Optical remote sensing of Lake Victoria

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Introduction

- Lake Victoria is the world's second largest freshwater lake; covering 68,800 km^2
- The lake serves as an important biodiversity hotspot and serves local fisheries (Hecky et al. 2010)
- Lake Victoria is currently under severe human pressure e. g eutrophication, over-exploitation, pollution and species introduction, which threatens ecosystem functioning
- Research links the decline in species diversity to water transparency controlled by total suspended matter, floating vegetation, algal blooms, and colored dissolved matter (Kolding et al. 2008)
- The large size of the lake makes it expensive and time-consuming to monitor, thus effective management of the lake is hampered

Research Objective: To demonstrate the suitability of using inexpensive and consistent remotely sensed satellite data to enhance management of Lake Victoria by providing thematic products such as maps of floating vegetation, SPM, and water transparency.

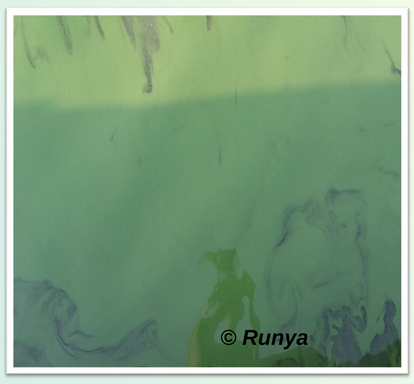

