Catchment characteristics & wetland P retention

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Background

Constructing wetlands for nutrient retention in agricultural areas is one method to achieve the governmental goal of reducing eutrophication in Sweden. Many studies show that there is a positive load-retention relationship both for nitrogen and phosphorus (P) in constructed wetlands, but with a large variation in the observed retention. Since the particulate-P losses are generally higher in catchments with a high proportion of clay soils, larger amounts of P would hypothetically settle in wetlands in such catchments, provided that the particles are large enough to settle in the wetlands (in g m^{-2} yr^{-1}). Also, other factors such as the proportion of tilled land, amount of manure used and slope of the catchment (affecting erosive losses of soil and P) affect the P losses in agricultural catchments, and hence also the load and amount of P that could settle in constructed wetlands. If there is a correlation between measurable catchment characteristics, affecting the P load, and observed wetland particle and P retention, this could be used in developing a planning strategy to identify suitable locations for wetland construction.

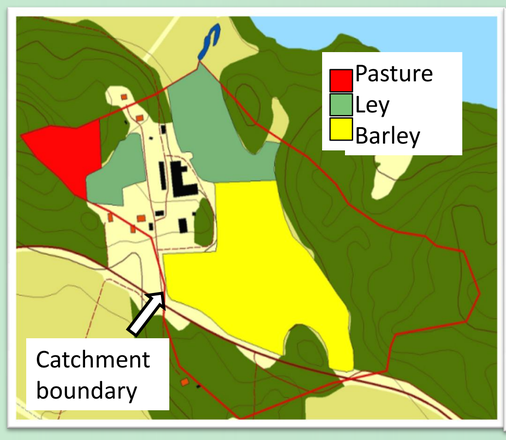
Aim

In this on-going study, the aim is to investigate if specific catchment characteristics, e.g, soil type, landscape slope, land use, runoff, can be used to explain differences in net soil and P retention in constructed wetlands.

Methods

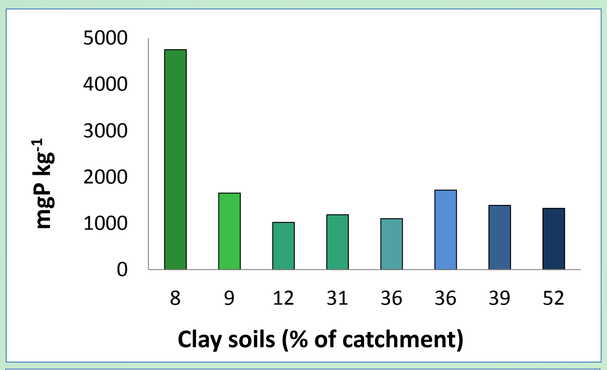
Seven wetlands in South Sweden were chosen; all constructed in agricultural catchments (CM) with variable amount of clay in soils. The CMs were characterised with respect to factors that might affect the particulate-P load and retention. Net sedimentation (g m^{-2} yr^{-1}) was measured with sedimentation plates placed in a transect from inlet to outlet, and the sediment TP content analysed. Here, we report the results after the first year data collection.

Statistical and geographical data bases, field surveys and GIS was used to quantify WL:CM area, the hydraulic load, % of clay topsoils in the CM, % tilled cropland, livestock units, rural sewage, wetland length:width ratio, CM slope, and the TP load was estimated from those data.

