global Climate Observing System (GCOS)** has defined 55 ECVs.

An **ECV** is a physical, chemical or biological variable, or a group of linked variables, that critically contributes to the characterization of Earth's climate.



137 lakes (sub-Saharan)

4 lakes globally



Under the framework of the European Space Agency (ESA) **Climate Change Initiative (CCI)**, the lakes\_cci project provides global, stable, consistent, and long-term satellite-based products of the Lakes ECV.

1. Explore the lakes\_cci dataset for sub-Saharan lakes
2. Perform a multivariate analysis spanning 20 years
3. Identify dominant lake-climate interactions
4. Identify sentinel lakes



1

How do **extreme weather events** affect the **water quality** of a subset of Sub-Saharan lakes?

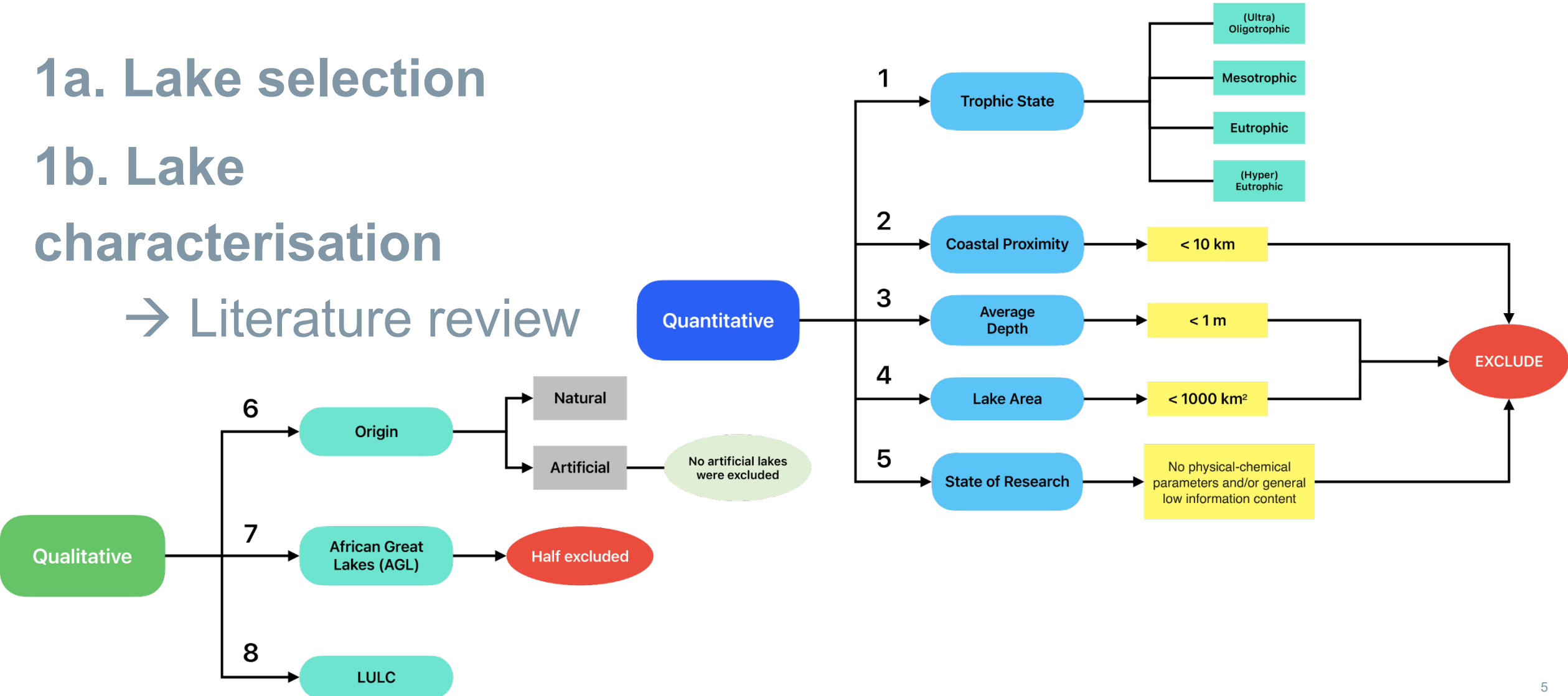
2

How are Sub-Saharan lakes influenced by **climate trends**? Can we identify “**sentinel**” lakes?

## 1a. Lake selection

## 1b. Lake characterisation

→ Literature review

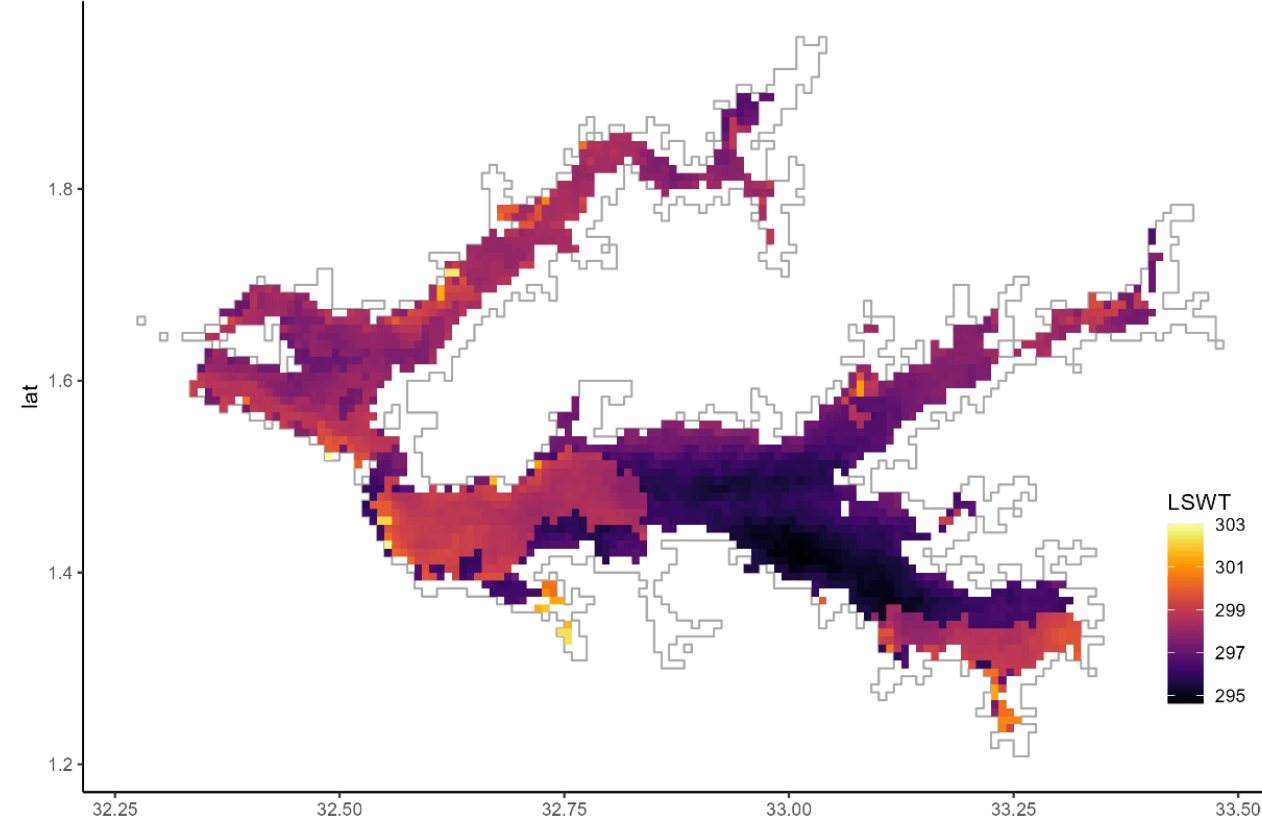


## 2. Timeseries and pattern identification

Using medium spatial resolution Sentinel-3 data

- Precipitation: TAMSAT
  - Air temperature: ERA5
  - Chl-a, turbidity, LSWT: Earth Observation (lakes\_cci)
- 1995 – 2020
- 2002 - 2020

