LONG TIME PERFORMANCE OF WOODCHIPS BASED SUBSURFACE FLOW CONSTRUCTED WETLANDS.

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Two subsurface flow constructed wetlands (CW) with horizontal flow and with a matrix consisting of willow woodchips and crushed mussel shells used for treating agricultural drainage water have been in operation since November 2012. During the first three years the CW's performed very well with an annual removal of total nitrogen (TN) amounting to 0.7 – 0.8 kg N m^{-2} $year^{-1}$ or 54-55 % of the load, which was around 1.5 kg N m^{-2} y^{-1}. In contrast to nitrogen, a high net release of phosphate-P (6-8 g PO_4-P m^{-2} $year^{-1}$) was seen in the first year of the monitoring period. Except for CW1 in 2013, both CW's retained total phosphorus (TP) in the range 1 – 16 g TP m^{-2} $year^{-1}$ during all the years and this was mainly due to retention of particulate P.

During the first two summer periods when the hydraulic loading was low the nitrate (NO_3-N) removal was 100 %, and the reduction sequence continued with sulfate reduction and formation of H_2S followed by methane production. Also, emission of nitrous oxide was occasionally high during summer. Thus in order to reduce the negative side effects it was decided to decrease water residence time during summer from approximately 80 hours to 10 hours by increasing the hydraulic load (i.e. four other CW's connected to the same drainage system were closed down). The aim of this step was to keep a higher redox potential mainly allowing nitrate reduction.

The results so far revealed that lowering the water residence time in summer decreased sulfate reduction to 1-2%, and lowered methane and nitrous oxide emissions considerably, but this was on the expense of TN and nitrate reduction, which decreased from 100 to around 30%. Although percentage TN and nitrate removal decreased the annual mass balances for nitrate and TN remained at the same level, exhibiting removal rates in the range 0.6 – 0.8 kg NO_3-N m^{-2} $year^{-1}$ and 0.7 – 0.9 kg TN m^{-2} $year^{-1}$, respectively.
During the first six years in operation, there has been a gradual change in the structure of the matrix. The grain size of the willow woodchips (8-60 mm) and mussel shells (2-4 mm) have changes to much smaller particle size, and the matrix in the two CW's have subsided with approximately 50 cm due to changes in porosity and consumption of carbon by the denitrifiers. In addition, concurrent laboratory tests with woodchips of different ages revealed that the nitrate removal capability of woodchips declined over the years. In May 2018, both CW's were refilled with 0.5 m willow woodchips on top of the old matrix layer.

BIO: Dr. Carl Christian Hoffmann is a senior scientist with more than 30 years of experience in wetland research and wetland restoration. At present CCH works with constructed wetlands/bioreactors treating agricultural drainage water.

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