Upscaled P filter for drainage water

Location

Country: Belgium
City: Middelkerke
Coordinates: 51.160063, 2.902289

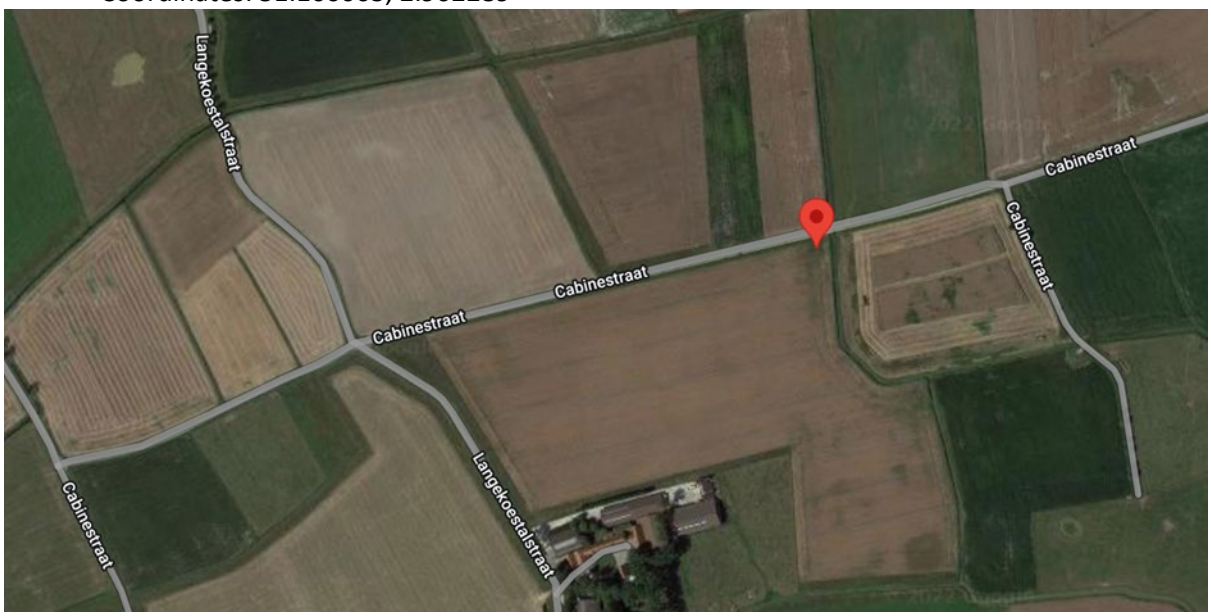

Figure 1. Location of the site at Middelkerke

Problem description

P concentrations in the drainage water are too high (on average 0.47 mg TP/l and 0.37 mg DRP/l) to meet the EU standard in the receiving surface water. The basic concept to reduce these P losses is installing a filter box containing a P sorbing material (PSM) at the end of the drainage tubes. This forces the water through the filter material and allows the removal of P from it before entering the ditch (Figure 2). We have developed filter boxes that have been installed at the end of single drainage tubes. This design works well for the typical discharge of individual drainage tubes, but needed to be upscaled to also efficiently treat larger volumes of water as in the case for collector drains.

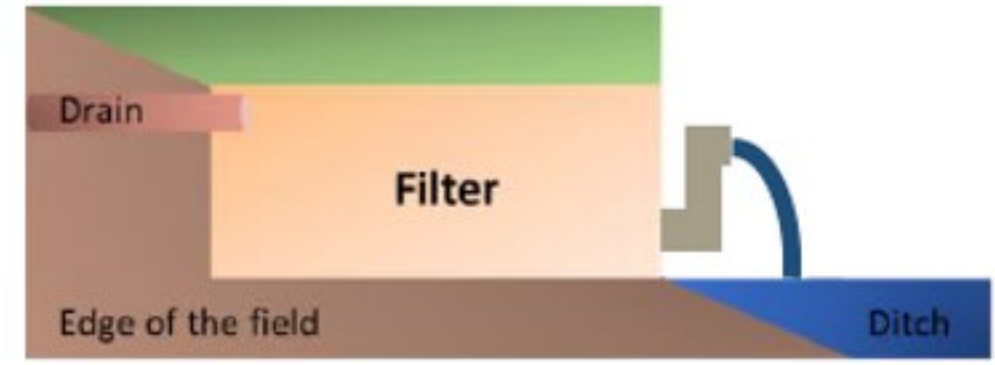

Figure 2. Schematic overview of the installation of P filters at individual drainage tubes in the field

