Unprecedented changes in lake functioning in the Anthropocene: assessment of lake ecological trajectories over the last millennium.

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Abstract

This study is based on a synthesis of research carried out on lacustrine archives by a multidisciplinary team since ten years. The 20th century was characterized by unprecedented changes in lake functioning due to local human impacts as outlined by two case study (Lake Igaliku in South-Western Greenland and Lake Remoray in the French Jura) and by a synthesis derived from the an extended dataset of 22 lacustrine records. A paleolimnological approach combining aquatic and terrestrial proxies evidenced the accelerated eutrophication of Lake Igaliku and Remoray consecutively to local agricultural intensification over the last century. In Lake Remoray, a critical threshold was crossed in 1975. The deep zone has since become " a dead zone " with a strong loss in biodiversity. In the extended dataset, the major changes in lake functioning were identified from the main shifts in chironomid communities.

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The probability distributions for the age of these shifts were derived from depth-age models and cumulated over the last 1300 years. This cumulative frequency curve combined to the individual ecological trajectory of lakes indicate that a strong shift occurred at the end of the 19th century. Before this turning point, ecological changes are asynchronous and mainly controlled by climate, whose impacts may be modulated by lake specific sensitivity and local human activities. The 20th century is characterized by a very high frequency of ecological changes and by the strength of the associated shifts in lake functioning. Local human impact (mainly eutrophication) is identified as the key driver of this unprecedented situation. Finally, this study shows that the Anthropocene corresponds to a paradigm shift in lake functioning (from climate to human control) and is marked by heavy loss in ecosystem goods and services.