01. February 2019  
Lake Surface Water Temperature. Lake Kyoga.





## 2. Timeseries and pattern identification

Using medium spatial resolution Sentinel-3 data

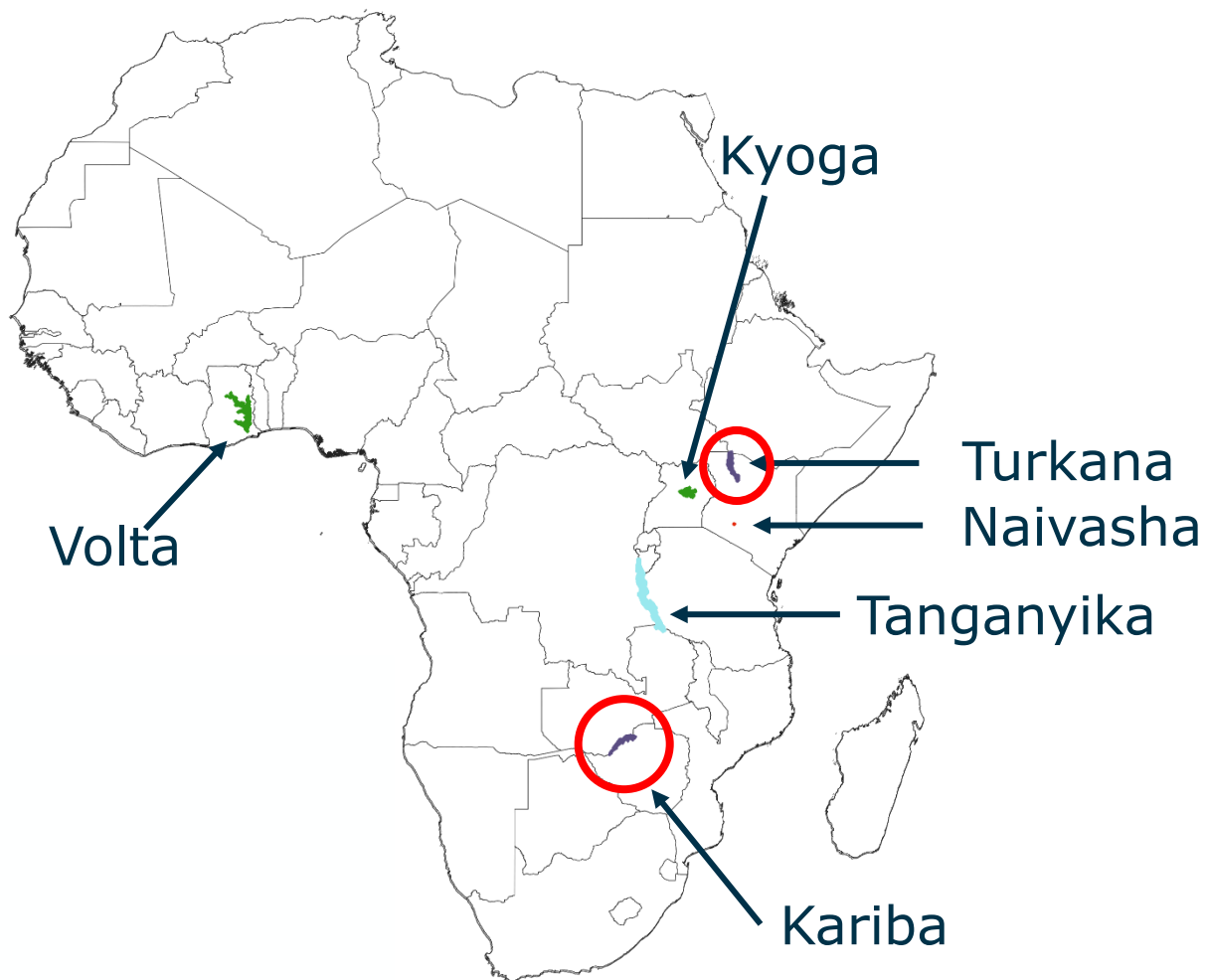
## 3. Identification and selection of (compound) extreme events

- Z-score and seasonal Z-score

## 4. Visualisation of water quality variables using CCI data

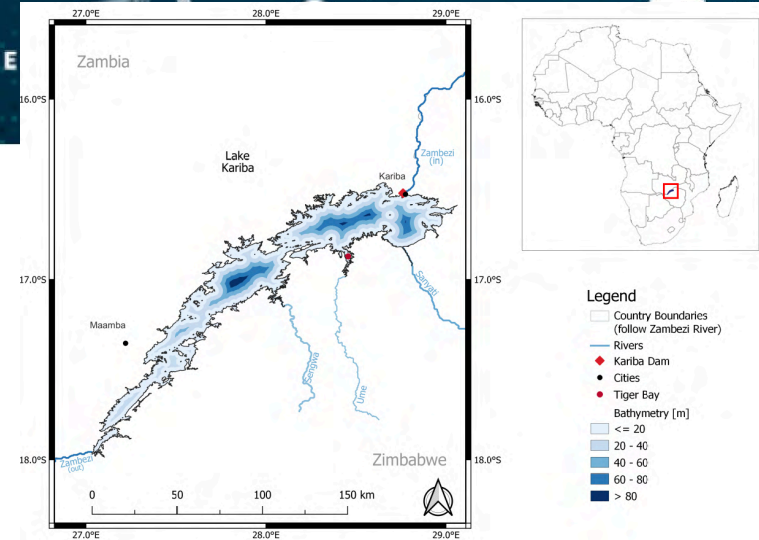
- Plot maps for each available date
- Apply threshold (# pixels > 50 %)

## 1. Lake selection

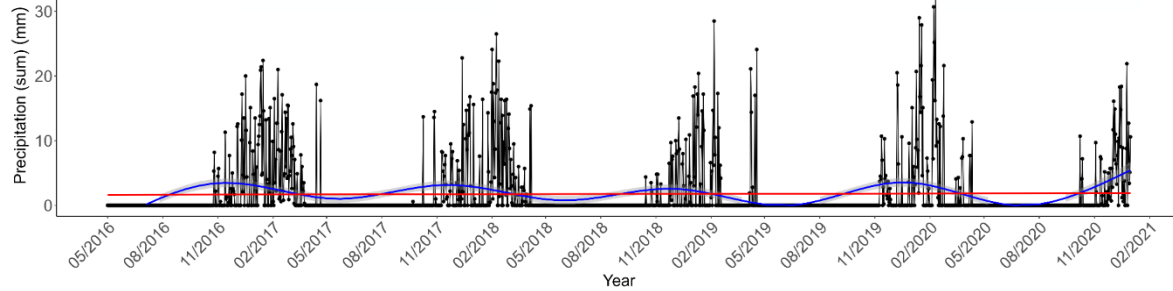




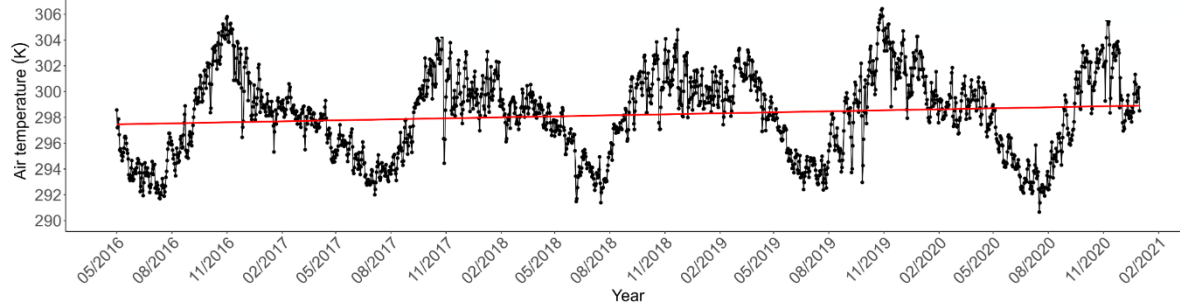
# Results: timeseries lake Kariba



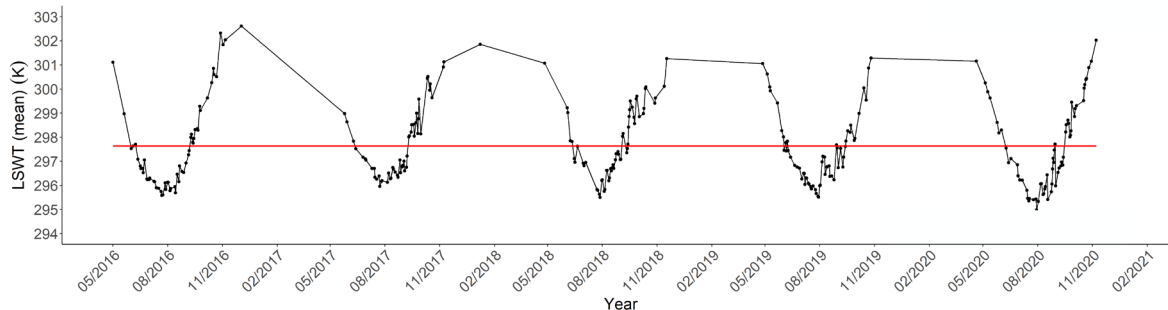
**Timeseries and trend of precipitation (sum) values for Lake Kariba.**  
Year: 2016-2020, daily.



