Combating eutrophication of the sea and enhancing biodiversity of the agricultural landscape: experiences from wetland creation in Sweden

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Keywords: constructed wetlands; nitrogen retention; phosphorus retention, biodiversity

Constructed wetlands have been identified as cost effective nutrient traps in the agricultural landscape in Sweden. The Swedish Board of Agriculture has promoted the creation of wetlands in southern Sweden through various support systems to landowners. The national environmental goal was to construct 12,000 hectares by 2010. This goal was not reached and approximately 7,000 ha have been constructed since 2000 through different subsidy systems. The purpose is that these wetlands should counteract eutrophication of the sea by removing nitrogen and phosphorus while simultaneously contributing to increased biodiversity in the landscape. The Wetland Research Centre has evaluated the extent to which wetland creation in agricultural areas of Sweden has contributed to these two environmental goals (Svensson et al., 2004; Weisner and Thiere, 2010).

Continuous automatic flow or time proportional water sampling for nutrient retention measurement, during 1.5 to 10 years, has been performed in 7 constructed wetlands receiving runoff from agricultural catchments in southern Sweden. A mean nitrogen retention of at least 500 kg N per ha wetland area and year was obtained in 5 of these 7 wetlands. Phosphorus retention was more unpredictable but mean retention rates of at least 10 kg P per ha wetland area and year were recorded for 5 of these 7 wetlands.

Approximately 2400 wetlands, with a total area of approximately 6600 ha, created between 1996 and 2008 in agricultural landscapes in southern Sweden, were identified in different registers. According to modelling of > 150 selected wetlands from these registers, the mean nutrient retention was considerably lower compared to the measured retention of the 7 constructed wetlands where continuous sampling were done. The reason for the apparent lower retention of constructed wetlands in general in Sweden is important to understand, in order to improve future use of constructed wetlands as an effective environmental tool. Analyses of the data for the modelled constructed wetlands show that many wetlands have been sub-optimally located so that the nutrient loads have been to low to give a high nutrient retention. Next step was to analyse why so many wetlands were sub-optimally located in the landscape regarding nutrient retention. At least three possible mechanisms may explain the relatively low nutrient retention in some of the constructed wetlands:

1) The system of locating new sites for constructed wetlands is based on the free will of the landowners. This means that the administrators of the subsidies have a sub-set of sites to choose from that are not optimal in terms of nutrient retention.
2) Poor knowledge of the administrators regarding factors determining high nutrient retention
3) Other aims for the constructed wetlands are prioritised (e.g. biodiversity)

Regarding strategies for improving the retention of constructed wetlands in general it has been shown that the mean retention for constructed wetlands is higher for regional/local programs compared to national programs. The reason for this might be

clearer defined goals, stronger focus on retention and a better knowledge of local landscape geography leading to better locations of the wetlands. A new strategy has also been tried in Sweden the last 2 years, where the landscape have been actively searched for optimal sites for wetland construction, with a subsequent approach to the landowner about his willingness to construct wetlands on that site. This is a new strategy compared to the normal procedure where landowners have applied for wetland subsidies on sites they themselves have chosen. It is too early to evaluate the effect of this new strategy.

Regarding the effect of the constructed wetlands on the biodiversity of the agricultural landscape, it has been shown that the wetlands have an immediate and potentially large positive effect on various organism groups in Sweden. Bird populations are most often monitored, but also amphibians, invertebrates and plants are relatively well monitored, and have been shown to increase on a regional scale after wetland construction. There have also been projects with active transplantation of rare and red listed species to new constructed wetlands (Strand and Weisner 2010).

Analyses of monitoring reports from different regional wetland projects reveal dramatic changes in e.g. bird populations over time in constructed wetlands. This is closely coupled to the vegetation dynamics and the management regimes of the wetlands. It has also been shown that not only wetland species benefit from wetland construction. Interestingly, also species not normally regarded as wetland species show increases in populations after wetland construction. It has also been shown that constructed wetlands maintain a similar species composition and diversity as natural wetlands in agricultural landscapes (Thiere et al 2009).

It should be emphasised that our measurements, in wetlands specifically constructed for nutrient retention, show that the cost efficiency of nutrient retention in constructed wetlands can be high, particularly for nitrogen. Further, created wetlands in agricultural landscapes provide a number of additional ecosystem services that should be included in economical evaluations (e.g. biodiversity, irrigation, biomass production, flood control). In fact, if the economical values of constructed wetlands were made clearer, this could motivate political decision makers to improve subsidizing systems to facilitate wetland creation, and land-owners to be willing to locate wetland at sites on their land where they do most good.

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