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The paleoenvironmental history of the wetland Gelba in the Gamo Highlands of Ethiopia: a Holocene vegetation reconstruction with sedimentary ancient DNA

Femke Augustijns[1,2], Charline Giguet-Covex[3], Alemayehu Kasaye Tilahun[1,4], Nils Broothaerts[1], and Gert Verstraeten[1]

[1]KU Leuven, Department of Earth and Environmental Sciences, Division of Geography and Tourism, Leuven, Belgium (femke.augustijns@kuleuven.be)

[2]Research Foundation Flanders - FWO, Brussels, Belgium

[3]Université Savoie Mont Blanc, EDYTEM, Le Bourget du Lac, France

[4]Arba Minch University, Institute of Water Technology, Arba Minch, Ethiopia

Multiproxy paleoenvironmental research in Ethiopia is limited to a handful of studies, mostly situated in central and northern Ethiopia. This results in lasting uncertainties about the nature and timing of the vegetation response to climatic changes such as the African Humid Period and the Holocene aridification, and the imprint of human activities on the vegetation.

Here we present the sedimentary ancient DNA (sedaDNA) and XRF results as part of a multiproxy study in the Gamo Highlands in the southern Ethiopian rift valley. A six meter long sediment core spanning the last 18 thousand years was retrieved from a wetland at Gelba at 2300 m asl in the Gamo Highlands. Previous pollen and charcoal analyses on the core showed a past vegetation dominated by Afromontane forest taxa over the entire record. A first shift in the pollen-based reconstructed vegetation was a decrease of afroalpine vegetation around 13 cal. ka BP, with a relative increase of Afromontane forest taxa. Around 7 cal. ka BP wooded grassland taxa increased. At ca. 2.5 cal. ka BP a sudden change in the vegetation was detected, with increased disturbance indicators and charcoal particles.

Samples spanning the entire core we analyzed for their plant DNA content targeting the extracellular DNA. For the last 2.5 cal. ka BP, both extracellular and total DNA extraction was applied to the investigated samples. The results showed similar results for both approaches, whilst them also being complimentary by each detecting additional taxa. The majority of DNA sequences was derived from herbs and wetland plants, indicating a relatively local vegetation signal. A first observable change in the DNA record occurs at 7 cal. ka BP (with e.g. decreasing Convolvulaceae), but the strongest shift is observed in the period 2.5-2 cal. ka BP, with in particular an increase of Lythraceae and Polygonoideae. The DNA analysis has some taxa in common with the pollen analysis, but both proxies complement each other strongly due to the dominant local versus regional signal they provide. Despite the difference in detected plant taxa, the timing of vegetation transitions matches well between both records.

The XRF results show a highly minerogenic sediment input in the late glacial period. From ca. 13 cal. ka BP, a strong decrease in minerogenic input is observed and the sediment becomes more organic. At ca. 7.5 cal. ka BP, the minerogenic input increases again until 3 cal. ka BP, followed by fluctuating levels of minerogenic elements and increasing phosphorus levels in the last 2000 years.