Filter description

Season of 2021-2022

One upscaled P filter, a concentric cylindrical filter element within a cubic container, was installed on 1st March 2022 (Figure 3). The concentric cylindrical filter element was constructed by two cylindrically shaped wire meshes, with 140 L ICS filled in between the cylinders. Water from the collector drain was pumped to the central cylindrical cavity of the filter element, and then forced to pass the concentric cylindrical filter element with a thickness of 14 cm, from the center towards the outside. The P in the water passing through the ICS is (partially) sorbed, and then discharged from the cubic container into the ditch. In the first year, there was only one outlet at the bottom of the cubic container for water discharge. This configuration led to partial use of the filter, as the inflow was lower than the capacity of the outlet, resulting in a water level that was not consistently high and, consequently, only partial use of the ICS for phosphorus absorption. To address this issue, the flow at the bottom outlet was reduced, and an additional outlet was installed at the top of the cubic container in the second year. This modification ensured a consistently higher water level in the cubic container, thereby facilitating the full use of the ICS.

Pictures of the concentric cylindrical filter

Figure 3. The upscaled P filter in Middelkerke

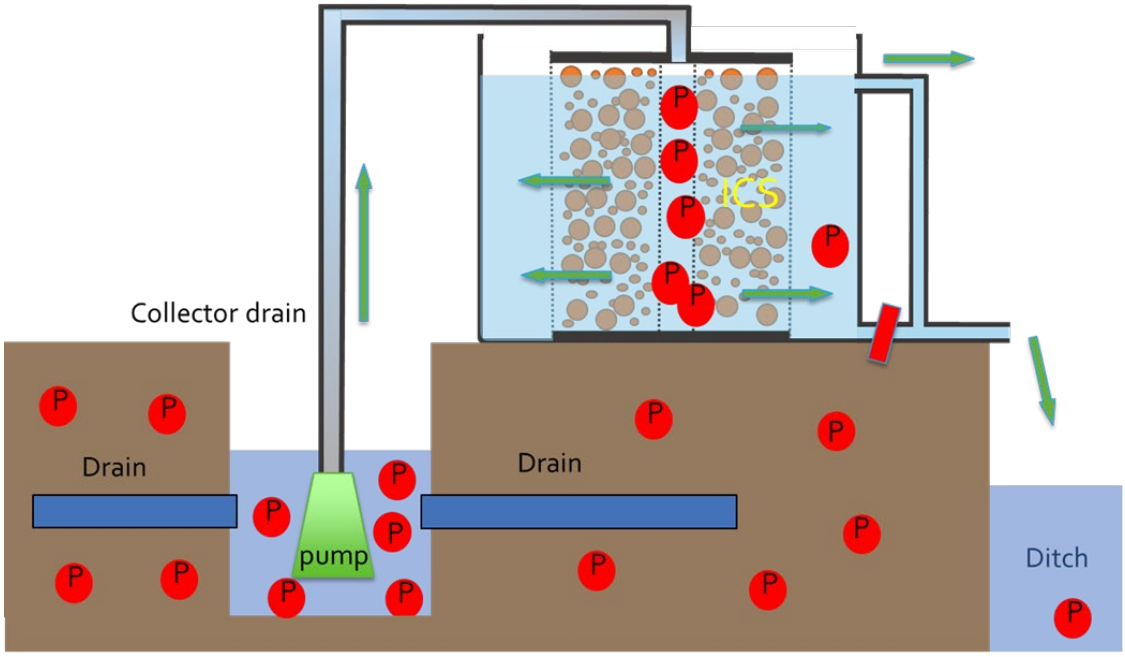

