

Upscaled P filter for drainage water

Location

Country: Belgium

City: Roeselare (Godelievegronden INAGRO)

Coordinates: 50.904067, 3.133274



Figure 1. Location of the site at Roeselare (Godelievegronden INAGRO)

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 of an open pond.

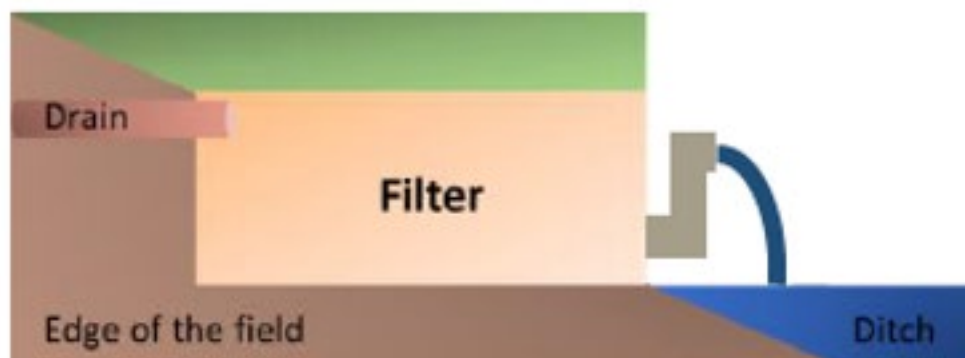


Figure 2. Schematic overview of the installation of P filters at individual drainage tubes in the field

Filter description

Season of 2021-2023

One upscaled P filter, a concentric cylindrical filter element within a cubic container, was installed on 30th Nov 2021 (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 installed at Roeselare (Godelievegronden INAGRO)

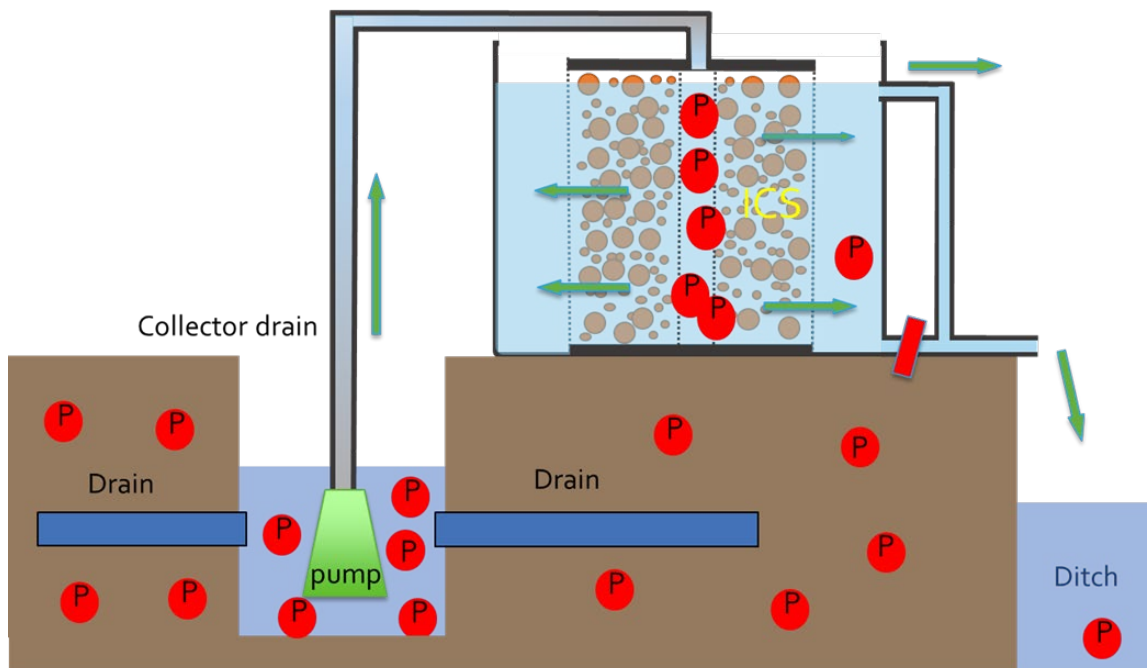


Figure 4. Schematic overview of the installation of upscaled P filters.

