Interreg
North Sea Region
NuReDrain
European Regional Development Fund

EUROPEAN UNION

FILTER SYSTEMS FOR A SUSTAINABLE AGRICULTURE

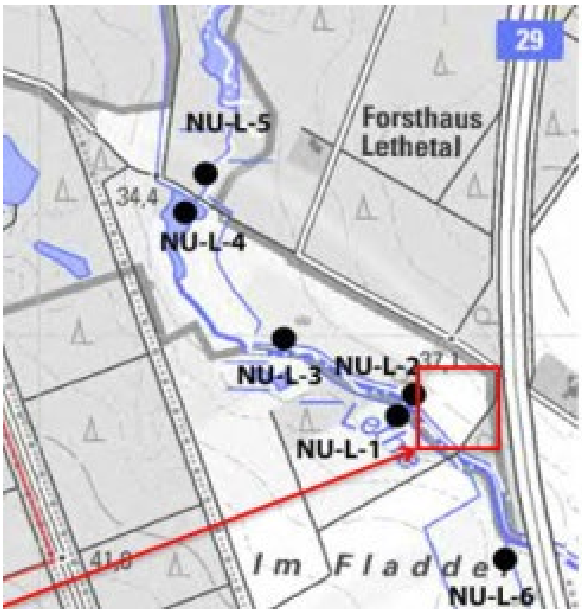
FIELD CASE DESCRIPTION

Transportable constructed wetlands to reduce nitrogen

OOWV

Location

Country: Germany
City: Ahlhorn
Coordinates: 52°54'10.5"N 8°09'49.1"E



Problem description

The river Lethe is characterized by water shortage in the summer time and relevant discharge of diffuse pollution of phosphorous and nitrogen through drainage water and recharge of the connected ground water. The Lethe flows into fish ponds and a Natura 2000 area, which also have to cope with water shortage and diffuse pollution.

Filter description

The wetland consists of 6 identical pots that are used to stimulate denitrification/nitrification processes and to trap ochre via aeration. The denitrification pots consist of two different sections. The upper section of the pot contains gravel and various types of plants. The plants are fixed to the upper section but their roots reach into the lower section to build a root system that is adapted to free-water areas. This enhances the active surface that is in contact with the water and therefore with nutrients as well. The plants take up nutrients continuously during their growth period. The gravel allows for the wetland to be walked upon without harming the plants or the installation as such.

The lower section consists of the root zone, water and plastic carriers for microbial growth. Due to the nutrients in the water, microbial growth will start as soon as construction and filling the plants with water is finished. With time, the nitrogen reduction efficiency will increase with an increasing mass of denitrifying bacteria attached to the carriers.

The water moves from chamber to chamber. The pots are connected in a way that only if water is flowing into a pot, water will flow out of a pot. This ensures that the plants/flowers will not dry out during dryer months in summer.

Each pot has a volume of 750 liters. The plastic carriers are filled with fired clay. The complete system of six denitrification pots holds a total of about 1.5 m^3 of water. The green nets prevent the clay from moving freely. The inlet is located at the bottom of the pots so that there is no short circuit. The cost of the six pots is about 6.000 €. A 50W pond pump was installed to pump water (about 70 ml/s).

Power is supplied by solar panels and a fuel cell as a buffer to fill the battery at night. This allows power supply in remote locations. However, this leads to high fuel consumption in cloudy weather and at night.

The ochre trap benefits from a gradient from pipe to water surface to increase aeration. This will oxidize the dissolved iron. Stones in the trap will help the ochre flocks to settle.

Photos filter

Results

First measurements were done from October 2020 until mid of December 2020, after which the temperatures dropped too low and monitoring was suspended to protect the pump, hoses and sensor from ice until air temperatures were high enough to continue monitoring. The following graph (Fig. 1) shows measurements with daily averages for the inflow and outflow from October 2020 until December 2020. The measurements at the inflow (black line) were influenced by the operation of the pump. In October 2020 there were problems with the delivery of new methanol cartridges for the electric cell and the exchange with old and empty ones. The measurements at the inflow then dropped because the inflow pipe with the inflow sensor was emptied due to leakage. During November, the high number of suspended solids in the inflow caked around the inflow sensor and prevented it to function properly. During December, the values show higher outflow nitrate concentrations than in the inflow.