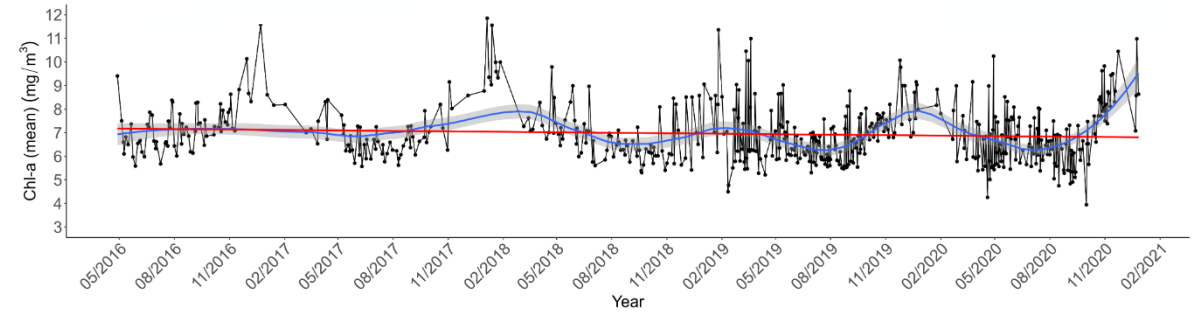
**Timeseries and trend of air temperature for Lake Kariba.**  
Year: 2016-2020, monthly



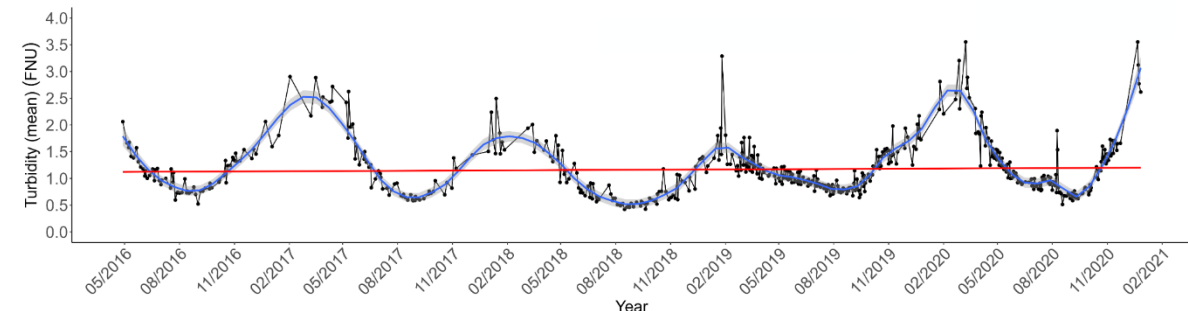
**Timeseries and trend of LSWT (mean) values for Lake Kariba.**  
Year: 2016-2020, daily. Limits: 200, 374 (K)



**Timeseries and trend of Chl-a (mean) values for Lake Kariba.**  
Year: 2016-2020, daily. Limits: 0, 150 (mg/m<sup>3</sup>)



**Timeseries and trend of turbidity (mean) values for Lake Kariba.**  
Year: 2016-2020, daily. Limits: 0, 300 (FNU)





## Timeseries

Lake	Rainfall	Air T	LSWT	Chl-a	Turbidity
Volta	↓	-	↓	↓	↓
Turkana	↑	-	↑	-	-
Kyoga	↑	↓	↓	↑	↓
Naivasha	↑	-	↑	↑	↑
Tanganyika	↑	-	-	-	-
Kariba	-	-	↓	-	↑

## 3. Identification and selection of (compound) extreme events

→ Precipitation and turbidity

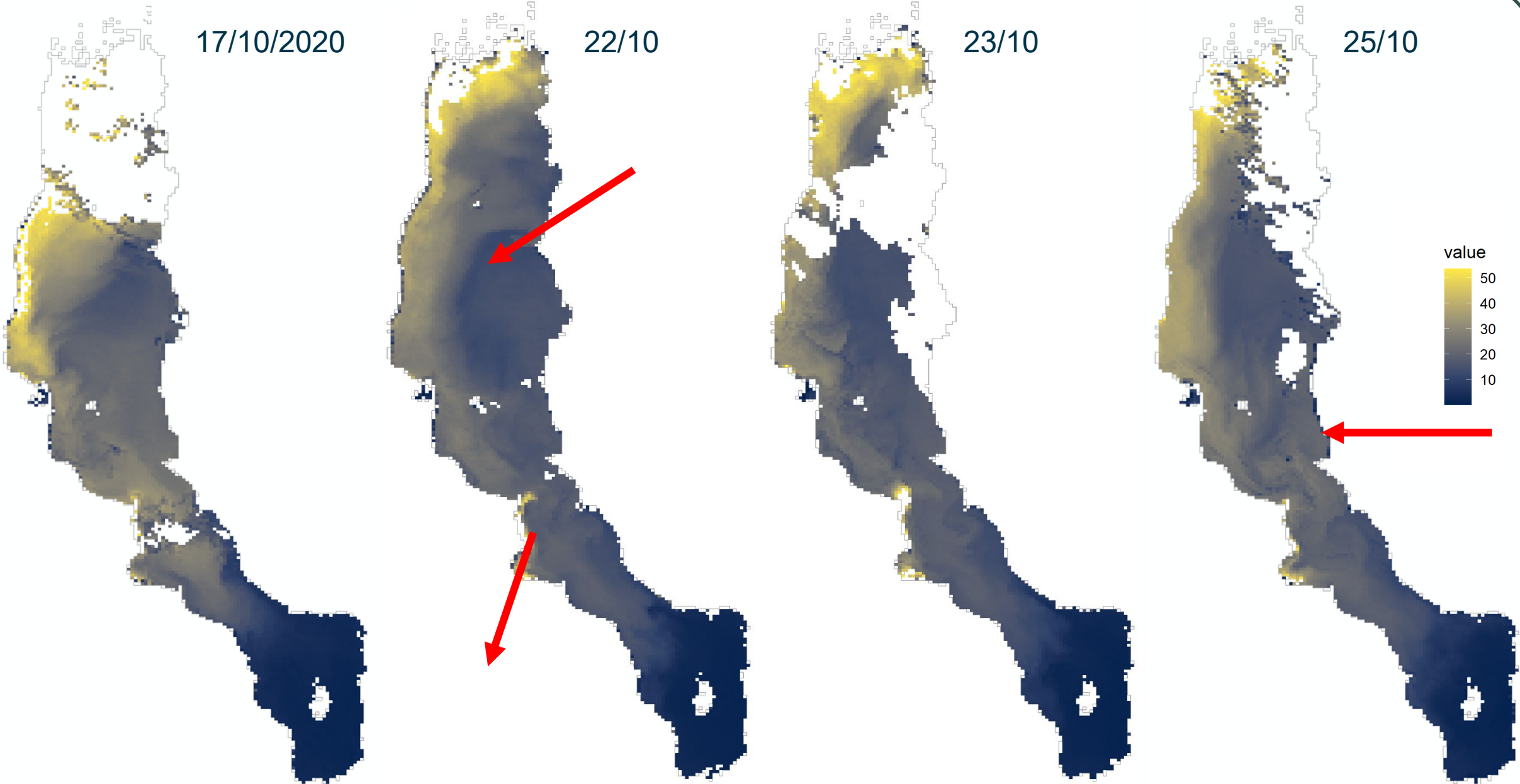
Lake	EE date	Parameter(s)	Value (mean)	Z-score
Turkana	17/10/2020	Precipitation	27.7 mm	6.4
		LSWT anomaly	0.63	
		Turbidity	13.5 NTU	3.8

