COMBINED EFFECTS OF NUTRIENT AND CLIMATE CHANGE INTERACTION ON PIBURGER SEE (AUSTRIA) – RESULTS FROM PALEO- AND NEOLIMNOLOGY

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Piburger See is a soft-water mountain lake located in the Central Eastern Alps (47°11'42''N, 10°53'18''E, Tyrol, Austria). The increase in recreational activities, tourism, and the application of fertilizer on nearby fields, resulted in enhanced primary production and rising hypolimnetic oxygen depletion in the lake during the 1950s and 1960s (Pechlaner, 1968). Lake restoration started in in 1970 by exporting anoxic and nutrient-rich hypolimnetic waters with an Olszewski tube, and by reducing external nutrient loading by altering fertilizer application and by diverting sewage from a public bath. Lake oxygenation rapidly improved after 1970 (Pechlaner, 1979), while the response of total phosphorus (TP) and phytoplankton biomass to lake restoration was delayed by two decades (Fig. 1). Since the early 2000s, phytoplankton biovolume has increased again, thus suggesting a reversing trend in lake trophic status (Tolotti et al., 2012). Simultaneous-ly, small changes in TP were recorded (Fig. 1).

Albeit Piburger See was part of the OECD study on eutrophication and is currently included in the Austrian LTER network, the 45 year-long data-base presents several data gaps (e.g. for phytoplankton).

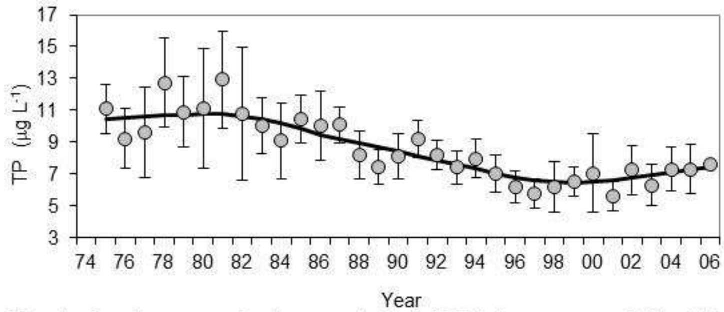

Fig. 1: Anual means of volume-weighted (0-24m) averages of lake TP-concentrations in Piburger See from 1974 to 2006. Vertical bars = standard errors of the means, thick line = LOWESS smoothed data.

To compensate such contemporary data gaps, a paleolimnological study has been carried out on a radiometrically dated short sediment core in order to reconstruction of the lakes' trophic state since the late 19th century and to define the reference conditions for the lake (Thies et al., 2012). Limnological data recorded during the last four decades provided the validation of the inferred TP concentration (Fig. 2). Changes in phytoplankton biomass and species composition were analyzed in relation to nutrients and water temperature. Epilimnetic temperatures of Piburger See, reconstructed by long-term air temperature records, show a pronounced increase during the mid-1940s and since the late 20th century. Both periods were related to increasing algal growth and changes in diatom species composition (i.e. increase in centric diatoms and recent blooms in *Asterionella formosa*).

The combination of paleo- and neolimnology allowed the analysis of the role of climate and nutrients in driving phytoplankton changes in Piburger See. In particular, the study on sediments outlined that long-term phytoplankton changes are mainly attributed to increasing lake temperature, while nutrients are supposed to act as modulating factor. On the contrary, short-term changes in phytoplankton of Piburger See since the 2000s were explained by varying nutrient concentrations and ratios (i.e. nitrogen and silica), while rising water temperature and enhanced thermal stability regulated the inter-annual lake variability. Our results underline that the combined impact of nutrients and climate on phytoplankton development can sustain short-time phytoplankton pulses, thus mimic short-term increases in the trophic level of less productive lakes.

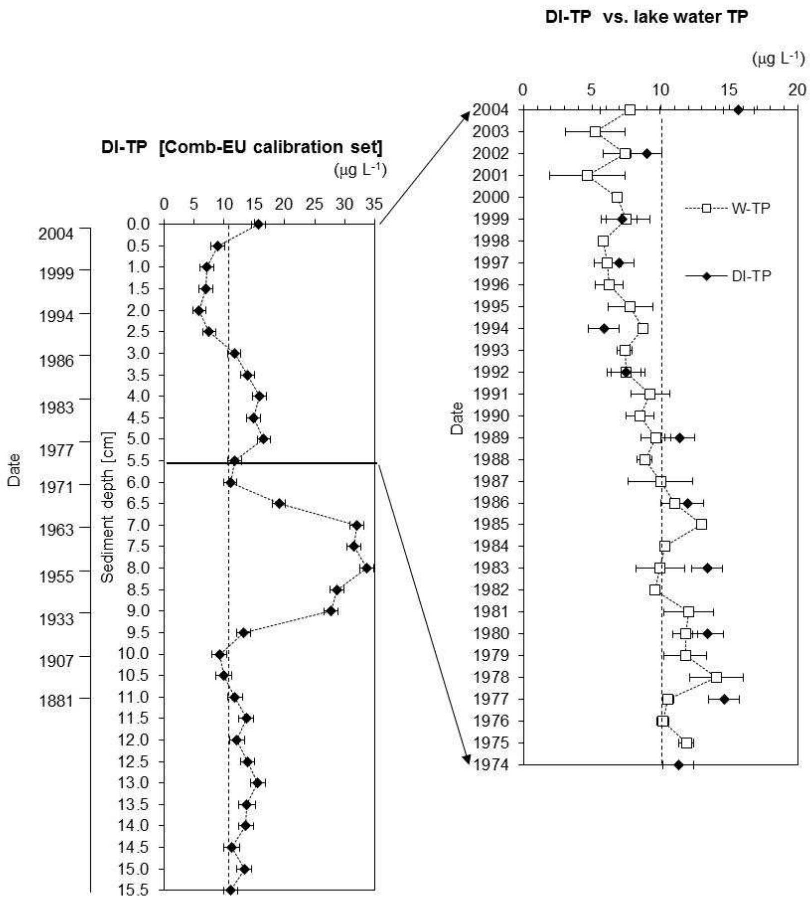

Fig. 2. Diatom inferred TP concentration (DI-TP) in the upper 16 cm of the Piburger See sediment core (left panel) and comparison (right panel) between DI-TP (black diamonds) and measured summer volume-weighted averages of lake TP (W-TP, open squared) from 1975 to 2004.

References:

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