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2,500 years of Ethiopian Hydroclimate from Lake Babogaya

Ethiopia and the Horn of Africa are densely populated regions that are particularly vulnerable to changing precipitation patterns. Current climate trends show that extreme rainfall events over the Ethiopian highlands cause severe floods in the downstream Nile Valley, such as the flooding of Khartoum in 1999 and 2020. Understanding past precipitation intensity recorded in lake systems under changing climate conditions is crucial for improved flood risk assessments. However, the instrumental record does not extend far enough back to reliably reconstruct longer decadal- and centennial hydroclimate changes and their drivers. Here we present a new hydroclimate reconstruction covering the past 2,500 years from Lake Babogaya (Central Ethiopia).

Lake Babogaya is situated close to the Blue Nile catchment, which is one of the main sources of the Nile River. We applied a multi-proxy approach combining micro-facies analyses, micro-X-Ray Fluorescence (XRF) mapping, and hydrogen (δ2H) and carbon (δ13C) isotope ratios of n-alkanes from plant waxes. The chronology is based on varve counting and radiocarbon analysis of charcoal deposits, which provide the ages for several tephra layers preserved in the core. The samples are dominated by short-chain n-alkanes (nC21 and nC23) likely derived from submerged aquatic plants, with long-chain n-alkanes (nC29, nC31 and nC33) from leaf waxes of higher terrestrial plants also present. Based on preliminary data, we observe pronounced variability in δ2H values over the past 2,500 years, with δ2H values of short-chain n-alkanes ranging from -40‰ to -140‰ and from -100‰ to -160‰ for long-chain n-alkanes. Rapid shifts between 2,000 and 1,200 yr BP might be related to changes in rainfall amounts, moisture sources or vegetation cover. More negative δ2H values around 2,100-1,900 yr BP and 1,300-1,100 yr BP contrast with less negative values around 1,800-1,500 yr BP and 700-600 yr BP, suggesting alternating hydroclimate conditions. In addition, varved sediment intervals predominantly occur during periods of more negative δ2H values, which is potentially related to reduced lake mixing and enhanced varve preservation. Both aquatic and terrestrial n-alkanes show coherent patterns, indicating regional-scale hydroclimate changes affecting both lake and catchment environments.

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