Earth observation for investigating changes in water quality and Lesser Flamingo abundance in East African Rift Valley lakes

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Background – Rift Valley lakes

- Rift Valley is an active continental rift zone in East Africa

- Lakes range from freshwater to hypersaline, some are the most productive aquatic ecosystems on Earth

- Many lakes are endorheic and are sensitive to water quality changes

Background – Lesser Flamingos
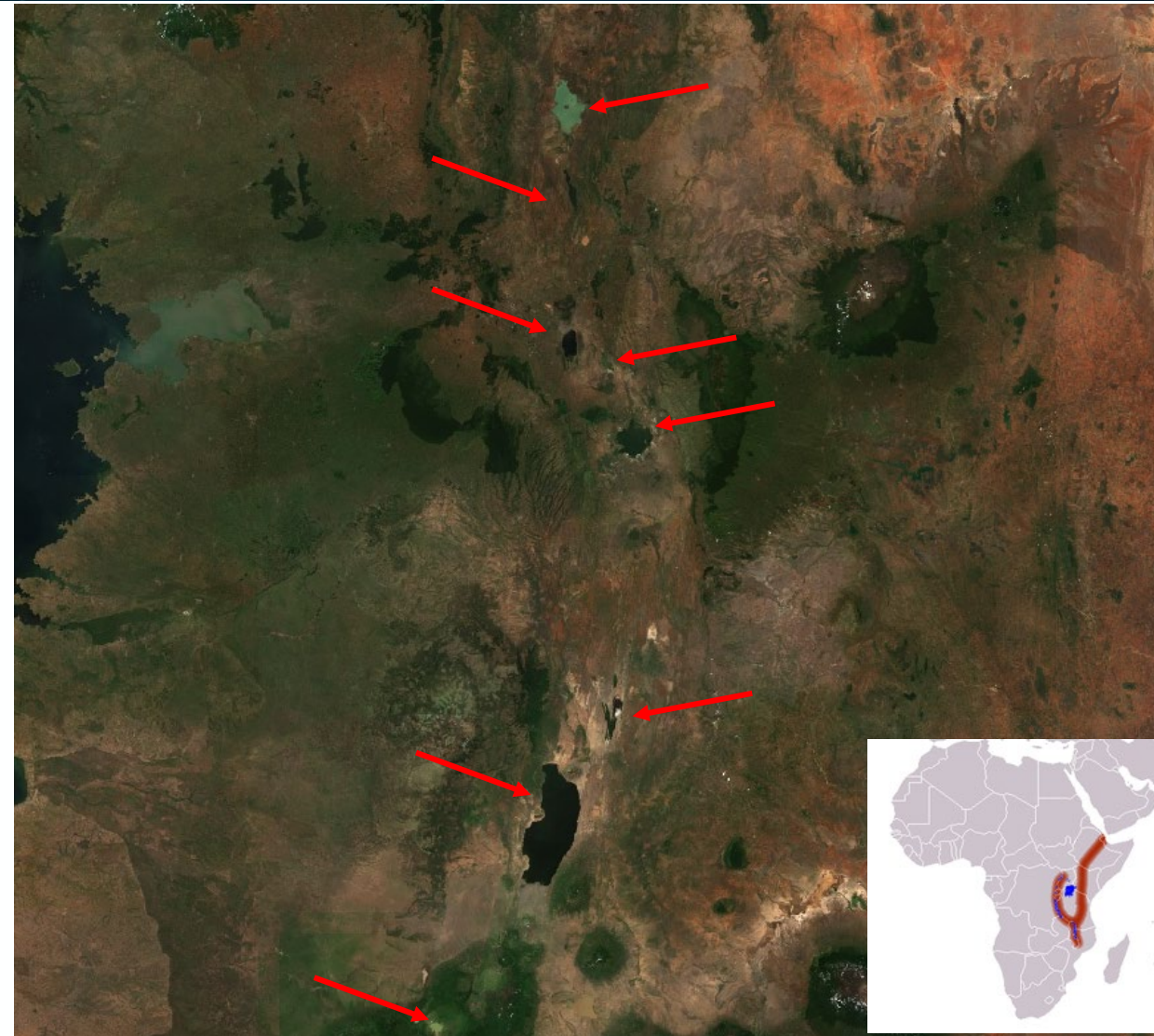
- >50% of Lesser Flamingos are found in the Rift Valley

- They are Near Threatened (IUCN) and are undergoing a moderately rapid decline (Birdlife International, 2018)

