CLIMATE CHANGE AS THE PRIMARY CAUSE FOR pH SHIFTS IN A HIGH ALPINE LAKE

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Abstract. Chemical and biological sedimentary records of a high alpine lake were used to reconstruct palaeoecological conditions and compared with two centuries of instrumental temperature measurements. Air temperature determined the lake water pH throughout the past 200 yr almost regardless of the level of atmospheric deposition. Our data suggest a strong climate forcing of the acid-base balance in sensitive high-altitude lakes. Their physico-chemical conditions and biota strongly depend on the duration of ice and snow cover which is significantly different between warm and cold periods. Beside changes in weathering rates, in-lake alkalinity generation and water-retention time, delayed freezing in autumn and earlier ice-out dates with a shorter duration of CO_2 over-saturation could be crucial for the tight temperature-pH coupling.

Key words: acid-base equilibrium, climate change, diatoms, palaeolimnology, pH reconstruction

1. Introduction

Although attention on interactive effects of climate change and acid deposition on aquatic ecosystems is increasing, the role of temperature on the pH of lakes is not fully understood. Palaeolimnological records of remote lakes are a useful tool to gain insights into effects of global warming on limnology (Smol, 1988; Smol *et al*., 1991, Battarbee, 1991; Pienitz, 1995). High alpine lakes are particularly sensitive to temperature changes for mainly two reasons: (a) Warming is more pronounced in the alpine region with increases of 1.5 to 2 °C since 1980 compared to +0.5 °C on the global scale (Benniston, 1994; Nicolussi and Bortenschlager, 1995). (b) Even small temperature changes of 1 to 2 °C can have large hydrological, physical, chemical and biological effects in ecosystems where the duration of snow and ice cover plays a predominant role.

Moreover, in more densely populated areas also local changes in the catchment (agriculture, forestry, construction, etc.) influence the limnology of lakes, whereas remote mountain lakes are among the few ecosystems which are almost exclusively affected by climate change.

However, temperature oscillations and changes in atmospheric deposition can occur simultaneously. We studied the interactions of these impacts by comparing air temperature measurements over the last two centuries (Austrian Academy of

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