Results

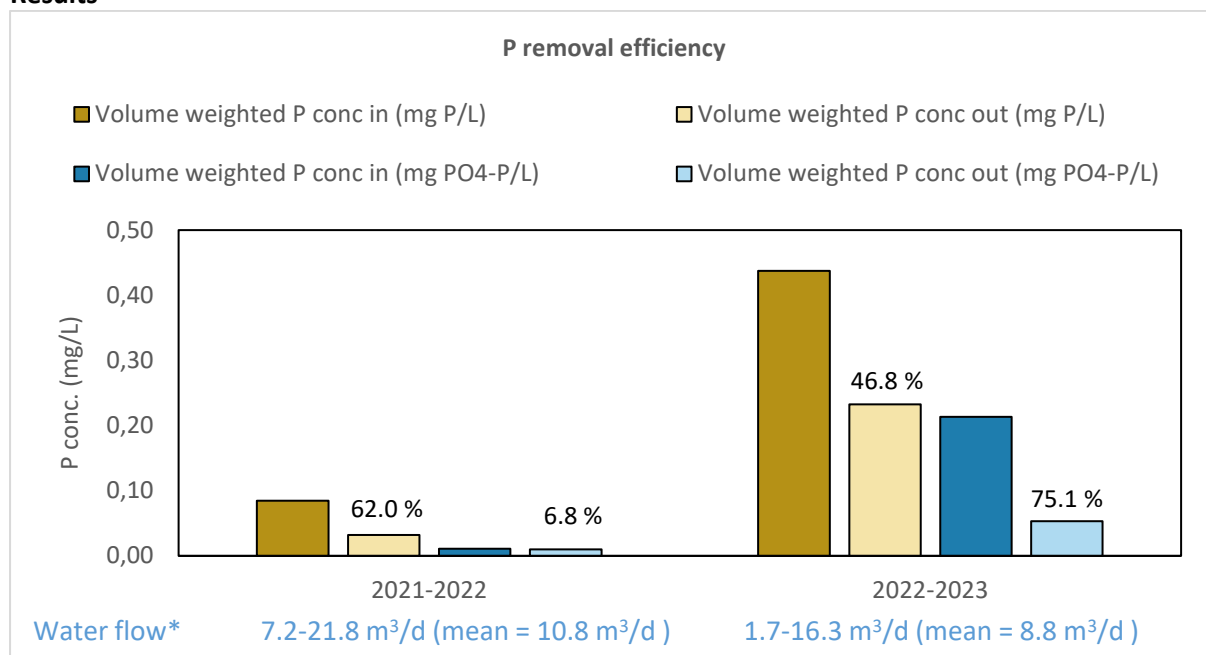


Figure 5. P removal efficiency of upscaled filter during the season 2021-2022 and 2022-2023.

At the site of Roeselare (Godelievegronden INAGRO), the concentration of total phosphorous (TP) and dissolved reactive phosphorous (DRP) of the open pond water was lower than 0.1 mg P/L during the drainage season 2021-2022. During the drainage season 2022-2023, the concentration of TP and DRP was around 0.4 and 0.2 mg P/L, in which 46.8% of TP and 75.1% of DRP was removed by the P filter with a mean water flow of 8.8 m³/day.

Cost evaluation

Filters	upscaled filter box (base on 1 filter for 1 year)
Total treated drainage water per year	1056 m ³
Average incoming P concentration	0.21 mg PO ₄ -P/L
Average outgoing P concentration	0.05 mg PO ₄ -P/L
P removal efficiency	75%
Total amount P removed	166g PO ₄ -P
Total cost efficiency	1500 €/kg PO ₃ -P

Conclusion

During the second drainage season, the upscaled P filter showed the potential of efficiently treating a large water flow up to 16 m³ per day. The P removal efficiency was satisfactory, particularly, around 75% for DRP and the concentration of DRP at the outlet of the filter was below 0.1 mg P/L. However, the open pond water often cause clogging problem for the upscaled P filter, most likely due to algae booming. Therefore, frequent cleaning and maintenance was conducted to ensure the continuous working of the upscaled filter. Further improvement of the upscaled P filter, i.e. a prefilter to prevent clogging, need to be considered to achieve optimal performance of the filter.