17/10/2020

22/10

23/10

25/10

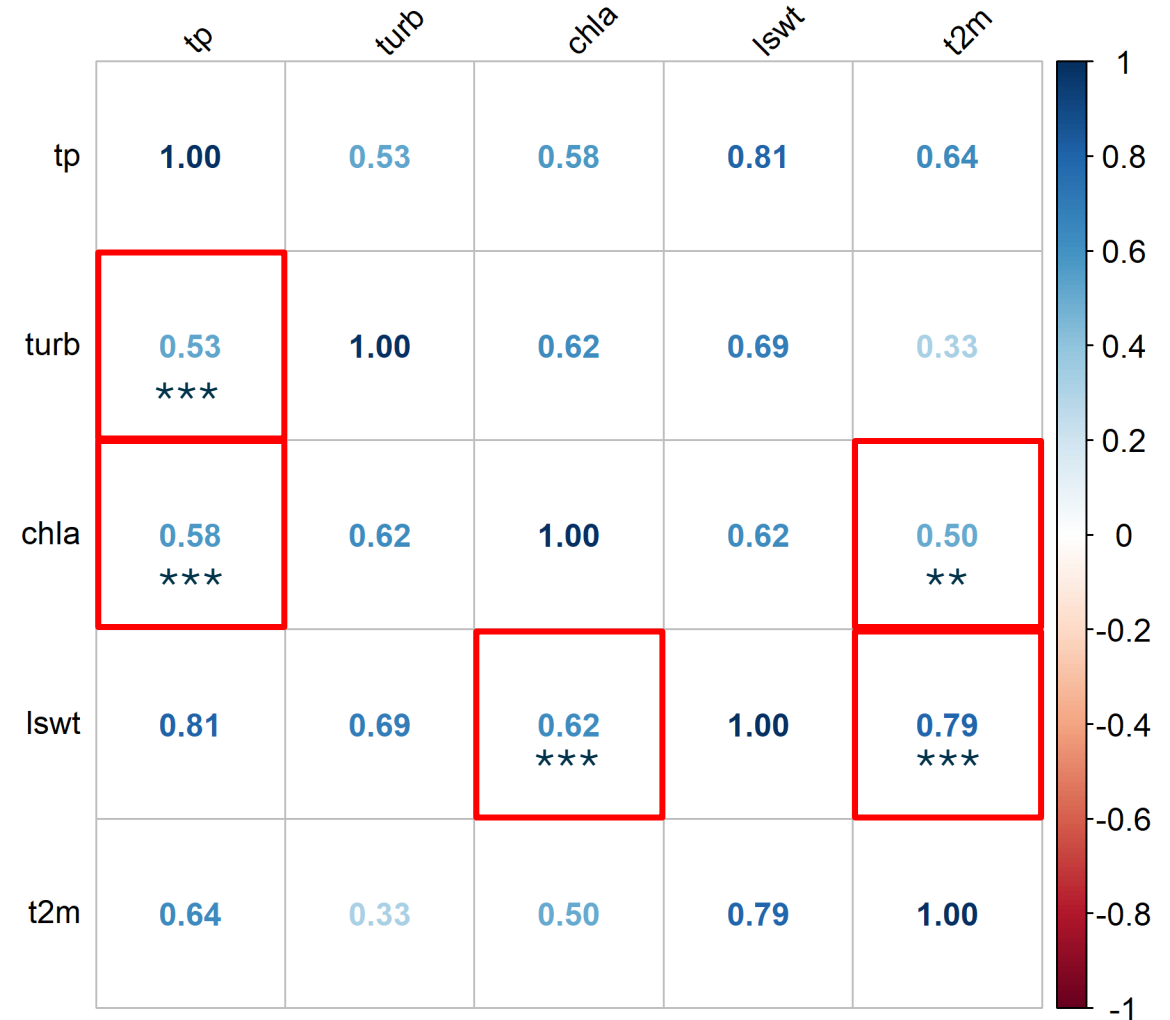




## 3. Effects on water quality

Significant positive correlations:

- Air temperature and LSWT
- Air temperature and chl-a
- LSWT and chl-a
- Precipitation and turbidity
- Precipitation and chl-a





# 1

High importance and demand for lake resources and other ES



# 2

1995 – 2020:  
Air temperature and cumulative precipitation increased for all lakes



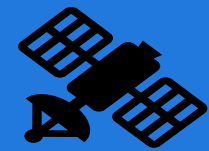
# 3

Water quality deteriorated in the context of the observed extreme weather events



# 4

RS is a powerful tool to continuously monitor water quality



## Morphology

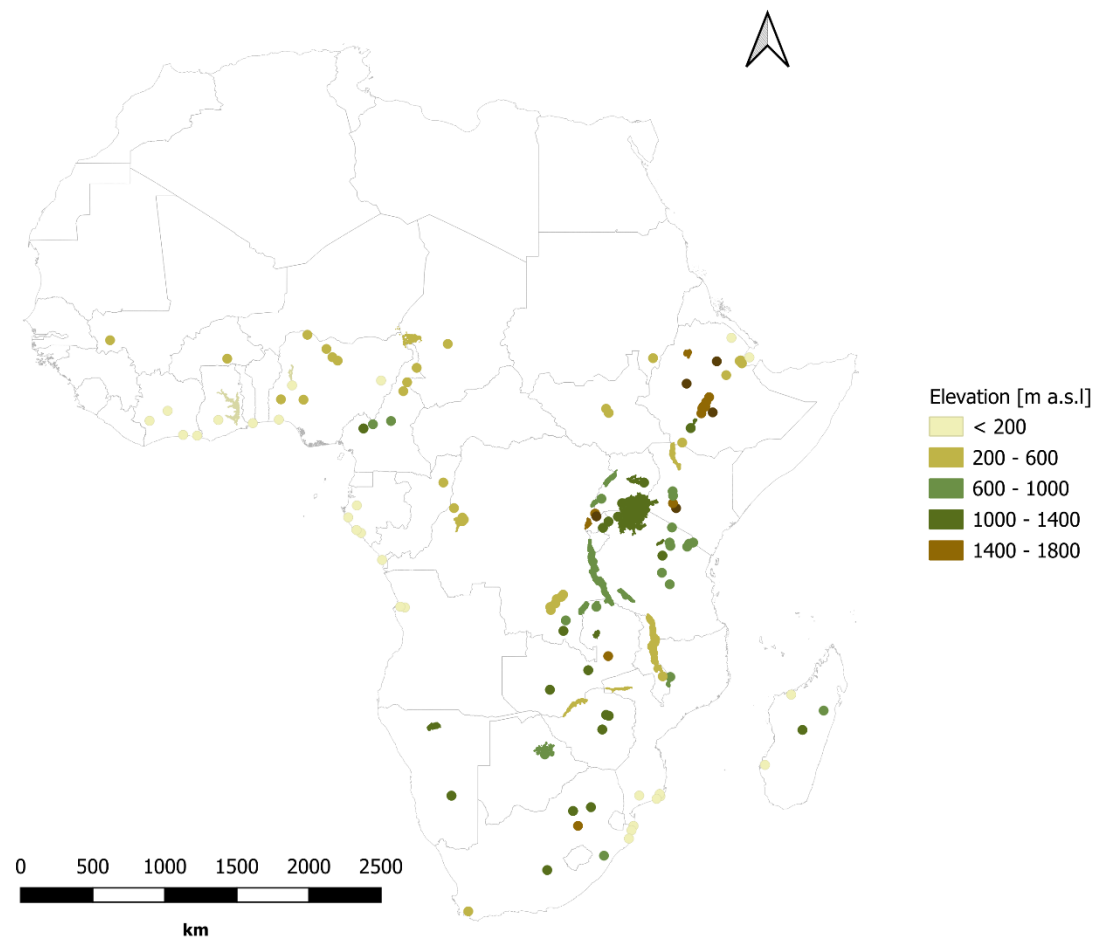
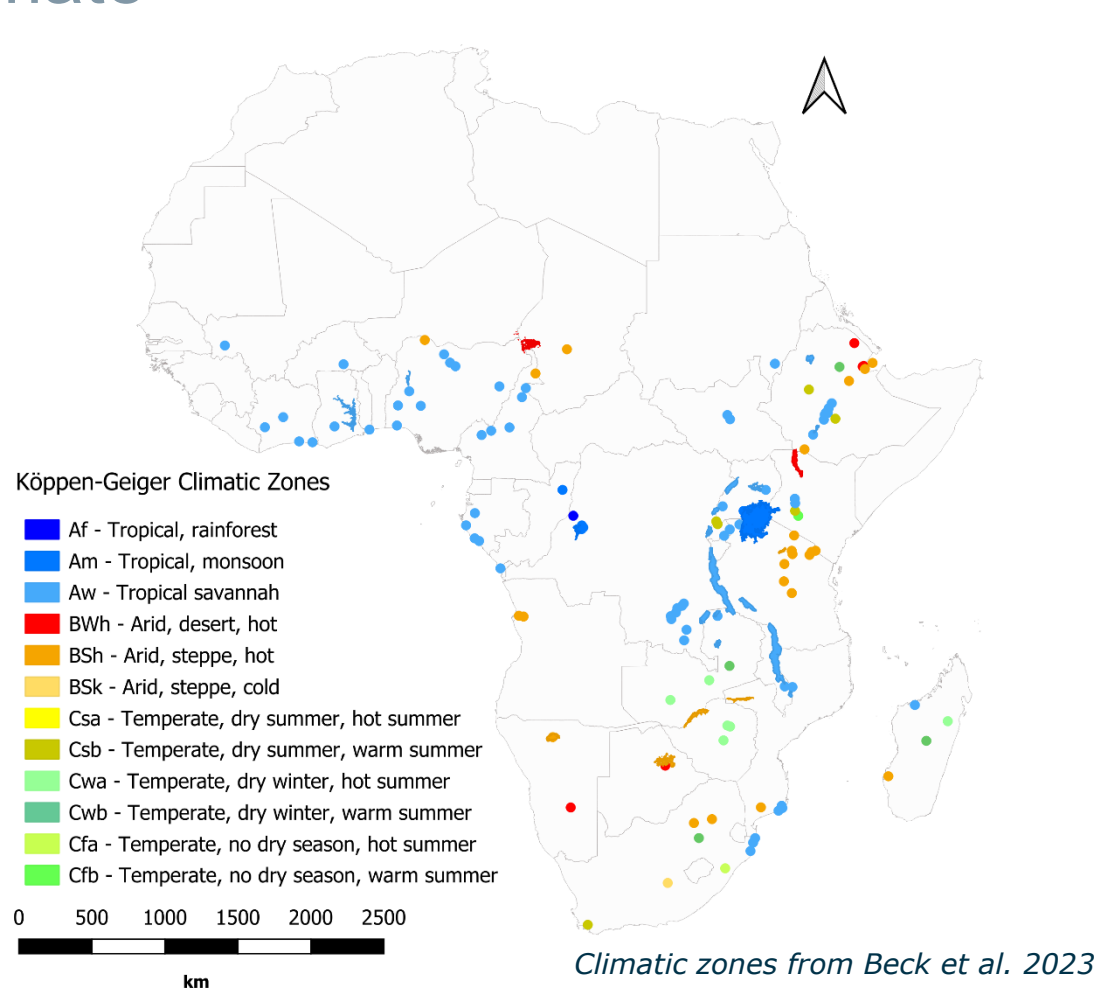
1. Explore the lakes\_cci dataset for sub-Saharan lakes
2. Perform a multivariate analysis spanning 20 years
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Is the information from global datasets suitable for such an assessment?

