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Processes controlling the flux of legacy phosphorus to surface waters at the farm scale

VICTORIA BARCALA[1], JOACHIM ROZEMEIJER[1], LEONARD OSTÉ[1], BAS VAN DER GRIFT[2], LAURENS GERNER[3] AND THILO BEHRENDS[4]

[1]Deltares
[2]KWR Water Research Institute
[3]Water Board Rijn and IJssel
[4]Utrecht University

Presenting Author: victoria.barcalapaolillo@deltares.nl

Phosphorus (P) leaching from agriculture is a major driver of water eutrophication in downstream rivers and lakes. In NW Europe, agriculture intensified after the second world war and recently P surplus is close to zero [1][2](Figure 1). In drained lowland areas with intensive agriculture, a reduction in the fertilizer applications may be insufficient to improve the water quality in the short term [3], as the P accumulated in the soil during decades of high fertilization may continue leaching for many years. A complementary approach to reduce P exports from agriculture are edge-of-field mitigation measures at the farm scale. The selection of effective measures requires a detailed insight into the chemical and hydrological transport mechanisms. We determined the main P sources, processes, and transport routes at the farm scale to support the selection of appropriate mitigation measures. We quantified the legacy P, the different P pools in the upper soil, and related it to the yearly P export downstream. To do this, we combined high-resolution monitoring data from the soil, groundwater, surface water, and ditch sediments. The legacy P in the topsoil was high, about 2,500 kg/ha. The predominant subsurface flow and the subsoils' P sorption capacity retained the P mobilized from the topsoil and explained the relative moderate flux of P to surface waters (0.04 kg/ha during the 2018-2019 drainage season). The dissolved P entering the drainage ditch via groundwater discharge was bound to iron-containing particles formed due to the oxidation of dissolved ferrous iron. Once leached from the soil to the drainage ditch, resuspension of P-rich sediment particles during flow peaks were the most important P transport mechanism (78%).

Figure 1 Phosphorus surplus in the Netherlands from 1970 to 2018 [4].

Figure 2 Water and phosphorus balance for the period from 24 December to 16 April 2019.

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