Interreg
North Sea Region
NuReDrain
European Regional Development Fund

EUROPEAN UNION

FILTER SYSTEMS FOR A SUSTAINABLE AGRICULTURE

FIELD CASE DESCRIPTION

Phosphorus filter box for drainage water at Staden

inagro
ONDERZOEK & ADVIES IN LAND- & TUINBOUW

GHENT UNIVERSITY

Location

Country: Belgium
City: Staden
Coordinates: 50.95666, 3.01749

Figure 1 Driving route to site Staden

Problem description

P concentrations in the drainage water are too high (on average 0.46 mg TP/L and 0.38 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).

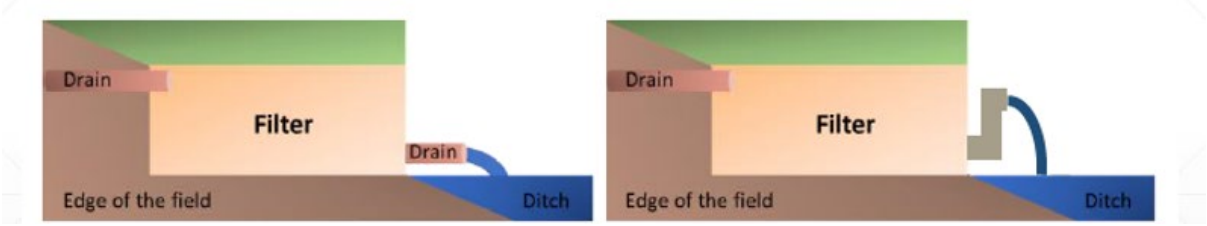

Figure 2 Schematic overview of the installation of P filters in the field

Filter description

Season of 2017-2018

One rectangular filter box was installed in January 2018 (Figure 3) filled with iron coated sand (ICS). Filter materials were filled a layer of no more than 20 cm (approximately 32 l). A layer of wire mesh of 0.75 mm was placed on the bottom to stop big particles. Water enters the filter directly from the top of box and the height difference between outlet tube and the top was 5 cm.

Season of 2018-2019

The same filter box was used but the ICS was removed as there was a lot of sediment/soil/algae in the filter. The filter box was cleaned and then refilled with fresh sieved ICS.

Season of 2019-2020

The new prototype filter (cylindric shape, Figure 4) was installed in December 2019 with sieved filter materials (ICS>2mm). A layer of 24 cm being approximately 35 l of ICS was filled in the filters.

Season of 2020-2021

The prototype from season 2019-2020 was kept until January 2021 to check the long-term performance of the filter. Then a bigger filter was installed on 2 February 2021 and filled with a layer of 24 cm, approximately 120 l, of ICS >2mm (Figure 5). The water in Staden was drained from a larger field (1-2 ha) which was beyond the processing capability of the small filter. Therefore, a bigger filter was designed and installed to check if P removal efficiency could be improved.

