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Holocene fire activity in the Carpathian region: regional climate vs. local controls

Gabriela Florescu (1) and Angelica Feurdean (2)

(1) Ştefan cel Mare University of Suceava, Department of Geography, Universitatii Street 13, Suceava, Romania (gabriella.florescu@yahoo.com), (2) Biodiversity and Climate Research Centre BiK-F, 25 Senckenberganlage, D-60325, Frankfurt am Main, Germany

Introduction. Fire drives significant changes in ecosystem structure and function, diversity, species evolution, biomass dynamics and atmospheric composition. Palaeodata and model-based studies have pointed towards a strong connection between fire activity, climate, vegetation and people. Nevertheless, the relative importance of these factors appears to be strongly variable and a better understanding of these factors and their interaction needs a thorough investigation over multiple spatial (local to global) and temporal (years to millennia) scales. In this respect, sedimentary charcoal, associated with other proxies of climate, vegetation and human impact, represents a powerful tool of investigating changes in past fire activity, especially in regions with scarce fire dataset such as the CE Europe.

Aim. To increase the spatial and temporal coverage of charcoal records and facilitate a more critical examination of the patterns, drivers and consequences of biomass burning over multiple spatial and temporal scales in CE Europe, we have investigated 6 fossil sequences in the Carpathian region (northern Romania). These are located in different geographical settings, in terms of elevation, vegetation composition, topography and land-use. Specific questions are: i) determine trends in timing and magnitude of fire activity, as well as similarities and differences between elevations; ii) disentangle the importance of regional from local controls in fire activity; iii) evaluate ecological consequences of fire on landscape composition, structure and diversity.

Methods. We first determine the recent trends in fire activity (the last 150 years) from charcoal data and compare them with instrumental records of temperature, precipitation, site history and topography for a better understanding of the relationship between sedimentary charcoal and historical fire activity. We then statistically quantify centennial to millennial trends in fire activity (frequency, magnitude) based on Holocene sedimentary charcoal records and compare these with pollen-based information of vegetation cover and diversity, climate records and archaeological data in order to disentangle between drivers.

Discussion. Our preliminary results indicate a recent enhancement in fire activity at all mountain sites between 1880 and 1920 AD, which contrasts with a markedly reduced burning over the past 60 years. Regression analysis with instrumental climate records reveals that the influence of climate on fire regime becomes negligible from the 60's. This recent drop in fire activity is perhaps reflecting fire suppression in land-use practices. In contrast, in the lowlands fire activity is increasing over the past decades, likely associated to post-socialist land abandonment and fuel accumulation. On a longer temporal scale, fire activity is highest in the early Holocene in lowlands and alpine areas, while at coniferous dominated sites burning is minimum. For the mid Holocene (7000-4800 BP) enhanced fire activity in uplands contrasts to lowest burning in lowlands. Trends in fire activity over the last 3500 BP are homogenous only across alpine sites. Our results point towards an increase in fire activity with fuel load and flammability related to climate conditions (warm and dry). Results also suggest that other local factors (e.g. vegetation type, exposure) might be locally more important fire controllers than climate. Humans enhance biomass burning earlier in lowlands than in mountains.

Conclusions. Our findings provide new insights into understanding trends in fire activity and its controllers at smaller spatial scale.