Tracking disturbances in forest plantations using high-resolution palaeoecology and dendrochronology

Climate change is affecting ecosystems all over the globe and is manifested by increased temperatures and low precipitation. As an effect of those changes we observe an increased number of catastrophic events worldwide, for example droughts, heat waves, fires or floods. Among catastrophic events, wildfires are especially important to study because fire weather seasons have significantly lengthened worldwide over the last 40 years and fires are occurring more often in areas that did not witness fires in the past. One of the affected European areas are Central European Lowlands (CEL) that witness catastrophic events more often over the last decades.

Many forests in the CEL have been turned into monocultures that are relatively easy to manage and harvest because of simplified forest stand. This has a negative influence on the complex system of connections between organisms because simplified inter-species connections make monocultures highly susceptible to disturbances: fires, windthrows, and insect infestations. Because trees effectively accumulate carbon dioxide, wildfires have a negative impact on climate change because burning of trees increases carbon emission to the atmosphere. Another important carbon sinks are peatlands which store 1/3 of soil organic carbon. Disturbing peatlands' water balance leads to drying, and dry peatland surfaces are highly susceptible to peat burning. In this regard, large forest complexes within which peatlands are located are vital for global carbon cycles. CEL monocultures and peatlands located within those forests may be at risk in the warmer world, therefore, recognising natural and current fire regime of these forests is crucial for choosing proper management and nature conservation strategies to protect them as an efficient carbon stock.

To reconstruct environmental changes in the past, peatlands are especially useful because peat contains information about the changes in past vegetation cover, hydrology, C accumulation rates, fire activity, and human impact. Combining information gained from various proxies enables to better reconstruct complex relationships between different ecosystem components and disentangle climate-human-environment interactions. The information about past fire activity in Poland is scarce, especially in the area of current monoculture forests. Recognizing natural fire regime of the areas of current plantations and defining if/how it changed after the establishment of monocultures is crucial to propose suitable nature protection pathways and forest management practices. Knowledge about the past fire regimes includes information about the tipping point at which forest loses resilience and can be ignited and the extent of caused damages.

The project will analyse last 1000 year-long history of two *Pinus sylvestris* monocultures in Poland: Noteć Forest and Tuchola Pinewoods. Analyses will be based on three peat cores sampled from three peatlands. We will use multi-proxy palaeoecological data (including reconstruction of past vegetation composition, hydrological changes, fire activity, carbon accumulation rates) with high-resolution sampling supplemented by dendrochronological analyses. The project will focus on various analyses and aspects of fire activity using contiguous charcoal record to reconstruct local and regional fire patterns, recognize the response of local hydrology and peatland vegetation to forest fires, identify other forms of forest disturbance which could potentially provide positive feedback to episodes of burning, e.g. insect outbreaks, local deforestation, and use dendroecological information to support and supplement the palaeoecological data.

Obtained results are expected to deepen the knowledge on how substantial changes in forest management influence the forest resilience and resistance to disturbances. The project will deliver first quantitative reconstructions of fire regimes documenting the transition from natural to planted forests in Poland. The results will inform about the extent of anthropogenic influence on peatlands' functioning and hydrology, carbon stock as well as on modification of peatlands' vegetation and microbial communities over time. Obtained data will be novel for palaeoecology, dendroecology and forest ecology. The project will help understand complex inter-species connections in forest and peatland ecosystems under substantial human pressure and climate change.