Are we trying to find answers to the right questions?  
How are Sub-Saharan lakes influenced by climate trends? Can we identify "sentinel" lakes?



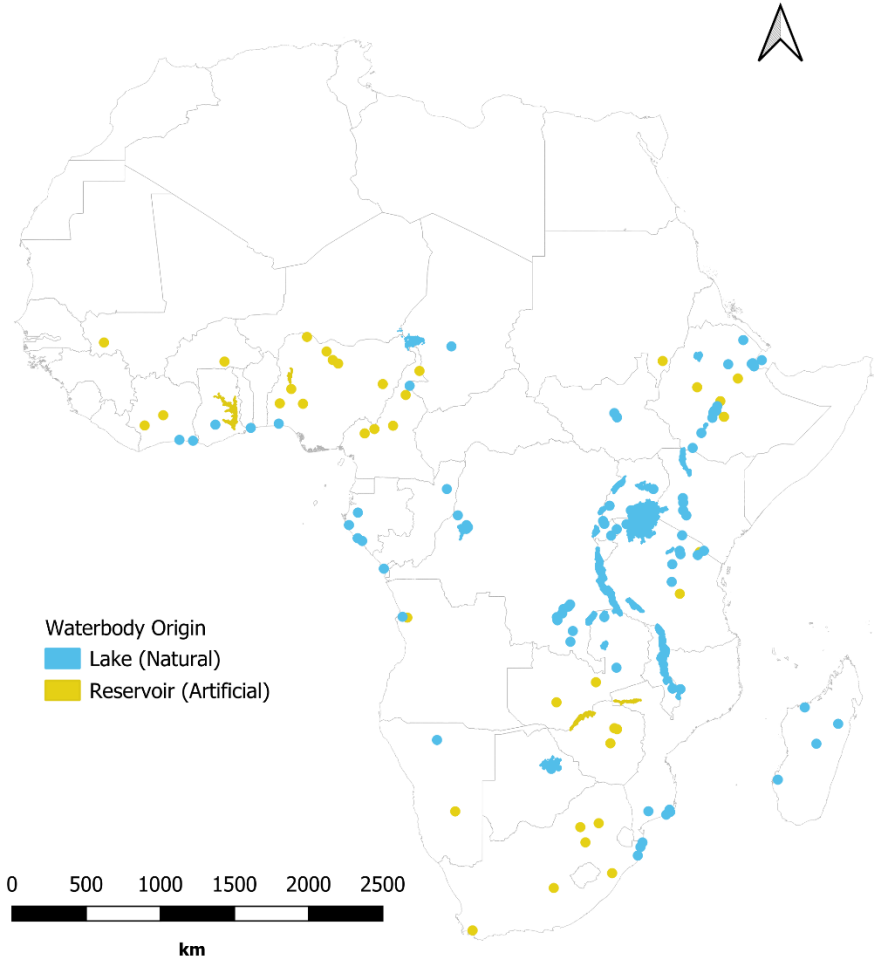
## Climate



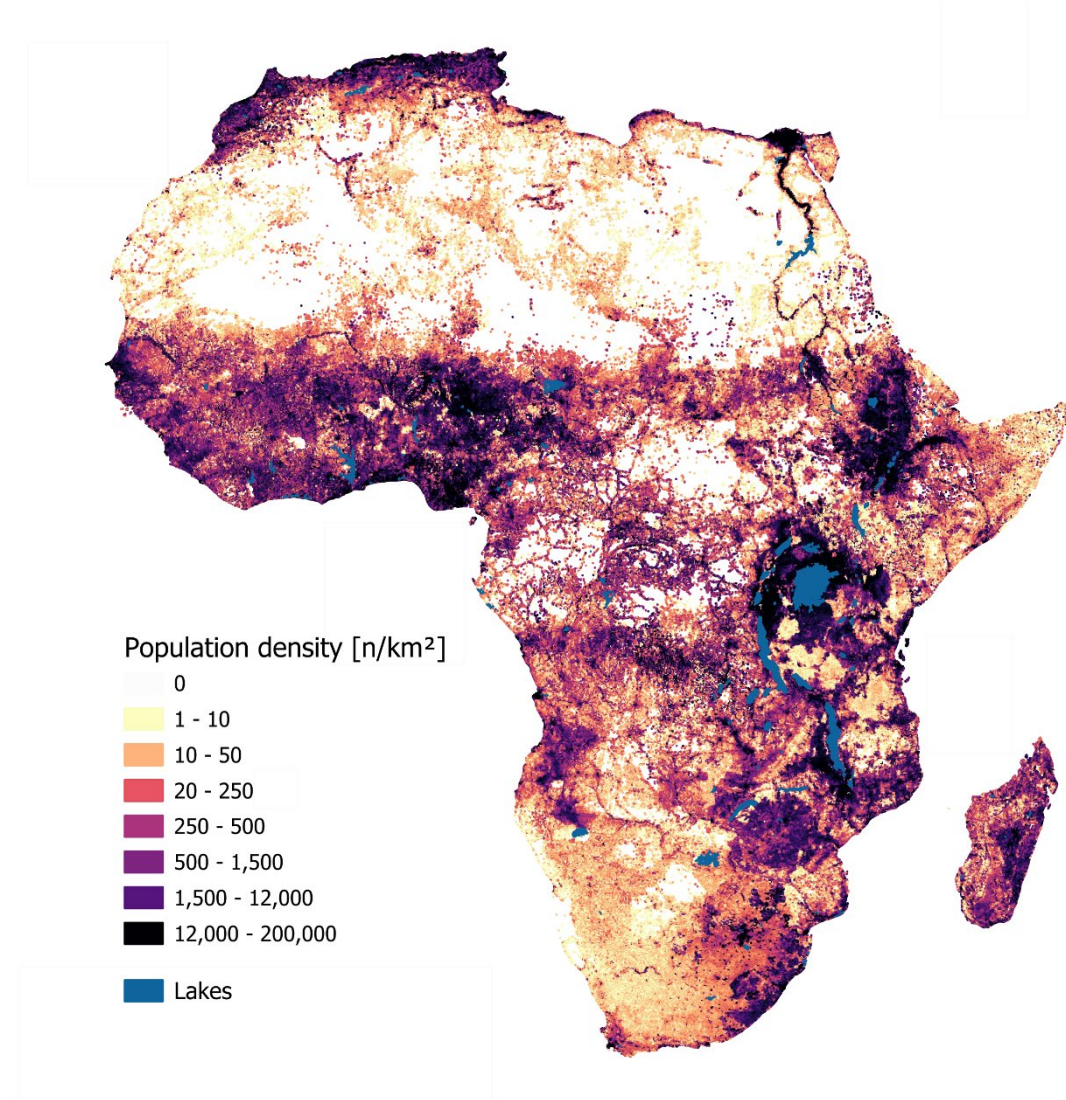
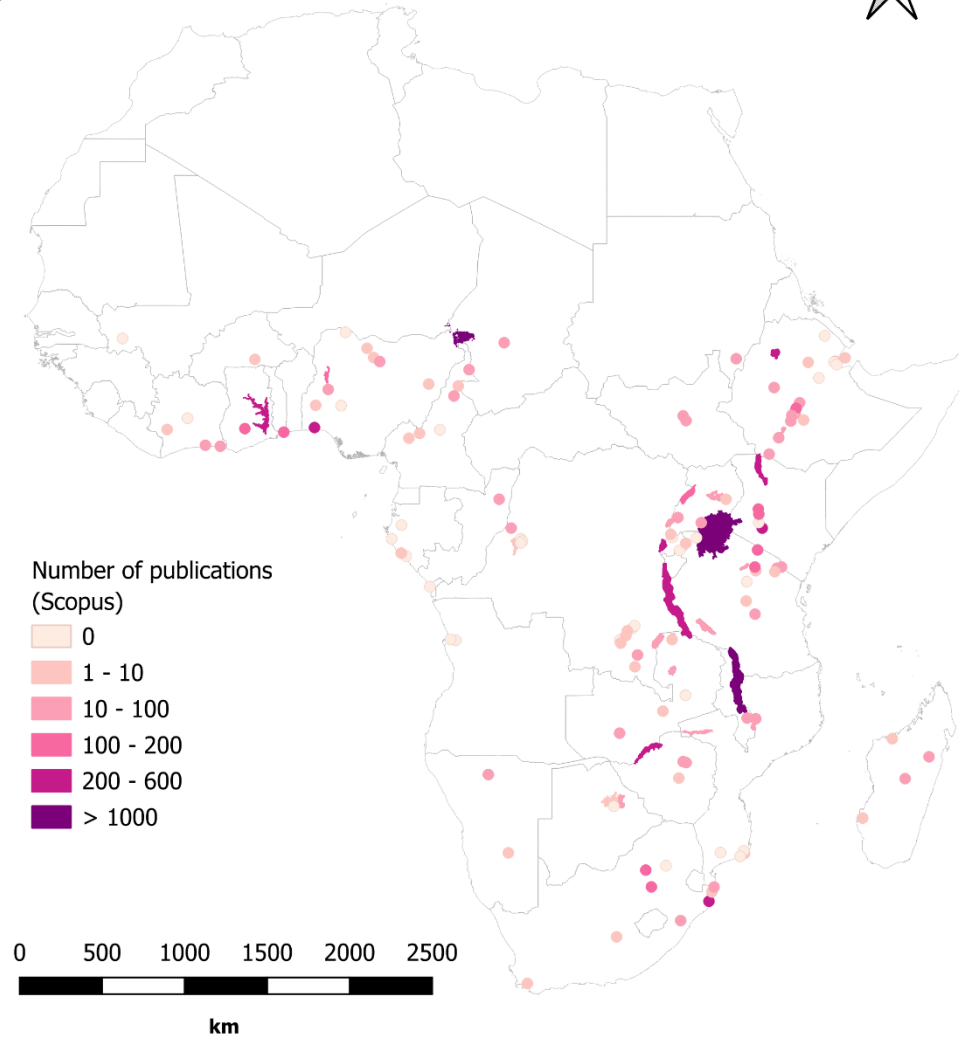