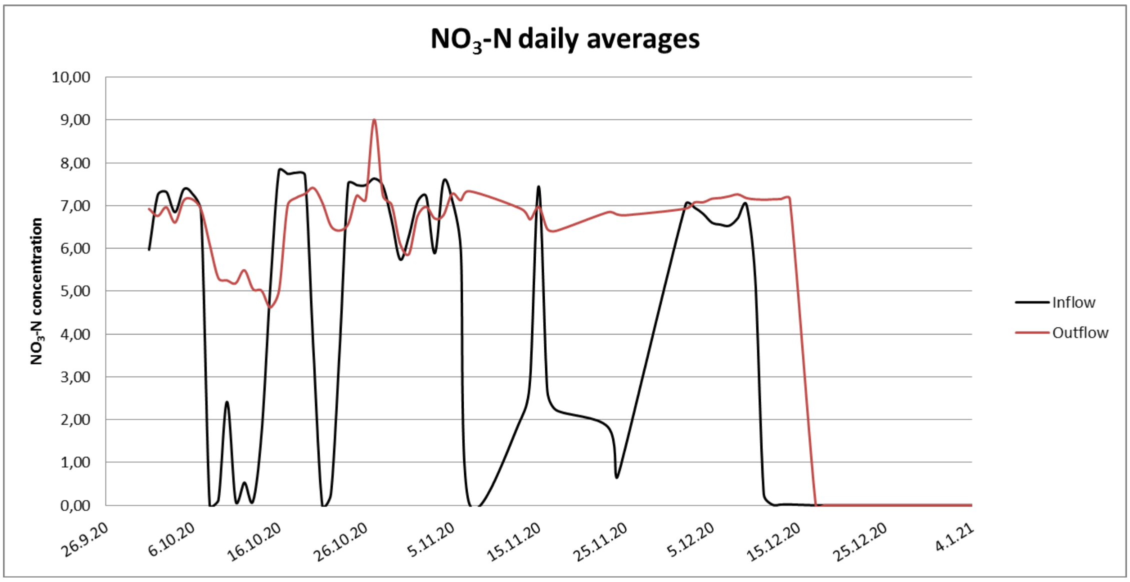


Figure 1 Nitrate concentration during in inflow and outflow of the reactors (Oct-Dec. 2020)

The following graph shows each measure taken in December 2020. Both sensors measure a big amount of values at or close to zero. The daily average values of the inflow are lower than the outflow values. However, judging from the measured values that are between 6 and 8 mg NO3-N/l, inflow values are higher than the outflow values by around 10-15%. The young plants with a small root system and the low temperature may be two reasons for the low rate of denitrification.

