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Evaluation and analysis on removal of nitrogen by hybrid subsurface constructed wetlands treating wastewater with concentrated organic pollutants

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1. Introduction

Excess nitrogen in the aquatic environment only does harm to the society and the environment. Livestock industry is considered as one of the largest point sources of nitrogen pollution. Therefore livestock farmers in Japan should expect stricter standard in the future so they must initiatively seek for solutions to avoid the degradation of nearby ecosystem. This research investigates three hybrid subsurface constructed wetlands that are treating livestock wastewater. The purposes of this study are: 1) how are their performances; 2) how are the performances changing; and 3) what mechanisms are removing nitrogen.

2. Methodologies

Three hybrid subsurface constructed wetland systems that are treating wastewater from livestock industries were investigated. Two systems treat wastewaters from milking parlours (Dairy1 and Dairy2) and the last one treats wastewater from a swine farm (Swine). At each site, samples were taken at the inlet of the system and outlet of each bed on a monthly to bimonthly basis. Samples were analyzed for total carbon (TC), total nitrogen (TN), ammonia (NH_4-N), nitrate (NO_3-N), nitrite (NO_2-N), organic nitrogen (Org-N) and suspended solids (SS). The inflow and outflow volumes were also recorded. The performances were evaluated based on concentration (purification efficiency; PE) and load (removal efficiency; RE).

3. Results and discussions

Influent TN concentrations fluctuated, although their magnitudes differed from system to system. However the effluent concentrations were rather stable for the entire operation. Dairy1 and Dairy2's effluents satisfied the nitrogen standard of 60 mg/L set by the Japanese Water Pollution Prevention Act. Dairy1's PE decreased in the second year, increased until the fourth year and stabilized around 90% ever since. Dairy2's PE decreased after the first year but it is still above 80%. Swine's PE stabilized in the third year at about 70%.

The main mechanisms in removing TN for all of these systems were classical nitrification-denitrification and probably filtration of particulate nitrogen. Filtration of particulate nitrogen assumed to be one of the mechanisms because Org-N removal had strong correlation with SS removal. One of the evidence of the classical biological removal was the increase in NO_3-N concentration and the relationship between the TC removal and the nitrogen transformation. But there were some cases where more nitrogen was removed when they did not have enough carbon. This suggests that other removal mechanisms that use less carbon maybe playing some part to remove nitrogen in these systems.

4. Conclusions

All the systems were working well in decreasing the TN of the livestock wastewaters and their performances were not decreasing after several years of operation. The main mechanisms that were removing TN were classical nitrification-denitrification and filtration of particulate nitrogen.