## Origin of lakes



## Population & Research



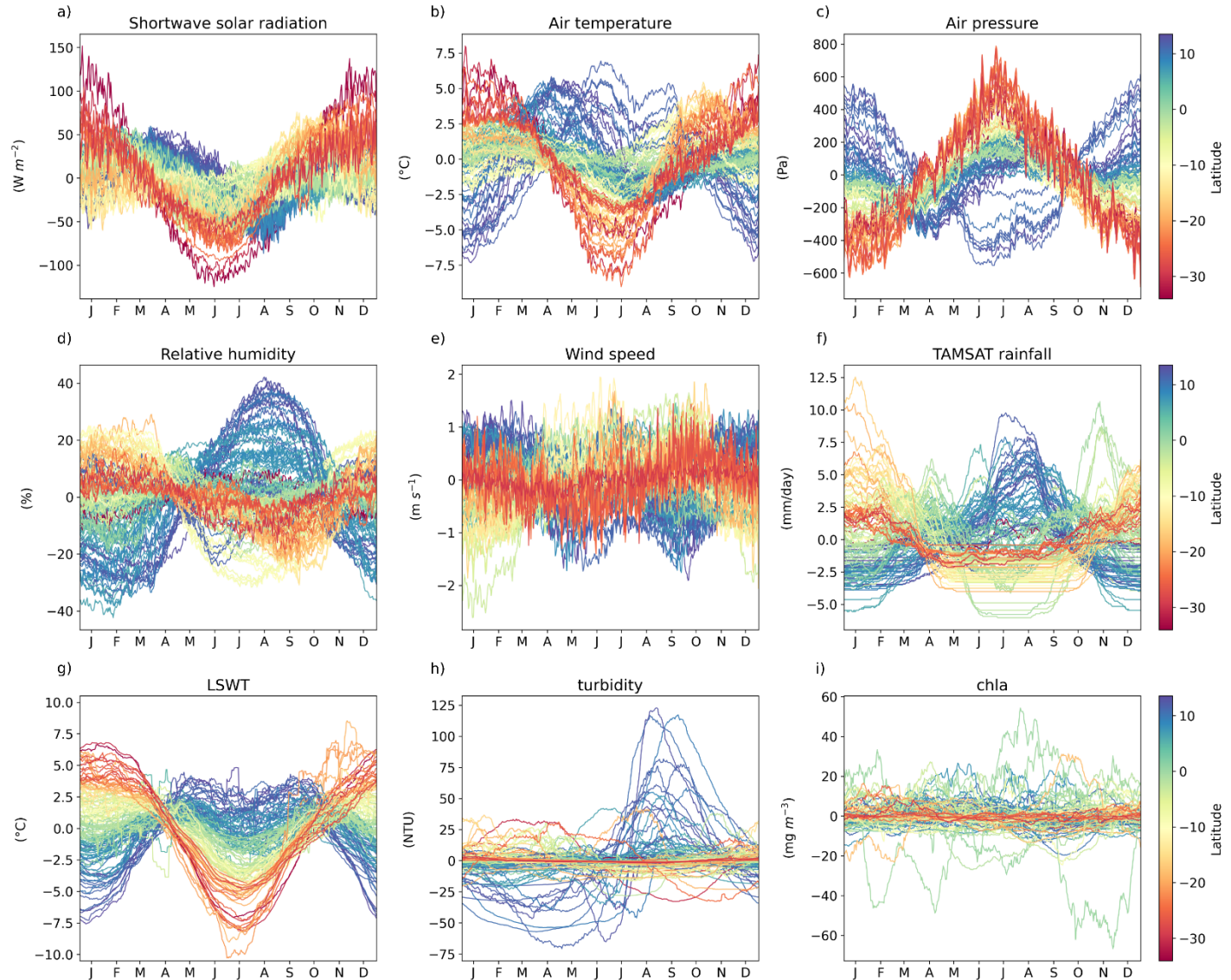
# Main climatic drivers



Climatology of all variables involved

Meteo variables from ERA5Land

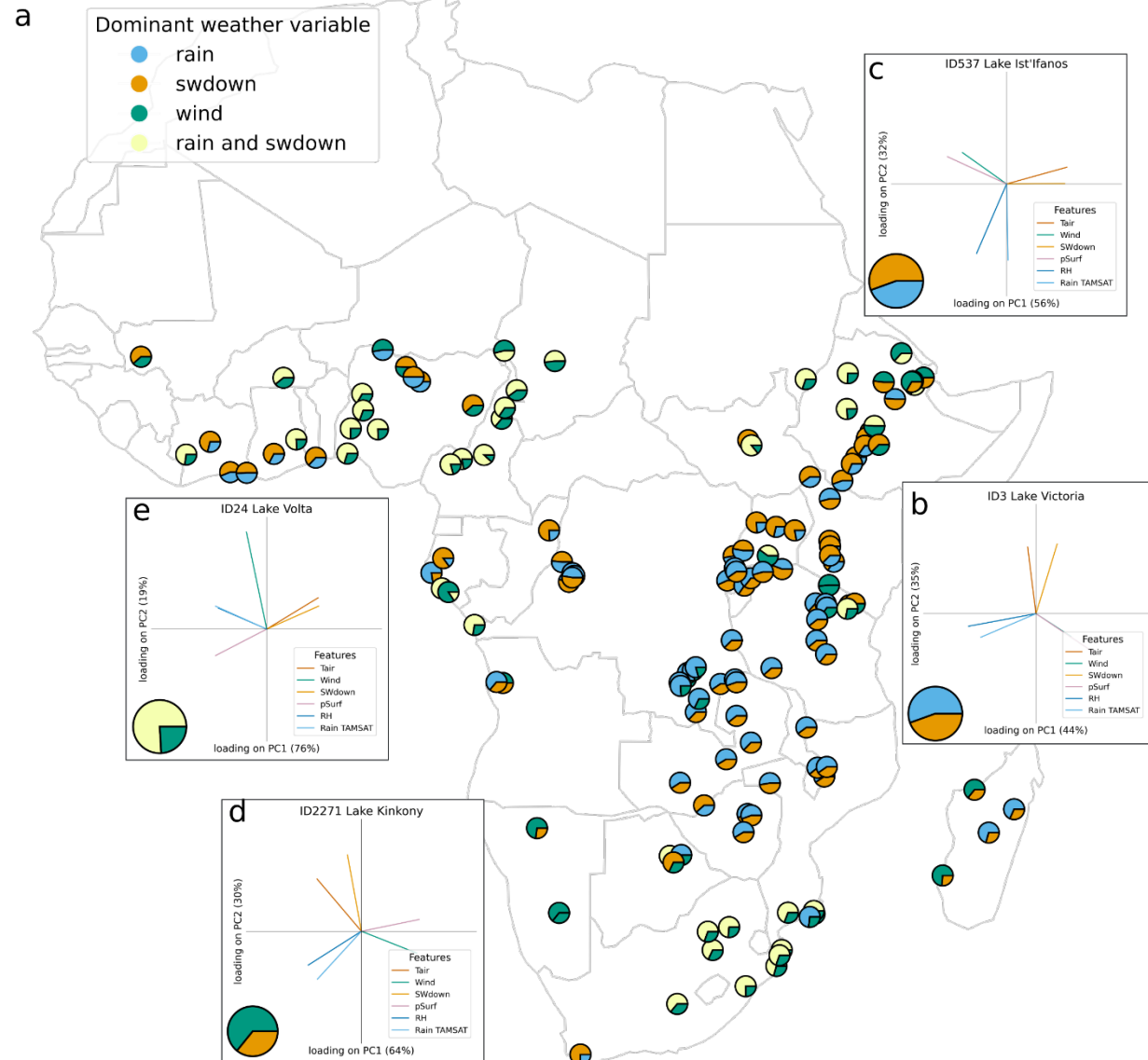
Rainfall from TAMSAT and CHIRPS



# Main climatic drivers



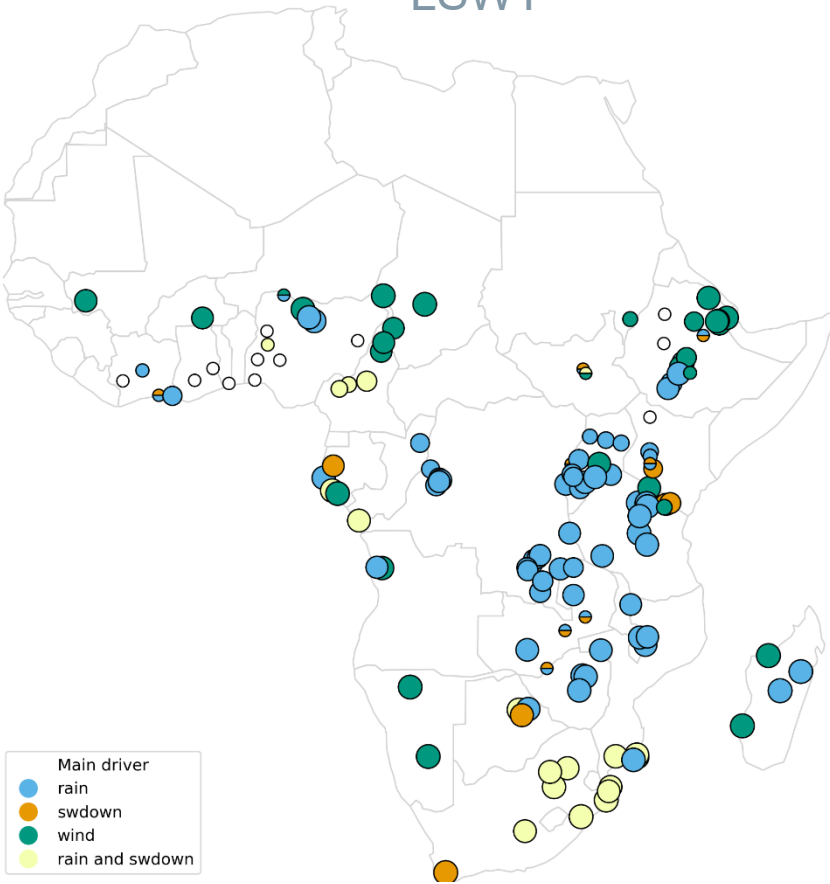
## Main climatic drivers across the regions