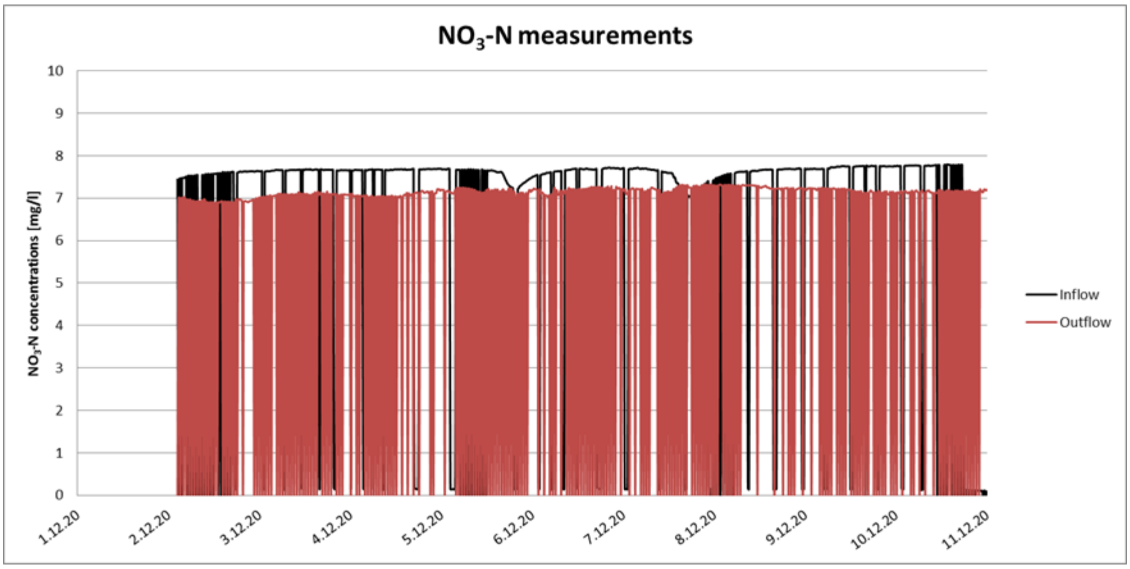


Figure 2 Nitrate concentration during inflow and outflow of the reactors in December, 2020

Since the 25th of March 2021 the plant is operational again and the sensors are working properly (Figure 3). The nitrate reduction is around 3%.

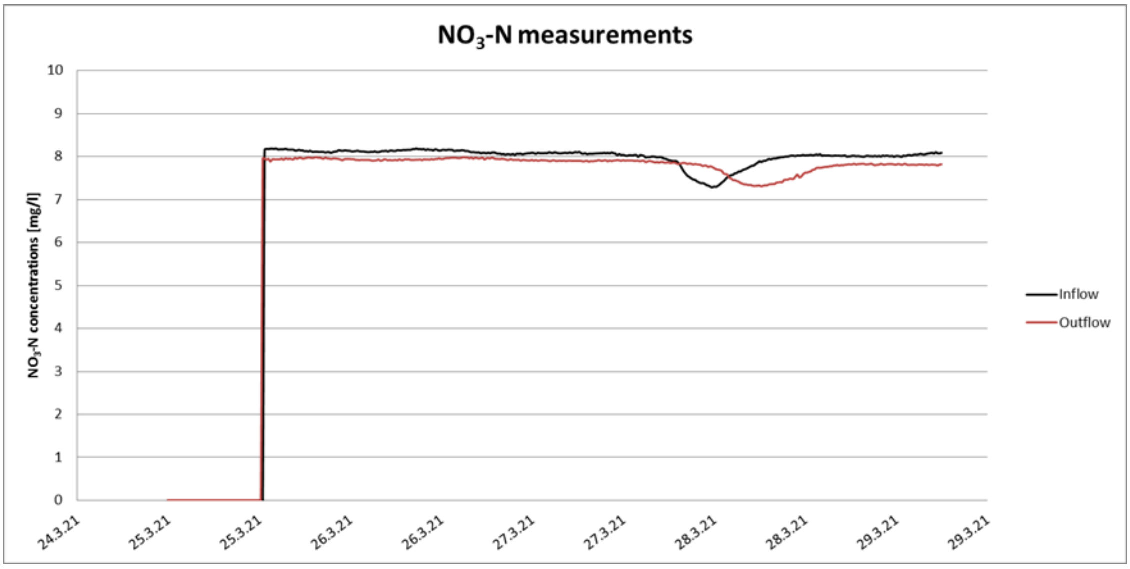


Figure 3 Nitrate concentration during inflow and outflow of the reactors in March 2021

