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Article

Past and current trophic development in Lake Ammersee – Alterations in a normal range or possible signals of climate change?

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With 9 figures and 5 tables

Abstract: In the past decades, nutrient concentrations in several pre-Alpine lakes in central Europe have increased due to human activity in the catchment area. Here, we examine whether this trend will continue in the future, through our analysis of the development of the trophic status, over a period of 25 years (1984–2009), of the pre-Alpine, dimictic tempered Lake Ammersee (South-Eastern Germany). The lake showed signs of an elevated eutrophic status until the 1990s. Immense management activities in the catchment area led to a reduction in the nutrient load in the tributaries. The study of dissolved oxygen, total phosphorus (TP) and chlorophyll-*a* revealed a substantial improvement in the trophic conditions of the lake. We identified a transition period in the development of trophic levels during the years 1996/1997. Therefore, our investigation is divided into two periods: 1984–1996 and 1997–2009. By comparing values during these two periods, we found that the annual mean TP concentrations of the complete water column declined from 18.2 µg l^{-1} (1984–1996) to 8.8 µg l^{-1} (1997–2009). During this period the chlorophyll-*a* values are in relationship to other trophic variables such as TP, dissolved oxygen and sight depths (R^2 between 0.41 and 0.56). At the same time, during the summer months, the surface temperature in the epilimnion increased (by about 0.8 K per decade), which was approximately in line with the thermal increase (about 0.6 K per decade) in the northern hemisphere (Pearson's correlation coefficient, omitting 2006, of 0.81). In conclusion, in the case of Lake Ammersee, a decrease in nutrient input has led, most recently (1997–2009), to a substantial improvement in the trophic state. This improvement is fundamentally a result of measures taken to correct any anthropogenic impact. Nevertheless, we show that the thermal stability of the lake reacts to climate-triggered alterations. Therefore it seems that the impact of recent climate change on trophic conditions will have to be monitored closely in the future.

Key words: trophic status, reoligotrophication, total phosphorus, anthropogenic impacts, climate change, Ammersee.

Introduction

The investigation of nutrient inputs into aquatic ecosystems, especially into freshwater lakes, is a very pertinent issue in current limnological research. A lake's water quality is very strongly related to the development of its trophic status, which in turn depends upon anthropogenic activity in the catchment area. In the past three decades, nutrient concentrations in several pre-Alpine lakes in central Europe have increased due to human activity in the catchment area (Lenhart 1993, Güde et al. 1998, Salmaso et al. 2007). In recent times, greater control and better management measures to prevent high input rates of nutrients due to anthro-

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