Plate 1: Algal bloom

Plate 2: Turbid waters

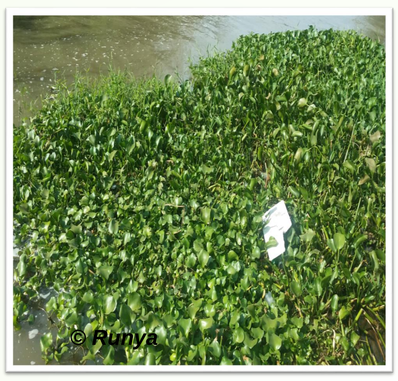

Plate 3: Water hyacinth mat

Methodology

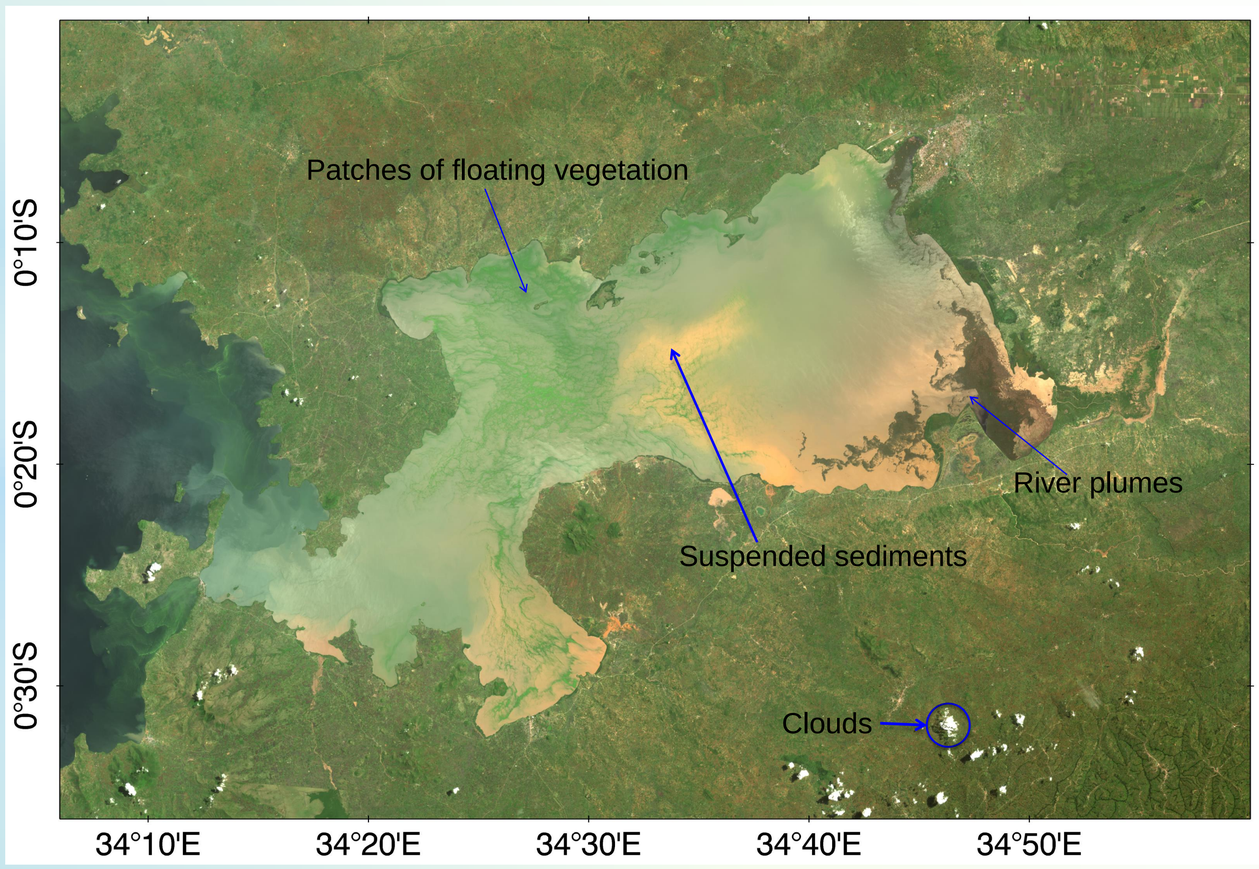

Fig 1: An RGB composite Landsat-8 image of Winam Gulf showing the different optical features observed from Landsat scene (LC81700602013109LGN01) captured on 19-APR-2013. The image was processed using ACOLITE (https://odnature.naturalsciences.be/remsem/software-and-data/acolite) and downloaded from the USGS website (http://earthexplorer.usgs.gov/)

Preliminary Results & Discussion

(i) Water-Leaving reflectance

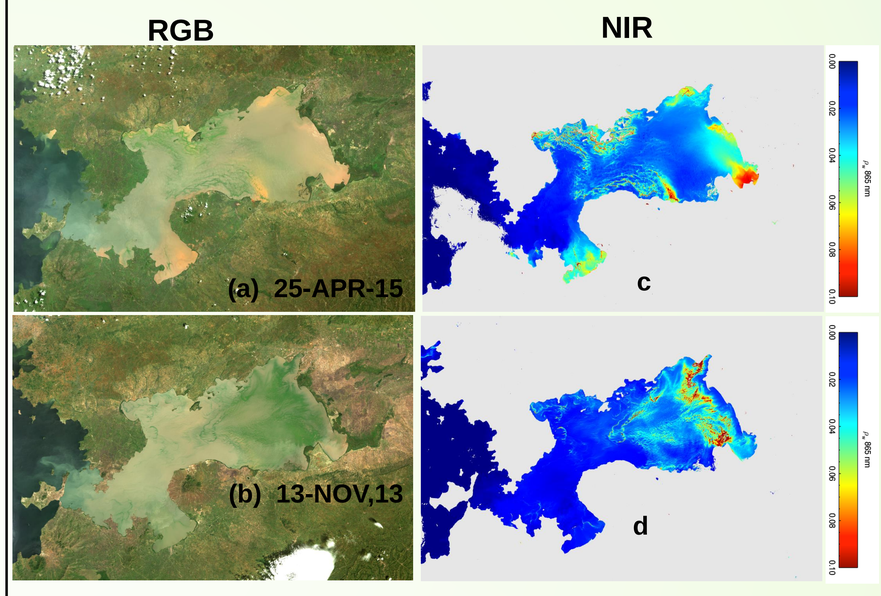

Fig 2: Landsat-8 RGB images (a & b) and water-leaving reflectance at 865 nm (c & d), scene LC81700602015115LGN00 and scene LC81700602013333LGN00 respectively. Images were processed using ACOLITE.

- Clear water normally appears blue since it has higher light absorption at longer wavelengths than at blue wavelengths.
- Suspended particulate matter (SPM) and floating vegetation cause a higher reflectance in the near-infrared band.

