Abstract

Peatlands constitute one of the key components of the global climate system, playing a crucial role in regulating the carbon cycle, storing organic matter over long timescales, and retaining freshwater in the landscape. Of particular importance are high-latitude peatlands in the Northern Hemisphere (>45°N) associated with permafrost, which store vast amounts of organic carbon and are especially vulnerable to modern climate change. One of the largest and most important regions where these ecosystems occur is the Western Siberian Lowland. Contemporary climate warming is driving progressive permafrost degradation across this region, resulting in hydrological and ecological changes that may affect peatland functioning and the stability of their carbon pools. Despite a growing number of studies, the consequences of these processes remain poorly understood, particularly regarding the response of individual peatland microhabitats.

The aim of this dissertation was to **investigate and explain the mechanisms controlling the functioning and long-term hydrological and ecological dynamics of peatlands in the discontinuous permafrost zone of the Western Siberian Lowland.** Particular attention was paid to determining how biotic paleoecological indicators respond to permafrost degradation processes, as well as to evaluating their suitability for paleohydrological reconstructions. The study was conducted using the Khanymei peatland complex as a case study, and was based on analyses of modern relationships between testate amoeba communities and environmental conditions, the development of a local transfer function for palaeohydrological reconstructions, multi-proxy paleoecological analyses, and a synthesis of previous paleoecological studies conducted across the Western Siberian Lowland.

The results demonstrate that depth to water table is the primary factor shaping testate amoeba communities, although this relationship is modified by the presence of permafrost, microhabitat type, and vegetation composition. The locally developed transfer function enabled more accurate hydrological reconstructions than models based on continental-scale training sets by accounting for specific environmental characteristics of peatlands in the study area. Paleoecological reconstructions confirmed permafrost degradation leads to spatially heterogeneous hydrological and

ecological changes, yet the response of individual peatland microhabitats to contemporary climate warming is not uniform. In addition, the synthesis revealed significant spatial and methodological gaps in existing peatland research across the Western Siberian Lowland.

The obtained results provide new insight into peatland functioning in the discontinuous permafrost zone under conditions of ongoing permafrost degradation, and have led to the development of new tools supporting paleoecological research in the region. These include a local transfer function and the *Western Siberian Peat Core Database* (WSPC), a peat-core metadata repository. The transfer function enables precise paleohydrological reconstructions of peatlands in the discontinuous permafrost zone, whilst the WSPC supports the planning of future research, comparing existing records, and identifying key knowledge gaps. **The dissertation thereby contributes to the development of the paleoecology of permafrost peatlands and to a better understanding of their response to contemporary as well as projected climate change.**