Investigating fire history in Poland over the last 2000 years using annually laminated lake sediments

Research project objectives/Research hypothesis

Fire history records using sedimentary charcoal are abundant across Europe, however, there are only a few long-term microcharcoal fire history records from Poland. This is likely due to the country presumed low flammability (i.e. generally humid conditions), low frequency of lightning strikes, and abundant broadleaf forests which typically do not burn. However, as it was demonstrated, the broadleaf forests containing European beech were capable of burning under fire-promoting weather conditions in the past, i.e. under warm and dry conditions. It was also highlighted that fires have been an important disturbance factor throughout the Holocene in central Europe, despite the perceived notice that fires are a negligible disturbance agent. Unfortunately, the long-term information on past fire regimes are currently lacking to reliably assess vulnerability of temperate zone forests to climate change and increasing fire risk. Poland is projected to experience an increase in both heat stress and wildfire activity over the next century which has the potential to turn the fire-resistant forests into fire-prone forests. Therefore, understanding how wildfire activity may change with future climate change is critical.

The proposal addresses two main objectives and two key hypotheses:

- **Objective 1**. Reconstruct the spatio-temporal patterns of fire and fire regime components over the last 2000 years in Poland.
    - **Hypothesis 1.** Fire has been a significant forest disturbance agent in Poland over the last 2000 years.

- **Objective 2**. Determine the role of climate, vegetation, and humans as drivers of fire regimes.
    - **Hypothesis 2.** Climate and human activities result in distinct fire spatial patterns with different burning frequencies and/or severities.

Research project methodology

The proposal aims at examining the long-term interactions among fire, climate, vegetation and human activity to determine the drivers of fire regimes and their changes over the last 2000 years. To achieve this goal, we will 1) conduct a detailed investigation of macrocharcoal from three annually-laminated sedimentary records from Poland (macrocharcoal analysis); 2) examine human activity as a trigger of fires (pollen analysis and historical data); 3) quantify area burned by calibrating past fires with available historical data, which will help to assess the timing of charcoal deposition (statistical analysis); 4) estimate the fire intensity as it is a key component in reconstructing fire regimes and charring temperature in particular (reflectance microscopy); 5) employ the use of charcoal morphotypes to assess changes in fuel source (burnt vegetation type) and quantify fire severity (macrocharcoal morphotypes analysis); and 6) investigate relations between plants communities/vegetation composition, climate variability and changes within the fire regime (synthesis);

Expected impact of the research project on the development of science

This project will contribute to a new understanding of past fire regime dynamics in forested and partially forested areas of Poland by i) improving upon the existing chronologies and ii) analyzing macrocharcoal properties preserved within the lake sediments. The project will also focus on the reconstruction of regional fire records in Poland over the last 2000 years, as this time period is essential for the understanding of the modern climate system, biodiversity, social organization, and economic structure. It is also a key for better anticipation of the possible future changes and development of advanced environmental protection strategies. **This project will fill the existing knowledge gap** related to understanding fire as a disturbance agent in Poland with a view towards assessing how future changes in climate and vegetation distribution may affect future fire regimes.