Figure 4. Schematic overview of the installation of upscaled P filters

Results

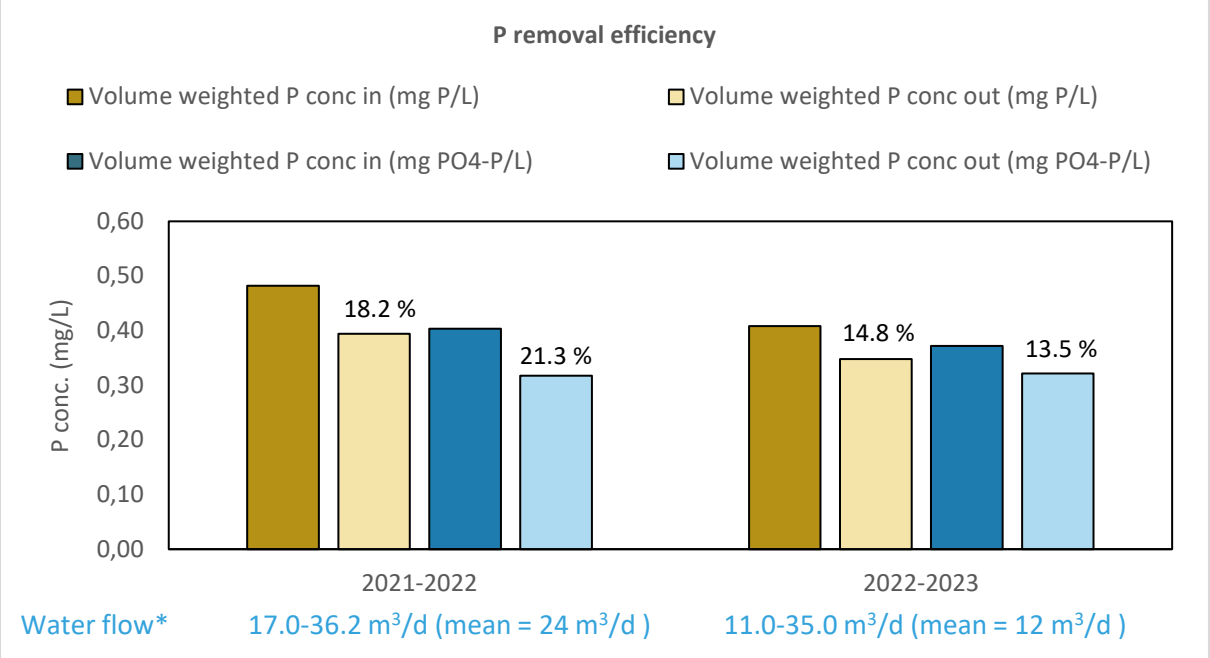

Figure 5. P removal efficiency of upscaled filter during the season 2021-2022 and 2022-2023.

At the site of Middelkerke, 18.2% of total phosphorus (TP) and 21.3% of dissolved reactive phosphorus (DRP) was removed by the filter box during the period of 01/03/2022 - 26/04/2022 with a water flow of 17-36 m^3/d. During the second drainage season, the P removal efficiency was not improved although the water flow was reduced to 12 m^3/d averagely.

Conclusion

During the first season, the upscaled P filter showed the potential of treating a large water flow up to 36 m^3 per day. However, P removal efficiency was not satisfactory (around 20%) and considerably below the performance of the small P filters for individual drainage tubes. We assume that the high water flow and thus the relatively short contact time is a possible reason for the reduced P removal efficiency. Adjustments of this filter system have been made to increase the contact time (e.g. reducing flow) during the second drainage season, however, the P removal efficiency was not improved and much lower than the other upscaled P filter installed at Roeselare (Godelievegronden INAGRO). We suspect that the water composition at this site might hinder the P absorption of phosphate by ICS, which need to be confirmed with further research.