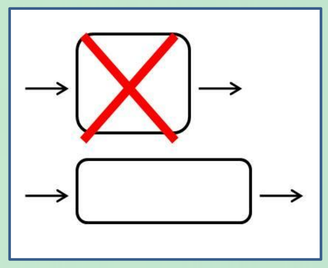


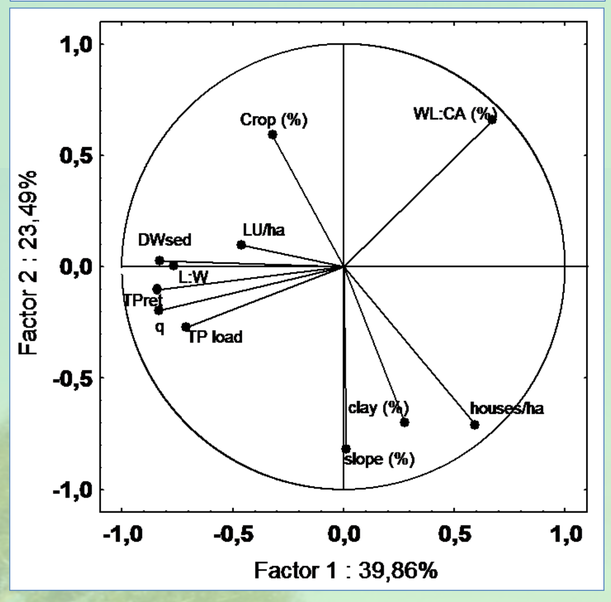
Accumulated soil particles

Results and Discussion

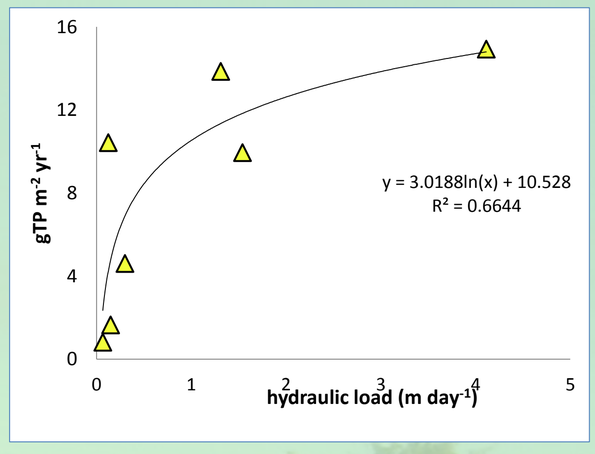


- The mean P retention varied between 0.8 to 15 g m^{-2} yr^{-1} in the 7 wetlands, and the mean net particle retention between 0.8 and 9 kg m^{-2} yr^{-1}. There was no significant difference in sediment P concentration between most of the wetlands, irrespective of the proportion clay soils in the catchment.

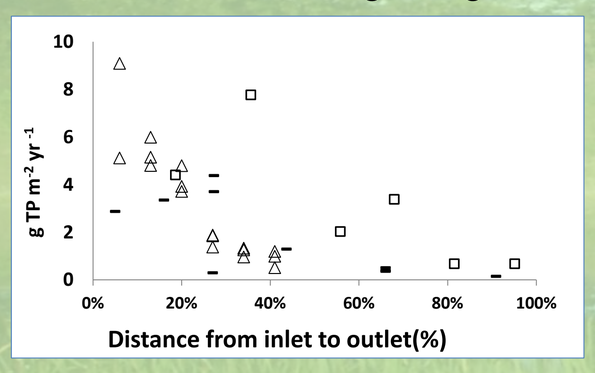




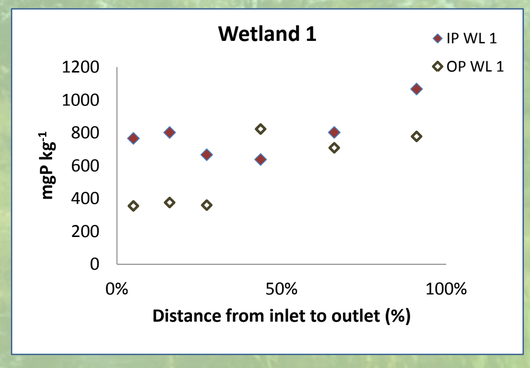
- The principal component analysis indicated that 40 % of the variation was explained by factor 1 (hydraulic load, TP load, L:W ratio, TP and particle (DW) retention), and 24% by factor 2 with % clay soils, slope and rural households. The inclusion of the L:W ratio suggests that wetland hydraulics was important for the settling process.
- The influence of the hydraulic load was seen up to ≈ 1.5 m day^{-1}. Probably a higher load of water corresponded with a higher load of particles that could settle in the respective wetland.
- There was no relationship with the factors catchment slope (an erosion ”indicator”) or the proportion of clay soils, implying a poor settling of clay particles in those wetlands; something that needs to be verified.

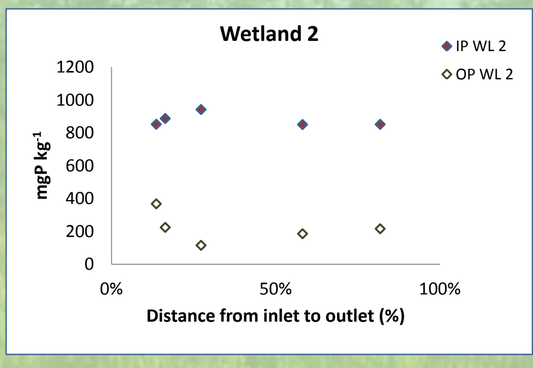


- Generally, the net sedimentation & P retention decreased from the inlet to the outlet, showing that the majority of the particulate-P retention occured in the beginning of the wetlands.
- The changes in sediment P concentrations from inlet to outlet differed considerably between the wetlands, ranging from an increase to a decrease, indicating that internal P cycling processes may have a considerable impact on the sediment composition in some of the wetlands.



- Catchment slope was positively correlated with the particle “settling efficiency” (slope: net particle retention vs distance), suggesting that coarser particles were transported in steeper CMs. In contrast, % cropland correlated negatively with P settling efficiency, implying that tillage resulted in losses of finer particles with a slower settling rate.





Conclusions

- The P retention associated with net sedimentation was variable, 0.8 to 15 g m^{-2} yr^{-1}, and the highest amounts were found close to the wetland inlets.
- Only the hydraulic load, P load and the wetland length:width ratio, but not % clay soils in the catchment, had a positive correlation with the particle and P retention.
- The lack of difference in sediment P concentration implies that the size fractions that settled were similar in the investigated wetlands, as higher P concentrations would have been expected where more clay particles had settled.
- The settling efficiency, i.e. the slope of regression line between P retention and relative distance from inlet, correlated positively with mean CM slope and negatively with % cropland, pointing to the importance of factors that affect the size of soil particles that are lost from the land.

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