Photo filter

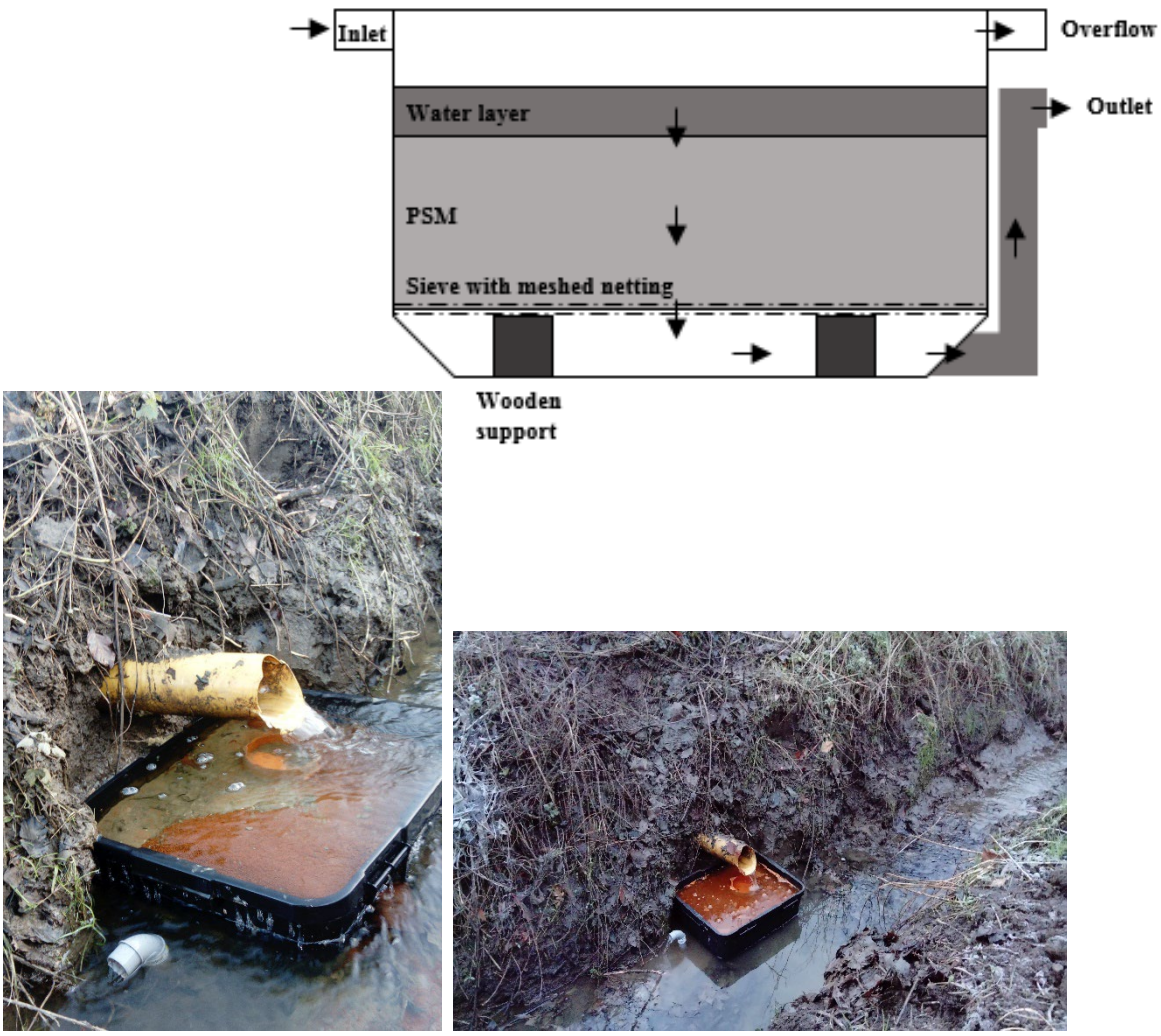

Figure 3 the custom-made filter in the season of 2017-2018

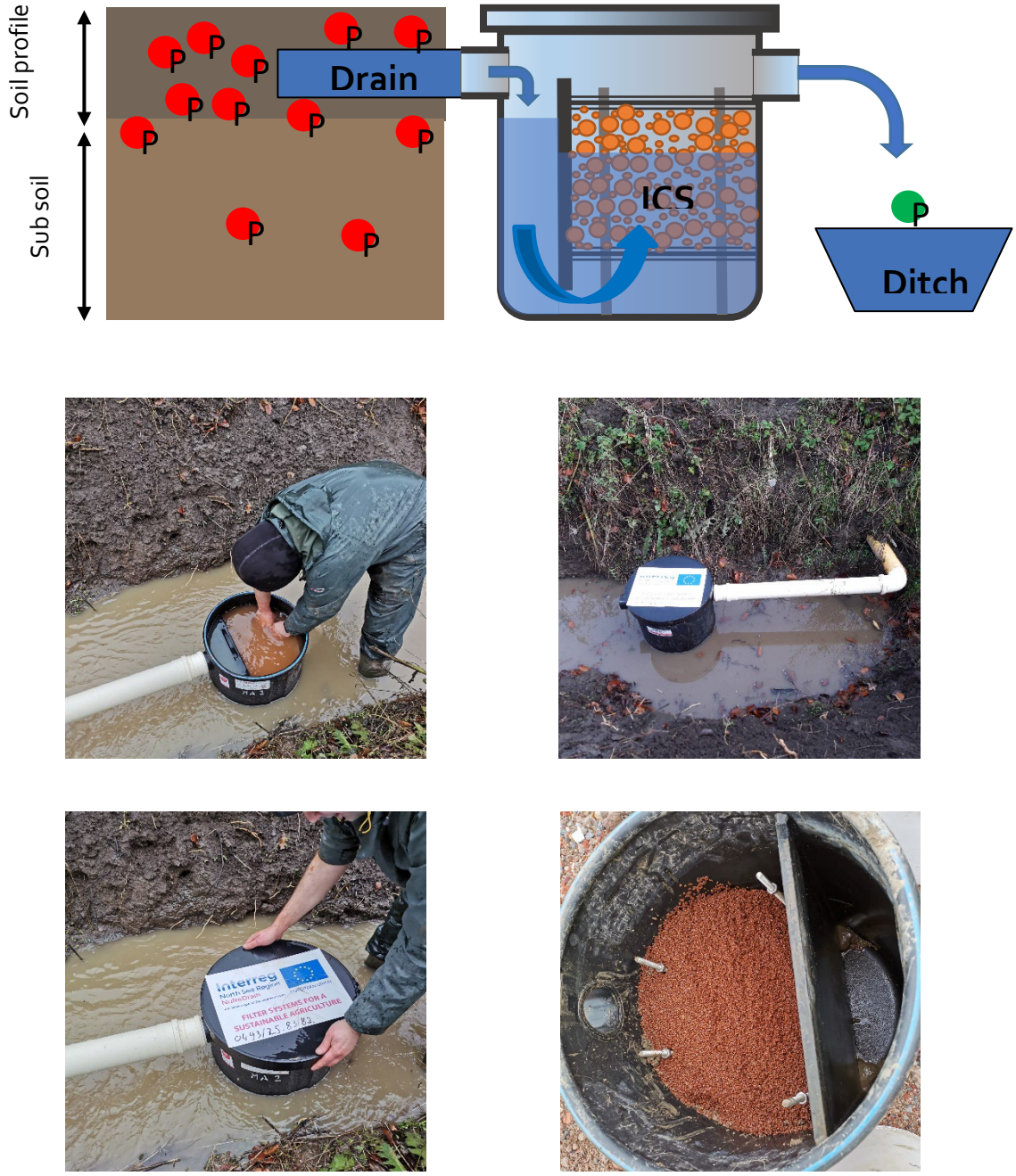

Figure 4 Prototype installed in the season of 2019-2021

Figure 5 Prototype installed in February 2021

Results (through the different seasons)