- Specialist diet of cyanobacteria found only in soda lakes

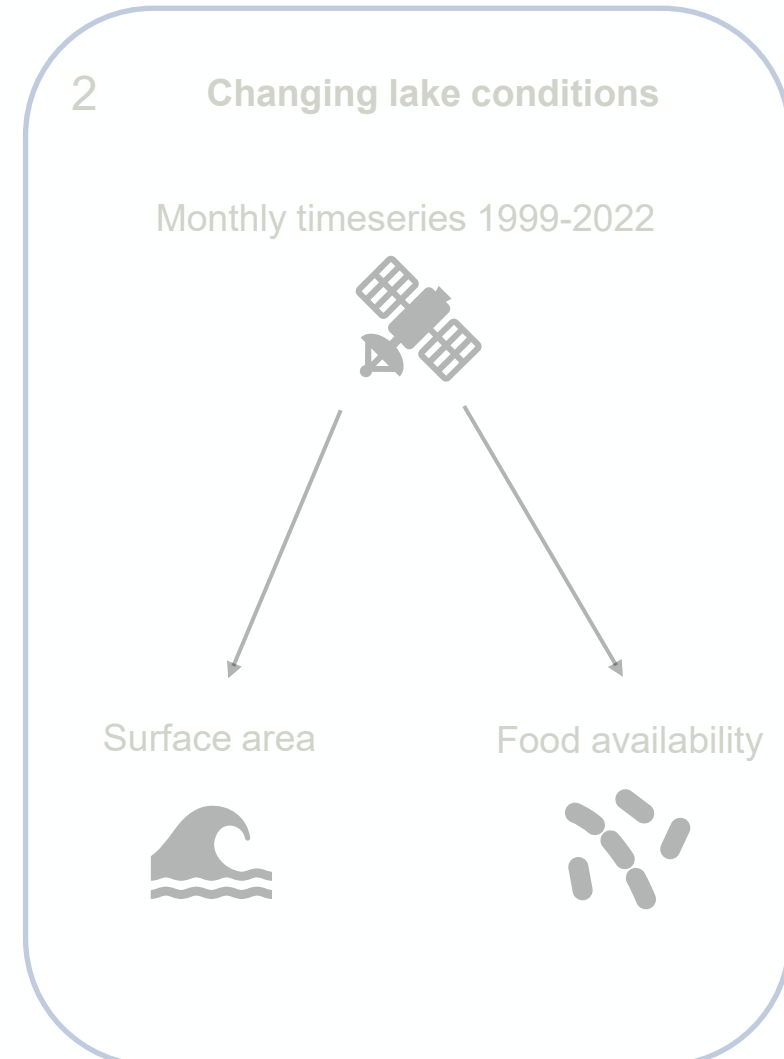- Nomadic movements are poorly understood so conservation is difficult
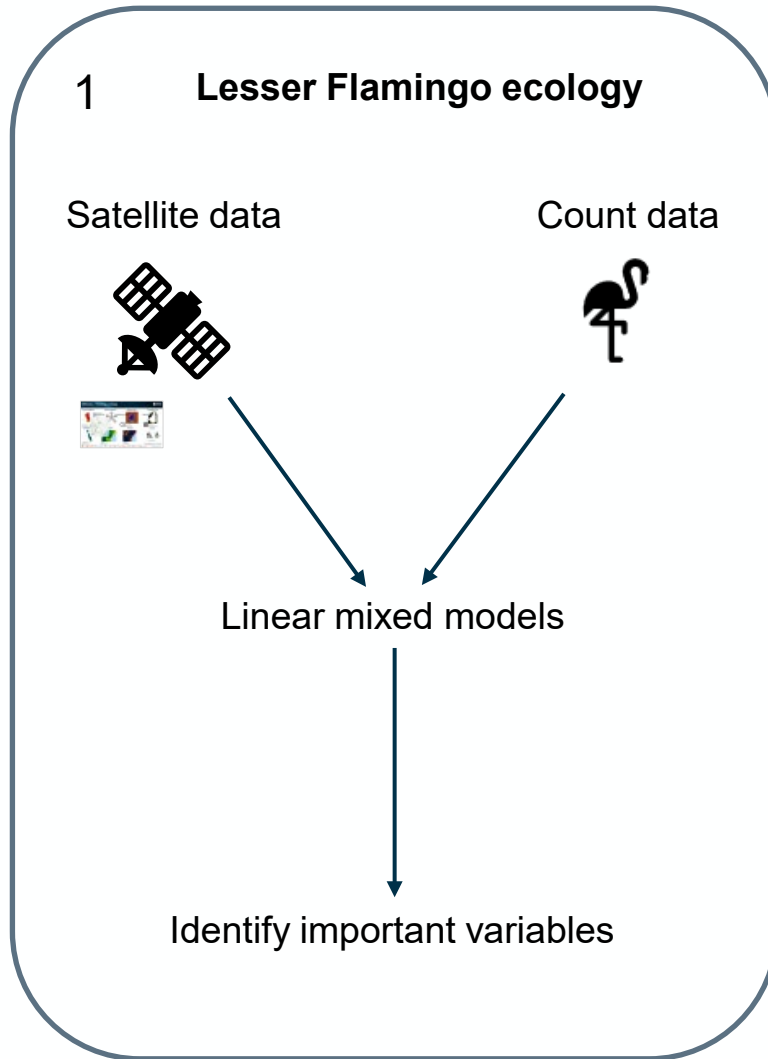
Research questions

