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Long-term thermokarst lake development and internal ecological feedbacks: A new reconstruction from Lake Satagay (Yakutia, Siberia)

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The permafrost-shaped landscape of Central Yakutia is particularly rich in thermokarst lakes, which provide important cultural and ecosystem services to the local population. Climate warming and an intensification of agriculture in alaas systems (i.e. mostly drained basins of large thaw lakes formed during the early Holocene under warm climatic conditions) in the Central Yakutian Lowlands may lead to pronounced changes in water resources, water quality, nutrient loading and biodiversity. This could in turn threaten the livelihoods of affected communities, who depend on functional alaas ecosystems. To better foresee potential future impacts of environmental changes on internal lake ecological processes, it is important to gain a better understanding of how thermokarst lakes reacted to such changes in the past.

Here, we present a new paleoenvironmental reconstruction of ecological changes within Lake Satagay (N 63.078, E 117.998, Nyurbinsky District), covering the last ca. 10,800 years. We use sedimentological and XRF-derived geochemical parameters, in addition to the metabarcoding of sedimentary ancient DNA (sedDNA) for diatoms and aquatic plants, and microscopic diatom analyses, to evaluate sedimentological and biodiversity shifts throughout the Holocene. Our study revealed 53 diatom DNA sequence types and 53 species morphologically. High distributions of *Stephanodiscus* and *Fragilaria*, among multiple other diatom genera in the early Holocene, indicate that initial formation of this typical alaas lake occurred earlier than expected (i.e. before 10,800 BP). In recent millennia diatom abundance decreased and their community is almost exclusively composed of *Pseudostaurosira* and *Fragilaria*. Composition of aquatic plants show an overall dominance of *Ceratophyllaceae* and strong fluctuations in *Potamogetonaceae* likely related to lake level and water chemical changes. All proxies investigated support that lake conditions and biotic composition has been resilient since 4,000 BP, but youngest samples since

47 BP indicate that land use influence has been crucial for the lake quality. This study represents a step towards a better understanding of climate and human-impacted alaas lake development and its consequences for their ecosystem services in eastern Siberia in the near future.