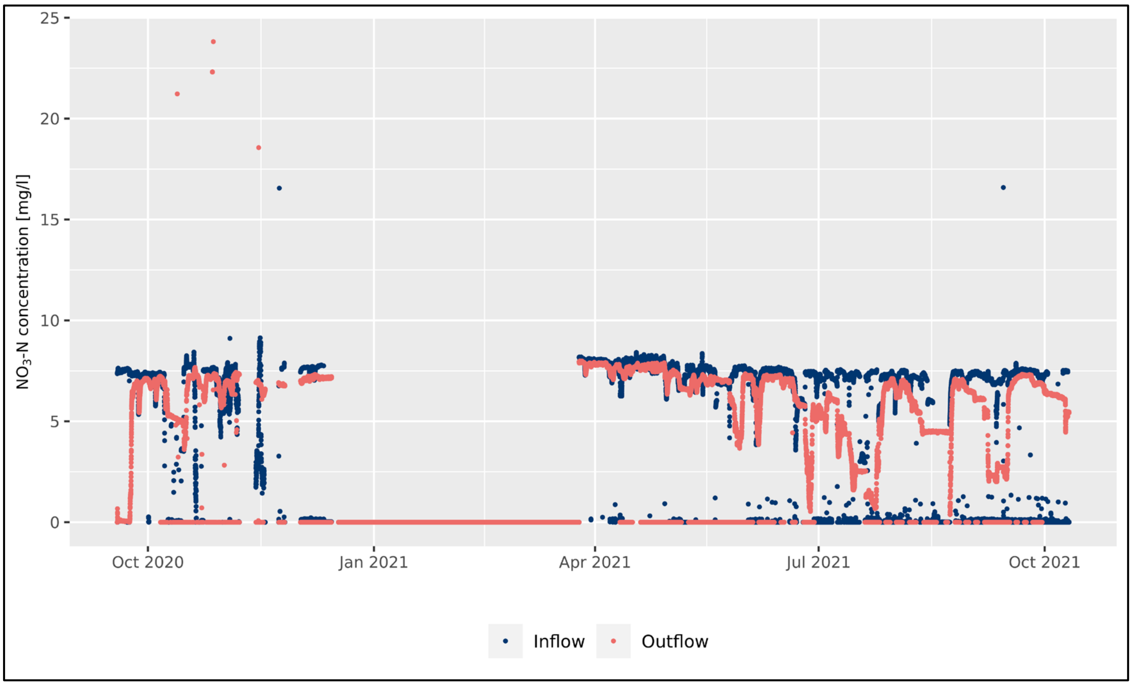


Figure 4 Nitrate concentration during inflow and outflow of the reactors until October 2021

Data were collected until October 2021 and are shown in comparison to the water level in the river Lethe and the precipitation rate (Figure 5). In periods of high precipitation rates and higher water levels, efficiency seems to be higher as well. It must be considered that the denitrification rates in the reactors might be over estimated due to dilution, because rain also fell into the buckets. Longer periods of sampling would have been necessary to see, whether or not there is a much higher effectivity during periods with high amounts of rainfall.

