This proposal revolves around a single key issue: the relationship between upper forest limits, abrupt climate events and mountain landscape evolution. Upper forest limits are currently facing multiple stresses due to climate change (extreme weather conditions, drought and rainfall), biological invasions, habitat fragmentation and fire regime change. Central Europe recent summer droughts have had devastating ecological and economic consequences, but the severity and cause of these extremes remain unclear. The proposed project will pay great attention to critical transitions in ecosystem functioning before, during, and after disturbances. Abrupt climate events like droughts are play an important role in the history of the last 2000 years, which is characterized by sudden hydro-climatological shifts that have triggered environmental regime shifts and human populations, economic losses and war. Notably, future predictions of global climate warming raise a highly challenging question: "how a future abrupt climate event has the potential to disturbed evolution of the mountain landscape?" It is currently unclear whether such events are common features during the last 2000 years and whether previously disturbed periods are triggered by climatic instability.

The main aim of this project is to trace in detail the succession of climatic conditions and the reaction of the landscape to abrupt climatic events during the last 2000 years in order to examine their spatial extents and temporal patterns across the Tatra Mountains. Why is it so important (?), it is frequently postulated that more and more areas of forest ecosystems in the world and in Europe in particular have been transformed by humans. As a result of recent climate variability, mountain ecosystems are undergoing massive physical and biological shifts, but the still details and the outlook remain unclear. As a result, biodiversity has declined and, more importantly, through impoverishment, these ecosystems have lost the ability to resilience to a rapidly changing climate. The detailed knowledge about the history of human-climate-environmental interactions during the last 2000 years in the Tatra Mountains will be significant in the context of recent and future climate changes. May therefore serve as an analogue for abrupt climate events that may occur under future warming climate. That's why learning about the past is so crucial and provides a lot of information that we cannot model and predict without this knowledge. Our main research hypothesis is that it is climate change, and more specifically droughts and associated disturbances that have changed the trajectory of ecosystem functioning in the Tatra Mountains. We want to learn how this cascading mechanism has worked in the past; how these stressors interact with each other affects; how, when, and whether ecosystems recovered, adapted, or transitioned to a different ecological state. Because the interplay between forest recovery or decline can take several decades or even centuries, predicting the outcome of different combinations of stressors is still difficult. We are aided by palaeoecological methods through which a projection of future trajectories of mountain forests and other ecosystems functioning in a changing climate can be obtained by examining past forest declines.

We plan to apply a novel interdisciplinary approach to carry out the proposed research to understand the interactions between ongoing climate change and the response of mountain ecosystems in the Tatras. High-resolution resolution biological proxies, geochemical data and paleoDNA will be applied to reconstruct environmental responses to rapid climatic during the last 2000 years. High-resolution palaeoecological analysis allowed tracing the dynamics of short-term shifts of the ecosystem triggered by abrupt climate change. The robust age control together with the high-resolution sampling will allow us the detection of leads and lags between different proxies connected with the climate shifts during the 2000 years.