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How wet is wet? Quantifying hydrological changes over the past 15,000 years in the Chew Bahir basin, southern Ethiopia

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Eastern African hydroclimate in the early Holocene created a lush landscape in what is commonly referred to as the African Humid Period (AHP: ∼15 to 5 ka). The termination of the AHP was characterised by a climatic shift towards drier conditions. This resulted in the desiccation of many lakes and may have pressured hunter-gather societies to move towards concentrated pastoralist settlements at the shores of the few remaining lake areas or river valleys. During the AHP, Lake Chew Bahir, in the East African Rift System, was presumably expansive with a paleo-shoreline ∼30 m higher than present day, and likely served as an important freshwater source and refugia. Today it is a predominantly dry playa mudflat with ephemeral swamps in the deltaic areas. Strontium (Sr) isotope ratios ($^{87}Sr/^{86}Sr$) preserved in carbonate-rich lacustrine strata provide regionally-specific records of past variability in weathering and regional drainage patterns. During humid episodes, the Chew Bahir catchment expands northwards to include the Chamo and Abaya catchments. As these catchments are dominated by volcanic lithology, with low Sr isotopic ratios, additional water inflow from here can potentially change the overall Sr isotope ratio of the lake water in Chew Bahir in a measurable way.

This study aims to reconstruct the hydrobalance of paleolake Chew Bahir using a three-step approach. We first establish the Sr isotope ratio of the input end members by sampling modern waters from the Chew Bahir and adjacent catchments, including groundwater, lakes, springs and rivers. We then analyse the Sr isotope ratios of microfossils from the time period of the most recent AHP lake level high-stand from three short cores (CB05, CB06 and CB03) along a transect from the centre to the western margin of the Chew Bahir basin. Finally, we use the paleo Sr isotope record over the last 15 ka to develop an isotopically-enabled hydrobalance model to quantify past lake levels. Over the last ∼15 ka $^{87}Sr/^{86}Sr$ ranges from 0.7059 to 0.7066, with higher values during the start of the AHP, decreasing towards the termination. This suggests a larger input of water entering paleolake Chew Bahir from the northerly catchments and paleo-connectivity of these lake systems during humid periods. This study provides valuable data for reconstructing millennial-scale change in hydrobalance and freshwater availability, in a highly-sensitive climate region, over a key time period for the transition from hunter-gather societies to pastoralism.