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Determining the sensitivity of the high mountain region in Northern Romania to climate and land use changes through multi-proxy analysis

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Climate and land use changes can have a great impact on high altitude environments due to their species' narrow tolerance capabilities, habitat fragmentation and habitat restriction. Since trees at the timberline and the treeline ecotone grow at their temperature and soil tolerance limit, even small alterations in these parameters can result in marked changes in the position of the treeline ecotone, diversity, and species composition. Current and future climate warming is anticipated to shift the tree and timberlines upwards, whereas land use changes can drive this movement in the opposite direction. Therefore the long-term responses of vegetation to past climate variations and land use changes are of particular relevance for the prediction of future vegetation change in high mountain areas. Here, we use a multi-proxy analysis (pollen, spores, micro and macrocharcoal, mineral magnetic properties and AMS 14C dating) of a 1m lacustrine sequence covering the last 5000 years located in the subalpine zone (1910 m a.s.l.) in the Rodna Mountains (Northern Romanian Carpathians) to determine the sensitivity of high mountain habitats (i.e. movements of the timberline and treeline ecotones, and changes in vegetation composition diversity) in response to climate, fires and land use.

The pollen and stomata records reveal regional forests dominated by Pinus sylvestris between ca. 5000 and 4250 cal yrs BP, which were replaced by Picea abies, Abies alba and Fagus sylvatica from about 4200 cal yrs BP onwards. The proximity of the lake was treeless, dominated by sub-alpine shrubs (Alnus viridis), alpine herbaceous communities (Poaceae, Cyperaceae, Apiaceae, Asteraceae Tubuliflorae, A. Liguliflorae, Thalictrum) and ruderal species (Artemisia, Rumex, Chenopodiaceae) through almost the whole record. However, Pinus stomata found between 5000 and 4000 cal yr BP probably indicate a higher position of the treeline and the local occurrence of Pinus before 4000 cal yr BP. Our results show that the treeline, and the timberline position and composition appear to be rather stable over the late Holocene with some elevation advances recorded around 4500, 3900, 3000 and 2000 cal yrs BP. A lowering of the timberline, signaled by the absence of conifers stomata, the decline in the percentages of tree taxa (P. abies and Pinus) and an increase in sub-alpine shrubs (A. viridis) and herbs (Poaceae, Cyperaceae, Apiaceae), is evident at around 2500-1700 cal yrs BP.

Anthropogenic impact on the local and regional vegetation increases after 2000 cal yrs BP and is manifested as a local expansion of alpine herbaceous communities including ruderals species, suggesting an enlargement of grazed areas. High values of macrocharcoal accumulation rate correlate with elevated percentages of NAP and are followed by SIRM/ARM peaks, probably indicating increased soil erosion after periods of more intense land use. This would also appear to include the use of fire for the expansion of grazing land. Regionally, the anthropogenic impact on the timberline composition is marked by a reduction in the proportion of Abies alba and Pinus sylvestris. Further study of macrofossil remains will provide a more detailed insight into the sensitivity of treeline and timberline composition and position to climate and human induced global environmental changes in this less studied region.