Anthropogenic Activities Control Rainfall Nitrate in the Lake Victoria Basin, Kenya

Benjamin Nyilitya[1 2], Catherine Mathenge[2], Ann Karuma[2], Stephen Mureithi[2]

[1]Water Research & Data Division, Ministry of Water, Sanitation and Irrigation, Nairobi, Kenya

[2]Watershed Hydrology Research Lab, Dept. of LARMAT, University of Nairobi, Kenya

Introduction

The Lake Victoria, Africa's largest fresh water lake experiences eutrophication related problems like the rapid proliferation of water hyacinth, algal blooms, water quality degradation, and decrease in fish population. This is closely linked to excess nutrient discharge in the lake's basin which is shared by five countries in Eastern Africa. Recently studies have been contacted to investigate nitrate flows and their potential sources in surface and groundwater on the Kenyan part of the basin [1, 2]. However, no studies have been performed to investigate the sources of atmospheric nitrogen in the basin, in spite of atmospheric deposition being reported as the main path way of nitrogen deposition in to the lake [3].

Objective: To study rainfall nitrate concentrations and potential sources in the Lake Victoria basin, Kenya

Methods

Weather data and rainfall samples were collected in a weather station located along river Nyando, a tributary of Lake Victoria (Figure 1). Samples were collected per rainfall event and per month for the period between April 2019 and May 2021. Laboratory analysis for nitrate concentration was conducted using an ion chromatogram at the Watershed Hydrology Research Lab, University of Nairobi

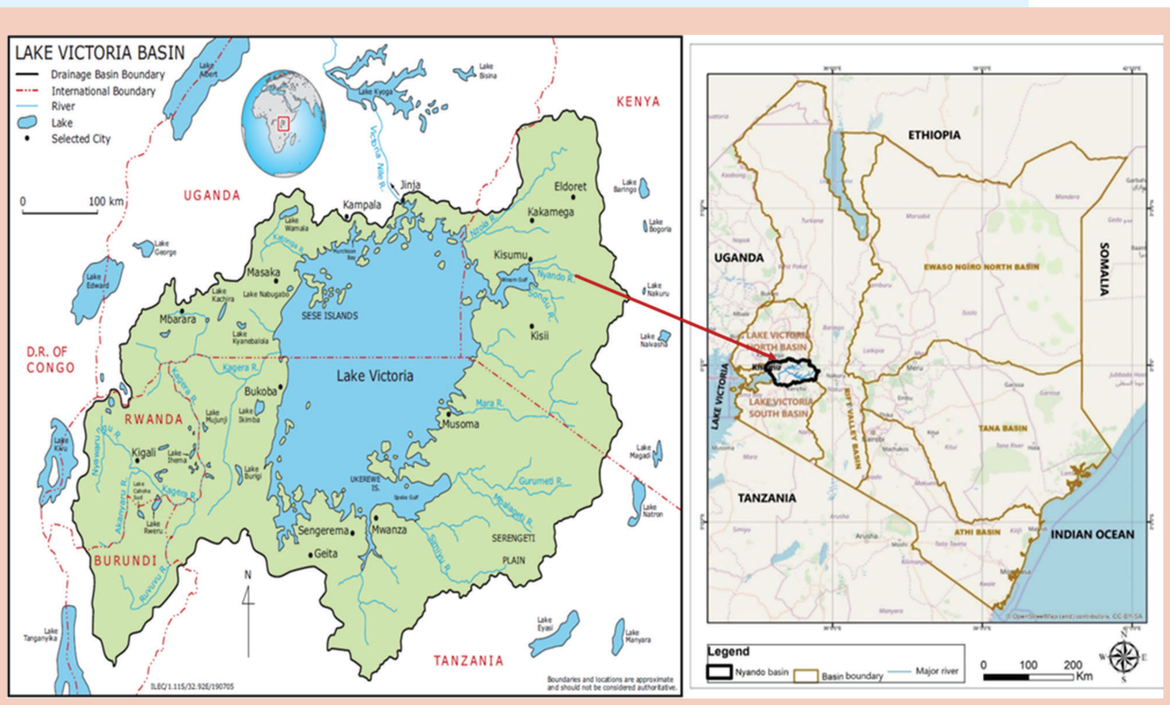
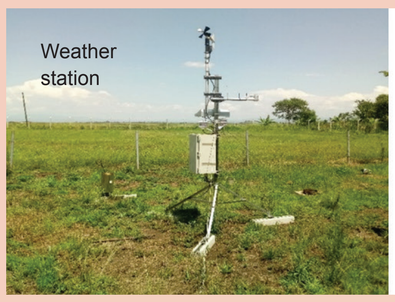
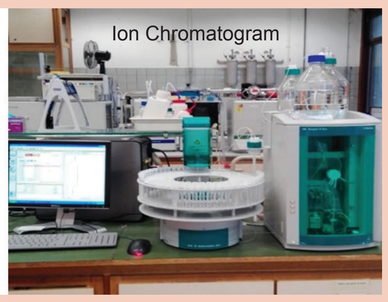