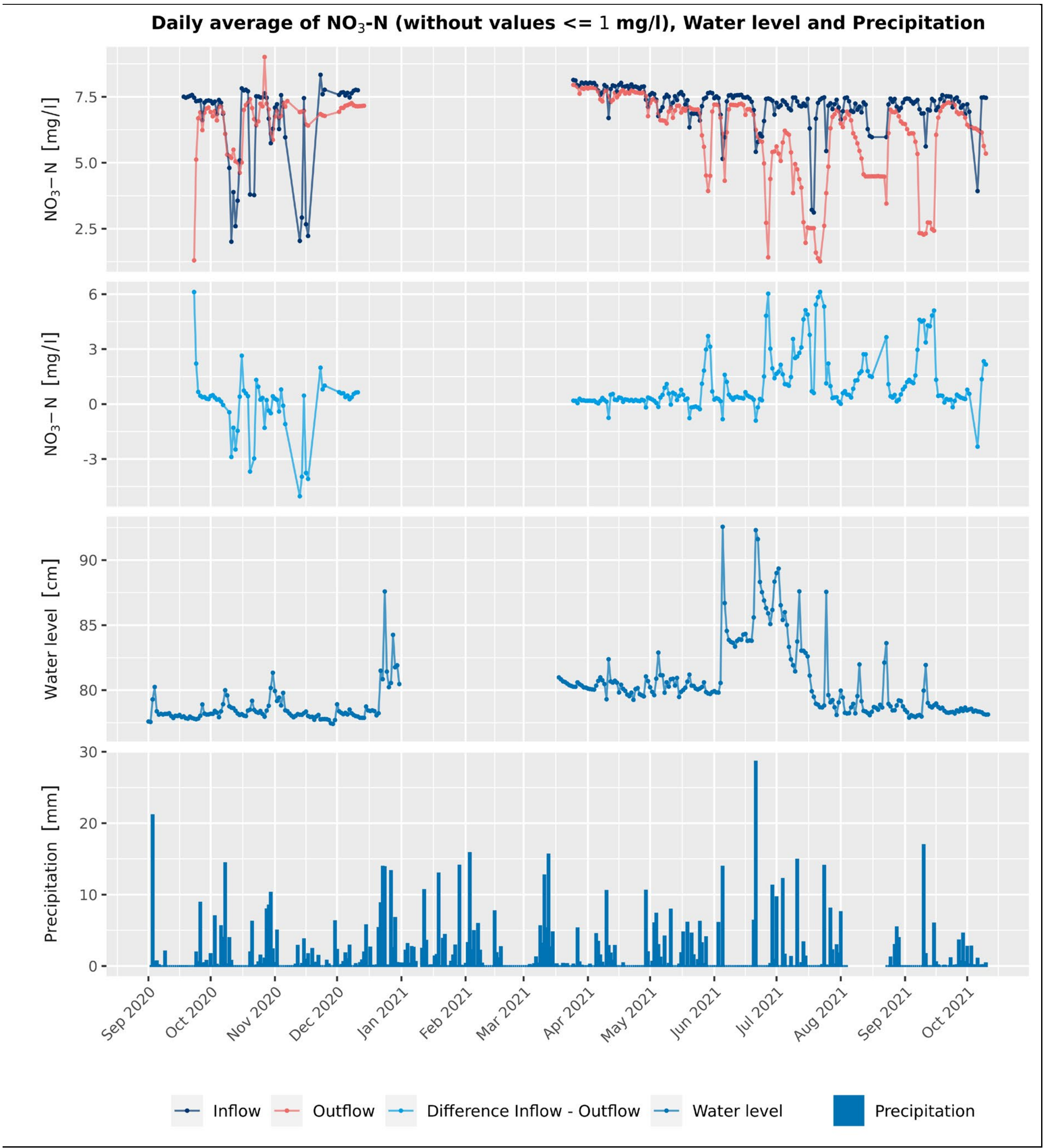


Figure 5 Nitrate concentration during inflow and outflow of the reactors until October 2021, efficiency (second graph), in comparison to water level and precipitation rate

Financial aspect

From the project start until the 31st of March 2021 a total amount of € 29.603 were invested in equipment and an additional amount of € 3.017 were spent for external expertise and services related to the pilot plant. In addition, expenses were incurred for staff and travel.
Operational costs refer to the staff needed to control the plant and the fuel for the fuel cell. In case of longer operation, additional costs could also be incurred for filter materials.

Conclusion

The aim of the project was to realize a wetland being beneficial to improve the water quality in the Natura 2000 area "Ahlhorner Fischteiche". The project was also of interest to get experience with the operation and the efficiency of constructed wetlands, with sensor technics and data management, because of the interaction between surface water and groundwater, which has to be considered by water providers when setting up their protection plans for drinking water winning areas. These were also the reason for the project partner to buy land in order to have a good position in the starting phase of the project. Due to different reasons the wetland could not be realized. The hydrological situation, the responsibilities divided to different counties, the delay in hiring a project engineer and the Natura 2000 status itself made it impossible of getting permits for a suitable location for the installation of a nature-incorporated wetland. Even to install an artificial wetland was difficult and an initial test failed. Finally, the activities of realizing a bigger size substitutional experimental plot, to get at least data of a 12 month running period felt into the Corona-lock-down-period and failed therefore as well. Nevertheless, data indicate a small effect in reducing nitrate concentration in the water when passing through the pot gallery.
Planning and stakeholder involvement should have started much earlier to get the project as a joined enterprise successfully implemented. For future similar projects it has to be concluded that plans and permits and support by the authorities are ideally available when funding is approved. And the ownership of the ground, where the wetland will be placed, should be transferred to a cooperative member of the stakeholder group.
The need of realizing a protected area in the vicinity of the river Lethe in order to lower the impact of intensive agriculture to the ponds and to the groundwater is still urgently relevant. The need of improving the quality of the surface water in almost every stream in the region of Weser-Ems is still evident. Experiences from participating in the project will be transferred to future projects.