1. How do food availability and other environmental drivers influence Lesser Flamingo distributions?

2. How are lake conditions changing?

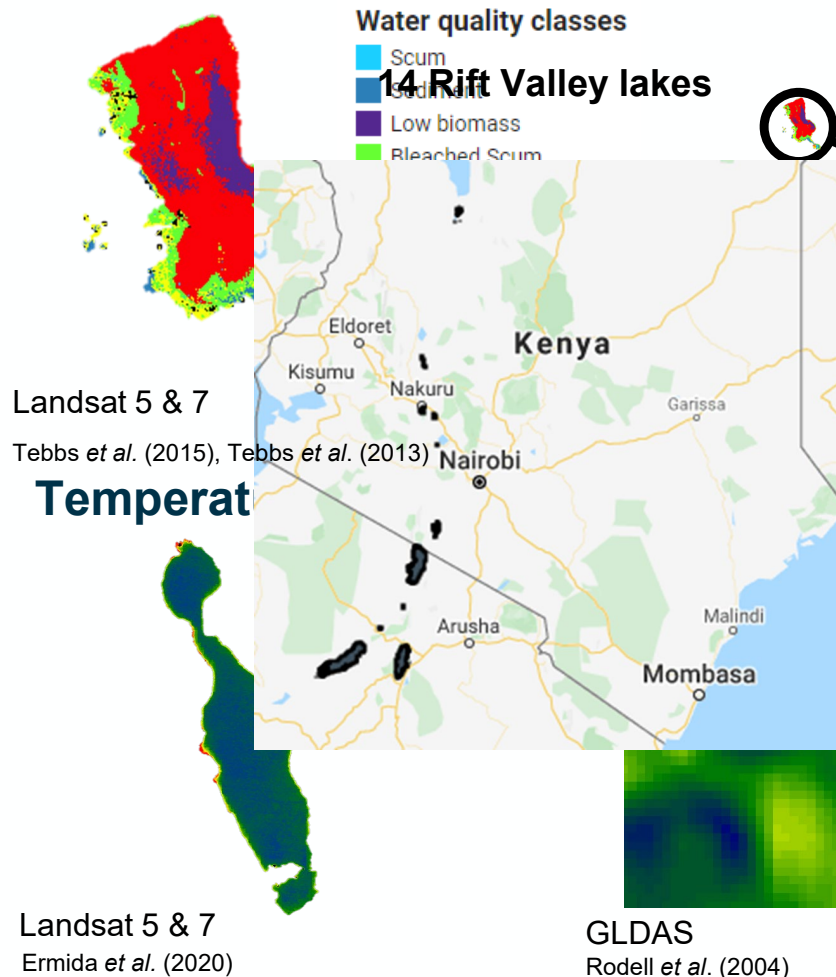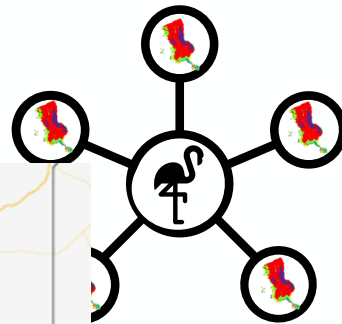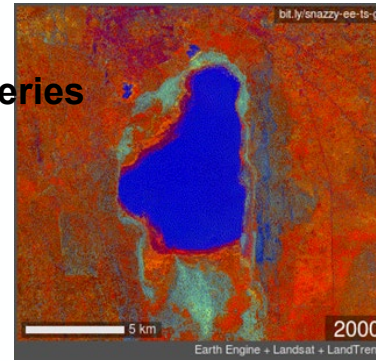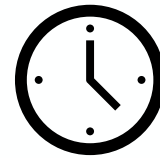3. What are the drivers of changing lake conditions?