Season of 2017-2018

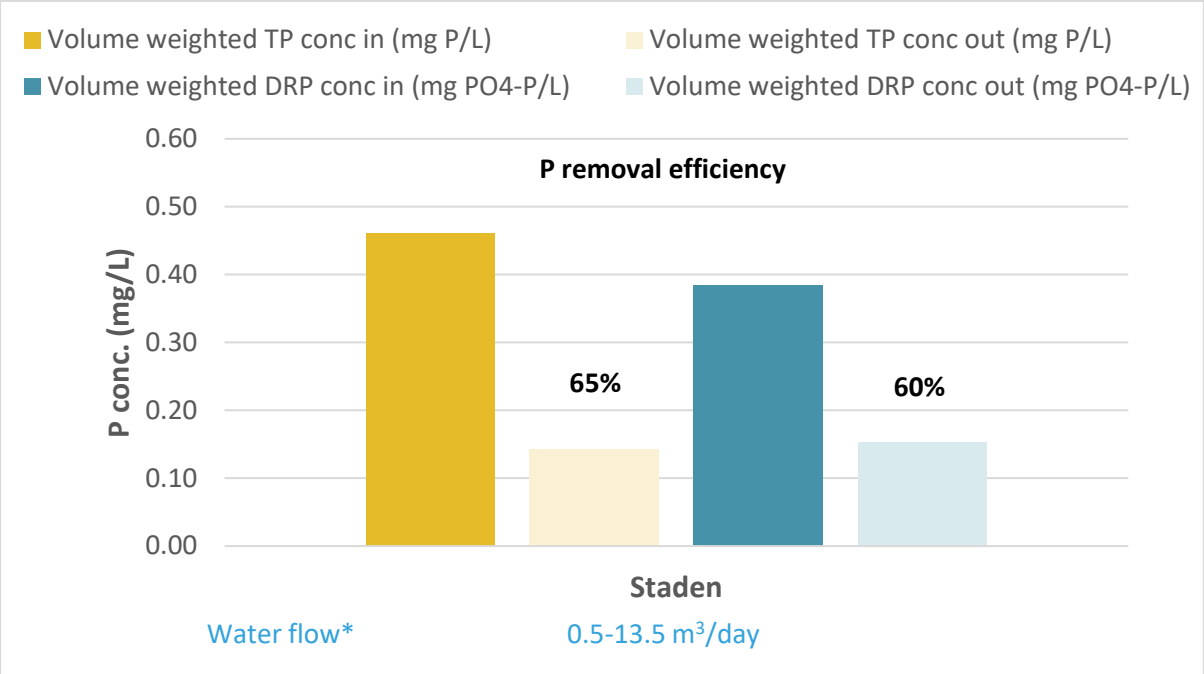

Figure 6. P removal efficiency of custom-made filter box during the season of 2017-2018.

*water flow was measured every week and this range represented the water flow on the measuring days.

In the site of Staden, 65% of total phosphorus (TP) and 60% of dissolved reactive phosphorus (DRP) was removed by the filter box during the period of 9/1/2018 - 11/4/2018 with an average water flow of 5 m^3/day. Frost problems occurred during the period of 21/2/2018 - 28/2/2018.

