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A multi-proxy evaluation of past environmental dynamics in the lowlands of south-eastern Romania, Eastern-Central Europe

Gabriela Florescu (1,2), Simon M. Hutchinson (3), Eva M. Niedermeyer (2), Roxana Grindean (1), Ioan Tanțău (1), Angelica Feurdean (1,2)

(1) Department of Geology, Babeș-Bolyai University, 1 M. Kogălniceanu str., Cluj-Napoca 40084, Romania (gabriella.florescu@yahoo.com), (2) Biodiversity and Climate Research Centre BiK-F, 25 Senckenberganlage, D-60325, Frankfurt am Main, Germany, (3) School of Environment & Life Sciences, University of Salford, Salford, Greater Manchester, M5 4WT, UK

The impacts of climate change and anthropogenic activities on the local environments are predicted to increase in the future, with important socio-economic consequences. Lowlands can be particularly sensitive to such developments, as many important agricultural areas and the majority of the population and settlements are located here. For example, the lowlands of south-eastern Romania have already experienced both increased erosion in agricultural areas, prolonged droughts and incipient aridisation, with important consequences for plant growth, agricultural productivity and the availability of drinking water. Due to the dry character of the Eastern-Central (C-E) European lowlands, which limits the occurrence of palaeo archives, relatively little is known about their past environmental dynamics. This hampers inferences of the spatial and temporal anthropogenic transformation of these landscapes, and any mitigation of the potential future risks posed by environmental degradation.

Here we present the first palaeoenvironmental record from the lowland, dry steppe area in south-eastern Romania. We used a multi-proxy approach on a high resolution lacustrine archive, i.e. sediment geochemistry, mineral magnetic properties, pollen, archaeological survey and, for the first time in C-E Europe, plant-derived n-alkane distribution patterns and microbially sourced membrane lipids ('branched GDGT-s'; Glycerol-Dialkyl-Glycerol-Tetraethers). We provide a detailed history of past interactions between local catchment dynamics, climatic conditions, vegetation change and human impact over the last 8000 years. Specifically, we i) explore how major shifts in the intensity of soil/bedrock erosion, chemical weathering and pedogenesis relate to human-driven landscape transformation, and ii) test the use of changes in n-alkane distribution patterns as a proxy for changes in vegetation and apply the br-GDGT-based palaeothermometer to reconstruct changes in mean annual temperatures in this area.

Our combined proxies show low to moderate phases of geomorphic activity between ca. 8000 and 4000 cal yr BP. Elevated concentrations of magnetic minerals characteristic of soil formation, a lower sediment particle size and increased chemical weathering indicate intense pedogenetic processes in the catchment. This parallels the geochemically inferred anoxic conditions in the lacustrine environment and a decline in steppic vegetation, which could point to higher lake levels /moister climatic conditions.

At ca. 4000 cal yr BP our records highlight a clear transition from surface soil erosion to deep/bedrock erosion, an abrupt increase in grain-size derived runoff intensity, together with a greater contribution of terrestrial vascular plant wax sourced n-alkanes. This was associated with a reduction by half of the pollen-based arboreal cover. Results appear to suggest that significant anthropogenically driven landscape change in this region began in the early Bronze Age. This inference is supported by the marked increase in the number of archaeological settlements at this time across the region.

Our findings provide new insights into the extent to which humans have impacted these dry, lowland environments at the landscape-scale through deforestation and, at the catchment-scale, through the enhancement of geomorphic processes.