Figure 1. River Nyando tributary of the Lake Victoria basin, Kenya





Results

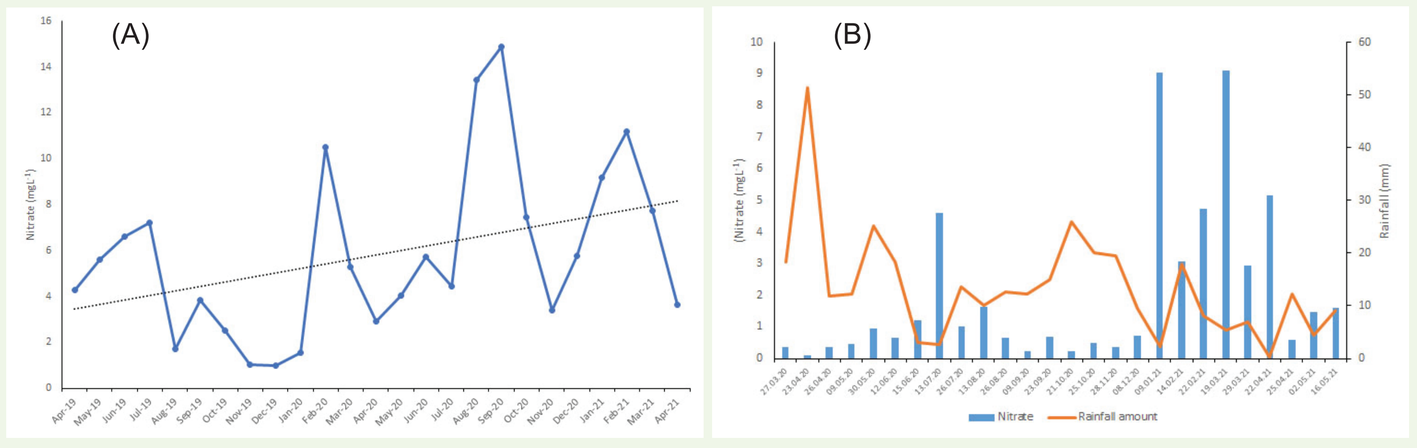


Figure 2. Monthly rainfall nitrate concentrations (A), and variation of rainfall event nitrate with rainfall amount (B) for the study period between April/2019 and May/ 2021

Monthly nitrate concentrations ranged from 1.0 (Dec/2019) to 14.9 mgL^{-1} (Sep/2020) with peak values being observed in February & September which are characteristically dry months. For rainfall events, nitrate concentrations decreased with increase in rainfall amount as shown in Figure 2(b) when the long (April-June) and short rains (September – November) rainfall events recorded the lowest nitrate values.

$\delta^{15}N–NO_{3-}$ and $\delta^{18}O–NO_{3-}$ rainfall data for this study was not available on time for this presentation. However, $\delta^{15}N–NO_{3-}$ and $\delta^{18}O–NO_{3-}$ data from studies conducted by the authors in the same station a year earlier (2018) ranged -5.6 to +8.6 and +22.6 to +64.5 respectively [2]. Based on literature $\delta^{15}N–NO_{3-}$ ranges in rainfall, biomass burning is a probable nitrate source. Indeed, the catchment is prone to biomass burning, primarily; charcoal, sugarcane farms in preparation for harvesting, and crop residue burning after harvest. This may explain the higher nitrate concentrations observed for rainfall events sampled between January and April (Figure 2b) which falls within or slightly after the crop harvesting and farm clearing period.

Conclusions

- An increasing trend in rainfall nitrate is observed during the 2-year monitoring period (Figure 2 (a)
- Wet atmospheric deposition is a major pathway for nitrogen deposition in the basin
- The common practice of biomass burning affects air and water quality in the basin
- $\delta^{15}N–NO_{3-}$ and $\delta^{18}O–NO_{3-}$ data , atmospheric chemistry and climate models needs to be integrated to establish atmospheric nitrogen sources in the basin

Biomass Burning - Lake Victoria basin

[1] Nyilitya, B., Mureithi, S., Boeckx P., Tracking sources and fate of groundwater nitrate in Kisumu city and Kano plains, Kenya. Water 12(2), 401 (2020).

[2] Nyilitya, B., et al. Nitrate source apportionment in the complex Nyando tropical river basin in Kenya Journal of Hydrology. 594 (2021)

[3] Lake Victoria Environmental Management Project (LVEMP). Kenya National Water Quality Synthesis Report. Kisumu, Kenya (2005).

Acknowledgements: The research was financed by the IAEA through CRP F32008: Global Monitoring of Nitrogen Isotopes in Atmospheric Waters

Correspondence: kyalob73@yahoo.com

University of Nairobi

IAEA International Atomic Energy Agency

Ministry of Water, Sanitation & Irrigation