Season of 2018-2019

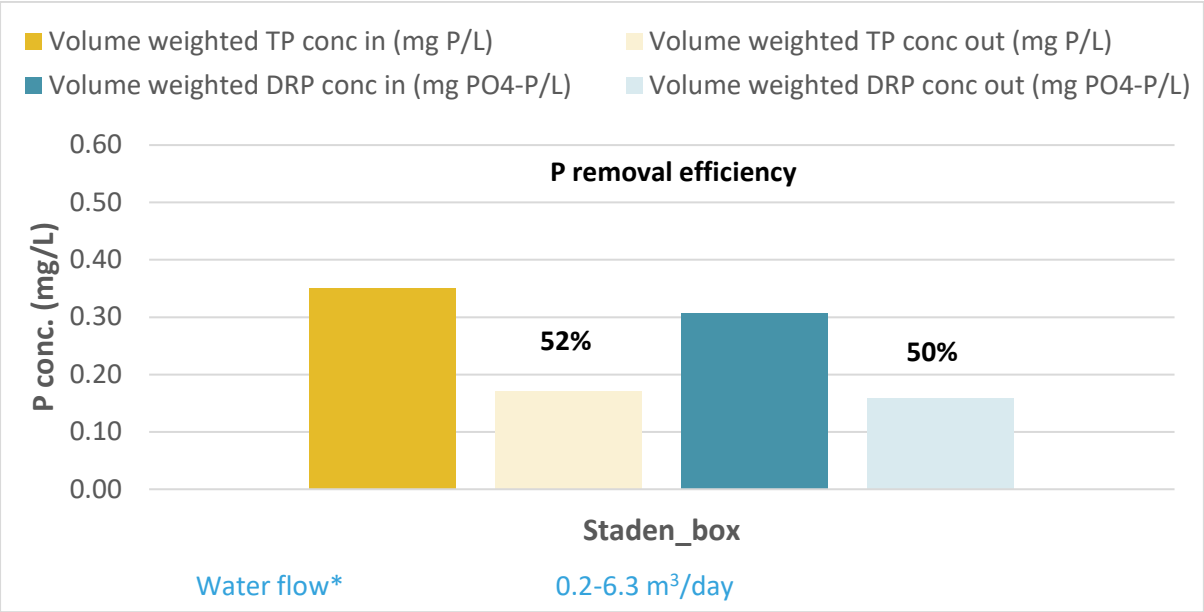

Figure 7. P removal efficiency of custom-made filter box during the season of 2018-2019.

*water flow was measured every week and this range represented the water flow on the measuring days.

In the site of Staden, 52% of TP and 50% of DRP was removed by the filter box during the period of 20/12/2018 - 28/3/2019 with an average water flow of 2.3 m^3/day. Overflow happened on the dates of 31/1, 8/2, 8/3, 15/3/2019 and a white foam was observed in the drainage tube on 8/2/2019.

Season of 2019-2020

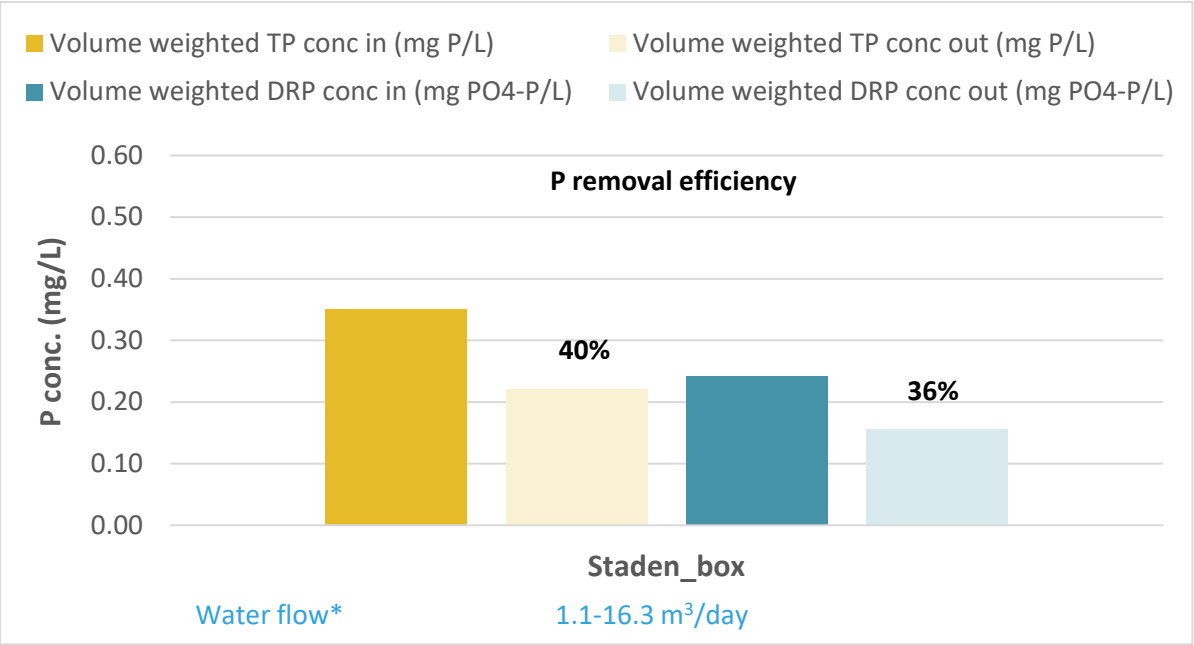

Figure 8 P removal efficiency of prototype filter during the season of 2019-2020.

