Phosphorus dynamics and retention in non-point source wetlands in southern Sweden

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Introduction

Seven wetlands in the south of Sweden was investigated with regard to phosphorus speciation in in- and outflow water, water flow and seasonal variations.

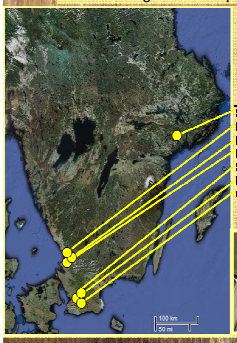
The aim was to assess factors affecting the outcome of phosphorus retention models in non-point source wetlands. As a first step we have:

- measured wetland retention of phosphorus from agricultural catchments
- investigated the dynamics of inflow and outflow phosphorus concentrations, by looking at phosphate-P and particulate-P in relation to water flow and different seasons

Methods

The wetlands

- Situated in southern Sweden, in areas dominated by agriculture
- Differ in size, design & catchment area
- Differ in age and sampling period



Wetland	A_w (ha)	A_w/A_c (%)	Agricultural land in catchment (%)
Stene	2.1	2.19	35
Lilla Böslid	0.41	0.06	98
Bölarp	0.29	0.13	85
Edenberga	0.25	0.25	100
Slogstorp	0.55	0.07	85
Råbytorp	0.75	0.26	100
Genarp	1	0.33	95

The wetlands differ in shape, size and design

Sampling

- Continuous water flow measurements
- Time or flow proportional water sampling, with additional grab sampling
- Grab samples during high flow periods with filtration of the samples in the field (0.45 µm) for two of the wetlands, Stene and Genarp

ISCO sampler, for automatic water sampling, either flow or time proportional

V-notch, measuring the water flow in the wetlands

Chemical analyses

- Autosamples: Total-P and PO_4-P
- Grab samples: Total-P on filtered and non-filtered samples

Total phosphorus was determined after acid digestion

Data analyses

Regression analyses

- Phosphorus retention vs. phosphorus load (annual means)
- Phosphorus concentrations vs. water flow

Analyses of variance

- Differences between wetlands regarding P load and retention

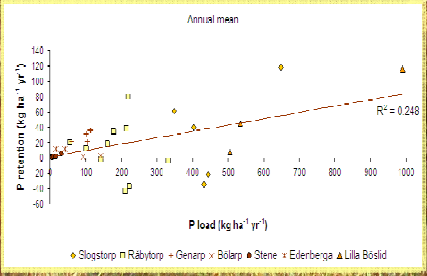
Results

Phosphorus retention

A positive phosphorus retention was observed in all wetlands, varying between 2.5 and 56.2 kg ha^{-1} yr^{-1}. However, there was a P release from two of the wetlands for specific years.

The phosphorus retention was correlated to the phosphorus load in the wetlands (R^2=0.25, p=0.004).

	Hydraulic load (m yr^{-1})	P load (kg ha^{-1} yr^{-1})	P retention (kg ha^{-1} yr^{-1})
Stene	7	16	2.9
Lilla Böslid	437	676	56.2
Bölarp	265	118	2.5
Edenberga	54	30	12.1
Slogstorp	684	455	32.7
Råbytorp	148	175	16.8
Genarp	85	92	28.3



Phosphorus and water flow

Grab sampling revealed a correlation between water flow and P concentration for several of the wetlands.

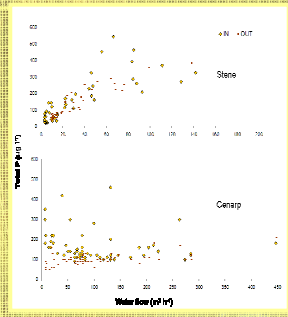
The inflow P was more variable compared to outflow P (i.e. Stene and Genarp).

	IN	OUT
	R^2	
Stene	0.64	0.82
Lilla Böslid	0.04	0.14
Bölarp	0.52	0.52
Edenberga	0.41	0.38
Slogstorp	n.s.	n.s.
Råbytorp	n.d.	n.d.
Genarp	n.s.	0.35

Regression analyses showed correlations between water flow and P concentrations for both inlet and outlet.

n.s. = not significant

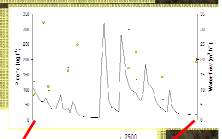
n.d. = no data, i.e. no grab sampling



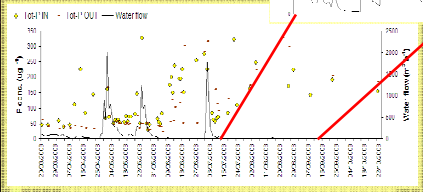
Seasonal effect

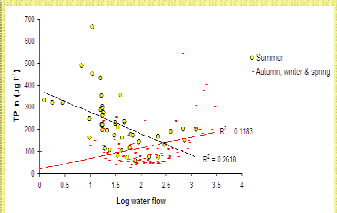
There was a seasonal effect of in- and outflow phosphorus dynamics for some of the wetlands (i.e. Lilla Böslid). High concentrations of P occurred during low-flow periods.

During summer, other factors than water flow determines in- and outflow P concentrations in Lilla Böslid.



Lilla Böslid





Conclusions

Phosphorus retention was correlated to the phosphorus load for all wetlands. However, there was a large variation, both between wetlands and between years. Thus, the phosphorus retention in a specific wetland is difficult to predict using simple load-retention models.

The strength of the concentration-flow relationship in the inflow varied considerably between wetlands. Outflow P concentrations were, however, less variable than inflow P, which showed some form of stabilizing effect of the wetlands.

In some wetlands, high P concentrations were observed also during low-flow periods in summer, suggesting that other factors than water flow influenced the phosphorus concentration dynamics, e.g. rural wastewater or anoxic standing water upstream.

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