Methods overview

1 — Lesser Flamingo ecology

1.

Satellite data   Count data

2.

Linear mixed models

Identify important variables

2 — Changing lake conditions

Monthly timeseries 1999-2022

Surface area   Food availability

Methods – Flamingo ecology

Food availability

Water quality classes
- Scum
- ~~Biomass~~
- Low biomass
- Bleached Scum

14 Rift Valley lakes

Landsat 5 & 7

Tebbs *et al*. (2015), Tebbs *et al*. (2013)

Food elsewhere

Monthly time series

...5 & 7

Surface area

Landsat 5 & 7

MNDWI - Xu (2006)

Predation risk

1990-2022

Landsat 5 & 7

NDVI - Kriegler *et al*. (1969)

Temperat...

Landsat 5 & 7

Ermida *et al*. (2020)

...speed

GLDAS
Rodell *et al*. (2004)

Rainfall
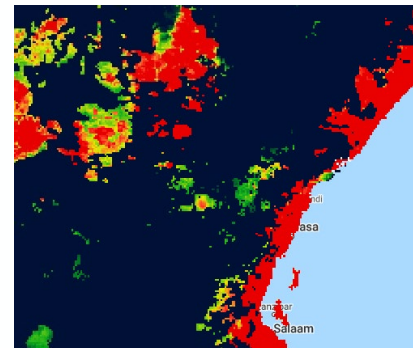
CHIRPS
Funk *et al*. (2015)

Season
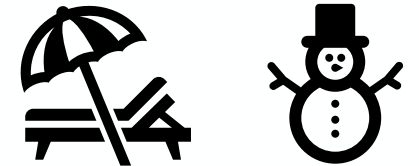
IWC count data

Google Earth Engine

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Methods - Classification
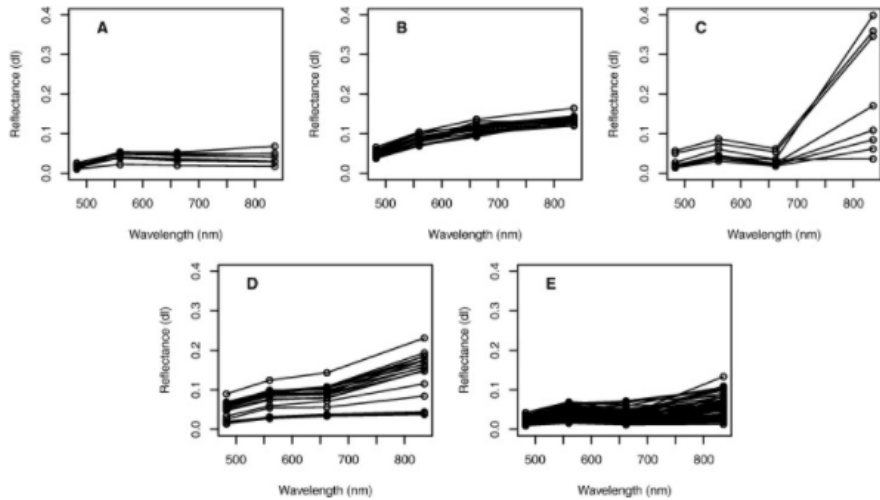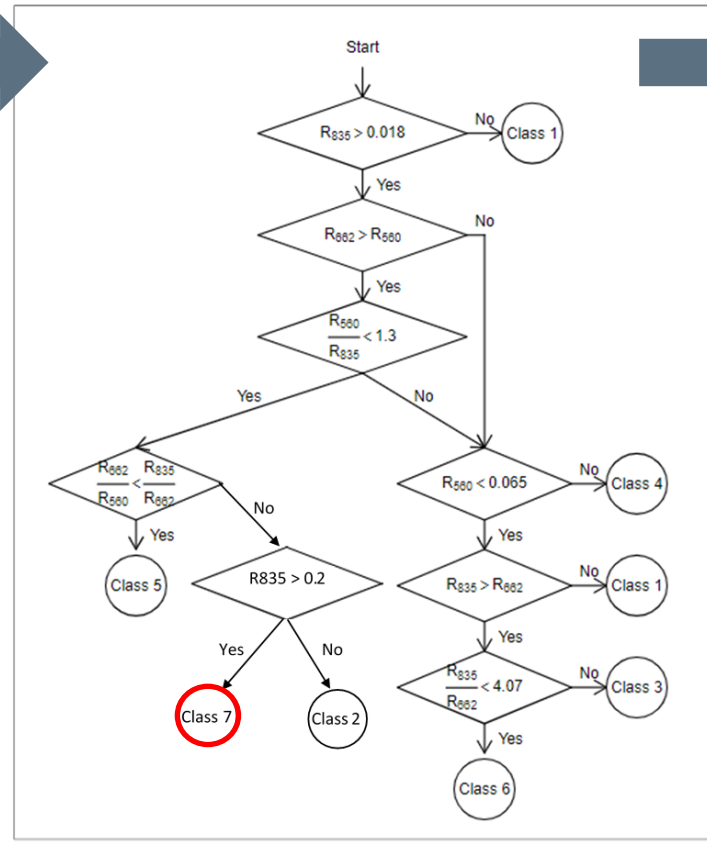
Workflow for classification of water quality and food availability

