

Measures to reduce nutrient emissions via tile drainage systems into river systems

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Measures to reduce nutrient emissions into surface waters are necessary to reach the goals of the EU Water Framework Directive (WFD, European Parliament and Council of the European Union 2000). In Germany, the potential to reduce nutrient inputs via point sources are almost exhausted. Diffuse pathways of nutrient emissions are now in the focus of measure implementation; especially nutrient emissions via tile drainages systems are suitable for a nutrient reduction due to their short-term retention potential (in contrast to long residence times of the groundwater emissions). In Germany, approximately 3 Mio. ha are drained artificially, mainly via tile drainage systems (De Cuerva 2006). Several measures exist to reduce the nutrient emissions into rivers via that pathway with the aim of restoring the retention capacity of a landscape. Retention processes are mainly based on denitrification, sedimentation, P-adsorption and removal with the biomass.

In Germany, there is little experience with specific measures for tile drainage at present. Therefore, different measures were chosen to proof their potential to be applied in Germany by the DWA (German Association for Water, Wastewater and Waste) working group. The goal is to collate, assess and compare the effectiveness and costs of potential measures. Measures could be located in the tile drainage systems itself, in the subsequent river system or a wetland could be positioned as an interconnection between both systems.

Measures in the tile drainage systems

“Controlled drainage systems” regulate the discharge at the tile drainage outlet in order to keep water and nutrients in the agricultural area and to provide a better water supply in droughts. With the reduction of the discharge a reduction of nutrient inputs into the rivers is intended, which mainly is due to the reduced water volume and to a lesser extent to additional denitrification potential (Sands et al. 2008, Fig. 1).

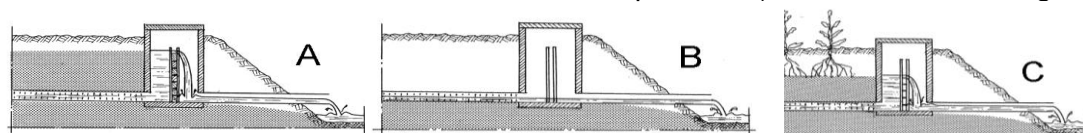


Figure 1 Function of Controlled drainage systems: A after harvest, B in spring, C vegetation period (Kahle et al. 2011)

“Tile drainage envelopes”. Many drains are wrapped with a drain envelope for hydraulic reasons. In addition to this property drain envelopes can be used for denitrification processes. Organic envelopes made of xylite or coconut fibre can be used as carbon donator. They are more effective by installation in controlled drainage systems (anoxic conditions). Another measure is the use of the drainage system to fortify the capacity of the subsoil for phosphorus sorption. This could be done, for example, by adding iron-containing material to the drain envelope or in the trench around a drain. This process works best under aerobic conditions.

Measures in natural or artificial river systems

“Removal of piped waterways”: Piped waterways (Fig. 2) were installed to gain additional agricultural areas or to assure a better usability of them. Retention, as usually takes place in rivers, is hindered. Because many of these systems have reached the

end of their useful life and could either be replaced or be uncovered. The latter option would regain retention potential.

“*Measures in river systems*” intend to restore or enhance the natural retention function of a river. Measures could be waiving of mowing, changing the shape of the river and abstraction of sediments.

Natural or artificial wetlands

Wetlands can be constructed to different specifications, such as infiltration, horseshoe, retention or natural wetlands. Wetlands should reduce the nutrient emission via denitrification, biomass accumulation and sedimentation.

“*Infiltration wetlands*” enable a controlled passage of the tile drainage discharge through filter substances to reduce nitrogen or phosphorous underground. These systems are known from urban wastewater treatment. Due to high cost of planning and construction, they are suitable for areas with high pollution risk.

“*Horseshoe wetlands*” are semicircle shaped dredging in buffer strips go along with rivers. They enable the tile drainage discharge to overflow a wetland with vegetation, before it reaches the water. In particular, if there is no adequate area for greater wetlands available, these small wetlands can be used.

“*Retention wetlands*” can be either a natural sink in the landscape or constructed. A wall could impede drainage water from directly reaching the river. Different processes involved can be seen in Fig. 3. In contrast to these artificial wetlands, which focus the optimization of nutrient reduction, the restoration of “*natural wetlands*” usually target further function beneath nutrient reduction, such as biodiversity. Examples are the restoration of fen, bogs, floodplains, natural sinks etc.

All these measures are assessed concerning their efficiency in the scope of a reduction of diffuse nutrient emissions, partly accompanied with pilot projects to measure their retention effects.



Figure 2 Piped waterway (Krämer 2006).

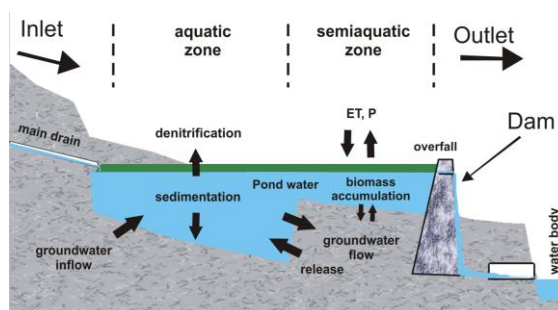


Figure 3 Scheme of a retention wetland (Steidl et al. 2008).

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