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Conference Abstract

How efficient are pre-dams as reservoir guardians? A long-term study on nutrient retention in small impoundments

Karsten Rinke ‡

‡ UFZ Magdeburg, Magdeburg, Germany

Corresponding author: Karsten Rinke (karsten.rinke@ufz.de)

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Abstract

Assessing nutrient loading and processing is crucial for water quality management in lakes and reservoirs. Understanding the fluxes of nutrients through the hydrological pathway and the involved transformations and corresponding retention patterns is therefore important for stakeholders, water managers, as well as researchers. Quantifying and reducing external non-point source nutrient inputs in these systems remains a significant challenge. The difficulty arises primarily from two factors:

1. the low nutrient monitoring frequencies and corresponding difficulties in quantification and
2. the limited availability of effective instruments to reduce diffuse source loading.

One of the few instruments is the operation of pre-dams, i.e. small impoundments at the inflow points into reservoirs, designed to retain nutrients by algal uptake and sedimentation. Although such pre-dams are engineered systems, their biochemical reactivity and corresponding retention capacities are blueprints for any other standing water body embedded in the fluvial continuum. This study tackles the issue by analyzing a long-term (ranging from 8 to 21 years) nutrient and discharge time series for nine

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German pre-dams. To assess the pre-dams' retention capacity, we followed a three-step workflow:

1. quantify nutrient loading by using and comparing four mathematical approaches,
2. calculate annual and monthly retention efficiencies for nine pre-dams based on long-term data, and
3. statistically analyze the major factors determining the retention efficiencies for Nitrogen (N), Phosphorus (P) and Silicon (Si).

The results show that soluble reactive phosphorus (SRP) (43.6%) and total phosphorus (TP) (39.9%) mean retention efficiencies are higher than for nitrate (NO3) (15.3%) and silica (Si) (15.9%) retention for all pre-dams. In a few years and pre-dams, there was negative retention of TP, NO3, and Si, and a nutrient release took place. The seasonal variation in retention efficiency demonstrated increased retention rates for SRP and TP during the summer months. Mixed effects models documented a significant influence of the pre-dams' hydraulic residence time (HRT) (p-value < 0.001) on retention efficiency.

Keywords

phosphorus nitrogen silica nutrient retention

Presenting author

Karsten Rinke

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Conflicts of interest

The authors have declared that no competing interests exist.