Download : Download high-res image (414KB)   Download : Download full-size image

Landsat 7 Bands 1-4 at Lake Natron salt crust 25/10/2000
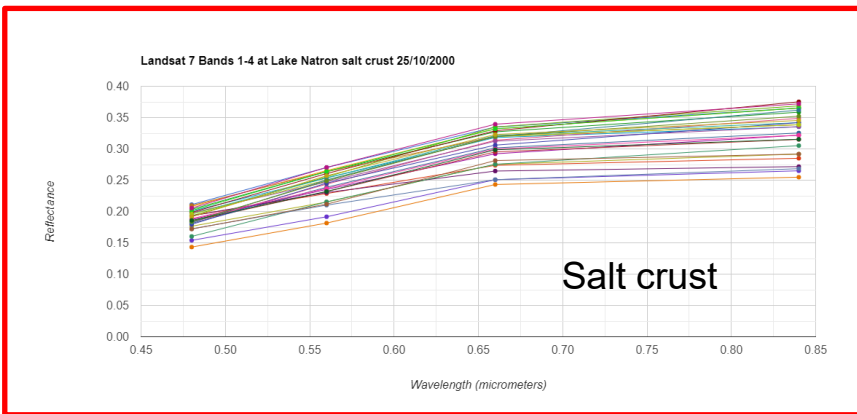
Salt crust

Lake Natron – July 2000
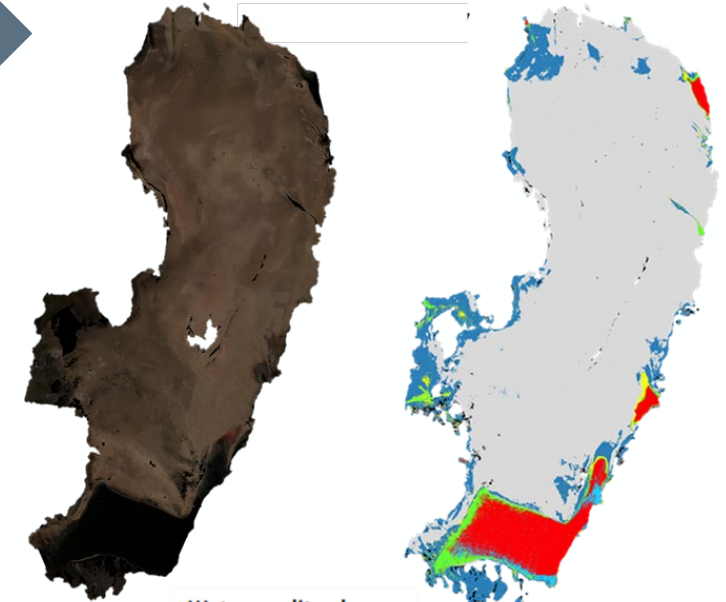
Water quality classes
- Scum
- Sediment
- Low biomass
- Bleached Scum
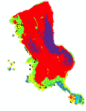- Microphytobenthos
- High Biomass
- Salt crust

Tebbs, E.J. *et al.* (2015) "Regional assessment of lake ecological states using Landsat: a classification scheme for alkaline-saline, flamingo lakes in the East African Rift Valley," *International Journal of Applied Earth Observation and Geoinformation*, 40, pp. 100–108.
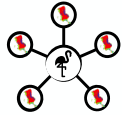
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Results – Lesser Flamingo ecology
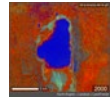
Methods overview