*water flow was measured every week and this range represented the water flow on the measuring days.

The same prototype filters were installed at three different sites. In Staden, 40% of TP and 36% of DRP was removed during the period of 9/1/2020 – 13/3/2020 with an average water flow of 6.36 m^3/day. It was reported with overflow on the dates of 10/2, 14/2 and 3/3/2020.

Season of 2020-2021

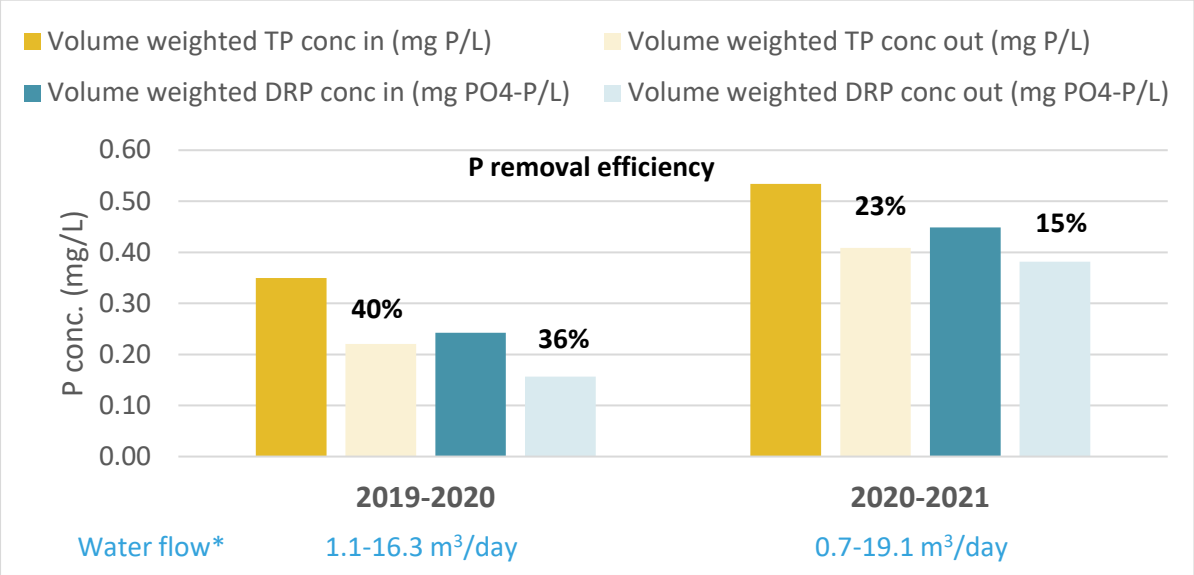

Figure 9 Long-term performance of prototype filter in Staden over two drainage seasons

*water flow was measured every week and this range represented the water flow on the measuring days.

After two drain seasons, the P removal efficiency of the prototype filter decreased gradually: on average 40% and 23% of total P (TP) and 36% and 15% of dissolved reactive P (DRP) were removed in the first and second season, respectively (Figure 9). To test whether ICS got saturated after two seasons, the sample (well mixed) was sent to KULeuven and an adsorption and desorption experiment was applied. At a P level of 0.45 ppm, ICS will still be able to adsorb P but the discharge standard will no longer be met.

Conclusion

During the four seasons, different filter boxes filled with fresh ICS showed P removal efficiency varied from 40-65% of TP and 36-60% of DRP while the long-term performance of ICS reduced evidently to 36% of TP and 15% DRP. The P removal efficiency was rather low compared with filters in Zedelgem due to the larger water flow (up to 19 m^3/day) beyond the designed processing capacity (6-8 m^3/day), therefore a bigger prototype with was installed in Febrary 2021. Unfortunately, the drain stopped running right after the installation and we could not compare the performance. Further monitoring of the bigger filter will be continued in season of 2021-2022.