CONSTRUCTED WETLANDS

First draft

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Description

Constructed wetlands are areas designed with the aim to optimize the removal of nitrogen and storage of phosphorus forms. As opposed to natural wetlands which are often situated at low-lying areas constructed wetlands can be made both on high-lying areas and low-lying areas where wetlands would not occur naturally.

Rationale, mechanism of action

Constructed wetlands are established with the principal aim to retain nutrients lost from neighbouring agricultural fields through processes like denitrification, sedimentation and sorption. The constructed wetland is either established in small ditches and brooks or as an end of tile drain pipe control. In all cases nutrient enriched water from agricultural fields passes through the constructed wetlands for purification before entering surface waters. Constructed wetlands can be made up of a combination of measures as small sedimentation basins, infiltration basins with horizontal flow through the artificial soil matrix (pebbles, leca, etc.) for sorption of P, shallow vegetative filters for storage of fine particles enriched in P and uptake of dissolved P and small basins with material that increases the P sorption potential [1,2,3,4,5,6].

Applicability

The measure can be used in many different locations and constructions where nutrient enriched water leaves agricultural fields through e.g. tile drainage pipes, ditches or small brooks. Particles are often lost as aggregates. Aggregates have high settling velocity; however, they will break up when transported in streams. As a result, wetlands should be constructed close to the problem. Constructed wetlands can be made up of a combination of small surface sedimentation basins and infiltration basins with horizontal flow through the soil matrix for sorption of P. Another often used type of constructed wetland is installed in open ditches or small brooks and posses an initial sedimentation pond area for capturing sediment associated phosphorus. A constructed wetland may include overflow zones for oxygenation of water and sedimentation of fine particles under small runoff situations, and shallow (0.5 m) vegetative filters for sedimentation of P enriched particles under higher runoff. Vegetation and algae may take up some dissolved P in the warm part of the year.

Effectiveness, including certainty

The effectiveness of constructed wetlands is normally high for nutrient removal and storage although most experience is from surface water systems in Norway, Sweden and USA. Experience with constructed wetlands established in small brooks shows an annual P retention of 1-50 g P m^{-2} yr^{-1} of constructed wetland. Usually the absolute and relative retention performance increases as the load increases. However, the P retention is more certain for particulate P than for dissolved P as some constructed wetlands experiences a net leakage of dissolved P.

Time frame

Effects of establishing constructed wetlands will increase as vegetation cover increase until ca 50 % vegetative coverage [5]. Depending on the erosion rate (filling of the wetland) constructed wetlands may last for 10-50 years before excavating. A decrease in N-retention performance has been monitored in some wetlands due to mineralization of organic-N. The P-binding capacity may also be filled up in the long run [1].

Environmental side effects
Constructed wetlands will also capture excess sediments and iron coming from agricultural fields, and remove N through denitrification and biological uptake. However, for wetlands in streams the retention time will often be too short for significant nitrate removal. Retention of organic-N through sedimentation and oxidation of ammonia to nitrate may be relevant. Constructed wetlands may also have effect on some pesticides.

Relevance, potential for targeting, administrative handling, control
Constructed wetlands can be used where nutrient enriched water from agricultural fields can be forced to pass through the facility. The ratio between the area of the constructed wetland and the contributing catchment area should be higher than a certain threshold (Norway: 0.2 %) as a certain hydraulic retention time is important for the different processes to take place. Biomass in the constructed wetland should not be harvested from the vegetative filters. Vegetation mitigates resuspension of sediment under storm runoff. Moreover, the sedimentation ponds may have to be emptied now and then and if sorption material is included it may have to be changed at time intervals.

Costs: investments, labor
The costs of this option relates to the costs of: (1) establishing the project proposal, (2) getting hold of the land eventually through buying the land from farmers, (3) establishing the constructed wetland, and (4) maintenance, including excavation of settled material and change of P sorption material.

References

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