(ii) Floating vegetation

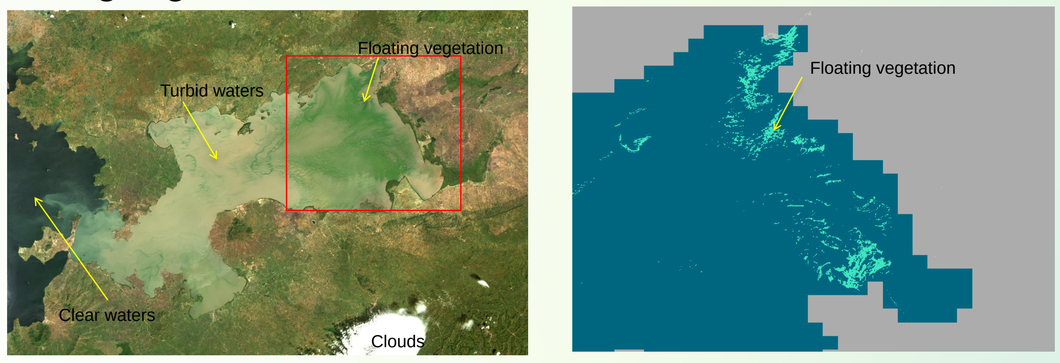

Fig 4: A mask (right image, subset shown on the left image) showing the area covered by floating vegetation in green (scene LC81700602013333LGN00). The vegetation pixels were calculated based on the mathematical expression (ρ_{rc} 865 - ρ_{rc} 655) > 0.05 and ρ_{rc} 1609 < 0.0215, which takes into account the the chl-a absorption in the red band and the reflectance in the NIR and SWIR bands (865 and 1609).

(iii) Reflectance spectrum

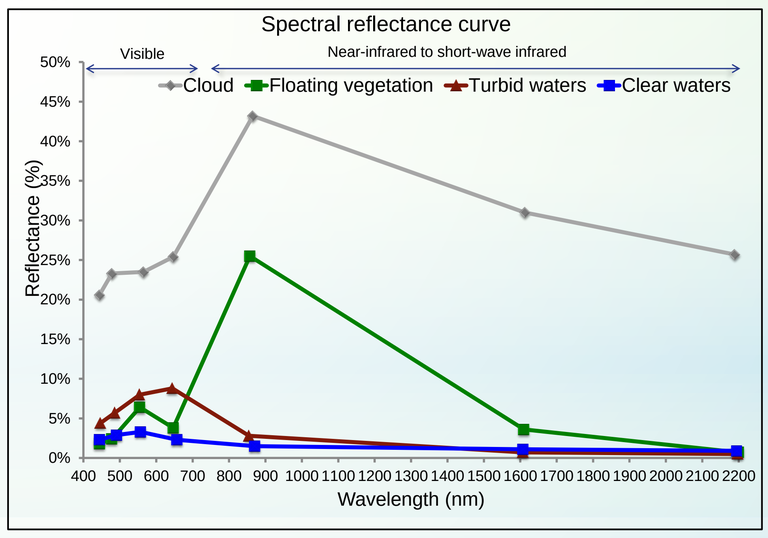

Fig 3: A plot showing the Rayleigh-corrected reflectance of different features observed in the image LC81700602013333LGN00.

- Turbid water (red line) contains suspended particulate matter which scatters light in the red and NIR part of the spectrum.
- The vegetation spectrum (green) shows reflectance peaks in the green (561 nm) and NIR (865 nm) bands, and a chlorophyll-a absorption in the red (665 nm).
- Cloud reflectance (grey) is much higher than water reflectance.

Conclusion

- Optical remote sensing (RS) makes use of sensors that image the earth's surface in visible, near infrared (NIR) and short-wave infrared (SWIR) wavelengths.
- The color of the water is influenced by its constituents such as SPM, phytoplankton, floating vegetation, and CDOM that scatter and absorb light differently across the spectrum.
- This enables the unique identification of optical features using their different spectral reflectance signatures in the remotely sensed imagery.
- Seasonal differences in the optical properties of Winam Gulf are detected by Landsat-8.
- Cloud cover impacts data availability but remote sensing products will be useful in supporting long-term environmental monitoring and management of L. Victoria.

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References

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