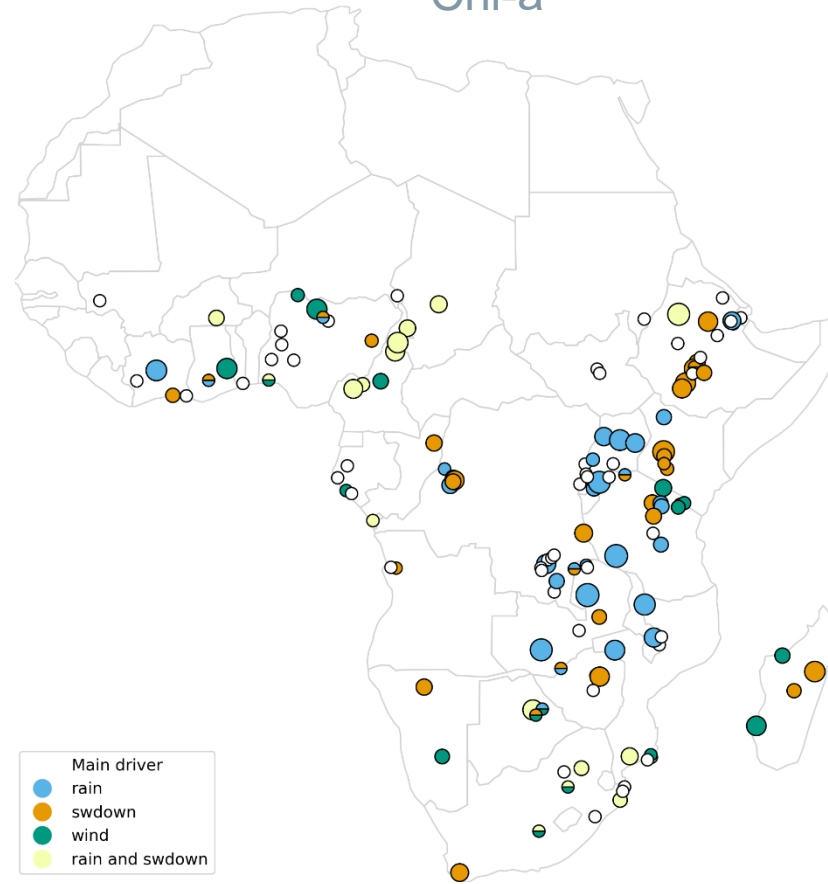
# Lake-climate interaction



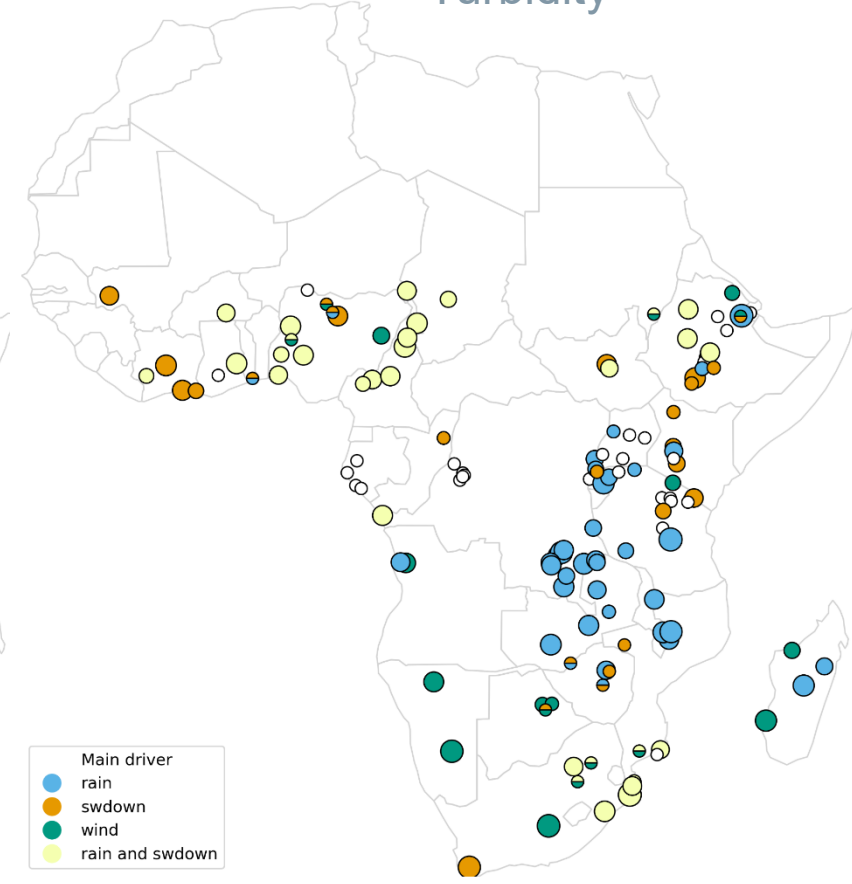
## LSWT



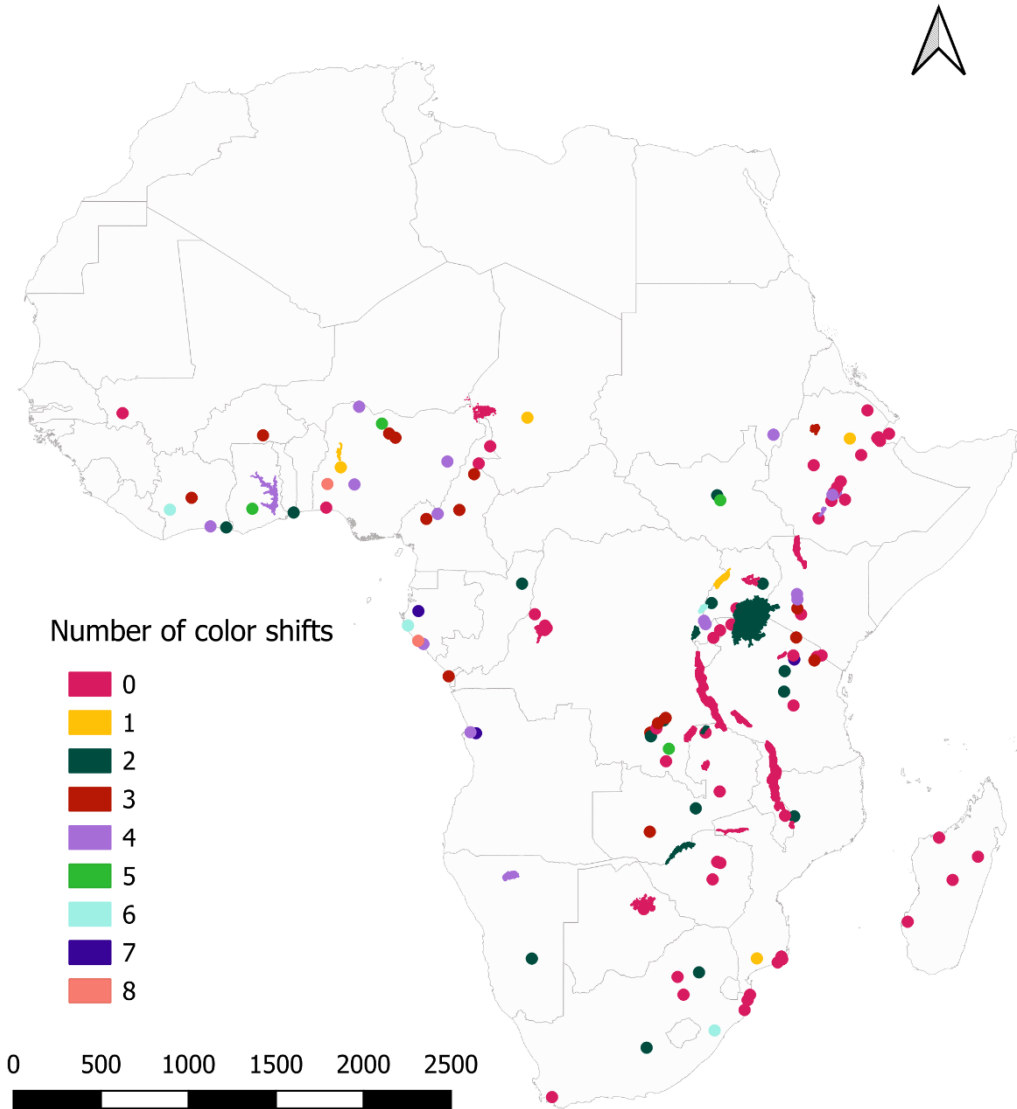
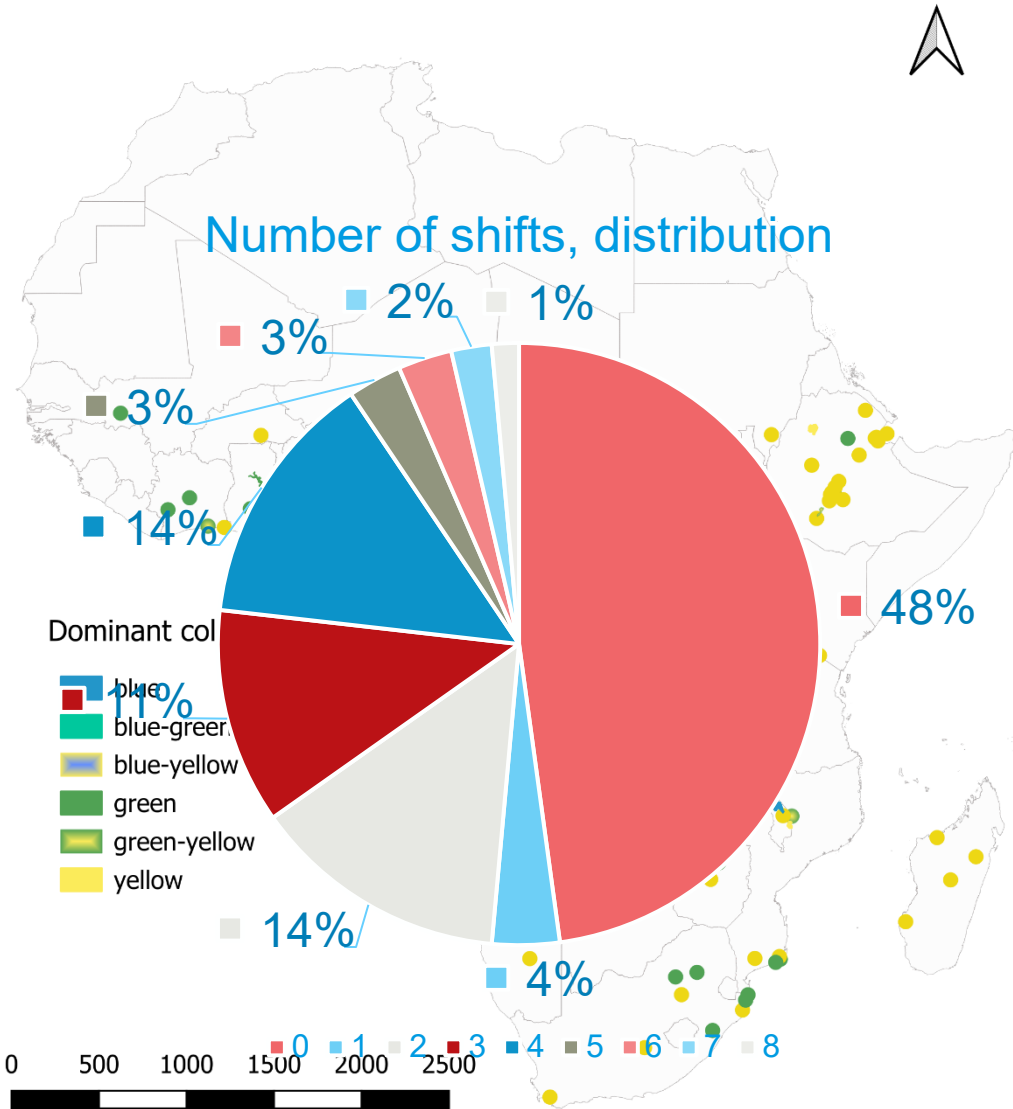
## Chl-a



## Turbidity



# Lake-climate interaction



# And what about the future...?



- Collaboration with local experts on individual lakes to assess our findings → interested? **Please reach out to us!**



GREIFE.J@IREA.CNR.IT; AMADORI.M@IREA.CNR.IT



# THANK YOU!

