Phosphorus and nitrogen losses from a grassland site on a heavy clay soil in a fluvial plain in the Netherlands

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Transport of dissolved nutrients by water through the soil matrix to groundwater and drains is assumed to be the dominant pathway for nutrient losses to ground- and surface water in level areas like the Netherlands. In 2003 a study was started to investigate nutrient losses from a grassland site on a heavy clay soil in a fluvial plain in the Netherlands. The site was drained by drains and trenches. Annual N and P surpluses (input minus uptake) were on average 115 kg N ha^{-1} jr^{-1} en 11 kg P ha^{-1} jr^{-1}. The topsoil (10-40 cm) was non-calcareous, with an organic matter content of 5%, a clay content of 57% and a low degree of phosphate saturation (7%). The $CaCO_3$ content increased with depth to 7% at 1 m depth. Amount and composition of the discharge from the drains, trenches and ditches were monitored for five years.

Monitoring results showed that rapid discharge by means of the trenches was the dominant pathway (60-90%) for water and nutrients. Discharge to the groundwater was negligible. The contribution of the drains to the discharge of the plot depended on the existence of shrinkage cracks in the clay soil. At the end of a dry summer (2002), cracks were abundant and discharge was equally divided to drains and trenches. After prolonged wet periods, cracks were absent and discharge by drains was almost negligible.

Average N losses to surface water by trenches was 13.1 kg N ha-1 jr-1, with an average concentration of 6 mg/l. Average N losses by drains was 3.5 kg N ha-1 jr-1 (5 mg/l). Average P losses to surface waters were 2.6 and 0.7 kg P ha-1 jr-1 for respectively the trenches and drains with average concentrations of 1.2 mg/l and 0.7 mg/l respectively. These concentrations are remarkable high considering the low degree of phosphate saturation and low concentrations in the soil solution. Results of the first three measurement years showed that only a small part of the N and P losses were in dissolved inorganic form (25-50%), accordingly a large part of the annual losses are due to the loss of organic, colloidal or particulate N and P. From autumn 2006 to spring 2008 the discharge was analysed for the presence of dissolved organic, colloidal and particulate N and P. Despite the fact that colloidal P was abundant in water extracts of soil samples (Koopmans et al., 2005), colloidal N and P were not detected in the discharge. Particulate N and P forms were abundant and contributed to 41% of the total N and 72% of the total P discharge. Dissolved organic forms contributed to 42% of N and 9% of the P losses.

It may be concluded that rapid discharge of water by trenches is the dominant pathway for nutrient losses on this heavy clay soil, leading to discharge concentrations which are far above environmental standards for surface water. However, large part of the N and P losses are in organic and particulate form, part of these fractions may not by bioavailable

Koopmans, G.F., W.J. Chardon, and C.van der Salm. 2005. Disturbance of water-extractable phosphorus determination by colloidal particles in a heavy clay soil from the Netherlands. J. Environ. Qual. 34:1446-1450.