1 **Lesser Flamingo ecology**

Satellite data   Count data

Linear mixed models

Identify important variables

2 **Changing lake conditions**

Monthly timeseries 1999-2022

Surface area   Food availability

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Food availability

Surface area

Bogoria

Elmenteita

bit.ly/snazzy-ee-ts-gif

5 km

2000

Earth Engine + Landsat + LandTrendr
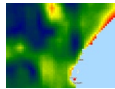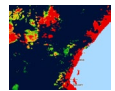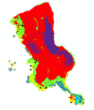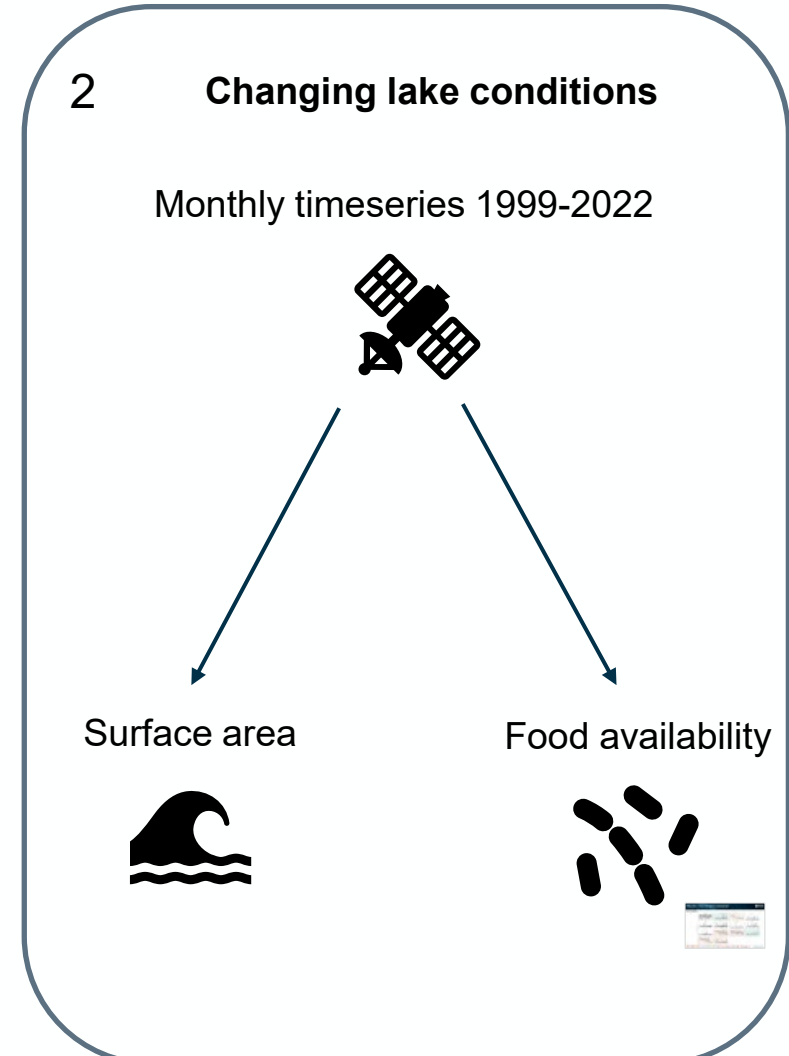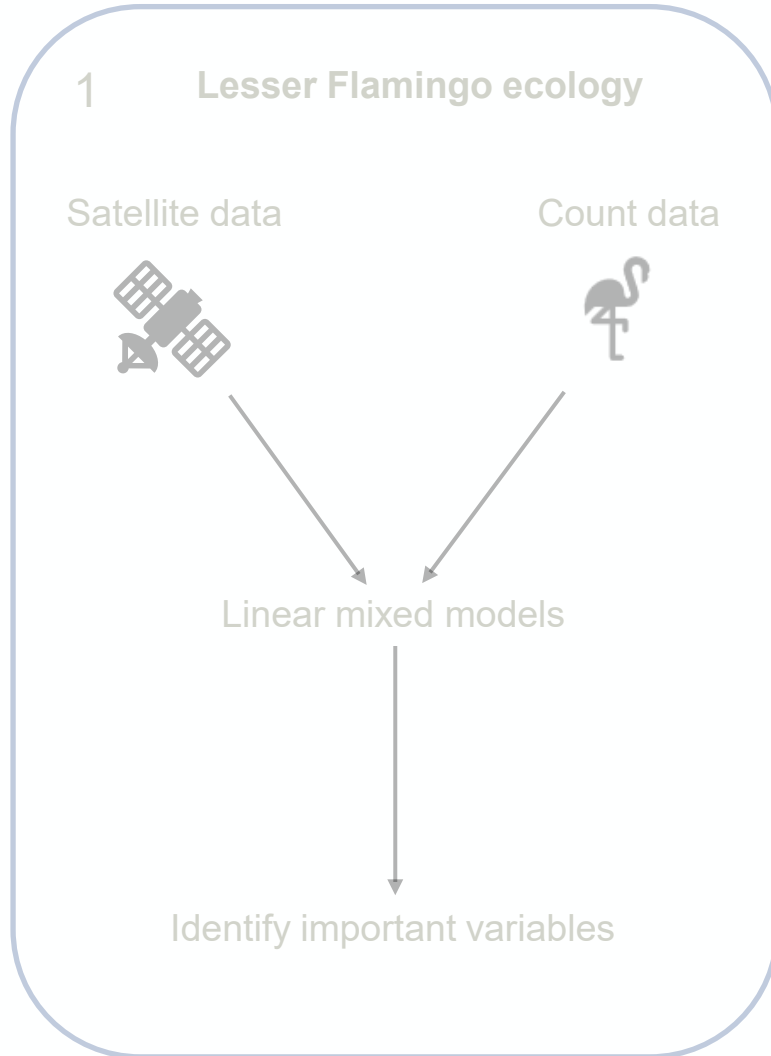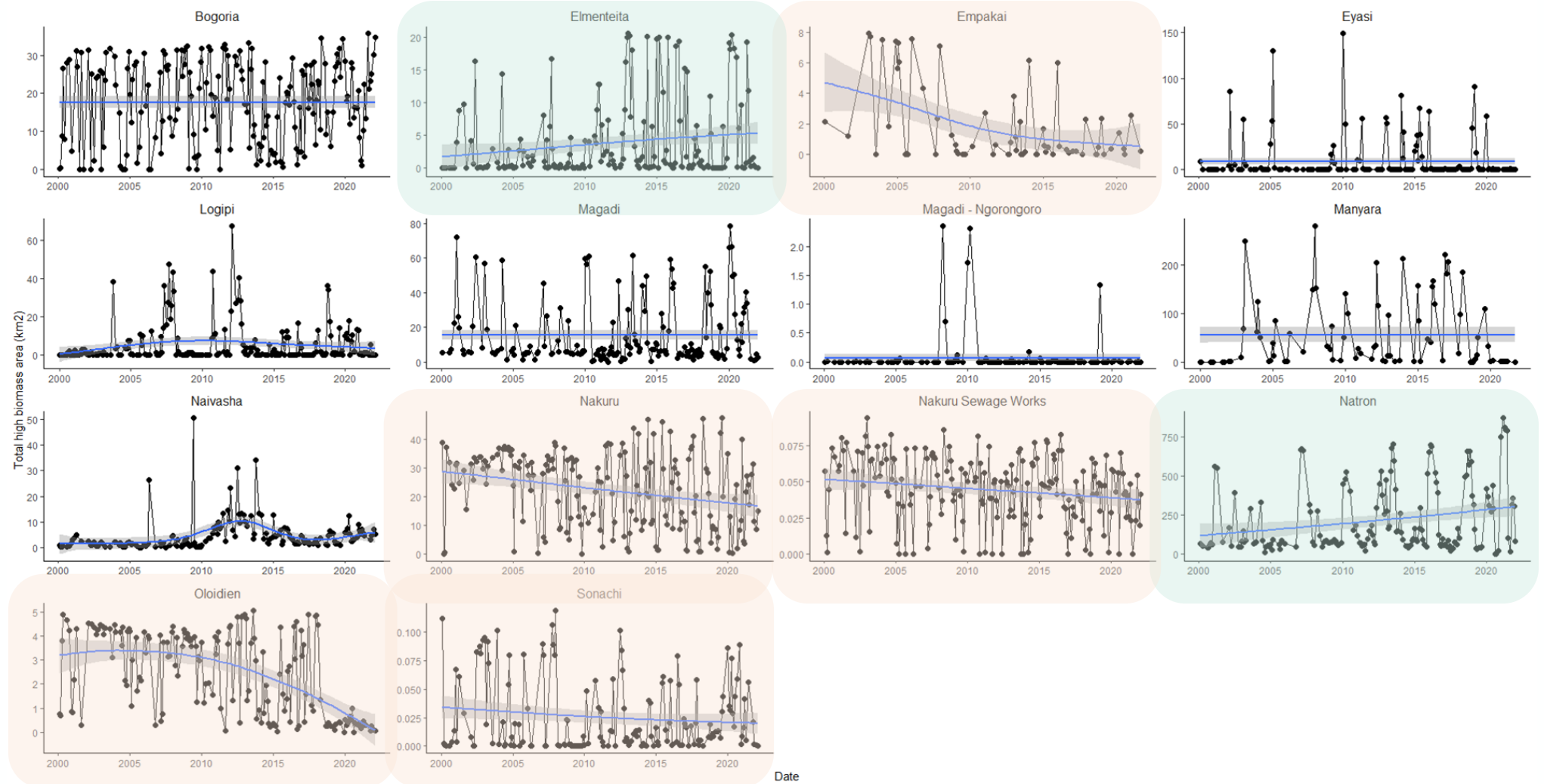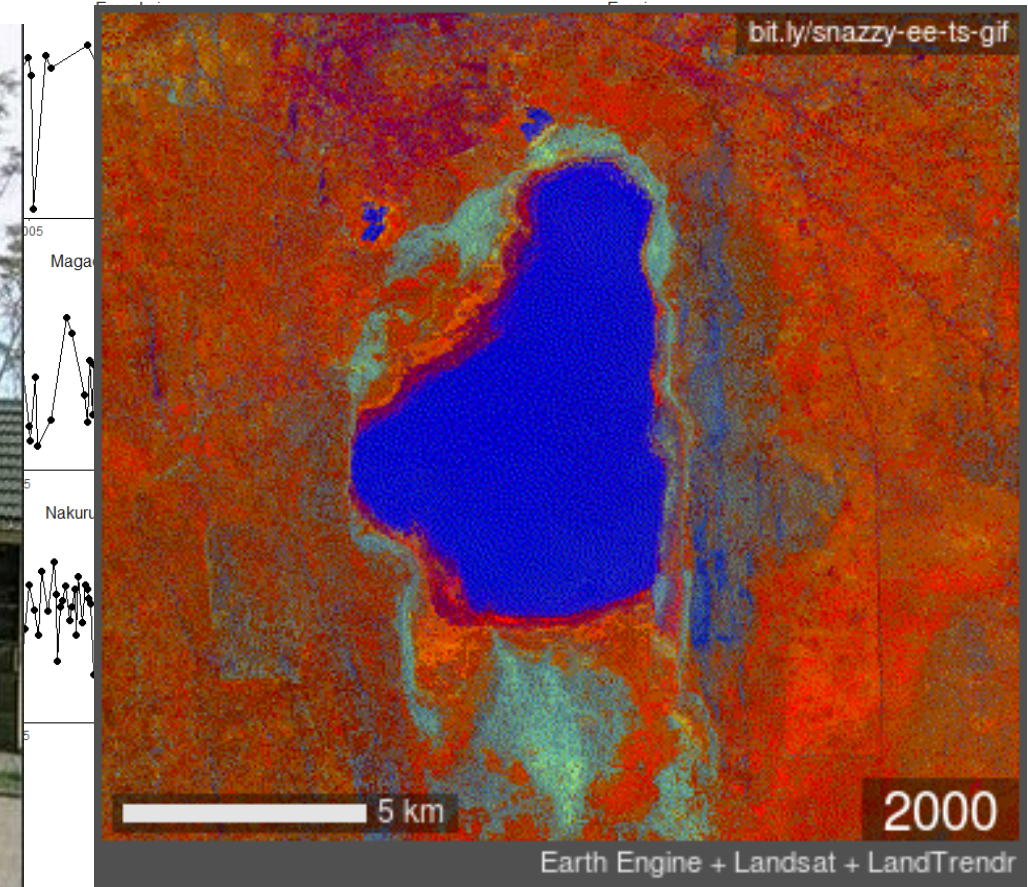
Lake Nakuru, Kenya, 2000-2021

Summary

- This study identified food availability, windspeed and predation risk as the key variables influencing Flamingo abundance

- Demonstrates the potential of using Landsat imagery and optical classification for long-term monitoring of inland lake water quality and ecology

- Next step is to investigate the drivers of changing lake conditions

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