Evaluating Ecosystem Responses to Extreme Extreme Hydroclimate Events in Lake Suigetsu Using Deep-Learning–Based Diatom Segmentation

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A lacustrine ecosystem is sensitive to rapid climate perturbations. During the last deglaciation, abrupt climate reorganizations occurred, yet their timing and expression were regionally heterogeneous. At Lake Suigetsu (central Japan),an abrupt Bølling–Allerød (B–A) warming preceded Greenland by ~200 years, followed by a ~200-year interval of frequent flood events known as —the Stormy Two Centuries. However, changes in diatom assemblages and their morphology
remain poorly constrained.

Here, we applied deep-learning–based segmentation to quantify diatom abundance and morphology from varved diatomaceous sediments spanning this interval. Image-based diatom metrics covary with chemically analysed biogenic silica content. During mid- to late Stormy Two Centuries ,the assemblage shifted from Aulacoseira subarctica to A. ambigua. Morphological changes in A. subarctica slightly preceded the taxonomic shift, potentially reflecting changes in their reproductive strategy in response to the lacustrine environment. An approximately three-decade interval marked by increased abundance of opportunistic taxa, including Asterionella spp. and Ulnaria spp., was identified between the two dominant states. These results suggest that repeated extreme hydroclimatic events triggered a transient phase of ecological destabilization before the establishment of a new dominant assemblage. Our findings highlight that ecosystem responses in East Asia were not merely synchronous reflections of North Atlantic climate signals but involved internally dynamic, multi-stage reorganizations under regionally asynchronous climate forcing.

Keywords: Laku Suigetsu, Quaternary, Diatom, Deep Learning

