Estimation of phosphorus input into an oligothrophic alpine lake in Austria

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Introduction and Methods

Phosphorus (P) is a driving force for net primary production in aquatic systems. After successful reduction of P concentrations in the open water of the alpine lake Mondsee during the last three decades, P concentrations started to increase slightly in recent years. As almost 100% of the wastewater is treated and the P loads stemming from this point sources can be quantified exactly, interest in describing the hydrology and the pathways of phosphorus within the catchment increased. Land use within Mondsee catchment (248km²) is grassland with extensive management and 40 % of the area is forested. It was argued that increased pollution stemming from diffuse sources may have led to higher lake P concentrations.

Two different measurement strategies were undertaken to estimate average annual lake P loads from diffuse sources. P concentrations during the snow melt and flood events were measured together with flow data in high temporal resolution for the two main tributaries of the lake (Zellerache, Fuschlerache). To gain information on the spatial distribution of P loads water discharge and P-concentration were measured at additional 98 sites within the catchment. Two field campaigns at dry climatic conditions in winter (February 2005) and summer (July 2004) were organized to get this spatially distributed picture of P loads at low flow conditions.

Water samples were analysed for total and dissolved P. Samples were filtered and prepared for analysis on the day of collection. Flow measurements for the sites Fuschlerache and Zellerache were obtained from the automatic flow recording stations available. Flow measurements for the 98 additional sites were measured either by a salt dilution method or using hydrometric vanes.

Results

Based on the “event based” measurements, relationships between P concentrations and water discharge were developed for the two main tributaries to the lake. Together with longer time series of flow and additionally available data on P concentrations for other tributaries, they were used to calculate P loads to the lake. It could be shown, that for an average annual input the criterion of the critical value for an oligotrophic state was met. However, years with higher than average annual P loads result in P concentrations that exceed the oligotrophic state.
Data on P loads for periods of high flow conditions were also used to estimate the contribution of the snowmelt period and high flow events to the total P load of the lake.
Comparison of these loads with the Vollenweider model for critical P inputs makes it possible to define critical P concentrations and areas for all streams draining into the lake. Finally, identification of critical areas of P concentration was obtained by comparison of the P limits obtained with the Vollenweider model with the P data measured at the 98 sites during the various sampling campaigns.